NITI Aayog

University of Manitoba

VISION 2035
PUBLIC HEALTH SURVEILLANCE IN INDIA

A WHITE PAPER

Vision 2035: Public Health Surveillance in India
A White Paper

Publishing Agency: NITI Aayog

Year of Publication: 2020

Book, English

ISBN 978-81-949510-6-3
DOI: 10.6084/m9.figshare.14093323

Suggested Citation: Blanchard J; Washington R; Becker M; Vasanthakumar N; Madangopal K; Sarwal R. et al. Vision 2035: Public Health Surveillance in India. A White Paper. NITI Aayog. December 2020.

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FOREWORD

India has made substantial progress in the prevention, control, and elimination of major communicable diseases. Smallpox was eradicated worldwide and Polio has been eliminated in India. India has substantially reduced the incidence of HIV infections by more than half in the last two decades. Recent outbreaks including the COVID-19 and Nipah virus have been effectively contained or controlled.

None of these initiatives would have been possible without strong Public Health Surveillance systems in place. The time is right to enhance the surveillance of non-communicable diseases and to replace traditional surveillance systems of data-entry with recent developments in digital health and technology, in alignment with the National Digital Health Mission. Further, building on the 2017 National Health Policy's directions for enhanced surveillance, it is important to enhance citizen-centricity into public health surveillance and services. As well, the Health and Wellness Centers established under the Ayushman Bharat provide a platform to enhance community-based surveillance for both infectious and non-communicable diseases.

The COVID-19 pandemic has provided us with an opportunity to revisit (re) emerging diseases due to increased interaction between human-animal-environment. Early identification of this interface is essential to break the chain of transmission and to create a resilient surveillance system. This vision document on Public Health Surveillance in India by 2035 is a step in this direction. It articulates the vision and describes building blocks. It envisions integration, enhanced citizen-centric and community-based surveillance, strengthened laboratory capacity, expanded referral networks, and a unified Surveillance Information Platform that will provide data for decision making and action.

I congratulate the NITI Health vertical for bringing out this document, in consultation with national and global level experts.

(Rajiv Kumar)

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PREFACE

The National Institute for Transforming India (NITI Aayog) functions as a think tank and resource centre or knowledge hub, fosters cooperative federalism, designs policy and program framework and guides monitoring and evaluation of National Programs in India.

In alignment with the Universal Health Coverage focus towards achieving the Sustainable Development Goals by 2030, NITI has focused on holistically transforming the delivery of health care services across the public and private sectors. Multiple stakeholder consultations were conducted to identify the priorities for core building blocks of a Health System for New India.

Enhancing Public Health Surveillance is an important public health function. This includes the detection of disease and early warning signs of impending outbreaks or epidemics, both those endemic to the country or those that constitute a public health emergency of international concern. Tracking acute and chronic disease trends and responding with timely and effective actions are critical functions of surveillance.

This paper is a vision for Public Health Surveillance in India in 2035, written by national and global experts in the field of public health surveillance. The document becomes even more relevant as India and the world tackles the pandemic of COVID-19. The gains made and lessons learned from COVID-19 and past experience with identifying and controlling outbreaks, reducing, eliminating and eradicating diseases must be consolidated to enhance Public Health Surveillance in India. In the spirit of Cooperative Federalism, we look forward to make this vision a reality and to thus ensure India's leadership in disease prevention and response at a global level.

Dr. Vinod. K. Paul,
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MESSAGE

The NITI Aayog was established in 2015 by the Government of India as a policy think tank. Its aim is to achieve Sustainable Development Goals through cooperative federalism, fostering the involvement of State Governments and using a bottoms-up approach. Recently launched initiatives of the Government of India provide an opportunity to re-look at Public Health Surveillance. The flagship Ayushman Bharat program that is focused on enhancing the provision of comprehensive primary health care through Health and Wellness Centres and on reducing catastrophic out-of-pocket expenditure among poor and middle-class families through the Ayushman Bharat Pradhan Mantri Jan Arogya Yojana (PMJAY) insurance scheme are opportunities to enhance public health surveillance. The more recent launch of the Prime Minister's Atma Nirbhar Swasthya Bharat Yojana (PMASBY) focuses on making India self-reliant. Under this program, plans are afoot to enhance laboratory infrastructure and health systems at the block level in order to prepare and respond in a timely manner to future pandemics.

Surveillance is 'Information for Action'. Public health surveillance, an important public health function, cuts across primary, secondary and tertiary levels of health care. Beyond improving existing isolated systems, the integrated solution envisioned in this document encompasses a 'One-Health' approach that amalgamates health information from different sources including human, plant and animal surveillance. A unitised and unified real-time surveillance that is not based on traditional systems of data entry and upload, but one that allows interoperability and data sharing mechanisms, capitalising on technological and digital advances are in alignment with the National Digital Health Mission.

The vision suggests the utilisation of new situation-aware real-time signals from social media, mobile/sensor networks and citizens' participatory surveillance systems for event based epidemic intelligence in addition to the existing systems and electronic health records for case-based surveillance linked through the optimal use of unique health identifier. Finally, the vision highlights the effective support coordination of multidisciplinary teams, risk communication with citizens as the primary stakeholders and the implementation of prevention measures at all levels for a timely and effective public health response. We must not lose the opportunity that the COVID-19 pandemic has provided us. We must strengthen our health systems and services and public health surveillance mechanisms. The vision document provides insights and ideas for India to move ahead in this direction.

Amitabh Kant,
Chief Executive Officer, NITI Aayog

ACKNOWLEDGEMENTS

Traditional public health disease surveillance systems in India have remained fragmented, siloed, and limited to few diseases. As India re-imagines and reforms its health systems, we need to ensure that our Public Health Surveillance systems are also made citizen-centric and within the context of the overall socio-economic development of the country.

In 2020, the NITI Aayog signed a Letter of Agreement with the University of Manitoba, Winnipeg, Canada to develop a white paper on a Vision for Public Health Surveillance in India by 2035.

This vision document on Public Health Surveillance in India-2035, which takes forward the vision as envisaged in the National Health Policy 2017, lays the foundation for integrated surveillance of both communicable and non-communicable diseases.

This document identifies four building blocks for this vision. These include a) an interdependent federated system of Governance architecture between the Centre and States; b) new data collection and sharing mechanisms for surveillance based on unitized, citizen-centric comprehensive Electronic Health Records with a unique health identifier, amalgamating existing disease surveillance programs, complemented by information from periodic surveys; c) enhanced use of new data analytics, data science, artificial intelligence and machine learning; and d) advanced health informatics.

We hope that this document will pave the road towards collectively propelling India to be a regional and global leader with 'Information for Action', in consideration of the overarching principle 'for the public good'.

We thank the Institute of Global Public Health at the University of Manitoba and the national and global experts who have compiled this vision document. We would like to acknowledge the various contributors listed for their unstinted commitment and dedication to this exercise.

We are grateful to Dr. Rajiv Kumar, Vice Chairman, Dr. Vinod K Paul, Member, and Shri Amitabh Kant, CEO NITI Aayog, for their constant inspiration and guidance that made this document possible, and the health division team Shri Alok Kumar, Former Advisor, and Dr. K Madan Gopal, Senior Consultant for having contributed to this exercise.

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ABBREVIATIONS

AES	Acute Encephalitis Syndrome
AFI	Acute Febrile Illness
AFP	Acute Flaccid Paralysis
AIDS	Acquired Immunodeficiency Syndrome
AMR	Anti-microbial Resistance
API	Application Programming Interface
API	Annual Parasite Index
CBHI	Central Bureau of Health Intelligence
CDC	Centre for Disease Control
CHC	Community Health Centre
CRS	Congenital Rubella Syndrome
CSU	Central Surveillance Unit
CTD	Central TB Division
DGHS	Directorate General of Health Services
DH	District Hospital
DHF/DSS	Dengue Haemorrhagic Fever, Dengue Shock Syndrome
DIM	Detection, Identification, Monitoring
DSO	District Surveillance Officer
DSU	District Surveillance Unit
EDL	Essential Diagnostics List
EHR/EMR	Electronic Health Record/Electronic Medical Record
EMS	Emergency Management System
ESIC	Employees State Insurance Corporation
GoI	Government of India
GHSA	Global Health Security Agenda
HIV	Human Immunodeficiency Virus
HR	Human Resources
HSS	HIV Sentinel Surveillance
HWC	Health and Wellness Centre
IBBS	Integrated Behavioural and Biological Surveillance
IBD	Invasive Bacterial Diseases
ICMR	Indian Council for Medical Research
IDSP	Integrated Disease Surveillance Program
IDSR	Integrated Disease Surveillance and Response
IHIP	Integrated Health Information Platform
IoT	Internet of Things
JE	Japanese Encephalitis

MC	Medical College
MDR-TB	Multi-drug resistant TB
MNCH	Maternal, Newborn and Child Health
MPH-EIS	Masters in Public Health, Epidemic Intelligence Service
NAAC	National Apical Advisory Committee
NACO	National AIDS Control Organisation
NAP	National Action Plan
NARI	National AIDS Research Institute
NCD	Non-communicable Diseases
NCDC	National Centre for Disease Control
NEDL	National Essential Drugs List
NFHS	National Family Health Survey
NHM	National Health Mission
NICD	National Institute of Communicable Diseases
NICED	National Institute for Cholera and Enteric Diseases
NIOH	National Institute for Occupational Health
NITI Aayog	National Institute for Transforming India
NTEP	National TB Elimination Program
NVBDCP	National Vector Borne Disease Control Program
OTP	One-time password
PHC	Primary Health Centre
PHS	Public Health Surveillance
PMJAY	Pradhan Mantri Jan Arogya Yojana
PoC	Point-of-Care
PROMED	Program for Monitoring Emerging Diseases
RCH	Reproductive and Child Health
RNTCP	Revised National TB Control Program
SARS	Severe Acute Respiratory Syndrome
SEED	System for Early Warning Based on Emergency Data
SSO	State Surveillance Officer
SSU	State Surveillance Unit
STI	Sexually Transmitted Infection
TB	Tuberculosis
UHID	Unique Health Identifier
VRDL	Viral Research and Diagnostic Laboratories
WHO	World Health Organization

EXECUTIVE SUMMARY

Vision 2035: Public Health Surveillance in India

NITI Aayog's mandate is to provide strategic directions to the various sectors of the Indian economy. In line with this mandate, the Health Vertical released a set of four working papers compiled in a volume entitled **'Health Systems for New India: Building Blocks – Potential Pathways to Reform'** during November 2019.

"India's Public Health Surveillance by 2035" is a continuation of the work on Health Systems Strengthening. It contributes by suggesting mainstreaming of surveillance by making individual electronic health records the basis for surveillance.

Public Health Surveillance (PHS) cuts across primary, secondary, and tertiary levels of care. Surveillance is an important Public Health function. It is an essential action for disease detection, prevention, and control. Surveillance is 'Information for Action'.

This paper is a joint effort of the Health vertical, NITI Aayog, and the Institute for Global Public Health, University of Manitoba, Canada, with contributions from technical experts from the Government of India, States, and International agencies.

In 2035,

- India's Public Health Surveillance will be a predictive, responsive, integrated, and tiered system of disease and health surveillance that is inclusive of Prioritised, emerging, and re-emerging communicable and non-communicable diseases and conditions.
- Surveillance will be primarily based on de-identified (anonymised) individual-level patient information that emanates from health care facilities, laboratories, and other sources.
- Public Health Surveillance will be governed by an adequately resourced effective administrative and technical structure and will ensure that it serves the public good.
- India will provide regional and global leadership in managing events that constitute a Public Health Emergency of International Concern.

Multiple disease outbreaks have prompted India to proactively respond with prevention and control measures. These actions are based on information from public health surveillance. India was able to achieve many successes in the past. Smallpox was eradicated and polio was eliminated. India has been able to reduce HIV incidence and deaths and advance and accelerate TB elimination efforts. Many outbreaks of vector-borne diseases, acute encephalitis syndromes, acute febrile illnesses, diarrhoeal and respiratory diseases have been promptly detected, identified and managed. These successes are a result of effective community-based, facility-based, and health system-based surveillance. The program response involved multiple sectors, including public and private health care systems and civil society.

The COVID-19 pandemic has further challenged the country. India rapidly ramped up its diagnostic capabilities and aligned its digital technology expertise. This ensured that there was a comprehensive tracking of the pandemic. As well, relevant information was widely shared with the public. India rapidly instituted both case-based (Trace, Test, Treat) and population-based measures (wear masks, wash hands, maintain distance, avoid crowding and closed spaces) for COVID-19 prevention, management, containment, and control. This vision document describes what India's Public Health Surveillance can be in 2035.

This vision document on India's Public Health Surveillance by 2035 builds on opportunities that include the Ayushman Bharat scheme that establishes health and wellness centers at the community level- to strengthen non-communicable disease prevention, detection, and control and assures government payment for hospitalisation- to reduce out-of-pocket expenses of individuals and families at the bottom of the pyramid.

- It builds on initiatives such as the IHIP of the Integrated Disease Surveillance Program.
- It aligns with the citizen-centricity highlighted in the National Health Policy 2017 and the National Digital Health Blueprint. It encourages the use of mobile and digital platforms and Point-of-Care devices and diagnostics for amalgamation of data capture and analyses.
- It highlights the importance of capitalizing on initiatives such as the Clinical Establishments Act to enhance private sector involvement in surveillance.
- It points out the importance of a cohesive and coordinated effort of apex institutions including the National Centre for Disease Control, the Indian Council of Medical Research, and others. As well, there may be a need to create an independent Institute of Health Informatics.

The document identifies gap areas in India's Public Health Surveillance that could be addressed.

- India can create a skilled and strong health workforce dedicated to surveillance activities.
- Non-communicable disease, reproductive and child health, occupational and environmental health and injury could be integrated into public health surveillance.
- Morbidity data from health information systems could be merged with mortality data from vital statistics registration.
- An amalgamation of plant, animal, and environmental surveillance in a One-Health approach that also includes surveillance for anti-microbial resistance and predictive capability for pandemics is an element suggested within this vision document.
- Public Health Surveillance could be integrated within India's three-tiered health system.
- Citizen-centric and community-based surveillance, and use of Point-of-Care devices and self-care diagnostics could be enhanced.
- Laboratory capacity could be strengthened with new diagnostic technologies including molecular diagnostics, genotyping and phenotyping. To establish linkages across the three-tiered health system, referral networks could be expanded for diagnoses and care.

Four building blocks are envisaged for this vision:

1. An interdependent federated system of Governance Architecture between the Centre and States
2. Enhanced use of new data collection and sharing mechanisms for surveillance based on unitized, citizen-centric comprehensive Electronic Health Records (EHR) with a unique health identifier (UHID). As well, existing disease surveillance data and information from periodic surveys will complement this information
3. Enhanced use of new data analytics, data science, artificial intelligence, and machine learning, and
4. Advanced health informatics.

Going forward, India's Public Health Surveillance will be based on individual EHR that capture and amalgamate individuals' health-care related information through the use of a UHID. This is used in every clinical, laboratory or pharmacy visit and for vertical disease control programs. Periodic surveys are positioned as additional complementary methods to reassess the incidence and prevalence of diseases/risk factors, to adjust and refine standard case definitions periodically, to define epidemic thresholds, and to refine response levels and measures. A Surveillance Information Platform will store, analyse, and auto-generate relevant reports for action. As well, this remains a repository for further analysis and research, which will complement the available surveillance information.

Drawing on best practices from India and other developing and developed country experiences, the document suggests next steps for India to move forward towards this vision. All these steps are in alignment with the principle to raise the profile of surveillance as a tool for the public good. The steps are suggested as a continuous cycle rather than a sequential process.

1. Establish a governance framework that is inclusive of political, policy, technical, and managerial leadership at the national and state level.
2. Identify broad disease categories that will be included under Public Health Surveillance.
3. Enhance surveillance of non-communicable diseases and conditions in a step-wise manner.
4. Prioritise diseases that can be targeted for elimination as a public health problem, on a regular basis.
5. Improve core support functions, core functions, and system attributes for surveillance at all levels - national, state, district, and block.
6. Establish mechanisms to streamline data sharing, capture, analysis, and dissemination for action. These could include the use of situation-aware real-time signals from social media, mobile sensor networks and participatory surveillance systems for event-based epidemic intelligence.
7. Encourage innovations at every step in surveillance activity.

All through this process, consider strengthening human resource capacity, laboratory infrastructure, referral networks, and community-based surveillance. Implementation of this vision can thrust India to be a global/regional leader in Public Health Surveillance - 'Information for Action'.

1 SCOPE OF THE DOCUMENT

SCOPE OF THE DOCUMENT

This is a vision document for Public Health Surveillance in India in 2035. The document defines the vision, illustrates the architecture, describes the proposed flow of information, lists key questions and considerations that are necessary to expand the scope of Public Health Surveillance in India, defines the four building blocks and lists possible steps towards achieving the vision.

The vision document briefly describes the progress made by India in Public Health Disease Surveillance and builds on the existing experience of public health surveillance systems with a focus on governance that is based on cooperative federalism, fostering the involvement of state governments and using a bottoms-up approach. It aligns with inclusive and sustainable growth and the principles stated in the National Health Policy 2017. These include human resources that practice professionalism, integrity and ethics, and public health services that reduce inequity and catastrophic costs for health care. The focus is on Universal Health Coverage and patient-centred quality of care that is gender sensitive, effective, safe, convenient and provided with dignity and confidentiality. The multi-stakeholder approach with partnership and participation of all non-health ministries, communities, academic institutions, not-for-profit agencies and the health care industry; pluralism to optimise services wherever patients first seek care; decentralisation of decision making; citizen centricity; and focus on expansion of Public Health Surveillance to include non-communicable and occupational diseases, including mental health, are all touched upon.

In addition to building on India's past experience, the document draws on lessons learned from global best practices including examples from Thailand, Taiwan, Germany, the United Kingdom, the United States of America and Canada.

The document does not include funding and budget requirements. The analysis of the capacity of existing institutions is only based on reviews of evaluation reports. The document excludes a focus on COVID-19, even though India's capacity and resilience have been challenged by this pandemic. Instead, the document focuses on expanding surveillance to be inclusive of non-communicable diseases, occupational, injury and environmental conditions in a One-Health approach for Public Health Surveillance.

Next steps include the creation of a road-map or blueprint for action. As well, it would be important to set up effective and responsive governance mechanisms that establish political, technical, digital and managerial leadership in order to enable India reach this vision by 2035.

2 VISION 2035: Public Health Surveillance in India

VISION 2035: Public Health Surveillance in India

Surveillance is defined as "a core public health function that ensures that the right information is available at the right time and in the right place in order to inform public health decisions and actions"[1]. In short, surveillance should be "Information for Action"[2,3].

Vision

In 2035, India's Public Health Surveillance will:

01 Be a predictive*, responsive[π], integrated[#] and tiered[@] system of disease and health surveillance that is inclusive of Prioritised[$], emerging and re-emerging communicable and non-communicable diseases and conditions. Readiness for actions at community, facility and health and governance systems are key aspects of the response.

02 Be a system that is primarily based on de-identified individual level patient information which includes health care facility and laboratory data as key sources, amongst others.

03 Be governed by an effective administrative and technical structure that is adequately resourced.

04 Serve public good through the provision of meaningful 'Information for Action' to relevant stakeholders^, with due attention to privacy and confidentiality of the individual, and enabled with a client feedback mechanism.

05 Provide regional/global leadership in compliance with International Health Regulations and management of events that constitute a Public Health Emergency of International Concern

**Ability to predict a disease event or outbreak*

[π]Ability to respond positively with speed and sensitivity

[#]Implies integration between centre, state and district, as well as between public and private health sectors

[@]Refers to the 3 tier health care delivery system in India; primary care at Health and Wellness centres, sub-centres and primary health care centres, secondary care at first level referral units and district hospitals (few specialities – medicine, obstetrics & gynaecology, paediatrics and emergency care), and tertiary care at medical colleges and apex institutions (all specialists and super-specialists, equipped with high level laboratories for advanced diagnostics and specialist procedures).

[$]Prioritisation is a periodic exercise, repeated every 3-5 years, based on specific objective criteria, described later within this document.

^Includes clients/patients, governments, academia, industry, media and non-government organisations.

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3 BACKGROUND AND INTRODUCTION

3.1 Definitions

1963	The French defined surveillance in three words, 'to watch over'[4].
1968	Langmuir defined surveillance as 'the continued watchfulness over distribution and trends of incidence through systematic collection, consolidation, and evaluation of morbidity and mortality reports and other relevant data"[5].
20 years later	The Centre for Disease Control, Atlanta, US defined surveillance as 'the ongoing systematic collection, collation, analysis and interpretation of data and dissemination of information to those who need it, in order that action is taken."[6]

The focus was towards 'action' that results from a system of surveillance. In this document, we propose to use the definition 'Surveillance is Information for Action', drafted by an expert group in 2012 by the Department of Health - Public Health Surveillance in the vision document entitled, "Towards a Public Health Surveillance for England".

3.2 Progress made thus far for Public Health Surveillance (PHS) in India

The 1988 Cholera outbreak in Delhi and 1994 plague outbreak in Surat prompted the Government of India (GoI) to constitute a National Apical Advisory Committee (NAAC) in 1995. In 1997, the National Surveillance Program for Communicable Diseases was launched. HIV Sentinel Surveillance (HSS) was perhaps one of the first nation-wide disease surveillance programs which began in 1992 and was scaled up country-wide a decade later.

The World Bank funded the GoI in 2004 for a ten year 'Integrated Disease Surveillance Project – IDSP'. This was later converted into a program and funded under the 12th plan (2012-17) within the National Health Mission. The Central Surveillance Unit of the IDSP is housed in the National Centre for Disease Control (NCDC), New Delhi.

The Indian Council of Medical Research (ICMR) has played a key role in strengthening surveillance and research related to surveillance. The network of ICMR continues to expand and at present has 106 Viral Research and Diagnostic Laboratories (VRDL), 35 diagnostic centres and a number of apex institutions. Together, these institutions have played key roles in the identification of existing and new pathogens and their variants, in controlling newly emerging infections (SARS, Nipah virus) and in estimating disease burden using mathematical modelling for diseases like malaria and dengue fever.

[4] https://www.etymonline.com/word/surveillance and https://www.merriam-webster.com/dictionary/surveillance

[5] Langmuir A D. The surveillance of communicable diseases of national importance. The New England Journal of Medicine.1963 DOI:10.1056/NEJM196301242680405

[6] World Health Organization. Report of the Technical Discussions at the 21st World Health Assembly on National and Global Surveillance of Communicable Disease. Geneva, Switzerland.1968

In 2019, the World Health Organization (WHO) in partnership with the GoI launched the Integrated Health Information Platform (IHIP) within the IDSP program. The IHIP is a digital web-based open platform that captures individualised data in almost real-time, generates weekly and monthly reports of epidemic outbreaks and early warning signs and captures response by 'rapid response teams', for 33+ disease conditions.

Other data sources capture information on diseases of national importance such as TB. TB was made a notifiable disease in 2012 and the Nikshay platform serves as a source of data to estimate burden and to track disease trends and outcomes. In late 2019, the pandemic of COVID-19 has given further impetus to strengthen PHS in India.

Over the years, these various institutions, networks and programs have been fairly effective. Small pox was eradicated in India in 1979, a year before its global eradication. India was declared 'Polio free' in 2014, three years after the last case detection in India in 2011. Epidemics of SARS, Nipah and rotavirus have been rapidly detected through the efficient viral research and diagnostic laboratory network of ICMR, and have been effectively controlled.

The ICMR network is playing a critical role in the containment of the COVID-19 pandemic. The pandemic has catalysed the GoI's laboratory infrastructure and health information network for surveillance truly epitomising 'Information for Action'.

3.3 Opportunities

There are important and timely opportunities within the Indian and global context that can be leveraged to expand a Public Health Surveillance system in India.

01 India recently rolled out the Ayushman Bharat scheme. One of the two inter-related key features of this scheme is the expansion of primary health care initiatives through the creation of 150000 Health and Wellness Centres (HWCs), staffed by front-line workers and a new cadre of Community Health Officers. The second is the Pradhan Mantri Jan Arogya Yojana (PMJAY). PMJAY is the largest health assurance scheme in the world which aims to provide a health cover of Rupees five lakhs per family per year for secondary and tertiary care hospitalisation for poor and vulnerable families that form the bottom 40% of the Indian population. The HWCs present an opportunity to conduct surveillance for infectious disease, non-communicable disease, occupational health and injury related conditions at the individual, family and primary care level. The PMJAY could be a useful source of information to estimate out-of-pocket expenditure on hospitalisation expenses, as well as for surveillance of diseases managed within in-patient facilities.

02 The Integrated Health Information Platform (IHIP) under the IDSP is already partially functional across several states. The experience in few states has demonstrated its potential to detect epidemics, issue early warning signals, capture outbreak investigation and respond appropriately. There is potential for this platform to be rapidly scaled up across the country, to expand on the number and type of disease conditions captured and to include data from the private sector. However, surveillance cannot be seen as a separate activity from patient care. This document emphasizes that surveillance can ride on top of a unitized, citizen centric electronic health record (EHR).

03 There has been an explosion of digital technologies in health. NITI Aayog launched the National Digital Health Blueprint in July 2019. Two key recommendations from the National Digital Health Blueprint document are the use of a unique health identity number (UHID) and the strengthening of electronic health records in the public and private health care sectors. These two recommendations are central to the basis for the future of surveillance in India, as outlined in this vision document.

04 The growth of smart phones and penetration of mobile telephones also presents a huge opportunity for the paperless capture of almost real-time information, inclusive of geo-coordinates. Additionally, the dissemination of meaningful information to relevant stakeholders is feasible using smart-apps, a health portal and to link to call centres that function as helplines and for other emerging purposes.

05 Legal frameworks for health care and surveillance already exist within the country. The Clinical Establishments Act (Registration and Regulation), 2010 has been passed and a number of states have been able to create directories of clinical establishments and use this information to build upon and enhance notification for disease, death and births, especially within the private sector. Similarly, nationwide digitisation of the Health Management Information System can enable timely and appropriate human resource recruitment and deployment, especially of specialist services, including microbiologists and pathologists at the block/district level.

06 Point-of-Care (PoC) diagnostics and screening tests, including gene testing for infectious diseases and non-communicable diseases are rapidly developing. The rapid development of PoC tests and hand-held devices will enable reaching populations that are otherwise unreached by the health system and can facilitate timely diagnoses and enable self-diagnosis as well.

07 Finally, institutions, including the ICMR and its apex institutions, the NCDC, and the Centre and State governments, have demonstrated strong ability to rapidly respond in order to contain, control and coordinate responses to 'Public Health Emergencies of International Concern'.

3.4 Threats

01 **Re-emerging and new Communicable Diseases:** A number of new infections have emerged and pathogens and diseases have re-emerged with resistant or mutant strains. 75% of emerging/re-emerging diseases are zoonotic and therefore a system of active animal surveillance and integration with agriculture and other sectors is critical. Travel, trade and migration are growing and people's exposure to more exotic food, exotic animals and travelling to exotic locations is increasing. There is increasing and more rapidly forming drug resistance and there are syndemics of diseases which may either both be infectious as in the case of HIV and TB, or in combinations where one is infectious while the other is not, as in the case of TB and diabetes. Either way, these syndemics adversely influence disease outcomes. Surveillance activities may consider these interactions. Finally, the role of social, structural and biological determinants of disease and death are rarely completely understood in terms of disease distribution or prevalence.

02 **Increasing rates of non-communicable diseases and acute and chronic conditions:** The Ministry of Health in its document "India – Health of Nation's States" (2019) states that 61% of mortality and 55% of the disability adjusted life years were caused by NCD in 2016. NCD are not a single entity and include cancers, cardiovascular conditions, respiratory diseases, diabetes, and hypertension. Palliative care, mental health, emergency care related to trauma, accidents, suicides and homicide are growing concerns as is gender-based violence, abuse of children, accidents and occupational injury. The elderly and adolescent are periods of life with increasing importance for public health interventions, including surveillance, as both age groups tend to be very vulnerable to disease, including accidents, abuse and injury. NCD surveillance is often focused only on the surveillance of risk factors. The risk factors for NCD are often multiple and are related to social behaviours including lifestyle, food, exercise, stress and behavioural or addictive behaviours relating to drugs, alcohol and tobacco, and environmental pollution. There is often a significant time-lag between exposure and disease and this varies for different disease conditions. Very often the ability to stage or capture this type of information from hospital records or cancer registries is a challenge because of the lack of standardisation and inadequate attention that is given to documentation.

03 **Anti-microbial Resistance – a growing threat:** A third but important threat that is emerging is the growing prevalence and complexity of Anti-microbial Resistance (AMR). A decade after New Delhi lent its name, unwillingly, to a dreaded super-bug gene, bla-NDM-1, the antibiotic resistant gene was

discovered in one of the pristine outposts on the planet—the Arctic. Between 2008, when the gene was first detected in a Swedish patient of Indian origin, who had travelled to India that year, and 2019 when it was traced in Arctic, the gene has been found in over 100 countries, and with new variants, confirming the rapid spread of anti-microbial resistance, and showing what a big mistake it would be to view this global challenge only through local lens. Factors which contribute to AMR include overuse and misuse of antibiotics through self-medication, indiscriminate access to antibiotics without prescription and the use of pharmacies and informal healthcare providers as basic sources for healthcare seeking, and the lack of knowledge about when to use antibiotics. The addition of antibiotics to agricultural feed, also promotes drug resistance. Veterinary use in livestock and poultry contributes to the problem of AMR. Additionally, effluents discharged from pharmaceutical manufacturing units also contribute to AMR development. In the face of growing ineffectiveness of existing antibiotics, and absence of new discoveries of superior next generation antibiotics, the world is heading to a public health emergency on AMR. It is widely known that India bears a very high burden of AMR but in the absence of detailed data, it is difficult to accurately estimate the size of the burden. AMR has been recognized as one of the top priority focus areas of the WHO, which has called for convergence between stakeholders and adoption of a "One-Health" approach in tackling this challenge.

The Ministry of Health and Family Welfare launched the National Action Plan on AMR (NAP-AMR) in April 2017, which highlights the need to tackle AMR across multiple sectors such as human health, animal husbandry, industry and environment in line with the "One-Health" approach[7]. However, at the state level only a few states have released their State Action Plan for Containment of Antimicrobial Resistance.

In India, the data on AMR that is being collated and archived appears to be too little and too patchy to be fully representative to make meaningful assessment and intervention. The ICMR collects AMR data from 25 public and private hospitals and laboratories and while this is an important part, there is an urgent need to expand on this for a country as vast and diverse as India. To better understand and respond to antimicrobial resistance patterns and key drivers, information about AMR incidence, prevalence, and trends may be gathered as part of country's disease surveillance mechanism. Stronger networks of information sharing, and alignment with the global strategic research agenda would help improve our understanding of the local, national and global AMR patterns, burden and trends.

[7] Ranjalkar J, Chandy SJ. India's National Action Plan for antimicrobial resistance - An overview of the context, status, and way ahead. J Family Med Prim Care. 2019;8(6):1828-1834. DOI:10.4103/jfmpc.jfmpc_275_19

3.5 Challenges in India's existing Public Health Surveillance

Despite significant progress and potential for an expanded and enhanced Public Health Surveillance system in India, there are a number of challenges that need to be addressed in the short term:

01 **Implementation challenges – patchy surveillance, not comprehensive:** The IHIP is not yet fully operational across the country. There are a number of notable implementation challenges. One of the important system design issues is that data on the citizen utilisation of services for treatment of disease is separate from notification mechanisms for disease outbreaks. There is a lack of uniformity in outbreak investigation and reporting and there are limitations in geographic coverage within states. HIV Sentinel Surveillance is a "program" activity, limited in scope to two government facilities within a district. TB notification still misses a modest proportion of estimated cases annually. There have been many pilot projects implemented to enhance the existing surveillance system, including influenza surveillance supported by the WHO, a CDC pilot to strengthen labs and referral networks for Acute Encephalitis Syndrome (AES) and Acute Febrile Illnesses (AFI). These remain as 'research driven' pilots, with limited resources and willingness by governments to scale these up.

India needs to address these implementation challenges, cognisant of the fact that relevant data on diagnosis and treatment provided to citizens across the public and private sector may be captured for effective surveillance. Additionally, a mechanism to transition, scale up and sustain pilot/innovative models for surveillance is urgently needed.

02 **Surveillance functions in vertical siloes of programs and institutions:** Vertical programs such as the National AIDS Control Program and the National TB Elimination Program have achieved significant success in reducing disease transmission, increasing the proportion of people who know their HIV or TB status, enhancing the coverage of treatment among those infected or confirmed with disease and reducing mortality from the disease. The Reproductive and Child Health (RCH) program portal is able to track coverage of pregnant women for antenatal care, institutional delivery and for maternal and child health outcomes. However, surveillance data from these vertical programs are not yet fully integrated within a single unified surveillance platform. Additionally, "Research" or the use of existing data systems to answer important programmatic/policy questions has been limited. Systematic quality control under surveillance was never optimally addressed. There is limited ability of program implementation structures to work in synchrony with research organizations and vice versa.

For example: Currently, similar data is collected by three organisations (IDSP, ICMR's Virology Diagnostic Research Laboratory Network and the National Vector Borne Disease Control Program (NVBDCP) surveillance network), and there is

no mechanism for sharing or the unified use of the data. Even within the public health system, there are a number of other institutions that are not yet involved in surveillance. For example, the Central Government Health System, Railways, Employee State Insurance (ESI) Corporation, and Defence related Army/Navy/Air-force hospitals are not yet fully integrated into the Health Surveillance activities.

Vision 2035 envisages that surveillance will need to graduate from traditional data entry systems based on vertical program implementation, to real-time data capture from existing health records which are integrated using an UHID. Systems could be enabled to transparently and safely exchange data based on standard protocols, determined by the federated governance architecture.

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03 **Private sector involvement in surveillance is limited:**

75% outpatient | **62%** inpatient

The private sector is not a homogenous entity; it includes unregistered practitioners, stand-alone clinics, pharmacies and laboratories, smaller nursing homes, medium to large hospitals, medical colleges, corporate institutions and apex institutions. Additionally, there are mission hospitals and independent trusts that run health care facilities, which are not-for-profit institutions that are also included within the private sector. Private sector participation in disease surveillance is minimal.

There are a number of questions that need to be explored before the private sector is involved in Public Health Surveillance. For which disease conditions could private sector be involved in surveillance? At what levels of care could private sector be involved in Public Health Surveillance? How does one ensure consistency and quality of a private sector site in surveillance, which is an on-going activity? Under what circumstances and for which diseases could data from private sector insurance be utilised for surveillance purposes?

A citizen centric EHR process where the citizen gets the advantage of his health record from birth to death getting updated both from the public and private sector will aid quality real time surveillance and ensure full population coverage. Care provision becomes the main objective on which the surveillance could operate.

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04 **Inadequate linkage of morbidity with mortality data:** The RCH program has recently begun focusing on enhancing maternal and neonatal death review to enable the identification of contributing factors and potential solutions to inform health care service deliveries and prevent future deaths. However, maternal, neonatal and child death surveillance and linking of mortality with morbidity reports is not yet fully integrated. The data available with the vital registration system is not yet shared/linked with IHIP, though this is possible through an Application

Programming Interface (API). Further, social and administrative barriers often lead to under-reporting of deaths, even within the facilities. The linkage of mortality and morbidity data even with infectious diseases is still limited.

How can we strengthen and integrate registration of vital events including birth, marriage and death, in order to enhance surveillance?

05 **Human resource challenges:** The recruitment of human resources for State and District Level Surveillance Units has been devolved to states, however, the response of States to address these human resource gaps is varied. Health is a state subject, while Health Surveillance is a national prerogative. Human resource vacancies and staff capacity continue to plaque the system. The Joint Monitoring Mission 2015[8] reported 42% of vacancies at state and district levels and indicated that even at the Central Surveillance Unit (CSU), positions tend to be filled by contract posts or on deputation with individuals loaded with multiple other responsibilities. The reasons for the lack of importance attributed to Public Health Surveillance by state governments needs to be explored and addressed.

The relevant questions in this context are, "How do we ensure sufficient staff? Is the supervisory and monitoring mechanism sufficient? How can we create and sustain staff & structures?

06 **Training of Public Health Core-Capacity:** There are many examples of training programs for public health professionals specifically in the area of surveillance. For example, the United States Epidemic Intelligence Service through the Centre for Disease Control (CDC) runs a two year Masters in Public Health course on Epidemic Intelligence Service to develop a cadre of highly trained and skilled epidemiologists for surveillance. The Public Health Agency of Canada runs a Field Epidemiology Training Program to build public health capacity for responding to urgent public health events. India lacks sufficient Public Health experts with this expertise.

Relevant questions are: What additional skilling will existent or new HR require in order to perform data analytics or use data science more efficiently? How can these skills be expanded in scale and with speed? How much of resources could Government at Central and State level invest in order to create and sustain this expertise? How can partnerships with private medical colleges, public health training institutes or Institutes of technology and management be leveraged for this purpose? How can the Government objectively evaluate how skills of EIS graduates are being utilised by the states, after course completion?

[8] DGHS.Joint Monitoring Mission Report 2015

07 **Limited use of digital, social and print media in surveillance:** Social and print media are increasingly being piloted for use in surveillance. A few states in the country do have operational media scanning cells or media-advocacy initiatives that help highlight disease outbreaks, or help identify a sudden increase in hospitalisation or death due to an unusual event. These media sources can also be used to promote disease prevention and containment actions at community level during new infectious disease outbreaks (eg. During COVID-19, extensive campaigns were used to promote social or physical distancing after hand-washing, cough hygiene and wearing of masks), or to raise public awareness about danger levels of indicators (eg. air pollution indices) and can help catalyse public health responses.

How can we use social media for surveillance in India? Can we commission a detailed impact evaluation to decide to what extent have social and print media succeeded in making an original contribution to detecting early disease/outbreak occurrences? How can India expand on its use of data science/"big data" strategies for surveillance, that include social and print media (eg., Taiwan's initial actions to contain COVID-19 such as imposing a ban on flights from Wuhan, China and its early travel restrictions were based on media reports of the outbreak in Wuhan, much before WHO declared COVID-19 to be pandemic)[9].

08 **Limited focus on non-communicable disease surveillance:** Non-communicable disease (NCD) surveillance was introduced in many developed countries almost 35-40 years ago. India faces the dual burden of non-communicable and communicable diseases. The WHO predicted that by 2020, NCD would account for 73% deaths and 60% of morbidity globally (WHO 2003). The IDSP has a division of NCD that includes surveillance and other pilot programs which have focused on diabetes, cardiovascular disease and cancers. The ICMR has played a crucial role in enhancing surveillance of these three conditions through periodic surveys, cancer registries and expansion of surveillance in newly formed regional centres for cancer control. However, full integration of surveillance for NCD risk factors, disease and death statistics, and surveillance of injury and accidents, air pollution and its effects are yet to be included into surveillance.

How do we optimally use data collection from health records for NCDs? How can we combine this information with periodic surveys on risk factors, disease prevalence and death in order to provide a comprehensive picture and to enable a continuum of care information, for the patient, the health care provider and policy maker?

[9] https://www.deccanchronicle.com/opinion/op-ed/130520/taiwan-has-just-65-active-440-total-covid-19-cases-despite-proximity.html

09

Fragmented and minimalistic approach in Occupational Health Surveillance: Occupational Health Surveillance in India falls into two broad categories: Hazard Surveillance and Health Surveillance. The NCDC has a division of Occupational and Environmental Health. India has a National Institute of Occupation Health (NIOH) in Ahmedabad, with regional institutes in Bangalore and Kolkata. With ever growing urbanisation, increasing vehicular pollution and industrialisation, Lead levels in air, water and soil are on the increase[10]. The NIOH has proposed to conduct a prevalence survey of Lead toxicity, the commonest toxicity in urban settings. Silicosis is the commonest occupational disease, seen commonly among people working in mines and construction labour, most of whom belong to the informal work sector[11]. The Employees State Insurance Corporation (ESIC) covers most factory workers in the formal sector and a proportion of workers in informal sector. Many formal sector workers also have other forms of health insurance that cover hospitalisation expenses. However, despite this progress and availability of occupational health data from these sources, Occupational Health Surveillance is not a core component of India's Public Health Surveillance. Silicosis is a notifiable disease under The Factories Act, but it is not yet included under the Public Health Act. Most doctors have minimal training on occupation health and disease.

Could India enhance and integrate Occupational Health Surveillance into its Public Health Surveillance? What mechanism can we institute to ensure that national and state governments facilitate consultations and collaboration between the Ministry of Labour, Ministry of Mines and Ministry of Health in order to focus on priority issues (eg., include Silicosis under the Public Health Act)? How can we ensure routine monitoring of lead pollution in air, water and objects, and their toxicity, to be included under surveillance? Could the most common, preventable conditions under occupational settings be made notifiable and compensable (eg., noise-induced deafness, muscular-skeletal disorders)? Finally, what other data sources could we integrate in order to capture information on accidents and injuries (eg., medico-legal cases, road traffic accidents, etc.,)?

[10] Patel K S, Ambade B, Sharma S, Sahu D, Jaiswal N K, Gupta S, Dewangan R K, Nava S, Lucarelli F, Blazhev B, Stefanova R, Hoinkis J.Lead Environmental Pollution in Central India, New Trends in Technologies, Blandna Ramov, IntechOpen.January2010.DOI:10.5772/7590.

[11] https://nhrc.nic.in/sites/default/files/NHRC_Interventions_on_Silicosis_27122016.pdf

4 KEY CONSIDERATIONS in Creating Vision 2035

KEY CONSIDERATIONS in Creating Vision 2035

Some of the key considerations in creating Vision 2035 for Public Health Surveillance in India are listed here. Concerned stakeholders including policy makers and the Government will need to address these questions in order to design and implement the vision for Public Health Surveillance in 2035.

What could be the goals of Public Health Surveillance?

- Predicting/Forecasting and Preparedness for Epidemic Outbreaks for communicable and emerging epidemics of non-communicable disease, both re-emergence of known illnesses in different forms (influenza, MDR-TB), or new disease outbreaks (NIPA virus, Corona virus, etc.,) or new geographic foci of NCD.
- Guiding Prevention and Health Promotion Strategies: Identify new/hidden reservoirs and sources of infection, block chains of rapid transmission and limit the resulting morbidity, disability or death.
- Responding to Outbreaks and Guiding Future Programs of Disease control: Institute standard protocols of a) characterising results beginning with molecular tests, b) digitise results and ultimate action in real-time, c) conduct genetic mapping to explore variations in the pathogen or the susceptible host.

What could immediate next steps include? Could it include:

- Setting surveillance priorities: Could this include chronic and acute conditions, especially in the context of occupational, environmental and nutritional health? Could community, facility and system level components including health care seeking and social determinants of health be included within Surveillance?
- Identifying and preparing the human resource capacity: How do we ensure that we have a dedicated Public Health Cadre at block, district, state and national levels, in adequate numbers and with composite competencies that are regularly updated?
- Landscaping and strengthening laboratory capacity: How can we optimise laboratory capacity within public and private sector? How do we strengthen Point-of-Care diagnostics, self-testing protocols and referral networks to reduce time taken to produce screening or diagnostic results that are reliable, valid and useful to the patient and provider? How do we ensure that laboratory results are smoothly amalgamated with relevant clinical and socio-demographic information that contributes not only to better patient care but also to public health actions?

- Developing and mobilizing technologies and methodologies: Could there be a horizon scanning for early warning signs through platforms such as WHO, PROMED and others? What is the role of social media? How do countries learn quickly on how to prevent, respond and act based on experiences of new outbreaks in a different part of the globe? How do we ensure 'Big data'[12] management and integrate Artificial Intelligence and machine learning into Surveillance platforms?
- Coordination and governance: Policy, Technical, Managerial and Digital?

How can Public Health Surveillance leverage existing talent and platforms?

- Digital Health interventions
- Integrated Communication Technology
- Science, Technology, Social and Business platforms

How can we use routinely collect individual level patient data to create population based datasets?

- Unique Health Identifier
- Unified Health/Medical record
- Standard data sharing protocols
- Interoperability between systems and programs

Could Public Health Surveillance integrate different sources of data for analyses, and how do we ensure an inter-sectoral response?

- Plant, animal and human disease statistics
- Environmental indicators
- Economic data

What is the design of a Federal National Health Implementation Architecture?

- Governance and Cooperative Federalism
- Data holding: Meta-data, data standards, case definitions, data protection, etc.,
- Patient care pathways and continuum of care: Individual, Family, course of disease, etc.,
- Open mechanisms for inputs/outputs: Call centre, India Health Portal, Health Apps, Insurance

[12] Healthcare big data refers to collecting, analysing and leveraging consumer, patient, physical, and clinical data that is too vast or complex to be understood by traditional means of data processing. Big data is often processed by machine learning algorithms and data scientists. https://partners.healthgrades.com/faq/what-is-healthcare-big-data

How does Public Health Surveillance broaden data access for relevant stakeholders to include all concerned while ensuring required patient confidentiality?

- Community/public access
- Access to intellectual property
- Apex institutes to stimulate research on diagnostics and vaccines
- Publication of big data science and data analytics
- Business development for mass electronic manufacturers

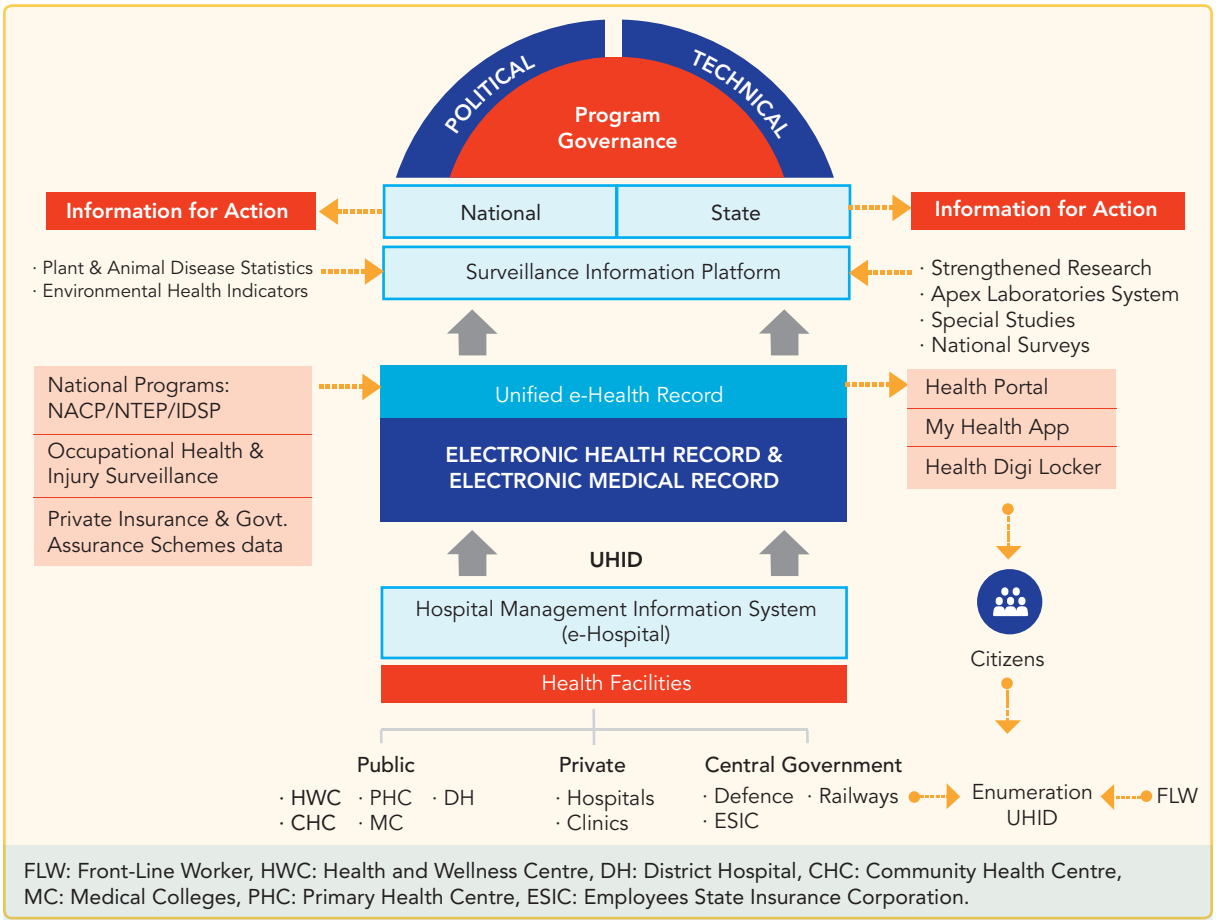
Which Diseases could India target for Elimination by 2030? What could be the pathway to elimination?

- Table 1 (Pg. 38) is a list of diseases targeted for elimination by the WHO. How can India use this list to define their own list of diseases and time-lines for Disease Elimination?
- Disease eradication appears to be a much more challenging goal and until date has been achieved only with smallpox. However, with many diseases slated for elimination by 2030, could the agenda for surveillance post-disease elimination also be defined? For example, many developed countries are today facing re-emerging epidemics of syphilis and other sexually transmitted diseases, which were eliminated previously.

5 THE BUILDING BLOCKS FOR VISION 2035: Public Health Surveillance in India

THE BUILDING BLOCKS FOR VISION 2035: Public Health Surveillance in India

Figure 1: The Architecture of Public Health Surveillance in 2035



FLW: Front-Line Worker, HWC: Health and Wellness Centre, DH: District Hospital, CHC: Community Health Centre, MC: Medical Colleges, PHC: Primary Health Centre, ESIC: Employees State Insurance Corporation.

5.1 Governance: Principle - Develop an eco-system for surveillance

A federated governance system that is based on ensuring 'public good' and that pools public health surveillance resources and information both for the 'Centre' and 'States/ Union Territories', is the foundation for Surveillance. A proposed architecture of future surveillance is depicted in Figure 1. Governance includes three functions.

A **political** function that includes resource allocation and guidelines for its use, enacting legislations relevant to control of epidemic diseases and creating new policies.

A **technical** function that includes priority setting, protocols for disease outbreak containment and management, case-definitions and setting thresholds for labelling the type of disease outbreak/epidemic.

A **managerial** function that includes planning, implementation, monitoring and evaluation. Each group is constituted as per existing guidelines.

Surveillance itself functions on a single Surveillance Information Platform that amalgamates all relevant information from multiple sources. Initially, this information can come from existing vertical and integrated disease surveillance programs. However, over time, this would be primarily driven from electronic health records (EHR) of populations and medical records of patients, that are individualised and identified through the use of a unique health identifier (UHID). Information from vertical and integrated disease control programs, hospitals and health centres, laboratories and pharmacies, insurance related routine medical check-up, PMJAY and other insurance records, and occupational health surveillance will all be amalgamated into the EHR. In alignment with the Principle of 'One-Health' environmental health surveillance, plant and animal disease surveillance will also be integrated into this Surveillance Information Platform. National surveys, special studies and research will be used periodically to validate case definitions and to address gaps within the EHR based surveillance.

Once the Surveillance Information Platform is fully functional, future Governance will include the following:

The Priorities for surveillance and indicators of success are clearly defined and performance is linked to Health Resource Allocation. Tools, thresholds and timelines for early warning signs and outbreak reports are established, re-examined and redefined, periodically. The performance of the Public Health Surveillance ecosystem is reviewed periodically by an expert group represented by political, bureaucratic and scientific leadership. Key stakeholders are periodically reviewed for their performance, measured by their use of 'Information for Action'. The expertise and network intelligence that exists within apex and research institutions is harnessed and specialist human resources are recruited, developed and retained in adequate and appropriate strength. Continuous quality improvement and legal mechanisms are in place to ensure global/regional leadership of India's public health surveillance. Finally, novel partnerships are established with developed and developing countries for continued learning and development, detecting emergence of new pathogens, identifying new phenotypes and genotypes of known pathogens, for monitoring anti-microbial resistance, new diagnostics, nanotechnology and its applications, etc.,

5.2 Information Systems linked with robust lab networks as data sources for Surveillance

New data sharing mechanisms ensure that Surveillance does not replace existing vertical and integrated programs, but amalgamates the data on a 'Surveillance Information Platform' in near real-time using data-sharing mechanisms, rather than traditional data-entry systems. In order to enable this, the use of a Unique Health Information Identifier (UHID) number, as envisioned in the National Digital Health Blueprint (2019), becomes universal. This facilitates linkage between clinical, laboratory and pharmacy related data, allows individual level data capture on disease diagnosis, management and outcomes, as well as analysis of disease patterns, prevalence and trends at the population level. Additionally, the UHID reduces duplication and enables analysis of new trends by individual socio-demographic characteristics and emerging risk factors, and appropriate

allocation of resources with measurement of disease burden. All information is captured from an EHR or a standard format, that is again universalized and standardized for use within the public and private health system, as well as other points of contact with service delivery, such as those provided outside the traditional health system, including rehabilitation services, social and welfare services, etc., Additionally, data collection leverages new technologies including the use of hand-held devices, rapid throughput screening devices in ports and entry points, mobile platforms and digital technologies, call-centre approaches, new 'Point-of-Care' screening and diagnostic tests that can be used for an array of diseases, self-collected and tested swabs, saliva and urine tests that can be done at home or in community settings, but with automated data capture. Data outputs from laboratories, pharmacies, health institutions and the insurance sectors, are captured directly in near real-time, compiled using standard protocols, and available for access, as and when needed. Data sharing agreements are configured and contracted, with due consideration to privacy and confidentiality of the individual.

5.3 Data Analytics (including Predictive Analytics)

Definitions of disease are standardized for surveillance that are agreed upon by clinician, researcher and epidemiologist, and between veterinary, plant and human sciences, in alignment with the 'One-Health' principle are universally utilised. Interoperability or free exchange of information from different systems and between different disease control program platforms are established to ensure that data is linkable and de-identified, stored safely and is available for refined and advanced analysis. New risk factors that emerge from research are rapidly integrated into models for disease prediction, especially for non-communicable disease (NCD) conditions. New Data Science analytical tools and methodologies including molecular epidemiology, genomics, mathematical modelling, prediction techniques and artificial intelligence are integrated for use within Surveillance Systems to inform public health responses and policy.

These may include:

Automated systems that flag/alert authorities of potential threats based on predefined thresholds for identified diseases

Analysis by researchers, modellers and others, which can help inform and improve case definitions

Predictive systems which flags authorities based on patterns of symptoms

Tools for performance management measurements

5.4 Information for Action: Principle - 'For Public good'

Public Health Surveillance undergoes a paradigm shift from being visualized as a core Government function, to one that is ultimately aimed at making relevant information available to the common citizen for public good. New dissemination techniques include the use of health informatics, electronic and digital platforms, social media and individually-accessed digital apps, with password-protected information. Health information ethics, patient privacy and confidentiality will be an integral part of any process which uses these tools for Public Health Surveillance.

New stakeholders are included. In addition to the patient, parent/guardian and the practitioner, the private or public institutions (that are academic, service-oriented, research-focused, product development-oriented or policy-centred), the policy maker, the press and the politician will be included. However, only meaningful, select and relevant information will be made available to stakeholders on an as needed basis, in order to ensure patient confidentiality.

Surveillance is 'Information for Action'. Examples of action at different levels is illustrated below. This is not an exhaustive list.

Citizen Level: Preventive actions to limit disease transmission and optimize health outcomes (actions for self-protection, self-quarantine, self-testing, self-care, timely access to the right services, adherence to treatment, etc.)

Block/District level: Outbreak investigation, Active and passive case-finding, Contact tracing, Isolation of index, Quarantine of presumptive patients, Social/physical distancing, Limiting air, water, soil, food, blood and its products and vector borne transmission, Treatment of confirmed cases/contacts, Chemo/Immuno-prophylaxis for susceptible individuals, etc.,

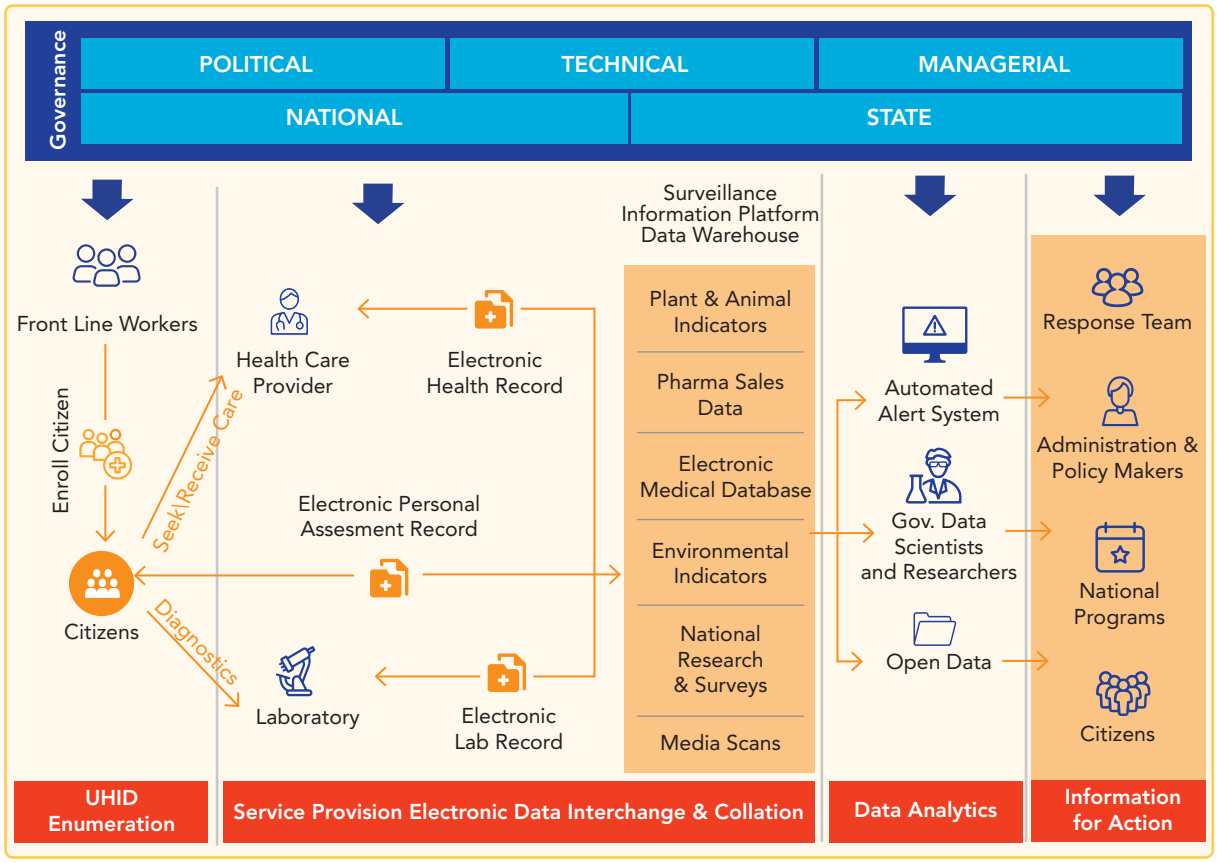
State/National level: Legislation, Resource Allocation, Monitoring trends, Disseminate meaningful information to relevant stakeholders, Monitor actions at different levels, etc.,

International level: Reporting under International Health Regulations and for Public Health Emergencies of International Concern.

For NCD and Occupational Health: Minimise exposure to known risk factors, regulate sources of environmental pollution, dedicate resources, inter-sector collaboration.

The proposed flow of information is depicted in Figure 2.

Figure 2: The Proposed Flow of Information for Public Health Surveillance in 2035

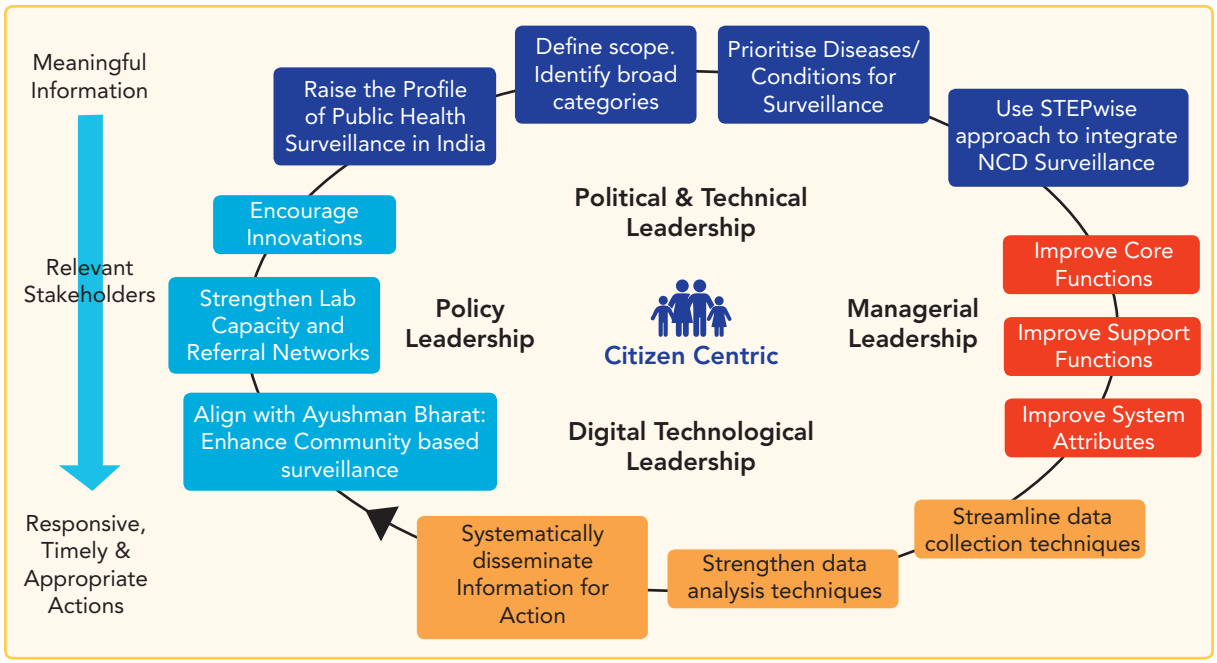


6 STEPS TOWARDS ACHIEVING VISION 2035: Public Health Surveillance in India

STEPS TOWARDS ACHIEVING VISION 2035: Public Health Surveillance in India

Drawing from India's past experience and global best practice, this document recommends steps to building Public Health Surveillance in India. The steps are not in order of priority. However, they have been presented as clusters and in a cycle of events, as depicted in Figure 3.

Figure 3: The Way Forward: Public Health Surveillance in India



6.1 Raise the profile of Public Health Surveillance

Public Health Surveillance in India is often considered as a separate activity, not related directly to health care service delivery. It is sometimes viewed as a stand-alone activity, with different institutions responsible for different aspects, as depicted in Figure 5 (Pg. 43). It is important to raise the profile of Public Health Surveillance in India and to position Public Health Surveillance as a tool for public good. In order to enable this, Information for Action may be made available to multiple stakeholders, including the citizen and the political and bureaucratic leadership at the central, state and district level. It is of paramount importance for an effective and responsive governance structure to be set up immediately. Periodic coming together of this leadership will be important to charter a way forward, as well as to deal with Public Health Emergencies of International Concern, as and when they arise. The governance team will guide the development of the blueprint or action plan that needs to be developed. The suggested architecture for PHS in 2035 is depicted in Figure 1 (Pg. 22) and Figure 2 (Pg. 26).

6.2 Create/Strengthen an Independent Health Informatics Institute

Public health informatics has an essential role in data collection, collation, analysis and transmission for public health surveillance and related actions. A dedicated Independent Health Informatics Institute will need to be created to support and guide innovations and analytic activities, including the use of Internet of Things (IoT)[13] surveillance activities. It is essential for both the centre and states to recognise the importance of Public Health Information for Action and allocate resources and dedicate appropriate technology to manage Health Information for Action.

6.3 Define the scope of surveillance into broad categories of diseases/ conditions, keep it simple and strategic

India has traditionally focused on Surveillance for Communicable/Infectious Diseases. Though initiatives are in place for NCD, Occupational Health, Injury and Environmental Health Surveillance, these are not yet given adequate surveillance attention. In order to facilitate strengthening of these areas, it may be important to create/identify nodal structures for different diseases and conditions. As an example, the Department of Disease Control, Ministry of Health, Thailand classified and focused on five main categories of disease that were prioritised for Health Surveillance: a. Acute Communicable Disease, b. HIV and TB, c. Non-communicable disease, d. Injury, e. Occupational and environmental disease. India may decide to follow these same principles. Currently, surveillance is in place for the first three disease groups/conditions. The list of diseases under the Integrated Disease Surveillance Program is shown in Table 2. Additionally, HIV and TB function as vertical programs, with their own surveillance systems. Inter-ministerial cooperation between 'labour' and 'health' is essential to expand on Occupational Disease Surveillance and to capture 'injuries'. India can redefine the scope and priorities for disease surveillance and establish /strengthen structures that can be held accountable for each of the prioritised disease categories. The exercise can be repeated, at least once every three to five years. In addition to disease based surveillance, response protocols and mechanisms for event based surveillance especially for Public Health Emergencies of International Concern, may be strengthened.

6.4 Use a WHO STEPwise approach to include NCD Surveillance

Surveillance for NCD has been fragmented. The WHO suggested the STEPwise approach, that is inclusive of death, disease and risk factors. Tables 3a and 3b (Pg. 43) in the annexure depict this approach. The STEPwise approach can be implemented beginning with Health and Wellness Centres in India, wherein front-line workers and Community Health Officers

[13] The Internet of Things (IoT) refers to a system of interrelated, internet-connected objects that are able to collect and transfer data over a wireless network without human intervention. https://internetofthingsagenda.techtarget.com/definition/Internet-of-Things IoT. An IoT system consists of sensors/devices which "talk" to the cloud through some kind of connectivity. Once the data gets to the cloud, software processes it and then might decide to perform an action, such as sending an alert or automatically adjusting the sensors/devices without the need for the user. https://www.leverege.com/blogpost/iot-explained-how-does-an-iot-system-actually work

watch over the health and wellness of a fixed population, with digitised person-centred, family based records. Personal health records, hospital and insurance records and surveys can complement this information.

6.5 Prioritise Diseases/Conditions that will be the focus for Surveillance/Disease Elimination

India can use multiple criteria, based on available information to prioritise diseases and conditions under each of the five broad categories that were listed above in the Thailand example. As an example, Germany used ten criteria including a. incidence, b. work and school absenteeism, c. health care utilisation, d. chronicity of illness and sequelae, e. case fatality rate, f. proportion of events requiring public health action, g. trend, h. public attention including political, media and public perception, i. prevention possibilities and j. treatment possibilities for prioritising diseases for surveillance, as depicted in Table 4 (Pg. 41). India could use similar criteria or adapt the same, based on local context. WHO has listed diseases for Elimination by 2025 and 2030, as depicted in Table 1 (Pg. 38). India could create its own list of diseases slated for elimination by 2030. India could adapt/design the prioritization criteria based on the context of each state or district, given its diversity.

6.6 Improve Core Support Functions, Core Functions and System Attributes

Revati K Phalkey et al in 2015 published, "Challenges with the implementation of an Integrated Disease Surveillance and Response (IDSR) system: systematic review of the lessons learned" highlighting the importance to first improve core support functions including health system support, workforce support and technological support, as depicted in Figure 6 (Pg. 44). Once this is taken care of, enhance core functions of surveillance including case definition, case confirmation, case registration, case notification, data management, data analysis, outbreak preparedness, outbreak detection and response and feedback. All the while, it would be important to focus on improving system attributes including Simplicity, Flexibility, Timeliness, Completeness, Consistency, Representativeness, Acceptability, Data Accuracy, Sensitivity, Positive Predictive Value and Stability.

6.7 Streamline data sharing, analysis, dissemination and use for action

The first and foremost pre-requisite for a unified Surveillance system is the need of a unique health identifier (UHID) for every individual. This will not only help to link Syndromic, Presumptive and Laboratory records that are currently used, but can also be potentially used to link morbidity and mortality data. It also allows for better NCD surveillance - for incidence/prevalence and understanding health outcomes - as well as for informing allocation of resources. India has made great progress by achieving almost universal coverage of the UID (Aadhar). There is potential to use UID or a similar system to ensure that every individual has a UHID, which will enable the patient and health care provider to have complete information on the health and disease status of the individual. The access to this information can be controlled by incorporating

one-time passwords (OTP). One will need to be cognisant of the rulings of the judiciary on the pertinent use of the UID for health and social protection. The UHID and EHR become core building blocks in order to streamline data sharing. Figure 7a and 7b (Pg. 45). depict core building blocks used in different contexts. Actions dependent on the use of social, electronic, print and digital media can be explored to build on data analytics, dissemination and for making meaningful information available for relevant stakeholders. Actions in response to epidemic disease outbreaks, high or clustering of NCD prevalence and occupational diseases have been mentioned previously.

6.8 Encourage Innovations

India is well known for its innovative approaches in Health and other sectors. Innovation could be encouraged within Public Health Surveillance as well. As an example, Public Health Surveillance England mentioned steps where innovation can be explored within the public health surveillance loop to include new collection techniques, new case definitions or new risk factors/groups, new Point-of-Care diagnostics and screening tools/devices, new analytical tools, new dissemination techniques, new stakeholders, new evidence/ research findings, as depicted in Figure 8 (Pg. 46). It would be necessary to identify opportunities for implementation of these innovations within districts/states to learn from and then ensure successful scale up and integration into the Public Health system.

Barker I, Brownlie J, et al in their foresight document entitled, "Infectious Diseases: preparing for the future. A vision of future detection, identification and monitoring systems", developed a framework for future detection, identification and monitoring systems, which is depicted in Figure 9 (Pg. 47). The framework explored consideration of the analysis of future threats, the analysis of societal contexts and the reviews of future science to be contributors of an evaluation of future Detection, Identification and Monitoring (DIM) systems. The future DIM systems would predict and suggest public health actions necessary for disease control.

6.9 Align with Ayushman Bharat

The Health and Wellness Centres present a unique opportunity to strengthen community based surveillance at the primary health care level, by capacitating front-line health personnel to perform syndromic reporting for infectious disease and screening for risk factors or for disease markers for common NCD and communicable diseases, using basic verbal screening tools or Point-of-Care diagnostics and devices. Additionally, information captured under the PMJAY assurance scheme and private and public insurance sector insurance schemes can also be amalgamated for disease surveillance of hospitalisation episodes.

6.10 Strengthen laboratory infrastructure, referral networks and community based surveillance

A well-functioning and robust laboratory system at various levels of healthcare is critical to establishing an efficient disease surveillance program. States may have decentralised diagnostic facilities in order to conduct surveillance of epidemic prone diseases. The IDSP has developed district public health laboratories that are being strengthened under the National Health Mission. These efforts may be accelerated and scaled up. The need for the rapid, accurate, affordable and robust diagnostics is obvious. The WHO released the first edition of essential diagnostics list (EDL) in May 2018. The ICMR finalised the country's first National Essential Diagnostics List (NEDL), a year later. NEDL has considered all levels of health care – village level, primary, secondary and tertiary care and builds upon the Free Diagnostics Service Initiative and other diagnostics initiatives of the Ministry of Health to provide an expanded basket of tests at different levels of the public health system. Availability of quality assured diagnostics at various levels of healthcare is critical for disease prevention, control and surveillance.

Primary Health Centres would need strengthened capacity of front-line workers for community-based screening for presumptive and active cases, active case-finding, contact tracing, to promote barriers to disease transmission including social/physical distancing, hand-washing, cough hygiene, use of toilets and safe drinking water, etc., as relevant. Laboratories at the primary care level can be strengthened with Point-of-Care, community-based or self-testing kits, in order to screen for or confirm disease, that may be endemic or new, within local geographic settings.

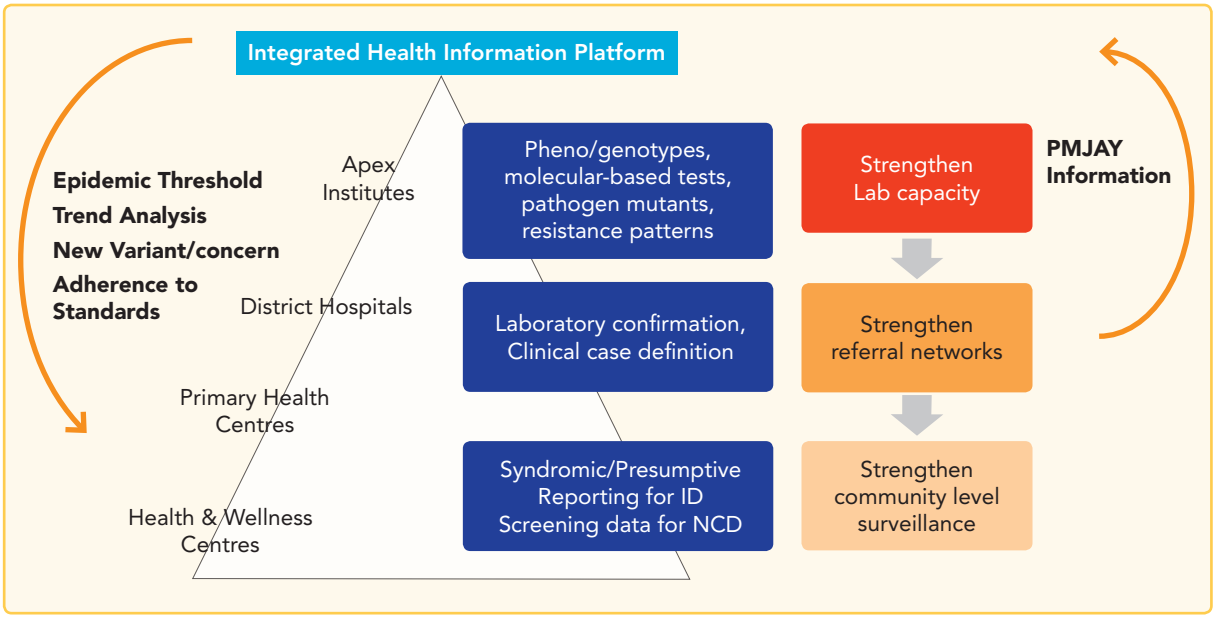
Block level labs may be strengthened in order to increase the efficiency of public health interventions and to decrease the load on district and state level labs. Accurate diagnoses of common endemic diseases in the region, based on common syndromes (eg., Acute Febrile Illness) is feasible in block/district level labs. Block level labs can confirm diagnosis early, during disease outbreaks and after the outbreak and thus support the right decisions related to action and intervention in a timely manner.

Additionally, it would be important to strengthen referral networks to ensure that primary care benefits from clinical and laboratory disease/risk factor confirmation that is made widely available at block and district level. This can be effectively implemented by putting into place PoC screening and diagnostics; making available and accessible community-based/ home-based testing kits, activating blood/ urine/ saliva/ sputum/ hair based sample collection, transportation, testing and reporting mechanisms, and rapid throughput screening or hand-held devices, in addition to enabling front-line and mid-line health personnel with smart phone apps and mobile based and digital technologies.

It would be important to strengthen nodal institutions with human resource, infrastructure, equipment and supplies for genotype, phenotype, detection of pathogenic mutants and for antimicrobial resistance. Additionally, these can be made responsible and accountable

for quality assurance of molecular, serological and microbiological testing in partnership with intermediate and state level reference laboratories. Private institutions can be engaged through a collaborative and mutually beneficial framework. Finally, it would be important to task and fund institutions to ensure Continuous Quality Improvement. The integrations into Ayushman Bharat and the three-tiered approach to lab strengthening are depicted in the Figure 4.

Figure 4: Integration of PHS into Ayushman Bharat: 3-tiered Approach



An illustrative example Surveillance for Infectious disease alone is the Public Health Surveillance of Taiwan[14], illustrated in Figure 10 (Pg. 48).

[14] Jian S W, Chen C M, Lee C Y, Liu D P. Real-Time Surveillance of Infectious Diseases: Taiwan's Experience. Health Secur. 2017 Mar/Apr;15(2):144-153.DOI: 10.1089/hs.2016.0107.PMID: 28418738; PMCID: PMC5404256.

7 CONCLUSION

CONCLUSION

In conclusion, India's Vision 2035 for Public Health Surveillance envisions integration within the three-tiered health system, strengthened community based surveillance, expanded referral networks and enhanced laboratory capacity. The EHR becomes the main basis of surveillance and is complemented by periodic national/state/district level surveys, special studies and research in order to reconcile the threshold and redefine standard definitions of cases, as disease patterns evolve. Surveillance is not solely dependent on individual disease driven active or passive surveillance systems, though these may remain important contributors to surveillance information. The building blocks for this vision are an interdependent federated system of Governance between Centre and States, new data sharing that is not dependent on traditional systems of data entry, but one that is positioned over and above existing disease surveillance programs. Surveillance uses new analytics, health informatics and data science and innovative ways of disseminating 'Information for Action'. This will further thrust India to be a global/regional leader in Public Health Surveillance.

ANNEXURES

TABLE 1 **WHO list of Diseases slated for Elimination and their Timelines**

Intervention	Disease	Region	Target Dates
Eradication: Worldwide reduction to zero	Small pox	Global	10 years from 1966
	Polio		2014
	Yaws		To be decided
	Dracunculiasis		To be decided
Interruption of local transmission	Malaria	Global	2030
	Measles		2020
	Rubella		2020
	Leprosy		2020
	Chagas	Regional: Americas	2015
	Sleeping sickness	Regional: Africa	
	Onchocerciasis	Global	2022 Latin America and 2025 Africa
	Schistosomiasis	Regional	2025
Elimination as a public health problem	Visceral Leishmaniasis	Regional: Indian sub-continent	2020
	Cholera	20/47 endemic countries	2030
	Lymphatic Filariasis	Global	2020
	Trachoma	Global	2020
	Mother-to-Child Transmission: HIV and Syphilis (and HepB)	Global	2030
	Maternal and neonatal tetanus	Global	2020
	Rabies	Global	2030
	Soil transmitted helminths	Global	2030

TABLE 2 **Diseases under Integrated Disease Surveillance Program**

L form	Diseases under Presumptive (P form) Surveillance
1. Dengue / DHF / DSS 2. Chikungunya 3. JE 4. Meningococcal Meningitis 5. Typhoid Fever 6. Diphtheria 7. Cholera 8. Shigella Dysentery 9. Viral Hepatitis A 10. Viral Hepatitis E 11. Leptospirosis 12. Malaria: PV, PF	1. Acute Diarrhoeal Disease (Cholera) 2. Bacillary Dysentery 3. Viral Hepatitis (A/E) 4. Enteric Fever 5. Malaria (PV, PF) 6. Dengue / DHF / DSS 7. Chikungunya 8. Acute Encephalitis Syndrome (JE) 9. Meningitis 10. Measles 11. Diphtheria 12. Pertussis 13. Chicken Pox 14. Fever of Unknown Origin (PUO) 15. Acute Respiratory Infection (ARI) / Influenza Like Illness (ILI) 16. Pneumonia 17. Leptospirosis 18. Acute Flaccid Paralysis < 15 Years of Age 19. Dog bite 20. Snake bite 21. Any other State Specific Disease (Specify) 22. Unusual Syndromes NOT Captured above (Specify clinical diagnosis); eg., scrub typhus

TABLE 3a The WHO STEPwise approach to NCD surveillance

NCD	Step 1	Step 2	Step 3
Risk factors (the future)	Questionnaire-based report on key behavioural risk factors	Questionnaires plus objective physical measurements	Questionnaires plus objective physical measurements plus bio-chemical measurements
Diseases (the present)	Hospital or clinic admissions, by age and sex	Rates and principal condition by age. sex and principal conditions: communicable diseases, NCDs and injury	Age, sex and cause-specific disease incidence or prevalence
Deaths (the past)	Death rates by age and sex	Death rates by age, sex and broad cause of death (verbal autopsy)	Death rates by age, sex and cause of death (death certificate)

TABLE 3b STEPS approach to risk factor assessment

Measures	Step 1 (Self Report)	Step 2 (Physical)	Step 3 (Biochemical)
Core	Socio-economic and demographic variables, years of education, tobacco and alcohol use, physical inactivity, intake of fruit and vegetables	Measured weight and height, waist, circumference, blood pressure	Fasting blood sugar, total cholesterol
Expanded Core	Ethnicity, Income, Education, Household indicators, Dietary patterns	Hip circumference, pulse rate	HDL-cholesterol, triglycerides
Optional (examples)	Other health-related behaviours, mental health, disability, injury	Timed walk, pedometer, skinfold, thickness	Oral glucose tolerance test, urine examination

TABLE 4 **Criteria for scoring to Prioritise diseases/conditions for surveillance**

No.	Criteria	Scoring Values		
		-1	0	1
1	Incidence (including illness and symptomatic infection)	<1/100 000	1-20/100 000	>20/100 000
2	Work and school absenteeism*	This pathogen causes a negligible proportion of absenteeism due to an infectious illness	This pathogen causes a small to moderate proportion of absenteeism due to an infectious illness	This pathogen causes a large proportion of absenteeism due to an infectious illness
3	Health care utilisation (primary)	This pathogen causes a negligible proportion of health care utilisation due to an infectious illness	This pathogen causes a small to moderate proportion of health care utilisation due to an infectious illness	This pathogen causes a large proportion of health care utilisation due to an infectious illness
4	Chronicity of illness or sequelae*	This pathogen causes a negligible amount of chronicity or persistent sequelae (estimate prevalence of those being <0.1/100 000 population)	This pathogen causes a small to moderate amount of chronicity or persistent sequelae (estimated prevalence of those being 0.1-1.0/100 000 population)	This pathogen causes a large amount of chronicity or persistent sequelae (estimated prevalence of those being >1.0/100 000 population)
5	Case fatality rate**	<0.01%	0.01-1%	> 1%
6	Proportion of events requiring public health actions (see Note 2 for explanation)**	A small proportion of the estimated total number of events or exceptional events require public health actions (<25%)	A moderate to large proportion of the estimated total number of events require public health actions (25-75%)	Almost all of the estimated total number of events require public health actions (>75%)
7	Trend**	Diminishing incidence rates	Stable incidence rates	Increasing incidence rates

8	Public attention (including political agenda and public perception)*	Risk perception of this pathogen by general public is low and it is not high on political agenda	Risk perception of this pathogen by general public is moderate and informal political expectations/ agenda is present	This pathogen implies international duties or its risk perception by general public is high or it is explicitly high on political agenda
9	Prevention possibilities and needs (including vaccines)**	Preventive potential seems low or the disease does not require prevention or effective prevention strategies are well-established; no need for significant strategy modification	Measures for prevention are established but there is need to improve their effectiveness	Need for prevention is established but currently no effective preventive measures are available
10	Treatment possibilities and needs (including AMR)**	Medical treatment is rarely necessary or effective regimens are well-established; no need for significant modifications	Medical treatment regimens are established but there is need to improve their effectiveness	Need for medical treatment is established, but currently no effective treatment is available or AMR limits treatment options

**Assessed against the total burden of infectious diseases*
***Assessed for each particular pathogen in question – takes into consideration the availability and adequacy of treatment for each case of illness.*

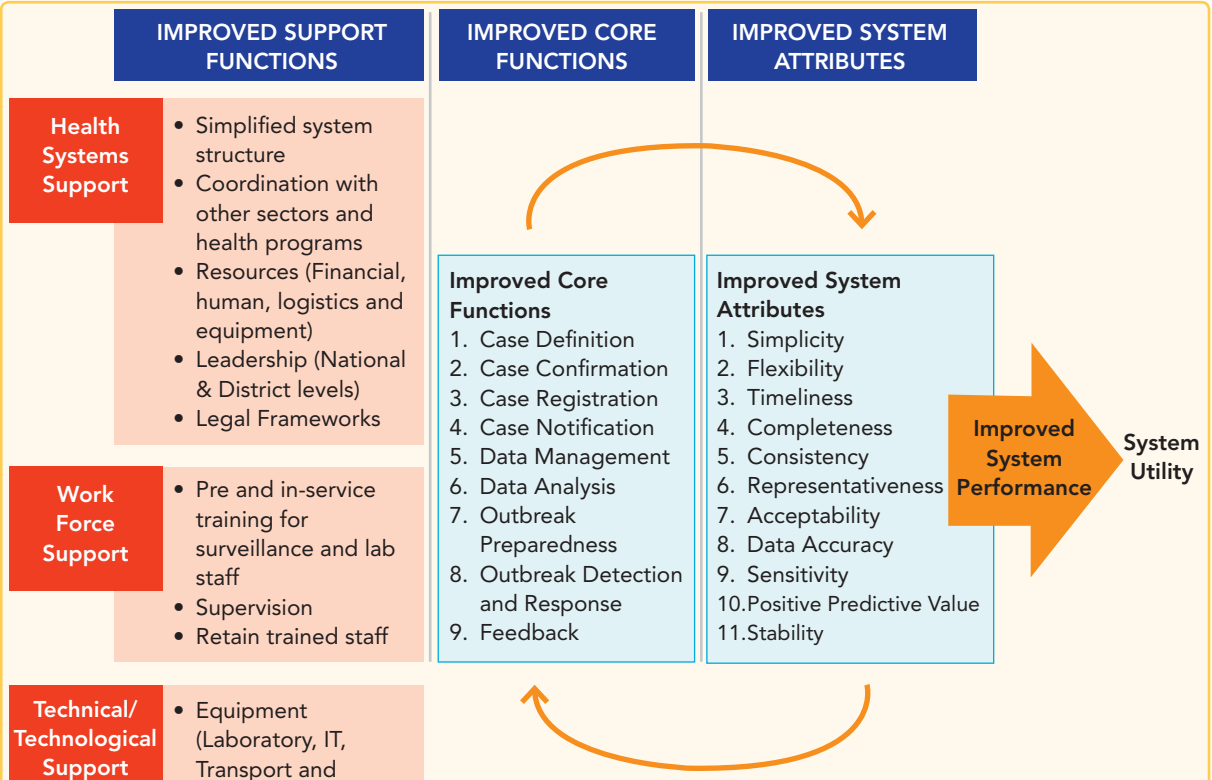
Source: Yanina Balabanova, Andreas Gilsdorf, Silke Buda, et al, "Communicable Diseases Prioritised for Surveillance and Epidemiological Research: Results of a Standardized Prioritization Procedure in Germany, PlOS One October 2011

FIGURE 5 **Existing Structure for Public Health Surveillance**

Technology Platform	Governance	Technical Support & Research	
IHIP SI-NACO	CSU/SSU/DSU CTD NACO NHM/Min. of Health	ICMR CBHI	Centre
Nikshay RCH portal	Directorate of Health Dept. of Health	26 Regional ICMR Institutes 8 NCDC Branches State Reference Labs	State
Vital Event Registration Other	Registrar of births/deaths NVBDCP	District level labs. Referral linkages for specimen collection, transportation & reporting systems.	District

SI: Strategic Information, NACO: National AIDS Control Organisation, RCH: Reproductive and Child Health, CSU: Central Surveillance Unit, SSU: State Surveillance Unit, DSU: District Surveillance Unit, CBHI: Central Bureau of Health Intelligence

FIGURE 6 **Improved Health Systems Support, Core Functions & System Attributes**



Source: Revati K Phalkey, Shelby Yamamoto, Pradip Awate, Michael Marx, "Challenges with the implementation of an Integrated Disease Surveillance and response System: systematic review of the lessons learned, Health Policy and Planning 2015

FIGURE 7a Examples of Key Building Blocks for Surveillance

India's Digital Health	US PHS for the 21st century	PHS England
Health Unique Identity Number	A skilled workforce	New Evidence/Research
Standards	A common lexicon	New Case Definition/Risk Factors/ Groups
Data collection: Mobile app/India Health Portal/Call centre	Global surveillance needs	New Collection Techniques
Interoperability HIE, NHS	Data management, storage and analysis	New Analytical Tools
Access and Control by Citizen	Informatics, including information technology	New Dissemination Techniques
Stakeholders	Data access and use	New Stakeholders

FIGURE 7b Key Building Blocks for Vision 2035: PHS in India

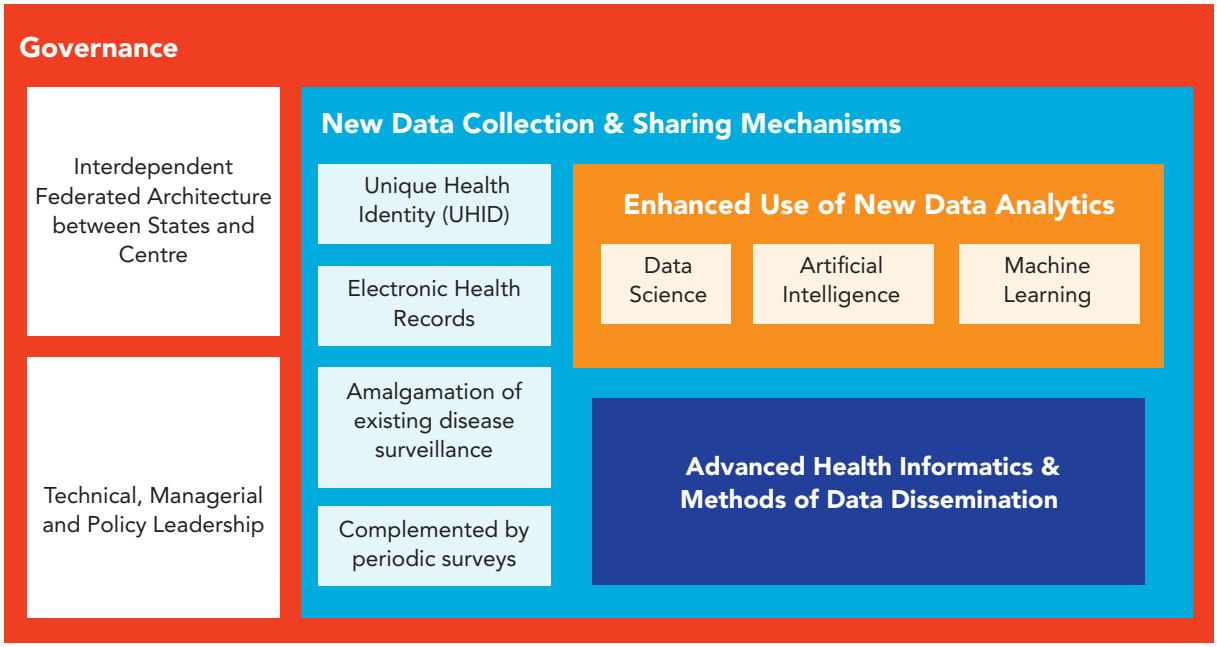
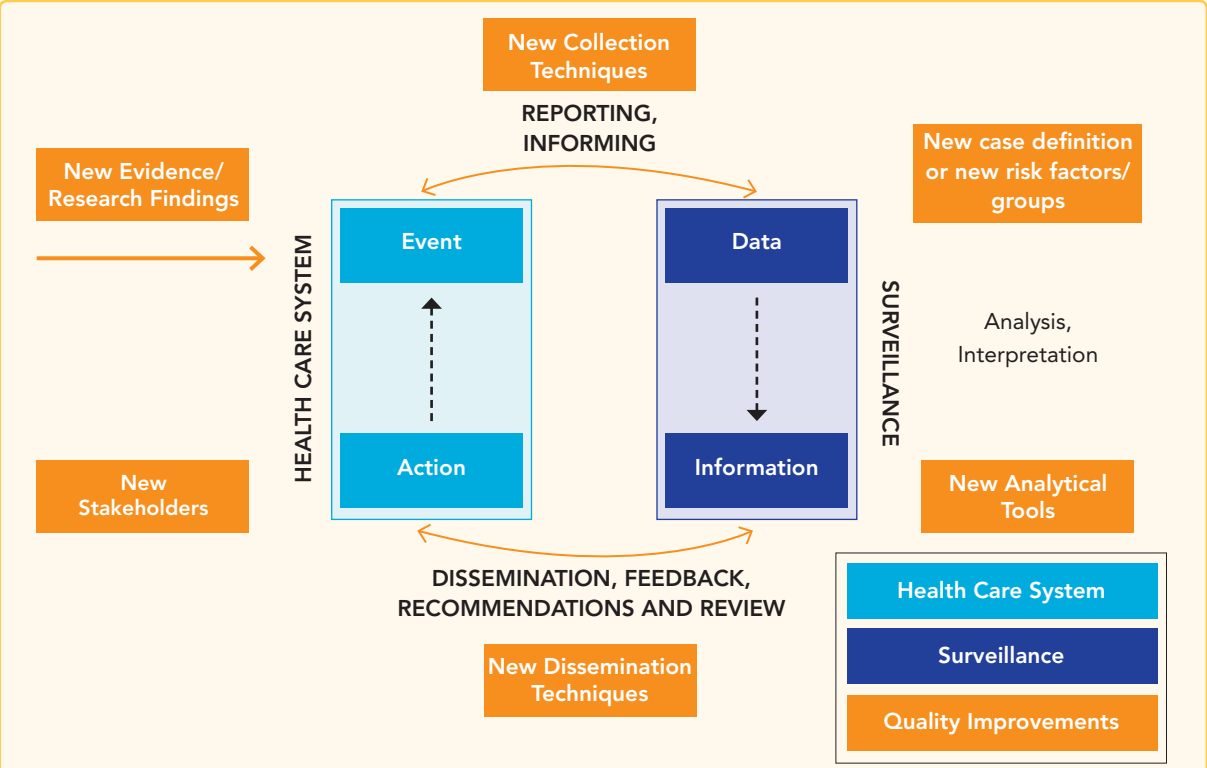


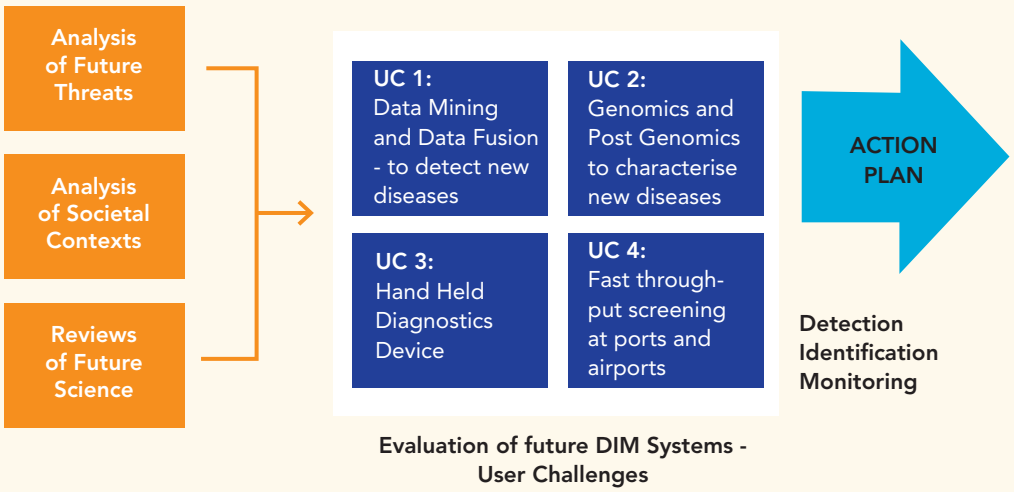
FIGURE 8 **The Public Health Surveillance Loop**



Source: Adapted from Dept. of Health, PHE Transition Team, "Towards a Public Health Surveillance Strategy for England" 2012 India can consider a seventh new step and include 'new screening and diagnostic tools' after new data collection.

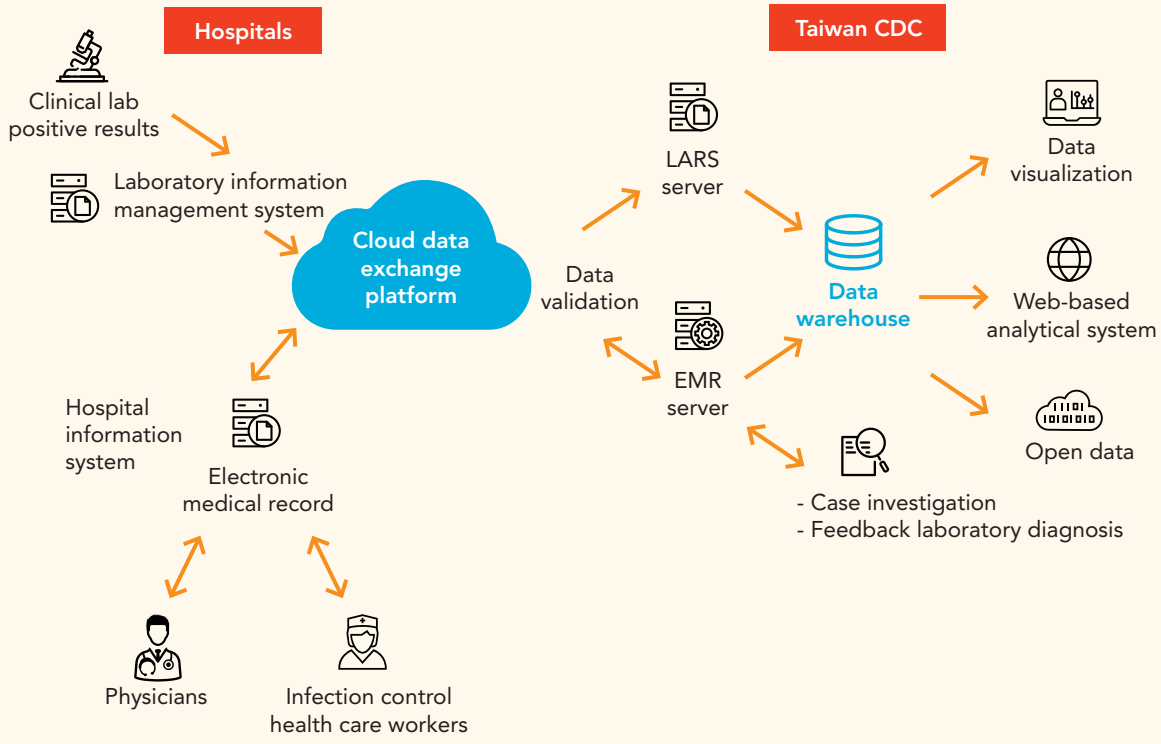
- **New collection techniques** could include hand-held devices, mobile platforms and digital technologies.
- **New screening and diagnostic tools** could include 'Point-of-Care' tests, self-collected and tested swabs, saliva and urine tests that can be done at home or in community settings, captured in near real-time and accessed when needed.
- **New definitions** would primarily include a standardization of definition between clinician, researcher and epidemiologist, or between veterinary, plant and human sciences.
- **New risk factors** will emerge as new evidence emerges from research. High levels of cholesterol were considered until recently to be risk factors for cardiovascular disease, but this relationship is under question currently.
- **New analytical tools** can include mathematical modelling, prediction techniques, artificial intelligence and big data analysis.
- **New dissemination techniques** include social media and other electronic or digital platforms.
- **New stakeholders** have already been previously listed and include the patient/parent, the practitioner, the private or public institution which may be academic, service-oriented, research, product development-oriented or policy-centred, the policy maker, the press and the politician.
- **New evidence/research** needs no further explanation.

FIGURE 9 **Framework for Future Detection, Identification and Monitoring Systems**



Source: Barker I, Brownie J, et al "Foresight. Infectious Diseases: preparing for the future: A Vision of Future Detection, Identification and Monitoring Systems" Office of Science and Innovation, London,2006

FIGURE 10 **Real-Time Surveillance of Infectious Diseases in Taiwan**



Source: Jian SW, Chen CM, Lee CY, Liu DP. Real-Time Surveillance of Infectious Diseases: Taiwan's Experience. Health Secur. 2017;15(2):144–153. DOI:10.1089/hs.2016.0107

3 Background, Scope and Organisation of Disease Surveillance in India

India launched the Integrated Disease Surveillance Project/Program (IDSP) as a decentralized, state based surveillance program in 2012. The intent of the program is:

- to detect early warning signals of impending outbreaks
- to help initiate an effective response in a timely manner
- to provide essential data to monitor progress of on-going disease control programs
- to help allocate health resources more efficiently

There is a list of more than 33 acute conditions covered under the IDSP. This list is provided in Table 2. There are three levels of surveillance under this program.

Syndromic (S form)	Presumptive (P form)	Laboratory/Confirmed (L form)
Diagnosis is made on the basis of symptoms/ clinical pattern observed by paramedical personnel and members of the community. Seven main conditions are reported under this including: fever, persistent cough, jaundice, diarrhoea, Acute Flaccid Paralysis/ vaccine preventable diseases, unusual events leading to death/ hospitalisation	Diagnosis is made based on history and clinical examination by Medical Officers. 22 diseases and conditions are listed under the reporting using the P form.	Diagnosis is based on clinical diagnosis confirmed by an appropriate test. 12 diseases are reported under the L form.

These three levels of surveillance align with the three-tier health system within the country, that includes sub-centres (SC) and primary health centre (PHC) facilities for provision of primary health care, community health centres (CHC) and sub-divisional hospitals/block CHC and district hospitals as secondary levels of care and medical colleges and apex institutes as tertiary care centres.

In addition, many states have also instituted 'Media Scanning and Verification Cells' as a function of the SSU, and very often, these serve as the 'Early Warning System' for a political and programmatic response to a disease outbreak.

The IDSP has categorized the public health response in order to address concerns raised through surveillance by three levels:

Level 1 response	Level 2 response	Level 3 response
Rapid response teams will work for 8 hours a day for seven days a week. This is usually a local response.	Multiple departments will be involved and the response will be for a minimum of seven days, with teams working for up to 14 hours each day. This includes both local, district and state level response.	This is a 24/7 effort which will be agency wide. This geographically extends to state, regional or national level response.

The IDSP has successfully integrated data from the Vector Borne Disease Control Program including data on malaria, filariasis, dengue fever, Japanese Encephalitis, chikungunya and Kyasanur Forest Disease, among others. Other programs such as the Diarrhoeal Disease Control Program, zoonotic infections (rabies/dog bite and snake bite), Vaccine Preventable Diseases and Acute Respiratory Infections are also included. However, vertical programs including the National AIDS Control Program (NACP), the recently renamed National TB Elimination Program (NTEP) and the Reproductive and Child Health (RCH) program are not yet fully integrated into the IDSP as the IDSP took a conscious decision to focus on 'early warning signals' for acute conditions, leaving the large vertical national programs to manage their own systems of surveillance.

Surveillance activities in India are largely either event-based or indicator-based. Event-based Surveillance is usually restricted to events of public health importance, whereas indicator-based surveillance includes monitoring of trends, occurrence of new events or compilation and analyses of a number of events.

A number of activities, though not directly related, also contribute to Disease Surveillance. Few examples of these are given below.

Notification

Certain diseases are notifiable under the law. While International Health Regulations mandate the notification of certain diseases (eg., Yellow fever), India has made notification of certain endemic and nationally prioritised diseases mandatory, such as Tuberculosis (TB). TB is currently notified on the Nikshay platform. Data on this platform serves as an excellent source of not only tracking progress in detection of missing cases of TB, but is also used to track outcomes among those treated in the public and private sector, by type of TB, by co-morbidity (HIV and diabetes) and other factors.

Sentinel Surveillance

An example is HIV Sentinel Surveillance among antenatal women and those presenting in STI clinics using sequential sampling during fixed periods of time from select public health facilities. This data is used as the basis for classification of districts (Type A-D, where A has the highest prevalence) and for defining the program response. HSS also tracks HIV trends using information from fixed sites.

Active & Passive Surveillance

Surveillance of Malaria is both active and passive. In active surveillance, health workers visit house-to-house enquiring about fever, collecting blood smears and administering presumptive treatment in malaria endemic areas. Passive surveillance is conducted among those presenting to a health facility with complaints of fever. Any fever, detected by active and passive surveillance, in a malaria endemic area (defined as an Annual Parasite Index of >2) is presumptively treated for malaria after a blood smear is collected for examination of malaria parasites. The program component is restricted to passive surveillance in areas where API is < 2.

Vector Surveillance

Vector surveillance includes indicators such as vector biting rate, vector density, surveillance of breeding sites, etc., It is used to detect outbreaks of dengue, chikungunya, malaria. Different local and state governments have launched campaigns to examine and eliminate breeding sites for mosquitoes, as a preventive measure for Dengue or Malaria outbreaks. While these campaigns are themselves not considered to be surveillance activities, they are good examples of preventive actions instituted as a result of information from surveillance that have previously indicated seasonal trends in disease outbreaks.

Laboratory Surveillance

Apex labs, intermediate and state level laboratories have been set up for most national programs including TB, HIV and other viral diseases to detect AMR. Pilot initiatives have successfully

demonstrated that it is feasible to diagnose a substantial proportion of Acute Febrile Illness or Acute Encephalitis Syndromes through minimal strengthening of collection systems, referral networks and laboratories at block or district level. AMR is a growing area of public health concern.

Sample surveys

Sample surveys have been conducted to determine risk factors for non-communicable diseases. Sample surveys are also used to determine the prevalence of disease. An example is the recently concluded TB prevalence survey conducted by ICMR institutes. The surveys help to estimate or revalidate the disease burden and programmatic response.

Registries

The main source of information that is being used for estimating the burden of cancer and its distribution are Cancer registries. These registries have been instituted in Cancer Care Centres, including Government and a few private sector institutions. Recently, 25 Cancer Care Centres were recognised and there has been a rapid expansion in the number of regional institutes of cancer in the country.

Outbreak investigations

Diarrhoea, Acute Encephalitis Syndrome, Acute febrile illness are examples of syndromes wherein outbreak investigations are conducted. Most acute conditions are reported by front-line health workers or primary care facilities and include the reporting of diarrhoea/cholera, acute encephalitis syndrome and acute febrile illness. Media and health authorities also routinely report outbreaks of food poisoning or sudden increase in hospitalisation due to a certain syndrome. This serves as an early warning signal for most outbreak investigations that are then investigated and confirmed by a rapid response team set up at district/state level. A single case of acute flaccid paralysis was considered to be an epidemic, under the National Polio Eradication program.

Special Studies

The Integrated Behavioural and Biological Surveys (IBBS) among at-risk populations for HIV infection is an example of special studies contributing to surveillance of disease trends and trends in risk behaviour.

The Organisation of Disease Surveillance in India:

Surveillance activities in India are organised at three levels: National, State and District.

CENTRAL SURVEILLANCE UNIT (CSU)

CSU is integrated administratively and financially with the National Centre for Disease Control (NCDC), New Delhi and established by the Ministry of Health and Family Welfare for the Global Health Security Agenda (GHSA). The CSU has 14 technical centres/ divisions, including epidemiology, microbiology, zoonosis, medical entomology and vector management, IDSP, Centre for AIDS and Related Diseases, biochemical and toxicology, biotechnology, parasitic diseases, malariology and coordination, occupational and environmental health, non-communicable diseases, statistics and M&E, planning, budget and administration. The CSU runs a two-year MPH course in Field Epidemiology.

STATE SURVEILLANCE UNIT (SSU)

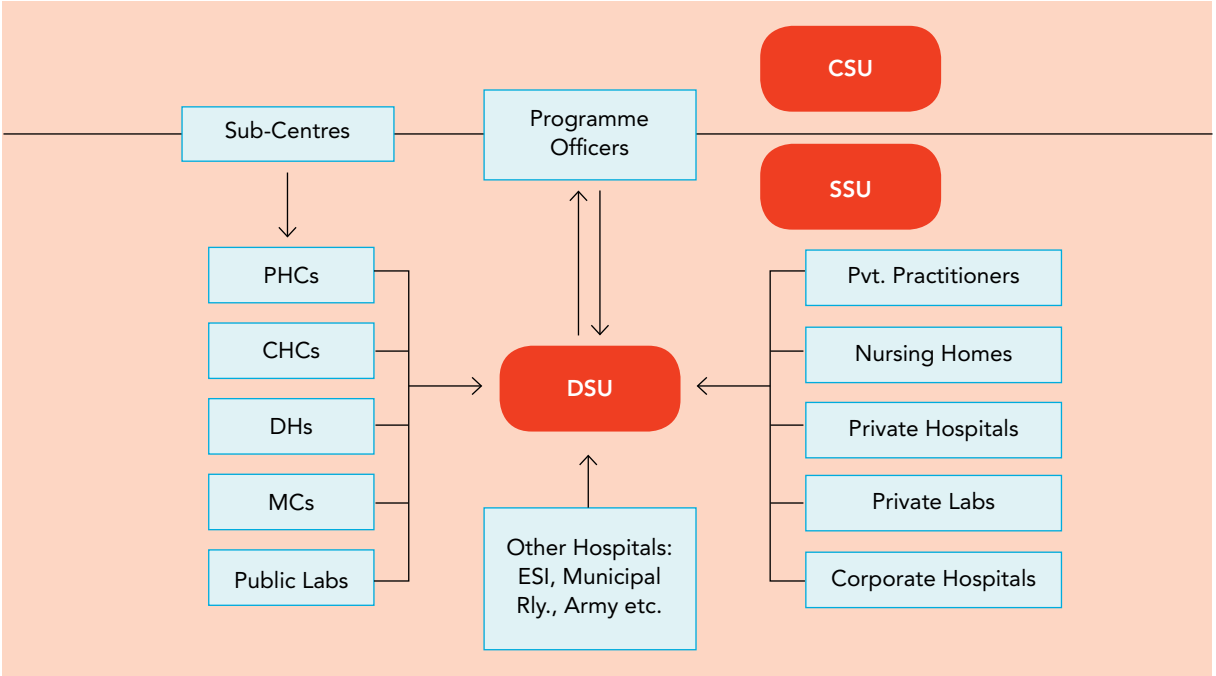
There is SSU in each State/UT with a regular officer identified as State Surveillance Officer (SSO). The SSO is supported by 7 contractual staff who include Training manager, Finance manager, Data manager, Epidemiologist, Microbiologist, Entomologist and a recently included Veterinary consultant.

DISTRICT SURVEILLANCE UNIT (DSU)

There is one DSU in each district with a regular officer as District Surveillance Officer (DSO), who is supported by 3 contractual staff.

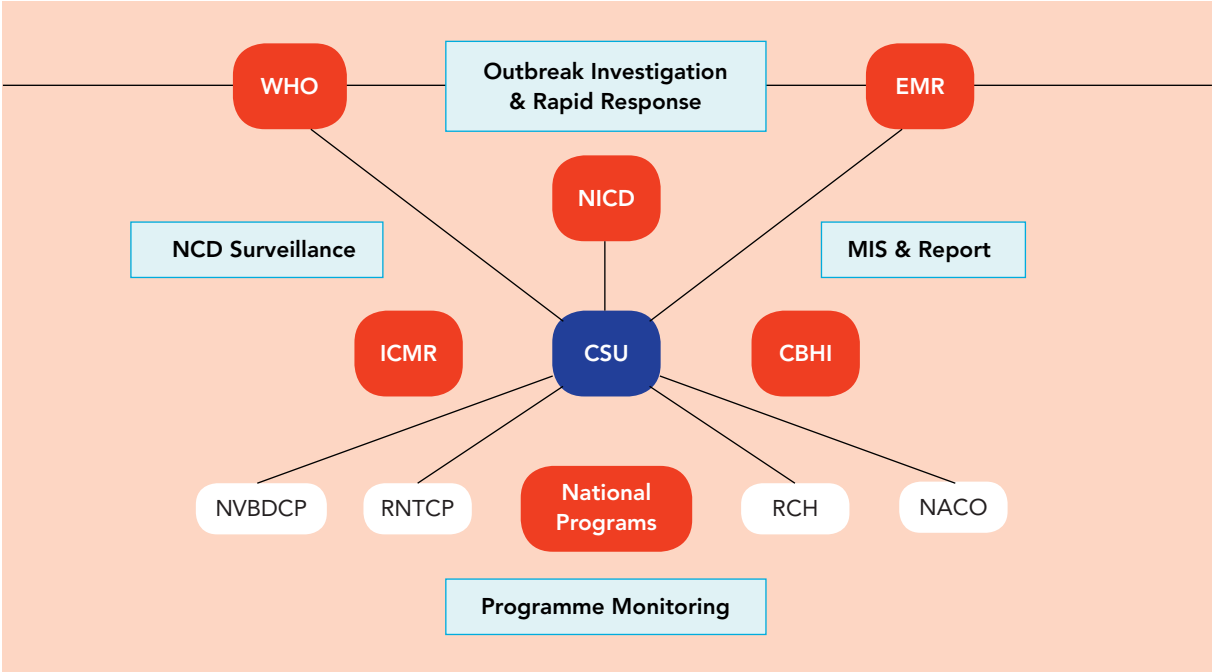
Data flows into the District Surveillance Units from peripheral health institutions as depicted in Figure 11.

Figure 11: Information Flow - Weekly Surveillance System



At the national level, the CSU coordinates with the WHO, the Indian Council of Medical Research (ICMR), the National Institute of Communicable Diseases (NICD) and the Central Bureau of Health Information (CBHI) as shown in Figure 12. Data pertaining to Surveillance from the national programs including National TB Elimination Program (NTEP), National AIDS Control Organization (NACO), Reproductive and Child Health (RCH) and National Vector Borne Disease Control Program (NVBDCP) is to be hosted, analyzed and available for concerned stakeholders.

Figure 12: Linkages of CSU at Central Level



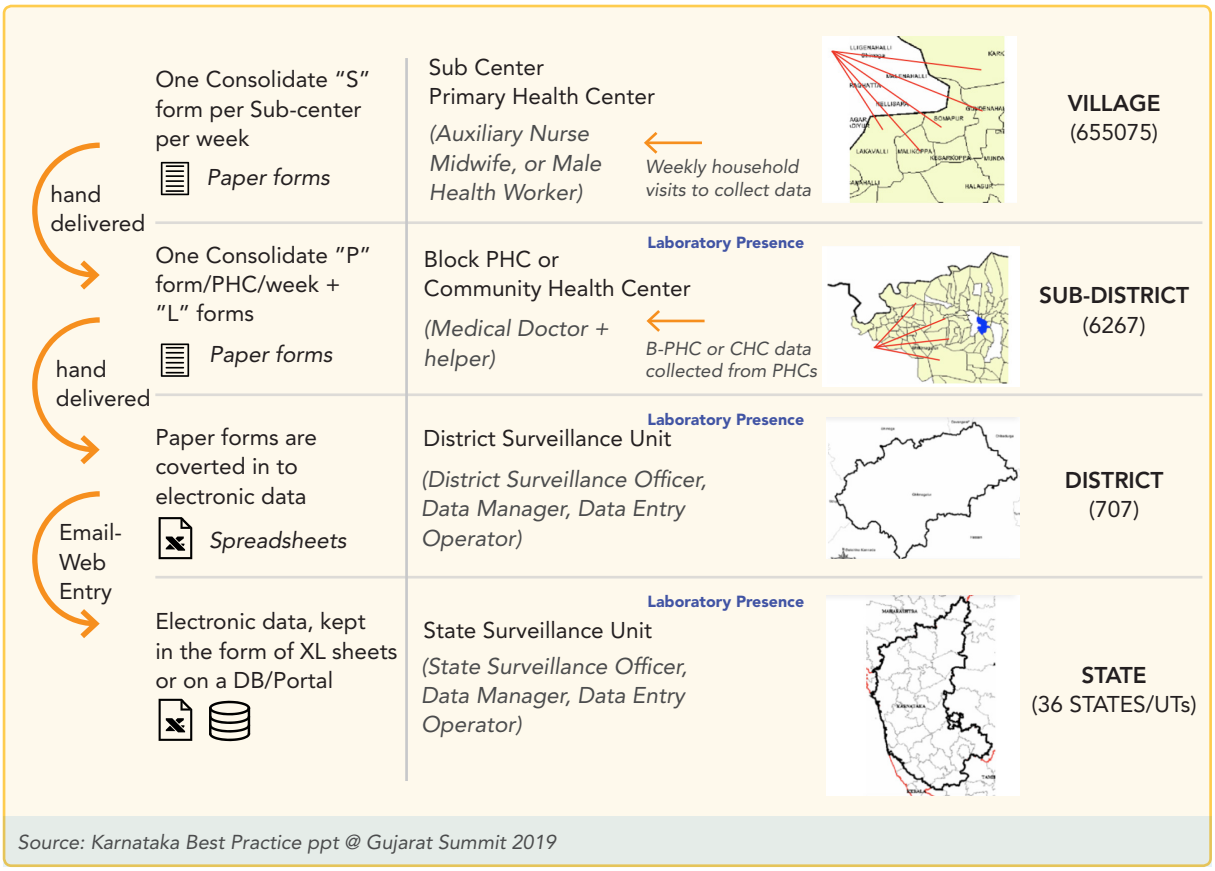
The Indian Council of Medical Research (ICMR) - Role in Surveillance:

The ICMR's contribution in understanding various diseases of national importance such as malaria, Japanese Encephalitis, tuberculosis, AIDS, Kala-azar, Filariasis, Leprosy and Poliomyelitis is remarkable. Additionally, ICMR has made extensive contributions in the areas of nutrition, reproduction and maternal and child health, occupational and environmental health with research complementing health systems. The ICMR has a regional network of 26 institutes. They are involved in the evaluation of new drugs, insecticides, vaccines, devices, diagnostic kits. Additionally, they play a key role in interventions for all diseases of national health priority along with neglected and regional diseases. ICMR has linked 106 viral research laboratories, which are used for lab testing in epidemic outbreaks and is involved in mathematical modelling for Malaria and Dengue in North East. Point-of-Care devices are being piloted for Leptospirosis. ICMR is also supporting a 'Center for One Health' for surveillance of nosocomial infections and hospital infection control in Nagpur, and a National Centre for Occupation Health conducts surveillance of heavy metals in plants. This Centre has a Surveillance program for Injuries and Accidents. ICMR is working towards developing systems for interoperability, which is expected to be finalized in about a year's time. During the recent outbreak, the National Institute of Virology confirmed the presence of Nipah Virus in Kerala, India. ICMR has funded pilots and projects to demonstrate that Kala-azar (Visceral Leishmaniasis) can be eliminated. ICMR also set up a Sentinel Surveillance for Congenital Rubella Syndrome (CRS) in India with six sites and a hospital-based sentinel surveillance for Pneumonia and Invasive Bacterial Diseases (IBD). The ICMR-National Institute of Cholera and Enteric Diseases (ICMR- NICED) houses the National AMR Hub and Repository and is envisaged to carry forward the AMR research in India from a multidimensional approach. There is potential to integrate IDSP surveillance of bacterial infectious diseases with AMR research and translate this into a National Programme of AMR in future.

From Old to New - From Integrated Disease Surveillance Program to Integrated Health Information Platform:

In the traditional system of surveillance which is still operational in the majority of the states in India, the IDSP captures aggregate data, is paper-based, is not able to link data from S, P and L forms, delivers only weekly surveillance and monitors only 13 health conditions (Figure 13).

Figure 13: Conventional IDSP's Data Collection Process



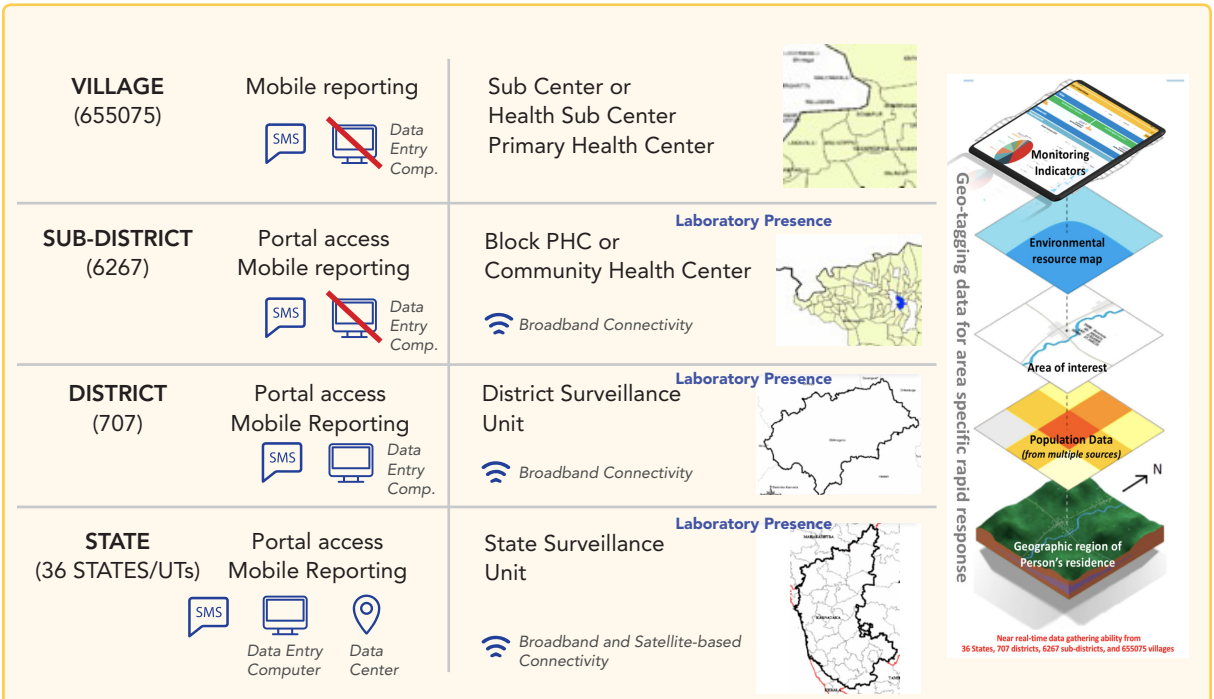
Source: Karnataka Best Practice ppt @ Gujarat Summit 2019

The new IDSP now uses the IHIP (Figure 14) to capture individualized data that can be disaggregated by age, gender and locality, links data from Syndrome, Presumptive and Laboratory, Early Warning Signals 1 and 2 forms, captures near real-time or daily surveillance data, provides analysis on mobile and electronic devices and monitors more than 33+ health conditions. The IHIP is already integrated with the NVBDCP, but full integration has not yet been achieved for the other national programs.

The IHIP is an open platform and has the ability to connect with eHospital Systems and the new National Health Management Information System. It can thus connect with both public and private hospitals, laboratories, and research centers under one platform to facilitate the exchange of health data in a secure manner. Data from the IHIP can be used to describe and analyze geographic variations in diseases in the context of demographic, environmental, behavioural , socioeconomic, genetic, and infectious risk factors. Data from the IHIP can also be used to explore geographic locations of persons with their socioeconomic and demographics attributes as data captures geo-coordinates and socio-demographic characteristics. However, the IHIP needs further refinement to:

1. Integrate Communicable disease with NCDs as comorbidity using unique patient identifier.
2. Capture complications and proportions with severe disease as this is useful to decide on appropriate action. For eg., Proportion with severe dengue fever, staging for cancer.
3. Integrate prevention (vaccine/chemoprophylaxis) and treatment data.
4. Integrate other types of data such as immunization coverage, AMR, nutrition status, vector indices, climatic factors, health system availability.
5. Capture the entire continuum in care including outcomes such as death, cure/recovery/ completed treatment, relapse/recurrence, number of episodes, etc. for enhanced understanding of disease spectrum/prognosis and health resource planning.

Figure 14: New IHIP Real-Time Data Flow Processes



Proposed System: Portal access allows reporting of all data from DSU, CSU, SSU to CSU/IDSP in near real-time. Mobile reporting is both store and forward and near real-time. Data analytics and results will be accessible at all levels for action.

Source: Karnataka Best Practice ppt @ Gujarat Summit 2019

HIV Surveillance:

HIV Sentinel Surveillance (HSS) was perhaps one of the first nation-wide surveillance systems that initially helped to confirm the presence of HIV in India through sentinel sites and designated laboratories beginning in 1992. By 1997, HSS expanded to both antenatal and high-risk populations which provided critical insights on the geographic distribution of the HIV epidemic within India. The HSS thus helped to identify six states with high prevalence. In 2003, HSS expanded to cover every district in all high prevalence states and to have a state representative sample for regions that were not yet declared to be high HIV prevalent. In 2006, the National Family Health Survey (NFHS) 3 for the first time integrated HIV prevalence among the indicators that were measured. About a decade later, the National AIDS Control Organisation (NACO) instituted Integrated Behavioural and Biological Surveillance (IBBS) which enabled tracking of not only the disease prevalence and distribution, but also helped to understand the risk factors that were determinants and drivers of the epidemic across geographies and sub-population groups. HIV surveillance thus provides useful information to estimate the burden of HIV, the distribution by population and place, and trends over time. Additionally, program data has been useful in estimating the new infections and their distribution, and in estimating over time, the reduction in death rates among those on treatment.

Polio surveillance in India:

India's Acute Flaccid Paralysis (AFP) surveillance system for detecting poliovirus transmission was considered to be one of the most sensitive surveillance systems in the world. The surveillance network was widespread. It included both public and private sector reporting sites. It even included non-allopathic healthcare providers and traditional healers. These sites would give a call on mobile phone to a designated district surveillance/ immunization officer whenever a case of AFP was detected. The district immunization officer would then ensure sample collection for laboratory diagnosis. India both met and surpassed all of the WHO AFP Surveillance

global performance indicators over 10 years. Following this, India was certified polio free. The development of *surveillance performance indicators is unique to AFP surveillance* for Polio and is an innovation worth applying to other diseases/health conditions of public health importance. India's AFP surveillance system provides evidence of operational feasibility for polio surveillance. It also provides a road map for global quality surveillance in low and middle income countries.

System for Early Warning Based on Emergency Data (SEED):

SEED was a collaborative project of the GVK Emergency Management and Research Institute (EMRI), India, and GEOMED Research, Germany to systemically explore the use of emergency data for syndromic surveillance at the primary care level in Andhra Pradesh. The project is a combination of a database and corresponding algorithm and GIS tools. EMS (emergency management system) data are generated and captured automatically at the state dispatch centre in Hyderabad. It serves as an early warning system for disease outbreaks through automatic comparison of real time data and pre-determined thresholds. The EMS data are generated and captured in 15 states and 2 union territories.

National Health Policy and Public Health Surveillance:

The National Health Policy 2017 clearly articulated that India needs to accelerate progress in order to achieve the Millennium Development Goals by 2015 and the Sustainable Development Goals by 2030. In alignment with the Universal Health Coverage objective and its guiding principles of ensuring universal health as a right and entitlement, guaranteed access to an essential health package including primary, secondary and tertiary care and freedom of choice for patients between the public and private sector, ensuring equity, non-exclusion and non-discrimination, comprehensive quality care, financial protection, and protection of patient's rights and respect for patient's choice, portability and continuity of care, community participation and putting health in people's hand, the plan also set ambitious targets. Prominent among these targets was an increased allocation of GDP for health from its existing level to 2.5% by the end of the plan and to 3% by 2022, ensuring availability of free medicines and reducing out-of-pocket services. The policy stated that 70% of all health care resources would be dedicated towards improving primary health care. Convergence of all vertical disease control programs under the umbrella of the National Health Mission, the integration of the delivery of all health services, universal and cashless access to an essential health package including essential medicines is stressed. A Health information system that captures both population, community and facility based information, linking all providers, laboratories, and public health managers, so that it is able to provide information to monitor disease burden and support decision making and resource allocation was laid out as a priority. Public health surveillance, research and control of risks and threats to public health are prominently included in the essential health package.

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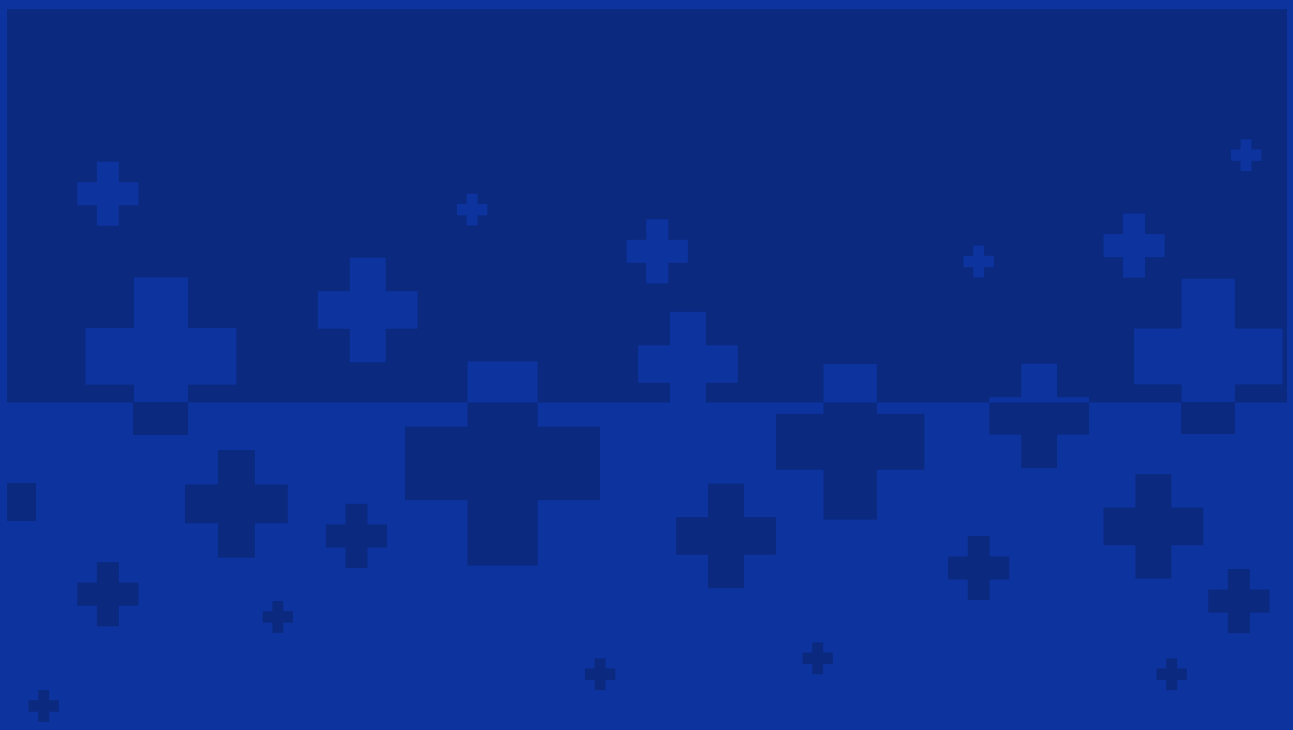

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ISBN 978-81-949510-6-3
DOI: 10.6084/m9.figshare.14093323