SITUATION OF DISEASE SURVEILLANCE SYSTEM IN BANGLADESH

DR. IQBAL ANWAR, Dr.PH

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Acronyms and Abbreviations

AES - Acute encephalitis syndrome
AFP - Acute flaccid paralysis
AHI - Assistant Health Inspector
BITID - Bangladesh Institute of Tropical and Infectious Disease
BLRI - Bangladesh Livestock Research Institute
BSMMU - Bangabandhu Sheikh Mujib Medical University
CC - Community Clinic
CDC - Communicable Disease Control
CG - Community Group
CHCP - Community Health Care Provider
CHRF - Child Health Research Foundation
CIPRB - Centre for Injury Prevention and Research, Bangladesh
CRS - Congenital rubella syndrome
CSG - Community Support Group
DGFP - Directorate General of Family Planning
DGHS - Directorate General of Health Services
DP - Development Partner
EIS - Epidemiological Information Sheet
EPI - Expanded Program on Immunization
FDR - Facility Death Review
FETP - Field Epidemiology Training Program
FP - Family Planning
FPI - Family Planning Inspector
FSWs - Female sex workers
FWA - Family Welfare Assistant
FWV - Family Welfare Visitor
GHSA - Global Health Security Agenda
GISRS - Global Influenza Surveillance and Response System
GoB - Government of Bangladesh
HA - Health Assistant
HAV - Hepatitis A virus
HEV - Hepatitis E virus
HI - Health Inspector
HMIS - Health Management Information System
HPNSDP - Health Population Nutrition Sector Development Program
HPNSP - Health, Population and Nutrition Sector Program
IANPHI - International Association of National Public Health Institutes
IBBS - Integrated Bio-behavioral survey
ICT - information and communications technology
ideSHi - Institute for Developing Science and Health Initiatives
IDI - In- Depth Interview
IEDCR - Institute of Epidemiology, Disease Control and Research
IHR - International Health Regulations

IPH - Institute of Public Health
IPHN - Institute of Public Health Nutrition
JE - Japanese Encephalitis
LBMs - live bird markets
MCHs - Medical College Hospitals
MCWC - Mother and Child Welfare Center
MIS - Management Information System
MMR - Maternal Mortality Ratio
MNCAH - Maternal, newborn, child and adolescent health
MNH - Maternal and Neonatal Health
MNHI - Maternal and Neonatal Health Initiative
MOHFW - Ministry of Health and Family Welfare
MPDR - Maternal and Perinatal Death Review
MPDSR - Maternal and Perinatal Death Surveillance and Response
MSM - Males having sex with males
MSW - Male sex worker
NCDC - Non-Communicable Disease Control
NCDs - Non-Communicable Diseases
NGO - Non-Government Organization
NID - National Identity Card
NISB - National Influenza Surveillance, Bangladesh
NMR- Neonatal Mortality Rate
NNT - neonatal tetanus
OP - Operational plan
PCR - Polymerase chain reaction
PNC - Postnatal Care
RCH - Reproductive and Child Health
RMO - Resident Medical Officer
RTI - Respiratory Tract Infections
RT-PCR - real-time reverse transcription polymerase chain reaction
SA - Social Autopsy
SARS - Severe acute respiratory syndrome
SSN - Senior staff nurses
STDs - Sexually transmitted diseases
TB - Tuberculosis
TTT - Training of Trainers
UFPO - Upazila Family Planning Officer
UH&FPO - Upazila Health and Family Planning Officer
UH&FWC - Union Health and Family Welfare Center
UHCs - Upazila Health Complex
UN - United Nations
UNFPA - United Nations Population Fund
UNICEF - United Nations Children Fund
US-CDC- United States Center for Disease Control and Prevention
VA - Verbal Autopsy
VIA - Visual Inspection with Acetic Acid
VPDs - vaccine preventable diseases
WGS - whole-genome sequencing
WHO - World Health Organization

Summary

Disease surveillance is an integral part of a national health systems to support disease control and to predict, observe and minimize the harm caused by outbreak, epidemic and pandemic situations, as well as to enhance knowledge about factors that contribute to such circumstances. International Health Regulations (IHR) obligates WHO member states to develop an effective disease surveillance system to enhance early detection and verification of epidemics from emerging and re-emerging communicable diseases to support timely and adequate response by the national governments to reduce damage and save lives. WHO's Health Emergency Program monitor a number of high-threat communicable diseases on a continuous basis. The ongoing COVID-19 pandemic urges for a robust and effective surveillance to improve public health. This consultancy assignment was contracted out by 'Better Health Bangladesh' as part of ongoing demand driven technical assistance (TA) to communicable disease control operational plan (OP) of the 4th Health, Population and Nutrition Sector Program (HPNSP) 2017-2022 of the Ministry of Health and Family Welfare (MOHFW) by the Foreign, Commonwealth and Development office (FCDO) of the British Government. The purpose of this TA was to explore the situation of disease surveillance system in Bangladesh in terms of their strengths, weaknesses and opportunities and threats to make recommendations for establishing a strong national disease surveillance system capable of supporting ongoing disease control programs of the government, and forecasting outbreaks and epidemics in the context of post-COVID-19 future health systems strengthening.

The exploration relied mostly on documentary review and in-depth interviews with key stakeholders which was supplemented by field visit to two districts (Nilphamari and Cox's Bazar) to observe both community and facility-based surveillance data collection systems on the ground. All related policy and program documents of the Ministry of Health and Family Welfare, DGHS, IEDCR, icddr,b, and WHO-Bangladesh were reviewed and their webpages were visited. The published literature on disease surveillance in Bangladesh were also reviewed. A total of 37 IDIs were conducted with respondents from IEDCR, DGHS, icddr,b, BRAC, USAID, BSMMU and field surveillance sites at districts and upazilas. A thematic analysis approach was followed to address the study objectives. Findings from desk-review, IDIs and field visits were shared through a workshop with relevant stakeholders and their suggestions were incorporated in the final report. All the activities under this assignment were undertaken under the guidance of the Line Director, CDC, DGHS and was completed in 40 working days during October to December 2021.

MOHFW has long experience of conducting disease surveillance in smallpox, malaria, poliomyelitis and vaccine preventable diseases. IEDCR, the mandated institute for conducting disease surveillance and outbreak investigation, initiated 'epidemiological information sheet (EIS)' since mid-nineties to collect data on certain locally endemic diseases through paper-based weekly data collection from upazila health complexes (UHCs) that included, acute watery diarrhoea, blood dysentery, pneumonia, malaria, poliomyelitis, and so on. National EPI program is conducting surveillance for certain vaccine preventable diseases since early nineties.

Our exploration depicts that in addition to IEDCR, a number of government and non-government organizations are involved in disease surveillance activities in the country. Surveillance for locally endemic communicable diseases such as TB, malaria, filaria, leprosy, kala-azar, diarrhoea is mostly conducted by disease control programs under DGHS. Surveillance for diarrhoea is conducted by icddr,b, CDC of DGHS, IEDCR, and MIS-Health of DGHS. Daily diarrhoea reports are collected from upazilas and districts during floods and epidemics by control room of DGHS with support from CDC. Icddr,b maintains a facility based surveillance in their Dhaka hospital since 1979 where 4% of admitted patients are studied for etiological agents of diarrhoea. IEDCR and icddr,b conducts sentinel surveillance in 22 secondary and tertiary hospitals throughout the country. MIS-Health of DGHS in collaboration with icddr,b has developed a surveillance system among forcefully displaced Myanmar nationals (FDMN) in Cox,s Bazar district to identify enteric pathogens and early detection of cholera epidemics.

BRAC supports active malaria surveillance in community settings in endemic districts through a network of NGOs with GFATM funding. Passive malaria surveillance takes place at UHCs and district hospitals of malaria endemic districts where private sector hospitals also participate. Blood samples are collected from fever cases at OPDs and IPDs and tested for malaria through RDT (rapid diagnostic test). Monthly malaria reports are submitted online using DHIS-2 platform monthly to malaria elimination program (MEP). In elimination settings, a case-based malaria surveillance system is in place where each positive case is investigated and detail individual level patient data is captured and reported to MEP. TB, Filariasis, Leprosy and Kala-azar conducts disease surveillance through quarterly paper-based reports from UHCs and other reporting units. TB control program has introduced case based online reports from 764 reporting units (out of 858 total reporting units) using ETB-Manager. Kala-azar control program in addition to quarterly aggregate report, has introduced an active case-search methods using 'camp-approach' in areas where there are reports of 2 or more old cases where in suspected cases are searched and tested for kala-azar and if positive data entered through online individual event capture system. Filariasis control program in addition to quarterly reports conducts TAS (transmission assessment surveys) in 19 endemic districts. Also, they conducted molecular genome-monitoring of W. bancrofti in culex quinquefas-ciatus mosquitoes in 2 endemic districts in the northern region of the country. Of total 9 behavioral and serological surveillance surveys conducted for HIV/AIDS and STDs since 1999, the first 8 surveys were conducted by icddr,b in collaboration with IEDCR but the last survey was carried out by Virology Department of BSMMU in 2020. Information about all these locally endemic diseases are also collected monthly by MIS-Health of DGHS and weekly by IEDCR through online DHIS-2 system. However, data for IEDCR and MIS-Health comes from same source and by same person.

In place of paper-based EIS, now IEDCR has introduced online weekly aggregate level data collection from 493 UHCs through DHIS-2 systems on 14 priority communicable diseases disaggregated by age and sex. In addition, IEDCR conducts outbreak investigation routinely with support from 'disease burden due to climate change' component of CDC operational plan of 4th HPNSP. During last 15 years, IEDCR has introduced innovative disease surveillance system for a number of emerging and re-emerging diseases in collaboration with icddr,b, CDC-Atlanta and others and that has contributed a lot in detecting and responding to a number of recent epidemics in the country. Newly developed surveillance systems for emerging diseases in IEDCR include (i) influenza surveillance, (ii) rota-virus and intussusception surveillance, (iii) dengue surveillance, (iv) hospital based Japanese encephalitis surveillance, (v) SARS-CoV2 genomic variant surveillance, (vi) nipa virus surveillance, (vii) AMR surveillance, (viii) hospital based foodborne disease surveillance, (ix) zoonotic disease surveillance, (x) anthrax surveillance (xi) respiratory event based surveillance, (xii) multi-system inflammatory syndrome (MIS) surveillance, (xiii) hospital based syndromic surveillance (xiv) wild-life surveillance and (xv) child health and mortality prevention surveillance (CHAMPS). For these emerging and re-emerging diseases, IEDCR conducts sentinel site, community based, cell-phone based, event-based, and media-based surveillance with strong institutional laboratory support. Event-based surveillance of IEDCR has been appreciated locally and globally for combating epidemics from emerging communicable diseases. However, most of the surveillance programs of IEDCR were project based with support from external donors challenging sustainability in the long run. IEDCR receive minimum support from ongoing 4th HPNSP and there is no revenue budget from government exchequer to support even the core functions of IEDCR.

Recently the government has developed surveillance for maternal and perinatal deaths, cervical cancer screening, nutritional ailments and some giant NCDs in collaboration with local partners with support from development partners. Entomological surveillance takes place in the form periodic surveys by different control programs and organizations such as City Corporations. In addition, disease profile data were collected monthly by MIS-Health through online system at aggregate level. Now, individual level detail patient data collection started from all admitted patients in government hospitals through online event-capture system following ICD-10 codes. However, analyses of all MIS data are inadequate which could be a goldmine source of data for country disease surveillance.

Last but not the least, the country has developed a fantastic disease surveillance system for COVID-19 throughout the country incorporating both laboratory and clinical outcome data using modern ICT and laboratory support by the DGHS and private sector which is analyzed and displayed online daily to support preparedness and response to pandemic by the DGHS.

Our exploration through desk-review and IDIs depicts a huge number of disease surveillance program exists in Bangladesh where IEDCR plays a major role as designated government institute. However, there are certain challenges on the ground which are:

- Surveillance programs of IEDCR are project based and donor supported. There is neither any core funding from government revenue budget nor from the HPNSP 2017-'22 to support routine surveillance. As a result, a number of surveillance programs died out when project funding stopped.
- Capacity in terms of data analysis and laboratory investigations are limited. There lies huge surveillance and monitoring data without analysis, interpretation and feedback. Virtually, there is no public health laboratory in the field. Many vital posts of IEDCR are occupied by non-trained health systems personnel contributing nothing to disease surveillance or outbreak investigations which are core functions of IEDCR. IEDCR has an organogram and that is back-dated and the core financial capacity is constrained.
- There is poor co-ordination between disease surveillance programs of IEDCR and disease control programs under DGHS. Data sharing is almost absent and control programs rely more on their own monitoring data for management and decision support than surveillance data captured by IEDCR or MIS-Health. There is lack of clarity between disease surveillance and disease monitoring (reporting) and certain overlaps and grey areas remain for disease surveillance and epidemic response.
- Field personnel involved in collecting surveillance data have little idea about purpose and objective of disease surveillance. Feed-back is rare to them and supervision, monitoring and evaluation of surveillance is virtually absent.
- There is no trained epidemiologist or public health expert in the field neither at division not at district.

On the basis of above findings, we make the following recommendations for the MOHFW:

A. Management and Co-ordination: Policy makers need to revisit the TOR of individual disease control programs under DGHS and that of IEDCR to harmonize surveillance, disease control and epidemic response activities which are core functions of the MOHFW. As mandated organization for disease surveillance and outbreak investigation, IEDCR should co-ordinate all surveillance activities of the government. Disease control programs should continue ongoing monitoring and surveillance but instead of quarterly paper-based reports, they should switch on to online system of reporting preferably through event capture system as initiated by TB and kala-azar control programs. However, surveillance data sharing should be in-built online, and periodic meetings between all relevant parties should be organized at least quarterly to ensure regular analysis, interpretation and use of surveillance data. IEDCR and MIS-Health should sit together along with LDs, CDC, NCDC and TB-Leprosy& AIDS/STDs to address data duplication for locally endemic diseases. One disease bulletin should be published periodically using data from all surveillance and monitoring activities including data captured through event-capture system introduced for IPD patients in government hospitals. Monitoring and supervision need to be strengthened to ensure quality, regularity and coverage of data
B. Re-organization and restructuring of IEDCR: Organogram of IEDCR is outdated and inadequate to address emerging surveillance needs for control of both CDs and NCDs. We propose restructuring the organization taking into consideration of HR proposal already submitted to the MOHFW by IEDCR. In this regard we propose for a development project proposal (DPP) through Planning Commission of the GOB to implement in next 3-4 years to further strengthen IEDCR to meet the health systems need of the country. The DPP should include district and upazila public health positions and PH laboratories in the field to strengthen disease surveillance.
C. Early warning system: The existing integrated disease surveillance system should be revisited and strengthened using laboratory support and ICT tools for functioning as an early warning system for

epidemics of locally endemic and emerging communicable diseases. Data analysis and visualization training is needed in this regard for IEDCR scientists.

D. Capacity: Public health laboratories should be established peripherally at strategically located districts/divisions to support IEDCR in surveillance. Also, there is need for establishing an epidemiological unit at district and division to support both surveillance and disease control. Capacity to conduct statistical analysis must be enhanced at IEDCR and program offices along with filed offices at districts and divisions. Public Health Epidemiology positions has already been proposed.
E. Funding: Uninterrupted and secured funding is essential to carry out core surveillance and outbreak investigation functions by IEDCR. We propose core funding from government exchequer through creating a surveillance code from revenue budget to perform core functions of IEDCR. Essential surveillance funds should be available from ongoing health sector program. We propose an incorporating a Disease Surveillance OP in the upcoming SWAp of the MOHFW. Additional funding should be mobilized through competitive project grants as practiced now by IEDCR.

1. Background

1.1. Global context

Disease surveillance is an integral part of national public health systems which is defined as "regular and systematic collection, analysis, and interpretation of important disease specific data for use in planning, implementing and evaluating public health policies and programs". The International Health Regulations (IHR) 2005 state that an effective public health system should conduct surveillance activities to enhance detection, reporting, notification, verification, response, and collaboration in the event of an outbreak. The main role of disease surveillance is to predict, observe and minimize the harm caused by outbreak, epidemic and pandemic situations, as well as to enhance knowledge about which factors contribute to such circumstances. Since 1969, WHO has required that all cases of cholera, plague, typhus, yellow fever, smallpox, and relapsing fever are to be reported. In 2005, poliomyelitis and SARS have been included in the existing globally notifiable disease list. WHO's Health Emergency Program monitor these high threat communicable diseases on an ongoing basis. International Health Regulations (IHR) 2005 obligates all WHO member states to develop an effective surveillance system to enhance early detection, reporting, notification, and verification of outbreaks and epidemics from emerging and re-emerging communicable diseases to support timely response by the national governments.[i] Thus, the main aim of surveillance is to identify outbreaks before they become epidemic and guide public health decision making for effective preparedness and response. The ongoing COVID-19 pandemic strongly urges for the need for a robust and effective disease surveillance system to improve public health.

Conventionally, disease surveillance covered high threat communicable diseases with epidemic potentials; but now in the context of epidemiological transition, disease surveillance covers certain NCDs and their risk factors, nutritional ailments and other health related outcome variables. COVID-19 pandemic has clearly demonstrated the need for a strong national surveillance system with adequate public health laboratory support to contribute to pandemic preparedness and response. With the advent of modern communication technology, there have been dramatic changes in the surveillance system throughout the world. However, to be effective, the surveillance data collection tools must be standardized and analysis and interpretation should be regular and scientifically sound, and communication and feedback should be adequate and timely to trigger action by the concerned authority. Surveillance being an active and continuous process, requires resources and capacities in terms of trained public health epidemiologists, tools, techniques, diagnostic facilities, and modern ICT support. Personnel that contribute to the national surveillance are most valuable part of the system itself and their skills, motivation and engagement must be guaranteed within inherent design of the surveillance system. Introduction ICT has revolutionized the surveillance system globally and organizations like WHO and CDC can now report cases and deaths from a number of notifiable diseases within days, and sometimes within hours and now during COVID-19 pandemic, daily updated dash-boards are available on-line for majority of WHO member countries using national surveillance data. However, in the context of post-COVID-19 health systems' strengthening, there is a need for innovation to streamline the national disease surveillance systems particularly in resource-poor countries to address future epidemics and health emergencies.

1.2. Country context

Bangladesh has a long experience in communicable disease surveillance that contributed a lot in the eradication of small-pox and polio, control of vaccine preventable and other communicable diseases and diarrhea, acute respiratory tract infections (ARI), malaria and filariasis. Epidemiological Information Sheet (EIS) was introduced by IEDCR during early nineties to monitor incidence and prevalence of certain communicable diseases of public health importance such as diarrhoea, pneumonia, malaria, measles, TB, filariasis and poliomyelitis. EPI is conducting surveillance for certain 'vaccine preventable diseases (VPDs)' since early nineties. In recent years, IEDCR has strengthened its capacity for web-based disease surveillance with data from communities and health facilities including sentinel sites. IEDCR has also introduced disease specific surveillance system with routine and ad-hoc data collection systems for a number of communicable diseases such as influenza, dengue, nipah-virus, dengue, and cutaneous anthrax. Disease control programs under Line Director CDC, and LD, TB, leprosy and AIDS/STDs also conduct surveillance for a number of communicable diseases. However, no formal evaluation of surveillance activities of IEDCR and other departments/organizations has been undertaken so far to inform policy for future health systems strengthening. Recent experience with COVID-19 pandemic suggests that an effective surveillance system is possible to develop throughout the country with modern ICT and laboratory support. In the post-COVID19 scenario there is a need for strengthening overall disease surveillance system of the country to develop early warning system for better preparedness and response to future epidemics and health emergencies.

This TA is to support the planned activities of the communicable disease control (CDC) operational plan (OP) under the 4th Health, Population and Nutrition Sector Program (4th HPNSP) 2017-2022 of the Directorate General of Health Services (DGHS), MOHFW by the FCDO of the British Government through BHB. The result will provide inputs for further strengthening of the country disease surveillance systems for early detection and prediction of future epidemics from emerging and reemerging communicable diseases.

2. Objectives

i) To describe the situation of the surveillance activities of the government and other stakeholders in the field of health, population, and nutrition.
ii) To identify the challenges, gaps and future needs in the existing disease surveillance systems of the government and other organizations for establishing early warning system for emerging and re-emerging communicable diseases.
iii) To explore the data system in terms of quality (validity, timeliness, and completeness), analysis, interpretation and communication the extent to which surveillance data is triggering appropriate control measures.
iv) To understand the challenges and opportunities for effective use of surveillance data by respective disease control programs
v) To review the current OP provisions and planned activities under 4th Health Sector Program (2017-22) as well as any other DP supported interventions in this area.
vi) To determine the additional inputs needed to make the surveillance system effective for disease control and forecasting/ signalling future epidemics.
vii) To make recommendations for appropriate measures at policy and programme levels, for strengthening the surveillance systems for epidemic preparedness and response.
viii) To develop an action plan in consultation with the concerned officials.

3. Methods and materials

All activities under this TA were guided by the Line Director, Communicable Disease Control (CDC), DGHS and Director, Institute of Epidemiology, Disease Control and Research (lEDCR), DGHS. The consultant worked closely with relevant professionals working at IEDCR and several disease-control programs under DGHS. Line Director Communicable Disease Control (CDC), Line Director Non-Communicable Disease Control (NCDC), Line Director TB/Leprosy & HIV/AIDS Control, and Line Director HMIS & E-Health were contacted for identifying relevant key personnel involved in disease surveillance activities under the respective operational plans (OPs) of the 4th Health Sector Program. In addition, the consultant made filed visit to 2 field surveillance sites (Nilphamari and Cox's Bazar districts) to understand field surveillance activities including data and sample collection and their transmission/transportation in detail.

Methodologically, it was a mixed-method exploratory study where documentary review and in-depth interviews (IDIs) with key stakeholders were main data collection methods which was supplemented by field visits to 2 surveillance sites and a stakeholders' consultation meeting to share and refine the findings from IDIs, field-visit and documentary review.

3.1. Data collection

Documentary Review: Extensive desk-review was undertaken that included published literature on disease surveillance from both developed and developing countries along with institutional publications of WHO and CDC-Atlanta. All program related documents on disease surveillance from DGHS, IEDCR, icddr,b and other organizations involved in disease surveillance were reviewed with particular focus on operational plans of related line directors such as CDC, NCDC, TB-Leprosy-HIV/AIDS, and MIS and e-health of the DGHS. Webpages of IEDCR, DGHS and icddr,b were visited to look for surveillance related data and documents. Disease surveillance activities undertaken or supported by icddr,b, BRAC, and BSMMU were also reviewed. In summary, through desk review, we gathered information on all major surveillance systems implemented in the country along with their usefulness in supporting disease control programs and signalling impending epidemics for better emergency preparedness and response.

In-depth Interviews (IDIs): IDIs were conducted with relevant stakeholders of related government and non-government organizations involved in surveillance activities to address the study objectives. IDIs helped in identifying all communicable and non-communicable diseases under surveillance in the country along with their data collection systems, reporting unit, periodicity of reporting, use of ICTs in data management and visualization, mode of communication (reporting and feedback), and extent of use by program managers and policy makers. IDIs also clarified the barriers and facilitators for effective surveillance along with skill-needs of the professionals involved, and logistics needs of the responsible institutes including laboratory facilities and ICTs. IDI respondents were selected in consultation with the Director IEDCR and LD, CDC, DGHS and that included relevant program managers and/or deputy program managers of TB, malaria, filaria, leprosy, kala-azar, NCD, and EPI program of the DGHS. We interviewed 7 professionals from IEDCR including Director, ex-director, CSO, PSOs and junior level epidemiologists and laboratory scientists. We also interviewed representatives from icddr,b, BRAC, UNICEF and NNP who are/were directly involved in surveillance activities to capture their perspectives about ongoing disease surveillance activities including usability of surveillance data for disease control and epidemic response. We also conducted IDIs with district civil surgeons, UHFPOs, RMOs, statisticians, senior staff nurses from 2 districts and 4 upazilas under Nilphamari and Cox's bazar districts. In particular, they were asked about loopholes in surveillance data collection, analysis, feedback and use, and way forward to overcome. All interviews were recorded using digital recorders with prior consent of

the respondents. An open-ended interview guideline (topic-guide) was developed to facilitate qualitative data IDI data collection. A total of 37 IDIs were conducted.

Field visit: We visited Cox's Bazar and Nilphamari districts to understand the ongoing surveillance activities at the most peripheral level along with their strengths, weaknesses, opportunities, and threats. Field visit helped in understanding local contexts and the extent of use of surveillance data at level of collection. Interview of district and sub-district health managers were organized during the field visit.

Stakeholder consultation: A stakeholder consultation was organized to share the findings from desk review, IDls and field visits to incorporate their inputs in the final report. LD, CDC facilitated the stakeholder workshop.

3.2. Analysis of data

Qualitative data analysis is an iterative process. Finding from desk-review was aligned to address the objectives of the study. In this exercise, qualitative data collection, transcription and analysis took place simultaneously. The analysis process started with preparing transcripts which took place immediately after each interview. All interviews were recorded with a digital recorder with permission from the respondents. A summary of each interview was prepared. After that, the transcript was read and re-read to develop a code list. This code list was applied for all transcripts to code the data. Data was coded manually. After coding of the data, the consultant searched for patterns in the codes across different interviews to identify the themes; and based on the themes, a thematic analysis was undertaken to address study objectives.

4. Results

In Bangladesh, the Institute of Epidemiology, Disease Control and Research (IEDCR) under DGHS, Ministry of Health and Family Welfare (MOHFW) is the national agency responsible for conducting disease surveillance and outbreak investigation. However, from the documentary review, IDIs with key stakeholders, and limited field visit to surveillance sites, it is evident that in addition to IEDCR, a number of public and private organizations are involved in disease surveillance activities. Important among them are the disease control programs under DGHS such as malaria, filaria, and kala-azar, TB, leprosy and diarrhoeal disease control programs; BSMMU, icddr,b and BRAC. Often, there is confusion among program managers and field implementers regarding the difference between disease surveillance and disease reporting/monitoring. Also, there is duplication of surveillance activities by different organizations and gray areas in terms of responsibility of surveillance and response. We describe country disease surveillance systems under the following broad headings for easy understanding of the target audience:

1. Surveillance for vaccine preventable diseases
2. Surveillance for locally endemic diseases
3. Surveillance for emerging and re-emerging communicable diseases
4. Surveillance for NCDs and other diseases and health conditions

4.1. Surveillance for vaccine preventable diseases

Surveillance for vaccine preventable diseases (VPDs) forms part of the wider country public health surveillance system – the continuous collection, analysis, interpretation and health outcome data needed for the planning, implementation and evaluation of disease control programs. In Bangladesh, national EPI program is conducting VPD surveillance since early nineties following both active and passive surveillance data collection systems. The VPDs include acute flaccid paralysis (AFP), measles, neonatal tetanus (NNT), congenital rubella syndrome (CRS) and acute encephalitis syndrome (AES). In addition, any adverse events following immunization (AEFI) are monitored continuously and incidences of AEFI are reported weekly for non-serious events and daily for serious adverse events by the medical-technologist, EPI (MT-EPI) of a upazila using a prescribed format. The country has maintained global AFP surveillance certification standards since 2001. Lab surveillance is well linked to field surveillance and the national WHO accredited laboratory for polio, measles and CRS is located at Institute of Public Health (IPH), Mohakhali, Dhaka, that supports the surveillance system conducting laboratory investigations for AFP, measles and CRS. Recently IEDCR has joined the mission and supports Acute Encephalitis Surveillance (AES) through conducting laboratory investigations of AES samples for detecting Japanese Encephalitis (JE) cases. The VPD surveillance system is well-functioning at all levels with defined norms and standards.

In the field both active and passive surveillance data collection for suspected VPD cases takes place simultaneously. Active VPD surveillance is facility based and conducted at OPDs and IPDs of district hospitals and UHCs by medical officers and RMOs. After detection, 1st case-investigation is conducted by government MOs using prescribed forms; and the second investigation by WHO deployed Surveillance Immunization Medical Officers (SIMOs) using pre-designed case-investigation forms. After investigation, samples are collected for AFP, measles, CRS and AES by the MT-Lab of UHCs or DHs. For AES both blood and cerebrospinal fluid (CSF) are collected, for AFP stool sample, for CRS blood sample, and for measles blood and nasal swabs are collected by MT-Laboratory working at DHs and UHCs. Samples are sent to Dhaka by a designated porter either at IPH or at IEDCR for laboratory investigation.

Under passive VPD surveillance, suspected VPD cases are detected by HAs during their routine domiciliary home visits and from community clinics. They report to AHIs who compile the VPD cases and send the report weekly to MT-EPI at upazila level who send the weekly report to EPI headquarter (often with the help of upazila statistician). Active surveillance cases detected from district hospitals and UHCs are added with the weekly VPD reports. Passive VPD surveillance is still paper-based except AES where web-based data collection is started through the DHIS-2 system. Private sector facilities also provide VPD data regularly to respective health offices which are included in the weekly reports. The VPD surveillance system is well-maintained by EPI Headquarter with support from WHO and LD-MIS, DGHS, IEDCR and IPH. Some NGO hospitals such as Aravind Hospital, Dinajpur function as CRS sentinel surveillance site where blood samples are collected from children with rubella syndrome for ELISA test.

4.2. Surveillance for locally endemic diseases

In this section we describe surveillance systems for malaria, tuberculosis, kala-azar, filariasis, leprosy, HIV/AIDs and diarrhoeal diseases. According to ongoing health sector program (HNPSP 2017-2022) the control programs for these diseases are led by 2-line directors under DGHS: one is LD, Communicable Disease Control (LD-CDC) and the other is LD, TB, Leprosy and AIDS/STD Control. Malaria, filaria, kala-azar and diarrhoea control programs are managed by PMs under LD-CDC while TB, leprosy and AID/STDs are under the purview of the LD, TB, Leprosy and AIDS/STDs.

Our exploration depicts that in general, surveillance for locally endemic diseases are conducted by the respective disease control programs mostly in the name of monitoring and surveillance. The program offices do mostly passive surveillance where aggregate level data are collected monthly (malaria) or quarterly (Tb, leprosy, filariasis, and kala-azar) from the field using paper-based data collection systems. Some of the programs such as TB, malaria and kala-azar has initiated individual level online data collection using DHIS-2 data-capture system. In addition, Weekly Infectious Disease Surveillance (IDS) system of IEDCR collects data through DHIS-2 systems on 14 infectious diseases disaggregated by age and sex (Table 1). While monthly field reports of health assistants (HAs) cover majority of locally endemic communicable diseases (if any). These monthly aggregate level surveillance data are submitted by HAs themselves or by upazila statisticians monthly using the DHIS-2 platform to MIS-DGHS. Previously, disease profiles from in-patient departments of government hospitals were sent monthly to MIS-DGHS using the DHIS-2 platform which also included these communicable diseases of public health importance. Recently an *event capture* system has been introduced for all government hospitals under the DGHS where disease information of all IPD patients is entered by an assigned staff-nurse of the hospital on a continuous basis using DHIS-2 platform following ICD-10 codes. DGHS control room (under Director-MIS) also collects data on a daily basis during flood, cold-waves, epidemics and outbreaks through online and telephonic communication that include diarrhoea, dengue, malaria and other diseases with support from LD-CDC, DGHS. However, analyses of the disease profile and routine surveillance data captured through IEDCR and MIS-DGHS is inadequate and rarely shared with relevant stakeholders than routine immunization or EOC performance data captured through similar online DHIS-2 systems. In addition, surveillance for certain communicable diseases are being conducted or supported by icddr,b, BSMMU and BRAC. For example icddr,b conducts surveillance for diarrhoeal diseases since 1979 and on a project basis they support IEDCR in conducting surveillance on certain emerging and reemerging communicable disease surveillance such as SARS-CoV 2 Genome variant, nipah, influenza, zoonotic diseases and rotavirus and intussusception.

Table 1 Communicable diseases under weekly integrated communicable disease surveillance of IEDCR

1. Acute watery diarrhea 2. Blood dysentery 3. Pneumonia 4. Severe pneumonia 5. Very severe disease, 6. Severe acute respiratory infection (SARI) 7. Acute meningitis-encephalitis syndrome	8. Dengue fever 9. Acute hepatitis 10. Kala-azar 11. Cutaneous anthrax 12. Malaria 13. Enteric fever, 14. Probable rabies

4.2.1. Malaria Surveillance

Malaria is a significant public health problem in Bangladesh. The disease is endemic in 13 (out of 64 total) districts, with over 17 million people at risk. Cox's Bazar and Chittagong hill districts (Bandarban, Khagrachhari and Rangamati) report over 90% of cases and 80% of deaths. Over 80% of malaria cases occur in the high transmission period from May to September, when there is increased rainfall and high humidity.[ii] A coalition of government and non-government organizations led by BRAC supports the malaria elimination efforts of the National Malaria Elimination Program (NMEP) under LD, CDC of DGHS works with a coalition of 16 NGOs steered by BRAC. Some evidence suggests that the prevalence of malaria in Bangladesh has decreased since the Global Fund to Fight AIDS, Tuberculosis and Malaria started to support the National Malaria Control Program (NMEP) in 2007.

Malaria surveillance is conducted by malaria elimination program of CDC, DGHS. They follow both active and passive surveillance data collection methods. Under passive surveillance, all patients with fever at OPDs and IPDs in government hospitals in the endemic area are tested for malaria using rapid diagnostic test (RDT). Positive case is reported monthly by UHC using DHIS-2 platform. Malaria case report also come from CCs in high endemic areas where there is facility for RDT. Majority of private hospitals in high endemic areas also participate in this passive surveillance system providing malaria reports monthly to UHFPO or Civil Surgeon. Upazila statistician include all these data in the monthly reports and submits to NMEP using DHIS-2 platform.

Active surveillance takes place in the community and by the community health workers of partner NGOs. Government HAs also participated in these active surveillance systems. Health workers (from government and NGOs) search for fever cases in the communities of endemic areas. They collect blood for RDT and if positive report monthly to their upazila managers. Monthly consolidated data are sent by NGO Upazila manager to NMEP using DHIS-2 platform. A hard copy is sent to UHC as well. Majority of malaria cases (more than 80%) are reported through this community based active surveillance system where BRAC led NGOs play a key role. However, all these data are collected at aggregate level; disaggregation is possibly by age and sex only.

In addition to the aggregate level reporting, the case-based surveillance is in place in elimination settings (10 malaria elimination-targeted districts). Each positive case diagnosed in elimination settings is investigated and classified (Indigenous / Imported). Additional case searching around the index case

followed by entomological interventions (focus investigation and response) are conducted there. The national program follows the 1-3-7 system there. Each positive case is notified from the field by SMS to all concerned up to central level on Day 0 (the same day the case was diagnosed). Then the case is investigated by Day 1, additional case searching by day 3 and focus investigation and response by day 7. Due to the scarcity of entomologists, the national program cannot conduct focus investigation and response all the time. But each positive case in elimination settings is investigated through a prescribed Case Investigation From and subsequently classified. It's paper-based at this stage. National program is working with HISP, India under a TA from WHO to develop the malaria modules (both aggregated and tracker) in DHIS2. If everything goes according to plan, the national program will be able to start piloting in DHIS2 from January 2022 onward. In addition, IEDCR and MIS-Health collects data weekly and monthly malaria data at aggregate level from UHCs through online DHIS-2 system.

4.2.2. Leprosy Surveillance

Leprosy Surveillance is conducted by the National Leprosy Program (NLP) under Line Director, TB, Leprosy and AIDS/STD. Upazila Health Complex is the reporting unit where statisticians with the help of TB and Leprosy Control Assistants (TLCAs) send data on quarterly basis to district and national program office. Indicators include (1) number of suspected cases, (2) smear positive cases (3) new cases detected (4) cases on treatment, (4) treatment completed, and (5) No. of grade 2 disability (G2D) in new cases. Analysis takes place at the NLP office and annual reports are generated compiling quarterly reports to submit to DGHS and MOH with a copy to WHO country office. Rates are calculated to monitor progress over time and compare between regions. In addition, monthly leprosy data come through the DHIS-2 system to MIS-DGHS on a regular basis.

Strengths: reports are regularly submitted and yearly compilation by NLP provide important inputs to improve control measures. Eight NGOs support program management, service delivery, supervision, monitoring, surveillance and research.

Weaknesses: Online monthly surveillance data collection through DHIS-2 software started but further input needed to ensure timely entry of complete data and proper analysis, interpretation, feedback to reporting units and dissemination through dashboards and annual reports to support future strengthening of control measures.

4.2.3. Tuberculosis Surveillance

Tuberculosis is an infectious disease caused by *mycobacteria tuberculosis* responsible for the highest number of deaths from a single infectious agent globally. Among the 30 high TB burden countries, Bangladesh is ranked seventh; and among the high multidrug-resistant TB (MDR-TB) burden countries, Bangladesh is ranked 14th. According to the Global Tuberculosis Report, 2020 of the World Health Organization, the estimated incidence of TB is 221 per 100,000 population per year with a mortality rate of 24 per 100,000. Some of the country's TB indicators have shown a positive trend over time: TB treatment coverage increased to 81 percent in 2019; deaths among TB/HIV-negative patients decreased to 24 per 100,000 in 2019; and a high treatment success rate (TSR) of more than 90 percent for drug-susceptible TB (DS-TB) cases has been maintained. While there has been an increase in TB treatment coverage, an estimated 70,000 TB patients remain undiagnosed each year. Additionally, only an estimated 40 percent of drug-resistant TB (DR-TB) cases are being enrolled on proper treatment regimens. Recently, the NTP developed a National Strategic Plan (NSP) for TB control 2021-2025 to achieve the key milestones of reducing TB deaths by 75 percent and TB incidence rate by 50 percent by 2025.

The national TB control program has established a strong monitoring and surveillance system to support TB control in the country. NTP collects quarterly TB reports from reporting units. Previously it was paper-based, now it through online DHIS-2 electronic reporting system. Besides quarterly reporting, an electronic individual case-based recording and reporting tool has been introduced in Bangladesh termed e-TB-manager. There are 1135 TB diagnosis sites and 858 TB reporting units all over Bangladesh. Among them in 764 units, all the data are being entered using ETB manager by TLCA. Among them 378 units are linked with central DHIS-2 data repository. The other 94 units are lacking in technical and human resource support to start the process. The analysis reports are prepared quarterly.

In addition, TB surveillance is conducted by both MIS-DGHS and IEDCR through their online monthly and weekly reporting systems from UIHCs. The indicators under surveillance are PTB+, PTB-, EPTB and TB in children.

4.2.4. Kala-Azar Surveillance

Kala-azar (KA), also known as visceral leishmaniasis (VL), is a vector-borne disease caused by the parasite *Leishmania donovani* carried by the vector sandfly. Kala-azar is a considerable problem in Bangladesh and affects mainly the poor community. The disease is endemic in 100 upazilas in the midland and northern part of the country. However, recent reports show cases in upazilas beyond declared endemic zones. Effective disease and vector surveillance is important for success in controlling kala-azar. Kala-azar is a mandatory notifiable disease according to 'Bangladesh infectious disease prevention, control and elimination act 2018'.

IEDCR had established a surveillance system based on passive VL case detection from the field through weekly EIS reports even before the initiation of the VL elimination program in 2008. The major weakness of previous EIS surveillance program was under-reporting and inadequate analysis of collected data. Nevertheless, this was the only surveillance system for the program to evaluate the disease situation in the country. Now kala-azar surveillance data are captured monthly by MIS-DGHS and weekly by IEDCR using the DHIS-2 platform. In addition, the Kala-Azar Elimination program quarterly collects disease reports from UHCs and compiles them annually.

Newly developed "Kala-azar Surveillance, Outbreak Investigation and Monitoring and Evaluation Guideline" emphasized 3 approaches for active case detection. The country program initiated a cluster/camp approach for active detection of VL and PKDL cases in endemic villages. Under this approach, if there are more than 2 old cases in a community or a village, a camp is established on a certain day for active case search in the community. An expert team goes there from the program office on that particular day. They first orient the local health staff that include government medical officers, nurses, AHIs, HIs and HAs. At least two volunteers are recruited for that day to facilitate the process where one of them is preferred to be educated kala–azar patient. With these people several teams are formed (one for every 30 households). The team members search for fever cases suffering for more than 2 weeks and send them to the camp for further tests. Patients with white patches in their skin with sensation are considered PKDL and are referred to UHC for further investigation and treatment. If the patches are painless, they are considered as leprosy cases. The doctors carry out clinical examination and a rapid diagnostic test (RDT) for confirmation of kala-azar. If it's a positive case of kala-azar then the patient is admitted to UHC. Every confirmed kala-azar and PKDL individual case records data are entered by HAs through online DHIS-2 data collection systems. In case of an outbreak in a non-endemic area a thorough investigation is carried out to find the source.

The camp approach has been found to be the most cost-effective intervention for active detection of cases with VL and PKDL. One of the remarkable successes of the program is that for the first time, all VL endemic villages are mapped and stratified according to their VL endemicity.

4.2.5. Filariasis Surveillance

The Bangladesh Lymphatic Filariasis (LF) Elimination Programme has made significant progress in interrupting transmission through mass drug administration (MDA) and has now focused its efforts on scaling up managing morbidity and preventing disability (MMDP) activities to deliver the minimum package of care to people affected by LF clinical conditions. At the inception of the programme, an estimated 70 million people were at risk of infection. Over the past two decades MDA has been successfully scaled up across the 19 endemic areas with the interruption of transmission confirmed through transmission assessment surveys (TAS). In total over 35 million people were treated in the 19 most endemic districts till September 2016. The other 15 endemic districts were classified as low-endemic not requiring MDA as mf prevalence rates were below 1%.[iii] Their low endemicity has also been confirmed through TAS, and recent molecular xenomonitoring for W. bancrofti in Culex quinquefasciatus in two districts in the northern endemic region.[iv] Collectively, these implementation activities and impact assessments provide evidence that the Bangladesh programme is on target to meet the GPELF's first aim of interrupting transmission.

Surveillance of filariasis is conducted by the Filariasis Elimination program through quarterly paper-based report from upazilas in endemic districts. MIS-DGHS collects monthly aggregate level data from UHCs through DHIS-2 platform. There was a survey-based surveillance program in Gaibandha, Dhaka and Panchagar districts, conducted by CDC to explore microfilaria and some antigen during 2013-2018.[v] Through these surveys if MF prevalence was found more than 1%, 5 round MDA was conducted; if MF rate was less than 1% then 3 TAS (transmission assessment survey) done among school children of primary schools where antigen is examined.

4.2.6. Surveillance of diarrhoeal diseases including cholera

Surveillance of diarrhoea is conducted by a number of organizations that include CDC, Control Room and MIS department of DGHS, IEDCR and icddr, b. Acute watery diarrhoea and blood dysentery case reports are sent routinely to IECDR (weekly) and MIS-Health (monthly) using DHIS2 platform from UHCs. In addition, daily reports are captured during floods and outbreaks by CDC and MIS with the help of control room of DGHS through DHIS-2 systems. Often, telephonic data collection takes place by the CDC and Control Room of DGHS during floods and outbreaks.

A facility based surveillance system is in operation since October 1979[vi] at icddr,b Dhaka hospital to study a 4% systematic sample of the admitted patients with diarrhoea who come to the hospital for care each year to study causes of diarrhoea.[vii] In May 2014, the icddr,b and the Institute of Epidemiology, Disease Control, and Research (IEDCR) collaboratively started the hospital based enteric disease surveillance in 10 hospitals in 8 administrative divisions of the country. From May 2016, surveillance was expanded to additional 12 facilities focusing on cholera surveillance. A total of 22 surveillance sites (13 districts, 6 subdistricts, 2 tertiary-level hospitals, and the Bangladesh Institute of Tropical and Infectious Disease [BITID]) were established across 21 different districts. Sentinel surveillance sites were selected based on reports of acute watery diarrhea and cholera (including analyses of data from the national database captured by MIS-Health through DHIS2 software) and previously published cholera surveillance studies.

Soon after the influx of Rohingya population in Cox's Bazar district, a surveillance network was established to identify the enteric pathogens and early detection of cholera epidemics.[viii] Some of the results of this ongoing surveillance system have been presented through scientific communication in peer-reviewed journals.

4.2.7 HIV Surveillance

Bangladesh has been implementing behavioral- and sero-surveillance survey since 1998 among high-risk population groups based on WHO/UNAIDS guidelines for 2nd generation HIV surveillance. Till today 9 surveys have been conducted. First 8 surveys were conducted by icddr,b in collaboration with IEDCR while the last (9th) survey was conducted by virology department of BSMMU. As Bangladesh has continued to remain a low prevalence country for HIV, sampling concentrated on those populations considered most vulnerable to HIV, and those that may act as a bridge from the most-at-risk to the general population. Blood samples are collected voluntarily through organizations running HIV intervention programs.

The 9th survey was conducted by BSMMU in 12 districts during Oct-Dec 2020 among high-risk population groups that included female sex workers (FSWs), intravenous drug users, males having sex with males (MSM), male sex workers (MSWs), and transgender women (locally known as hijra). This sero and behavioral surveillance were conducted on over 9800+ populations. This is now known as the Integrated Bio-behavioral survey (IBBS). Every sample was tested in the field and an external quality assessment was in place for ensuring test quality. All syphilis positive samples were sent to BSMMU for confirmation. All HIV positive slides along with 5% negative samples were sent to BSMMU for re-examination. Antibodies to hepatitis C was also measured. In addition, the GOB has been compiling annual HIV case figures by passive reporting from a number of institutes since 1989.

Suggestions: There should be an organization with appropriate manpower and resources who should plan and execute the surveillance plans, there should be coordination between organizations, it should be done in regular intervals, should have appropriate use of IT for data and survey and all the reports should be properly disseminated. The COVID-19 labs could be integrated into public health Labs.

4.3. Surveillance of Emerging and Re-emerging Communicable Diseases

Surveillance for emerging and re-emerging diseases are being conducted by IEDCR. The organization conducts sentinel sites, community based, cell-phone based, event-based and web-based disease surveillances throughout the country for a number of emerging communicable diseases with epidemic potentials. In recent years, the country experienced a number significant outbreaks of dengue, nipah virus, infection, chikungunya, avian influenza, pandemic influenza H1N1, Japanese encephalitis, hepatitis E, cutaneious anthrax, etc. In response to these, IEDCR has taken initiatives by developing workforce and enhancing diagnostic facilities to identify pathogens responsible for these outbreaks. During last 15 years, the organization has established multiple new surveillance systems for a number of emerging communicable diseases mostly in collaboration with US-CDC, icddr,b, WHO and other national and international collaborators. All these innovative surveillance activities of IEDCR is in addition to their core task of outbreak investigation and web-based integrated disease surveillance for 14 priority communicable diseases (mentioned in the section under 'surveillance for conventional tropical diseases). The new surveillance systems of IEDCR cover a number of emerging communicable diseases that include influenza, nipah, dengue, anthrax, rotavirus and intussusceptions, chikungunya, Japanese encephalitis, hepatitis E, genomic surveillance for SARS-Cov2 variants, acute meningo-encephalitis syndrome, and

unintentional acute pesticide poisoning among young children. Data from community, as well as from health facilities (sentinel sites), are collected under these surveillance programs. The laboratory investigation capacity of IEDCR has been strengthened in recent years to support these new surveillance activities for emerging communicable diseases. Capacities of some medical college and district hospital laboratories have been strengthened to support disease surveillance activities of IEDCR. In 2009, the organization established a *media-based surveillance system for public health events*[ix] through monitoring print and electronic media to detect outbreaks quickly. The national rapid response team, consisting of key staff members from IEDCR receive an email containing all health-related articles and video-clips, examine them and decide whether to go for an outbreak investigation on the basis of their epidemiologic knowledge (numbers of cases, deaths and severity of symptoms); and verification by local health officials. The event-based surveillance could draw attention of the national and global community as an effective measure to support epidemic control.. IEDCR has also established *cell phone-based disease surveillance system* to collect information on women about their reproductive health. The project was supported by International Association of National Public Health Institute (IANPHI) and United States Center for Disease Control and Prevention (US-CDC) provided the technical assistance.

In 2016 IEDCR started *Behavioral Risk Factor (BRF) and Non-communicable disease (NCD) surveillance* with the support from NCD Control Program of Directorate General of Health Services (DGHS) and funding from Health Population Nutrition Sector Development Program (HPNSDP) of Ministry of Health and Family Welfare (MoHFW). This was the first nationwide community based BRF and NCD surveillance.

Event-based surveillance is another innovation of IEDCR that collects data from usual surveillance system as well as from dedicated hotlines (24/7) of IEDCR, media monitoring, and any formal and informal sources. IEDCR has established Public Health Emergency Operation Centre (PHEOC) which in time of any outbreaks plays an vital role during in any outbreaks. They immediately optimize the national response team which verifies and further investigates and coordinates outbreak response. During last 15 years, event-based surveillance of IEDCR contributed a lot in combating epidemics of influenza, nipah-virus infection, and anthrax. However there remains discord and poor communication between different departments about who should response, which creates problems during even based response. PHEOC should be independent and have full control over emergency response.

Most of these surveillance activities under IEDCR are project based with support from external donors. As a result, after project tenure, it becomes difficult to continue the developed surveillance program with own resources. Here we describe disease specific surveillance system for major emerging communicable diseases organized by IEDCR.

4.3.1. Influenza Surveillance

Influenza is a serious and highly infectious respiratory illness. Historical records indicate that influenza epidemics have occurred among the human population for hundreds of years. Since its establishment in 1948, the Global Influenza Surveillance and Response System (GISRS) has updated seasonal vaccine compositions and developed a global alert mechanism for the emergence of influenza viruses with pandemic potential. GISRS functions through 143 National Influenza Centers in 113 countries. Since 2007, IEDCR has been functioning as NIC for Bangladesh.

Influenza surveillance was established in Bangladesh by IEDCR with support from US-CDC and WHO in May 2010 with an objective of identifying strains of influenza viruses circulating in the country. Influenza surveillance is being conducted in 8 district hospitals and 2 government medical college hospital (Annex 3). From each sentinel site 10 samples are collected from OPD patients with ‘influenza

like illnesses' (ILIs) every 2 weeks. Samples are also collected from all 'severe acute respiratory illness' (SARI) patients admitted in the IPDs of these hospitals. Samples are transported to the IEDCR laboratory biweekly by dry shipper for virological testing. Results of the surveillance are disseminated by the periodic National Influenza Surveillance, Bangladesh (NISB) bulletin.

IEDCR and icddr,b have been conducting avian influenza surveillance in poultry since 2007 in collaboration with the department of livestock services (DLS), of the government of Bangladesh. US-CDC has provided funding and technical support from the beginning. The surveillance team visits selective live bird markets (LBMs) on a monthly basis to collect samples and data from poultry. Samples are tested to detect avian influenza viruses using RT-PCR at icddr,b lab. During 2007 to 2017, a total of 16,757 poultry and 2,040 LBM environment samples were collected.

4.3.2. AMR surveillance

Antimicrobial resistance is one the most complicated threats to global health. Excessive and unsupervised use of antimicrobials have resulted in the emergence of multi-drug resistant infections causing very limited options for antimicrobial treatment. In May 2015, the 68th World Health assembly adopted the Global Action Plan (GAP) on Antimicrobial Resistance. One of the 5 strategic objectives of the GAP was to strengthen the evidence base through surveillance and research. All countries are required to develop their own action plan based on GAP and start and start implement it at country level. Accordingly, GOB developed "National Action Plan for Containment of AMR 2017-2022". Surveillance is one of the effective tools to address this multifaceted problem.

IEDCR started a nationwide AMR surveillance since 2016 with support from the US-CDC through Global Health Security Agenda (GHSA) and later on with support from the World Health Organization (WHO) and the Government of Bangladesh. This is a case-based surveillance in accordance with the Global Antimicrobial Resistance Surveillance System (GLASS) protocol of the WHO where the objective is to know the sensitivity pattern of some common bacteria to help developing a national guideline for the clinicians and policy makers to address the problem. The AMR surveillance is going on in 9 sentinel sites (public sector tertiary level hospitals) throughout the country (Annex 3)). Under this surveillance program five types of cases (UTI, diarrhoeal diseases, wound infection, pneumonia and septicemia) are selected according to case-definitions and 6 types of specimens (urine, stool, wound swab, blood, sputum and endotracheal aspirate) from the selected cases are collected and tested in the microbiology department of the sites (medical college hospitals) for identification of causative agent (bacteria) and their antibiotic sensitivity pattern. All surveillance data comes to IEDCR and their laboratories function as reference laboratories for human health while Bangladesh Livestock Research Institute (BLRI) function as reference laboratories for animal health. Funding was initially from US-CDC and WHO and in 2018 Fleming Fund joined. The Fleming Fund is now is running the program in collaboration with the CDC of DGHS and IEDCR.

Strengths: The awareness of AMR has increased significantly among the public; there are collaborations with multiple donors and partners; political commitment is there from a high level.

Weaknesses: Lack of workforce, the laboratories are overburdened and lack of supplies, poor quality of care (reports are not reliable), funding not continuous (project based), surveillance reports are not regularly communicated to the target audience; public health laboratories are becoming service labs.

Suggestions: It should be programme based, not project based; the laboratories should not be in medical colleges but in district hospitals; the quality of laboratories including reference laboratories should be enhanced; surveillance data should be published regularly to improve the programme.

4.3.3 Hospital-Based Rotavirus and Intussusception Surveillance (HBRIS)

The Hospital-Based Rotavirus and Intussusception Surveillance (HBRIS) was established in 2012 with joint participation from IEDCR and icddr,b with technical support from US-CDC.[x] Later in 2019 IEDCR took over HBRIS (as per transitional plan) with the support of WHO. The goal of this surveillance was to find out the frequency of hospitalizations due to rotavirus-associated illness in children under 5 years of age in Bangladesh. It also wanted to estimate the rate and ratio of intussusception-associated hospitalizations in the country. The Rotavirus surveillance was initiated at 3 sites in July 2012 and now is extended to 7 divisions all over in Bangladesh. Surveillance follows 'WHO protocol for rotavirus surveillance in hospital settings'.[xi] These hospitals were selected due to their higher number of pediatric gastroenteritis admission. At each hospital, from each day (except for weekends and holidays), field assistants identified children under 5 years of age and younger admitted to pediatric wards with diarrhoea by reviewing admission logbooks and screened them for acute gastroenteritis (AGE) symptoms. Surveillance physicians enrolled every 4th child listed who met the surveillance inclusion criteria, recorded demographic and clinical information, assessed the extent of dehydration and obtained a stool specimen (with the help of a field assistant) from every fourth child admitted who met the AGE case definition. The collected data and samples are sent to virology laboratory of IEDCR for rotavirus antigen testing by ELISA.

4.3.4. National SARS-CoV 2 Genomic Variant Surveillance in Bangladesh (NGSB)

Bangladesh observed a second wave where there was a significant rise in the COVID-19 infections since March 2021. This was due to the highly contagious variants of COVID-19 that spread more quickly and cause more infections. Therefore, it was mandatory to develop and scale up the whole-genome sequencing (WGS) capacity following a systematic approach to support the country's epidemic preparedness and response. In this context, a consortium has recently being formed with IEDCR, icddr,b, Child Health Research Foundation (CHRF), and Institute for Developing Science and Health Initiatives (ideSHi) to conduct genome sequencing for SARS COV 2 for next 12 months. The Bill & Melinda Gates Foundation is funding this consortium.

The overall goal of this collaborative approach is

- to build necessary capacity for genome surveillance
- to implement a strategic approach to amplify the information about the evolution of the virus within the country and
- to share these data between stakeholders to create a sustainable platform for epidemic surveillance in Bangladesh.

The collected data is shared between all the national and international stakeholders and the report of the circulatory SARS-COV-2 variants are submitted bi-weekly to the GISAID.ORG database which can be accessed by any of the stakeholders at any time. So far, the consortium has published 2 reports on IEDCR website. The infrastructure and capacity built through this collective initiative will hopefully create the framework for future surveillance and respond to epidemic threats.

4.3.5. Hospital based surveillance for Japanese encephalitis

Japanese encephalitis virus (JEV) is a mosquito-borne flavivirus, primarily cases asymptomatic infection in humans, but also cause illness ranging from fever and headache to encephalitis. About 3 million people in Asia and western Pacific region are at risk of Japanese encephalitis (JE). JEV is maintained in enzootic

transmission cycle between culex mosquito and animal hosts mostly pigs and wading birds, humans are infected incidentally and transmit the virus to others. Although no antiviral therapy is available, JE is largely preventable by vaccines and many Asian countries has introduced the vaccine through national immunization program. In Bangladesh, the 1st JE outbreak was reported in 1977 in the central part of the country. It is most identifiable cause of viral encephalitis in Bangladesh.

IEDCR in collaboration with icddr,b started hospital-based JE surveillance in 2007 in 3 tertiary medical college hospitals (later on, one more MCH was included) to assess the epidemiology of JE to inform public health decision making for introduction of JE vaccine into routine EPI. Surveillance coverage varied due to funding instability. Under this surveillance program, JE was defined as cases with acute onset of fever (=> 38C) and one or more of the followings: altered mental states, a neurologic deficit or sign of meningeal irritation. Surveillance physicians visited adult medicine and pediatric wards daily (except Fridays) to identify patients as per case definition, collected sociodemographic and clinical information using a standardized form, and coordinated collection of samples (CSF and 2 samples of blood on admission and discharge). Samples were tested at IEDCR lab for detection of virus and at CDC lab for confirmation. So far case positivity rate recorded was 8% during 2007-2016.

4.3.6. Hospital-based food-borne disease surveillance

Hepatitis A virus (HAV) and hepatitis E virus (HEV) cause acute hepatitis and are transmitted mainly through the fecal-oral route. HAV resulted in approximately 1.4 million cases worldwide annually and 27,731 deaths in 2010, according to the World Health Organization (WHO).[xii] Since the introduction of the hepatitis A vaccine and the start of mass vaccination in several countries in the 1980s, hepatitis A incidence has declined substantially, not only among vaccinated children but in the population as a whole.[xiii] HAV and HEV infections are endemic in many low-income settings. In Asia, many countries have been reported as low, moderate, or high endemic regions for HAV infection. Regions of high endemicity include Bangladesh, as well as India, China, Nepal, Pakistan, Myanmar, and the Philippines.[xiv]

In May 2014, icddr,b and the Institute of Epidemiology, Disease Control and Research (IEDCR) collaboratively started the diarrheal diseases surveillance system in 10 sentinel surveillance sites (seven district and two tertiary level hospitals and BITID), covering seven divisions of Bangladesh.[xv] Participants who met the case definition were enrolled after the clinical evaluation by the study physician, five days a week. Upon receiving consent, the physician collected the patient's socio-demographic characteristics, food history, medical history (including assessment of dehydration status), sanitation and hygiene, and requested a blood sample. Five milliliters of blood from adults and 2 ml of blood from children were collected in red-top vacutainers by a trained medical technologist or nurse. For each blood sample, serum was separated, stored at –20°C at the sentinel sites, and later transported to IEDCR twice a week, maintaining the cold chain. HAV IgM and HEV IgM antibodies were detected by Enzyme-linked immunosorbent assay (ELISA) kits, according to manufacturer instructions. IEDCR is also conducting leptospirosis surveillance by utilizing the existing Foodborne Illness Surveillance Platform. The existing protocol was updated in collaboration with Bacterial Special Pathogen Group of CDC-DGHS. The sentinel site personnel were trained and they have been using RDT to identify leptospirosis cases leptospirosis cases within the surveillance case Definitions in those patients with clinical presentation of fever for 5 to 14 days. The IEDCR has also developed capacity to conduct PCR for leptospirosis.

4.3.7. Hospital based zoonotic disease surveillance

Emerging and reemerging zoonotic infectious diseases represent a potential devastating threat to human health. The early detection of zoonotic diseases through surveillance allows for the implementation of early response measures, reducing loss of human life and economic disruption.[xvi] A One Health approach to surveillance for zoonotic pathogens involves the implementation and integration of both animal and human surveillance platforms. The zoonotic disease surveillance platform is layered on two existing hospital based sentinel surveillance systems maintained by icddr,b and IEDCR: *meningoencephalitis surveillance* targeting patients with neurologic presentations and *hospital-based respiratory illness surveillance.* In case of zoonotic surveillance, one health approach is followed which has been proven to be most effective.

Surveillance was conducted at a total of 14 hospital sites, with one hospital site (Rajshahi) participating in both meningoencephalitis and respiratory illness surveillance. The meningoencephalitis surveillance platform operates in three governmental tertiary care hospitals and defines meningoencephalitis cases as hospitalized patients with a history of self-reported fever or axillary temperature greater than 38.58 C combined with at least one of the following: new-onset altered mental status, new-onset seizures or new neurological deficit. Respiratory illness surveillance operates in 12 districts (six governmental and six private tertiary care hospitals, representing all administrative divisions of the country) and defines severe acute respiratory illnesses (SARI) as patients aged 5 years and above with a history of fever or measured temperature of 38 C or above and cough or sore throat in the 10 days preceding hospital admission. Both meningoencephalitis and respiratory illness surveillance systems collect basic demographic data and mortality data for patients meeting the case definitions and consenting to enrolment. All patients meeting the case definition for meningoencephalitis or SARI are screened for the risk of zoonotic exposures with five brief questions. Patients giving at least one positive response were considered to have an animal exposure that was potentially infectious. The five screening questions addressed (i) vocational exposures and, in the three weeks prior to the onset of illness, any of the following: (ii) preparation or consumption of meat from a sick domestic animal; (iii) a history of being bitten or scratched by a wild animal; (iv) exposure to or consumption of meat from a wild animal; and (v) consumption of date palm sap.

In all patients meeting criteria for an animal exposure that was potentially infectious, surveillance staff arranged specimen collection with the help of hospital staff. Blood samples (approx. 10 ml) and throat or nasal swabs collected in viral transport medium. Samples went through routine testing for either the meningoencephalitis or the respiratory disease surveillance platforms depending on the originating surveillance platform. Samples routinely undergo testing for NiV (if the patient is hospitalized during the season when raw date palm sap is collected and consumed) and Japanese encephalitis year-round. Samples that tested positive for a known pathogen through routine testing were not further evaluated as zoonotic exposure cases and were handled as per the protocol from the originating platform. In case of any outbreak, a team of IEDCR investigators is sent to find the causative factors and to provide proper interventions. *Human Nipah Virus transmission surveillance was conducted during the outbreak in 2017-2018 to characterize the conditions and risk factors for transmission of NiV.*

Also the PREDICT project is implemented by Eco-Health Alliance in collaboration with IEDCR, DLS and icddr,b to establish surveillance for pathogens that can spillover from animal to hosts to detect and discover viruses of pandemic potential. By 2018, it has investigated two outbreaks and collected samples from animals at high-risk human animal interfaces for zoonotic transmissions. These samples are screened for novel, high-consequence viral families (coronavirus, filovirus, flavivirus, paramyxovirus and influenza A viruses) using consensus PCRs. The laboratory work is carried out in Virology Department of IEDCR and the positive samples are genotyped in icddr,b.

4.3.8. Anthrax surveillance

Anthrax is primarily a disease of herbivorous mammals. Human generally acquires the disease from infected animals or occupational exposure to infected or contaminated animal products. Control in livestock, is key to reduce the incidence. The 1st outbreak of anthrax was reported in 2010 and since then outbreaks are reported from different parts of the country especially northern and western districts.

Since 2018, IEDCR is conducting active surveillance for human anthrax at 9 sentinel sites of the 5 anthrax endemic districts, based on previous outbreak reports (Annexure 3) While passive surveillance takes place throughout the country through web-based weekly integrated disease surveillance for communicable diseases. Field staffs at surveillance sites collects data related to anthrax cases and report to upazila health complex. From UHCs, samples are collected and sent to IEDCR for microbiological and molecular testing. One health approach is being followed in the surveillance for anthrax. Though surveillance is going on at nine sentinel sites, only one site- Gangni upazila of Meherpur district has been actively reporting human anthrax cases. The surveillance team contacts the veterinary department for to initiate vaccination programs among suspected animals and to explore the underlying factors responsible for causing cutaneous anthrax.

4.3.9. Hospital based Dengue Surveillance

Hospital based dengue surveillance is going on in 4 medical college hospitals; Dhaka Medical College Hospital, Chittagong Medical College Hospital, Khulna Medical College Hospital and Uttara Adunik Medical College Hospital. Blood samples are collected from medical colleges from those districts and those are analyzed in IEDCR. Now dengue surveillance has been expanded and at present confirmed dengue case data from 32 governmental and nongovernmental hospitals of Dhaka city are participating under this surveillance program using the DHIS2 software and data are being analyzed and published by IEDCR. Currently, data from WHO climate change surveillance is also helping in dengue surveillance.

4.3.10. Respiratory event-based surveillance

IEDCR is piloting an event-based surveillance (EBS) to enhance and strengthen the existing EBS activities across the country to improve early detection and rapid reporting of emerging and re-emerging respiratory disease threats. This surveillance focused on human outbreaks of MERS-CoV, Avian influenza and other evolving respiratory pathogens.

4.3.11 Multi-System Inflammatory Syndrome (MIS) surveillance

Multisystem inflammatory syndrome (MIS) is a systemic disease among children and adolescents following exposure to COVID-19 infection. IEDCR with support from UNICEF has established a surveillance system to identify MIS among children and adolescents following case-definition in 15 hospitals in the country (including 1 private hospital). The purpose is to improve management of these cases through early diagnosis, reporting and treatment. As of 7th September 2021, total 111 MIS- cases were identified from the surveillance hospitals. 4.3.12 Child Health and Mortality Prevention Surveillance (CHAMPS)

4.3.13 Hospital based syndromic surveillance

PREDICT projects working with Faridpur Medical College Hospital and conducting a human behavioral survey along with biological specimen collection to explore the diseases of unknown origins including fever, acute encephalitis and acute respiratory illness.

4.3.14 Child health and mortality prevention surveillance (CHAMPS)

It is a network of disease surveillance sites in developing countries with high under-five mortality rates to develop a long-term network of sites to collect robust and standardized primary data aimed at understanding and tracking the preventable causes of childhood deaths globally. The IEDCR, icddr,b, and Bangabandhu Sheikh Mujib Medical University (BSMMU) are jointly implementing the surveillance in Bangladesh. The Bangladesh site also covers surveillance of under-5 deaths and stillbirths to find out the cause of death of the children the ways to prevent those; utilizing minimal invasive tissue sampling (MITS), verbal autopsy, and clinical findings of the deceased. The field site is in Baliakandi upazila of Rajbari district which has a high child mortality rate (50/1,000). The sentinel facilities are in the Faridpur Medical College Hospital (FMCH), Zahid Memorial Children Hospital (ZMCH) and the Baliakandi Upazila Health Complex (BUHC), where MITS facilities are established with trained human resources. To further strengthen the MITS activities in FMCH and ZMCH, six upazilas of Faridpur districts were later included as the extended field study sites.

4.4 Surveillance for NCDs and other diseases and health conditions

4.4.1. Non-communicable disease surveillance

The global burden of NCDs continue to grow accounting for 73.4% of all deaths globally. Bangladesh is not an exception where 73.2% deaths are due to NCDs. The well aware of the situation and the MOH has formulated the multi-Sectoral action Plan for NCD Control 2018-2025. The key to success is strengthening primary prevention through population-based health promotion programs including identification and surveillance of most common NCD risk factors. WHO STEP-wise approach facilitates the process to track NCD status including 25 key indicators.

Two STEP surveys have been conducted in Bangladesh so far; one in 2010 and the other in 2018. The NCD control program is akin to introduce effective surveillance system for giant NCDs and their risk factors through existing workforce of the DGHS although there were few NCD surveillance data on systolic and diastolic blood pressure and blood-sugar level of patients of community clinics captured through online DHIS-2 system of the MIS-Health of the DGHS. Now discussion is going on and a surveillance activity is incorporated in the NCD operational plan of the 4th health sector program. Accordingly, an apps has been developed to collect data routinely on certain NCDs (and risk factor) in Model UHCs. RESOLVE and the Heart Foundation is working with NCD control program in 70 upazilas in Sylhet, Jamalpur and Kishorganj districts. In addition, M-Power is working on breast-cancer surveillance, and BSMMU is conducting Ca-Cervix screening under the MNCAH program of the DGHS.

4.4.2 Nutritional surveillance:

Nutrition surveillance systems involves regular collection of representative primary data on nutrition indicators and the factors that affect them which could be used for early warning, for policy and program adjustments, evaluation, research, and other purposes. The nutrition surveillance project (NSP) began in October 1989 in collaboration with a number of NGOs, the Bangladesh Institute of Public Health and Nutrition, and UNICEF; it receives financial and technical support from USAID and is coordinated by Helen Keller International (HKI).

From the very onset the NSP incorporated extensive training-both training for the initial implementation of activities and refresher courses throughout the project. Data are collected every two months 26 sentinel points, corresponding to 20 subdistricts and 4 urban slums. In each round of data collection, 5,000-6,000 households are randomly selected, and anthropometric measurements are taken from 7,000-9,000 children between the ages of 6 and 59 months. Three measurements are taken for each child- weight, height, and mid-upper arm circumference (MUAC)-and are recorded together with the child's age and sex. Four health indicators are used in the NSP: prevalence of diarrhoea, night blindness, acute respiratory infection, and vitamin A capsule distribution coverage. The quality of the collected data is assured by an HKI monitoring team. Every two months a report is compiled on the data collected from the previous round.

At present Bangladesh National Nutrition Council (BNNC) along with partners developed a Guideline for a surveillance system in 2021 based on the lessons learned from the past experiences which is multisectoral, technically updated and inclusive in a sustainable programmatic approach. It covers both humanitarian and developmental dimensions of nutrition. The proposed Guidelines of nutrition surveillance offer a regular system which aims to establish ongoing monitoring of the key indicators which underpin the nutritional status of Bangladesh, both at short, intermediate and long intervals.

4.4.3. Cervical cancer screening

Cervical cancer is one of the most common malignancies among women worldwide. Bangladeshi women are at higher risk for cervical cancer due to several risk factors like the lack of screening, early marriage, early initiation of sexual activity, multiparity, sexually transmitted diseases (STDs) and low socio-economic conditions. In that context, Bangabandhu Sheikh Mujib Medical University (BSMMU), has introduced online individual level longitudinal data from collection from women in 413 centers throughout the country with support from the World Health Organization (WHO) and the United Nations Population Fund (UNFPA). This 413 data collection centers include CCs, UHCs, DHs, and MCHs and from each CC centers 10 HAs, 10 FWAs and 10 CHCPs have been trained to data and sample collection from these designated CCs. This longitudinal data collection system allows clinical, sociodemographic and laboratory investigation data at every level such as CC, UHC, DH and MCH and laboratory investigation facilities have been developed tier-wise to support the treatment as well as surveillance. At the community level, trained HAs, FWAs, and CHCPs encourage women aged 30 to 60 years to register for screening at CCs for cervical cancer. Interested women are registered online at CCs by using their NID and Telephone number and thus they have a unique ID. Registration takes place at higher level designated facilities as well. These socio demographic data of every are being uploaded in the database by CHCP at the community level and nurses or doctors in the hospitals. The patients who are diagnosed with positive VIA results are referred to higher centers for colposcopy and further investigation and treatment and related lab and clinical findings data are being uploaded in the individual longitudinal patient

database. Also, there is scope for entry of prognosis data supporting creating this a lifelong individual level data-system which can be used for treatment, follow-up, surveillance and research.

4.4.4 Maternal and perinatal death surveillance and response (MPDSR)

Directorate General of Health Services (DGHS) in collaboration with the Directorate General of Family Planning (DGFP) of the Ministry of Health and Family Welfare (MOHFW) of Government of the People's Republic of Bangladesh, initiated Maternal and Perinatal Death Review (MPDR) through the national health system to notify maternal, neonatal deaths and stillbirths in the Thakurgaon District of Bangladesh in 2010, with technical assistance from UNICEF. Later on, the MPDSR program was scaled-up in 13 districts in 2012 and it is now undergoing in 51 districts covering over two thirds of the population. The MPDSR programme is conducted by Directorate General of Health Services (DGHS) in collaboration with the Directorate General of Family Planning (DGFP) of the Ministry of Health and Family Welfare (MOHFW) of Government of the People's Republic of Bangladesh with technical assistance from UNICEF. Obstetric & Gynecological Society of Bangladesh and Bangladesh Neonatal Forum, UNFPA, WHO, CIPRB and now Save the Children.

Under the MPDRS programme any maternal or neonatal death or stillbirth is notified by the front-line health workers () of DGHS and DGFP at the community level and by the senior staff nurses (SSN) or family welfare visitors (FWV) at the facility level (upazila health complex, maternal and child welfare centre, district hospital and medical college hospital, private clinics). After the notification, verbal and social autopsies are carried out by the health officers in the community to explore social causes and build awareness among the community to prevent future deaths. At the facilities, death review is carried out by the nurses with support from doctors using facility death review forms. All the reported death is uploaded on the DHIS-2 database from the community clinic and the facility deaths from the upazila health complex or district hospitals and the real-time data can be accessed at any point of time. The cause of death information is entered quarterly into health management information system (HMIS) at the divisional level. The MPDRS is a unique approach by which not only causes of maternal & neonatal deaths are identified but it also helps in identifying the socio- economic factors, reasons for not taking proper care, age groups who are most affected, any gap and challenges in care given in the facilities and also manages to track district specific mortality trend. According to the data, feedback is given to undertake appropriate action plan to avert similar death in future, death mapping of a district is used to understand the burden of deaths in a specific focused area where intervention is needed and also actions are taken to improve facility health care services. Thus, MPDSR intervention effectively contributes to health system strengthening as well as prompting responses to reduce maternal and newborn deaths.

4.4.5 COVID-19 surveillance

Initially IEDCR was the only institution which had the capability to perform molecular diagnosis for COVID 19 virus using real-time reverse transcription polymerase chain reaction (RT-PCR). But as the infection continued to spread more rapidly, it was mandated to establish well-structured diagnostic laboratories. A committee was formed to explore the existing institutions with COVID 19 diagnosis capacity and establish new well-structured laboratories. BITID Chittagong, Dhaka medical college, BSMMU, CHRF and ideSHi were well equipped with PCR machine and also 20 new PCR machines were installed in 20 medical colleges around the country covering every corner of Bangladesh. At present, there are 151 PCR labs (56 governmental, 95 private), 57 (54 governmental, 3 private) GeneXpert labs and 638 (545 government, 93 private) rapid antigen test labs.

At present, lab call centers coordinate among all diagnostic laboratories in the country and collects data in a daily basis. Every diagnostic center (government and private) sends their data to the laboratory call

centers and also upload them directly in the MIS using DHIS2 system. Data on cases and deaths, quarantine, isolation, and recovery are also collected by the lab call centers from the district hospitals and medical college hospitals from all over Bangladesh. These data are compiled, analyzed and interpreted by statisticians. MIS-DGHS Covid reporting cell would compile all reports and present them in the unique COVID 19 dashboard. COVID-19 Dynamic Dashboard for Bangladesh was established by MIS DGHS, IEDCR with technical supports from UNICEF. This is an open access source, where anyone can access to number of positive cases (by division, gender, age groups), quarantined, recovered and deaths due to COVID 19 daily. Also, there is a detailed map of COVID-19 Sample Collection and Lab Center Location, comprehensive list of hospitals (ICU bed, ICU equivalent bed with high flow nasal canula, HDU bed) providing treatment for COVID 19 and detailed information about vaccination status.

5. Summary findings from In-depth Interviews (IDIs)

A total of 37 IDIs were conducted that included key personnel from IEDCR, DGHS, icddr,b, BRAC and BSMMU who are involved directly or indirectly with any disease surveillance activity. Interviews revealed that a considerable improvement has taken place in the field of disease surveillance in recent years undertaken by IEDCR, DGHS (disease control programs and EPI) and icddr,b. Although IEDCR is mandated for conducting surveillance, a number of strong surveillance systems lies outside IEDCR such as COVID-19, Malaria, Vaccine Preventable Diseases, TB, Kala-azar, Diarrhoeal diseases, Dengue, and Dog bite. The recent surveillance initiatives undertaken by IEDCR is also praiseworthy. The organization has contributed tremendously during recent epidemics and outbreaks that include COVID-19, dengue, chikungunya, Nipah virus infection, anthrax, Japanese encephalitis, and hepatitis E. Since 2004, the organization has initiated a number of new surveillance system for a number of emerging diseases mostly in collaboration with icddr,b, US-CDC, WHO and other global partners funded by external donors as research grants. Government support was minimum in these innovative newly developed surveillance activities. More importantly, as majority of these surveillance initiatives are donor driven, continuity was threatened when project funding stopped. Uninterrupted funding is solicited by most of the IEDCR respondents.

The core responsibility of IEDCR is to support DGHS and MOHFW in disease control and epidemic preparedness and response through conducting routine surveillance, outbreak investigation and disease control research. These are core health systems functions to support epidemic control and to ensure global health security. But surprisingly there is no core funding from government exchequer to perform these vital health systems' functions efficiently and effectively. So, far IEDCR has developed and contributed in field of surveillance through donor funded surveillance and research projects. Key stakeholders of IEDCR highlighted this problem during IDIs with them. The respondents mentioned that there was even no Operational Plan (OP) for disease surveillance under SWAp, initiated by MOHFW since 1998. In the ongoing 4th SWAp (HPNSP 2017-2022), there is a component named 'disease burden due to climate change' under OP of CDC where the program manager is from IEDCR and some support comes from there to conduct outbreak investigation and some surveillance activities. However, that is inadequate to support even core integrated disease surveillance program of IEDCR. Surprising to note that there is no routine funding from government revenue budget for conducting essential disease surveillance and outbreak investigations though considered vital for epidemic preparedness and response.

In regards to management and co-ordination, there are many challenges. IEDCR has an organogram where majority of senior positions like CSO and PSO are occupied by non-technical persons who has little knowledge and skills in public health and epidemiology to contribute to ongoing disease surveillance or research activities of the organization. Often IEDCR is termed as a 'dumping place' to accommodate redundant senior officials of DGHS who like to stay in Dhaka without any contribution to national health systems performance. Key stakeholders opined that the organogram is outdated and should

be revisited to streamline surveillance activities and all positions must be filled-up with persons with technical skills in public health and epidemiology. One respondent asked for autonomy of IECDR with its own recruitment and promotion rules. A number of young medical officers are trained in epidemiology and public health through field epidemiology training program (FETP) of IEDCR who should be deployed in right place to use their earned skills to contribute to UHC and global security. A career path needs to be developed to accommodate these trained epidemiologists within existing health systems. IEDCR proposed developing public health and epidemiology positions at sub-districts and districts to strengthen public health functioning including monitoring, surveillance, evaluation and research.

There is lack of clarity and line of demarcation between *disease surveillance* and *emergency response*. Often there is complains that surveillance groups are performing disease control activities and visa-vis the disease control programs are conducting surveillance activities without involving IEDCR. Program stream people are of opinion that surveillance data are not readily available from IEDCR particularly during emergencies when the need is acute and urgent. "Getting data from IEDCR is not easy' one respondent mentioned from policy stream and justified the need for own monitoring and surveillance data collection systems by the disease control programs themselves. As a result, there is duplication of surveillance activities particularly for certain locally endemic tropical diseases such as TB, leprosy and filariasis where disease information is captured weekly by IEDCR, monthly by MIS-DGHS and quarterly by disease control programs creating confusion in the field as all these information come from same source i.e., the upazila statistician. One statistician in this regard mentioned,

"We provide same data to IEDCR and different sections of DGHS at different time-intervals. Why do they not add weekly values to get monthly figures and quarterly from monthly data? We are overburdened, authority should think about it."

Data analysis is inadequate for routine surveillance and monitoring data and that is true for both program offices, IEDCR and MIS-Health. Tons of surveillance and monitoring data are stored on the cloud and computer hard-disk without any analysis, interpretation, feedback and use. Analytic capacities of professionals working at both program and surveillance offices should be enhanced. Those who collect data, are often unaware about the usefulness of the data that they collect as feedback is rare to them.

There is scope for improving collaboration and co-ordination between disease control programs and IEDCR and MIS-Health of DGHS for optimal use of data for effective and efficient disease control measures. Still, majority of disease control programs rely more on their own data collected quarterly using conventional paper-based data collection systems than using surveillance data captured weekly by IEDCR and monthly by MIS-DGHS. One respondent mentioned that real time surveillance data should be made open in public domain so that all citizens of the country can see the disease scenario particularly during epidemics as practiced by DGHS during ongoing COVID-19 pandemic. Others mentioned that bureaucracy in accessing monitoring and surveillance data from IEDCR and MIS-Health should be removed so that researchers and post graduate students can work with this data for knowledge generation and academic attainments.

Skilled manpower and advanced laboratory facilities are prerequisite for an effective surveillance system. IEDCR has improved its capacity in recent years but there is need for further improvement in this area. A number of IDI respondents mentioned about developing a pool of trained public health epidemiologists at districts and Upazilas for supporting disease surveillance and outbreak investigation task of IEDCR. Trained public health epidemiologists who work for a long period during middle of their career are often deprived of regular promotions as per cadre service rules. They are to touch the 'feeder-post' of UHFPO or DCS to get promotion or to get senior scale. Another HRH problem mentioned is high vacancy rates in

the field particularly for laboratory technicians and health assistants who are considered vital for community and facility-based disease surveillance systems.

There were recommendations for strengthening existing weekly integrated web-based disease surveillance system of IEDCR. Focus should be more upon this integrated disease surveillance system than project-based or ad-hoc disease specific surveillance system. Core policy program managers should revisit the list of diseases under 'must surveillance', 'useful surveillance' and 'nice surveillance' and focus should be more upon 'must surveillance' list. Analysis should be regular and results should be shared with program managers and policy makers immediately for appropriate control measure by them.

Many organizations are involved in disease surveillance activities in this country. There is suggestion to reorganize surveillance functions by them to reduce cost and maximize benefit in terms disease control and epidemic preparedness and response. Disease control programs are the users and beneficiaries of disease surveillance activities. They must be trained on how to use surveillance data generated by IEDCR and MIS-Health to streamline disease control and epidemic response activities. Similarly, IEDCR researchers should know how to best feed the surveillance information in the most palatable form for the benefit of disease and epidemic control measures. 'Producers' and 'users' of surveillance data must work in close collaboration to make both surveillance and disease control measure stronger for the benefit of the people.

Surveillance systems usually capture aggregate level data but recently MIS-Health has established an online event-capture systems in the IPDs of DHs and UHCs to collect individual level detail patient data including final diagnosis using ICD-10 coding system. However, analysis of these disease profile data is still inadequate. IEDCR experts can exploit this goldmine source of data for monitoring diseases of public health importance with epidemic threats along with analysis of their ongoing integrated disease surveillance data to provide real-time disease information vital for disease control and epidemic preparedness and response.

Laboratory support is essential for accurate diagnosis of communicable diseases under surveillance. Public health laboratory facilities are very limited in the country and more importantly, they are highly centralized. Responded asked for establishing public health laboratories in strategically located sentinel sites to support IEDCR and IEDCR laboratory should function mostly as reference laboratory. Some respondents preferred district hospitals than medical college hospitals for establishing decentralized public health laboratories.

Modern ICT has facilitated the surveillance activities and the country COVID-19 dashboard has clearly shown how ICT helps in making real-time data available for policymakers and program managers at national and international level. COVID-19 dashboard of the DGHS is well organized which could feed surveillance data to global COVID-19 dashboard maintained by WHO and CDC-Atlanta. Respondents opined that key surveillance personnel should have advanced training on data analytics including TABLU and other advanced statistical software such as SPSS, Stata, R and EPI-Info to support analysis and interpretation for ensuring 'data for decision'.

Scientific communication is also inadequate though a considerable number of collaborative donor-funded surveillance projects has been implemented in recent years. The limited number of scientific articles published out of collaborative disease surveillance projects were written mostly by scientists from collaborators rather than by IEDCR scientists as first authors; mostly they contributed as co-authors. Research capacity of health systems and public health professionals working in the public sector need to be strengthened.

Establishing early warning system for signaling impending epidemics with existing surveillance data seems impossible with existing surveillance practices. The data quality of weekly online integrated disease surveillance system is questionable in terms of timeliness, completeness, and reliability and validity. A number of reporting units we observed are not giving complete information as designed, in a timely fashion. Supervision and monitoring of surveillance are poor from districts, divisions and central level DGHS and IEDCR. *The existing online integrated disease surveillance system must be strengthened with regular analysis and feedback using modern ICTs to function as early warning system to signal outbreaks before they become epidemic.* The COVID-19 pandemic has shown that an effective and efficient disease surveillance system is possible to develop and sustain integrating modern ICT and laboratory investigation system in the present context of Bangladesh to signal outbreaks of emerging and re-emerging communicable diseases. However, that requires a strong pollical commitment as well as concerted effort from both 'disease-surveillance' and 'disease-control' sides to work together to redesign the system catering news needs during post-COVID period involving relevant stakeholders' groups including civil society members.

6. Feedback from stakeholders consultative meeting

A stakeholders meeting was organized on 21st December, 2021 to share preliminary findings from desk-review and IDIs. The participation was encouraging where key surveillance and disease control experts give their valuable inputs to improve the consultancy report. Their key suggestions were:

a) A financial 'Code' should be there for disease surveillance under the revenue budget of the MOHFW to ensure uninterrupted funding continuous integrated disease surveillance. There should be separate OP for disease surveillance in the upcoming SWAp with Director IEDCR as LD for the OP.

b) A clear guideline should be there (without any grey areas) about who will do which surveillance. Disease control programs and other organizations should be allowed to do their own disease surveillance. However, all surveillance activities are to be coordinated by IEDCR. All the surveillance systems should be redesigned and relocated. IEDCR should continue innovative surveillance activities in addition to their core functions of integrated disease surveillance and outbreak investigation. Disease control programs should continue their respective surveillance programs. There should be a clear distinction between disease surveillance and reporting.

c) PHEOC should be independent center for immediate response during outbreaks and inter-agency data sharing should be ensured.

d) Epidemiological units should be established at all tiers with trained epidemiologists and statistician for proper health surveillance including data analysis, interpretation, feedback and use. Every related individual should be trained and informed about their duties and importance of their work.

e) Community based surveillance, surveillance or pesticides, chemical use, atomic surveillance, entomological surveillance, molecular surveillance should be introduced.

f) An integrated health surveillance should be introduced which will be action oriented. For that an advisory committee could be established who will create a framework for surveillance in Bangladesh for the future.

g) Restructuring of IEDCR is needed to cater emerging needs during post-COVID19 health systems strengthening

7. Conclusion and recommendations

"A satisfactory and well-functioning disease surveillance system, which is vital for proper planning and implementation of effective CDC interventions, is yet to be achieved. Capacity of the IEDCR will need further strengthening along with adequate funding to take the lead role in integrated disease surveillance. Effective collaboration and coordination is required with other public and non-public institutes. Continuation and further strengthening of capacity development programs like Field Epidemiology Training Program (FETP) is required for effective CDC interventions. Behavioral and sero-data are also required to be updated regularly and made available for effective program design and strengthening control measures."

The above statement of the PIP of the 4th HPNSP (2017-22) of the MOHFW remains equally true in regards to disease surveillance systems in the country even after 4 years of implementation of the 4th HPNSP.

Our exploration through this short-term TA affirms that the country has experience of implementing successful disease surveillance program such as smallpox, malaria and vaccine preventable diseases. In recent years IEDCR has developed its capacity in terms of laboratory facilities and human resource development to support surveillance, outbreak investigation and research. Under dynamic leadership of recent directors, the organization contributed a lot in diagnosing and responding to recent epidemics of COVID-19, chikungunya, Nipah virus infection and so on. A number of other organizations are involved in disease surveillance activities and some of them implemented successful surveillance programs such as VPD surveillance by EPI, diarrhoeal disease surveillance by icddr,b and malaria surveillance by national malaria elimination program. Often there is duplication of surveillance activities for certain diseases by IEDCR and DGHS. Program office rarely use surveillance data for strengthening disease control and epidemic preparedness rather they rely more on their quarterly monitoring data for decision making and program planning. Co-ordination and collaboration between surveillance-research stream and policy-program stream is often poor. Government input to support country disease surveillance is inadequate both from revenue and development budget. Majority of surveillance activities rely on project-based donor funding which may jeopardize sustainability if an appropriate project exit-plan is not in place. There is confusion in the field about the utility and usefulness of surveillance data and they rarely get feedback from central level authority. Often, they are to provide same disease information at different time intervals to different health authorities. Supervision and monitoring of surveillance activities is inadequate by the hi9gher level authority.

In this context, we recommend following measures to undertake to strengthen existing surveillance systems to function as early warning system to signal impending outbreaks and epidemics from emerging and re-emerging communicable diseases:

I. Management and Co-ordination

Policy makers need to revisit the TOR of individual disease control programs under DGHS and of IEDCR to harmonize surveillance, disease control and epidemic response activities which are core functions of

the MOHFW. As mandated organization for disease surveillance and outbreak investigation, IEDCR should co-ordinate all surveillance activities of the government. Disease control programs should continue ongoing monitoring and surveillance but instead of quarterly paper-based reports, they should switch on to online system of reporting preferably through event capture system as initiated by TB and kala-azar control programs. However, surveillance data sharing should be in-built online, and periodic meetings between all relevant parties should be organized at least quarterly to ensure regular analysis, interpretation and use of surveillance data. IEDCR and MIS-Health should sit together along with LDs, CDC, NCDC and TB-Leprosy& AIDS/STDs to address data duplication for locally endemic diseases. Monitoring and supervision need to be strengthened to ensure quality, regularity and coverage of data. Coordination between disease control bodies and surveillance authority must be strengthened to ensure proper supply and use of surveillance data for strengthening disease control interventions. In this regard, collaboration and coordination between IEDCR and MIS-Health with CDC and TB-Leprosy and HIV/STDs need to be strengthened. Online surveillance bulletin should be published quarterly incorporating real-time data from all disease surveillance programs.

II. Re-organization and re-structuring of IEDCR

Some structural changes are proposed for IEDCR such as redesigning the organogram and re-defining the task of IEDCR in the context of ongoing epidemiological transition. Organogram of IEDCR is outdated and inadequate to address emerging surveillance needs for control of both CDs and NCDs. We propose restructuring the organization taking into consideration of HR proposal already submitted to the MOHFW by IEDCR. In this regard we propose for a development project proposal (DPP) through Planning Commission of the GOB to implement in next 3-4 years to further strengthen IEDCR to meet the health systems need of the country. The DPP should include district and upazila public health positions and PH laboratories in the field to strengthen disease surveillance. The organization need to identify their core (must do), essential (useful to do) and advanced innovative surveillance including research (nice to do) jobs to perform. Core functions must be funded from government exchequer (revenue budget of the MOHFW). For essential functions funds may come from Health Sector Program or Bi-lateral Development projects and research and other innovative surveillance should be funded from research grants.

III. Early warning system

Integrated disease surveillance should be streamlined by IEDCR and regular analysis, interpretation and feedback and visualization through developing dashboard need to be ensured for multiple stakeholders group including disease control programs, field mangers, policy-makers, donors and civil society members and journalists. Surveillance focus should be more on locally endemic diseases and emerging diseases with high epidemic potentials (probability?). Communicable disease under weekly integrated surveillance of IEDCR should be revisited. An expert consultation workshop may be organized to finalize the list. Weekly integrated disease surveillance should be organized in such a fashion so that the developed system can signal about impending outbreaks/epidemics of communicable diseases. Integrated Disease Surveillance should be the core function of IEDCR along with outbreak investigation and reference public health laboratory.

IV. Capacity

Public health laboratories should be established peripherally at strategically located districts/divisions to support IEDCR in surveillance. Also, there is need for establishing an epidemiological unit at district and division to support both surveillance and disease control. Capacity to conduct statistical analysis must be enhanced at IEDCR and program offices. Public Health Epidemiology positions has already been

proposed. The need for capacity enhancement is mandatory to develop and sustain an effective and robust surveillance system. Ongoing FETP program should continue from government funding; specialized training on epidemiology and ICT is needed along with enhancing laboratory capacities. Carrier-path including promotion rules should be revisited.

V. Funding

Uninterrupted and secured funding is essential to carry out core surveillance and outbreak investigation functions by IEDCR. We propose core funding from government exchequer through creating a surveillance code from revenue budget of the MOHFW to perform core functions of IEDCR. Other surveillance funds should be available from ongoing health sector program. We propose incorporating a Disease Surveillance OP in the upcoming SWAp of the MOHFW. Additional funding should be mobilized through competitive project grants as practiced now by IEDCR.

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Annexures

Annexure 1. Key informants list:

1. Prof. Mahmudur Rahman, PhD, Ex - Director of IEDCR and National Influenza Centre (NIC), Ministry of Health and Family Welfare, Bangladesh
2. Dr. A S M Alamgir, Principal Scientific Officer (PSO), IEDCR
3. Dr Md Mushtuq Hossen Ex- Principal Scientific Officer (PSO), IEDCR
4. Dr. Ahmad Raihan Sharif, Medical Officer, IEDCR
5. Dr. Mahbubur Rahman, Assistant Professor, IEDCR
6. Dr. Ashek Ahammed Shahid Reza, Ex- Principal Scientific Officer (PSO), IEDCR
7. Dr. M. Salimuzzaman, Principal Scientific Officer (PSO), IEDCR
8. Dr. Md. Nazmul Islam, Director, Disease Control and Line Director, CDC, DGHS
9. Dr Benazir Ahmed, ASCEND, Ex Director CDC, DGHS
10. Dr. Sania Tahmina, Ex- Additional Director General (Planning and), DGHS
11. Dr. Md. Shah Nawaz, Ex- Additional Director General (Admin), DGHS
12. Prof. Dr Nasima Sultana,Ex- Additional Director General (Administration), DGHS
13. Dr M N Akhteruzzaman, AD (Current charge), DPM, Filaria, CDC, DGHS
14. Dr Md Ekramul Haque, DPM, Malaria, CDC, Deputy programme manager, DGHS
15. Dr S M Golam Kaiser, DPM, National Zoonotic Control Programme, CDC, DGHS
16. Dr Abu Nayeem Mohammad Sohel, Deputy programme Manager, National Kala-azar Elimination Programme, CDC, DGHS
17. Dr Md. Mahbubur Rahman, Lead and Project Coordinator, Infectious Disease Division, icddr,b
18. Mr. Anjan Kumar Roy, Senior Research Investigator, Infectious Diseases Division, icddr,b
19. Dr Dinesh Mondal, Acting Senior Director, Laboratory Sciences and Services Division, icddr,b
20. Dr. Ashrafunnessa, Professor, Department of Gynecological Oncology, BSMMU
21. Dr. Saif Ullah Munshi, Professor, Department of Virology, BSMMU
22. Dr Abdul Alim, Programme manager, NCDC
23. Dr.Md. Ariful Alam, Program Coordinator, BRAC Health
24. Dr ASM Sayem, Health Specialist (Maternal, Adolescent Health & HSS), UNICEF
25. Dr Md Abdul Hamid Selim, MDR TB and Global Fund Advisor, NTP Bangladesh
26. Civil Surgeons (2), Nilpjhamari and Cox,s Bazar
27. UHFPOs (4), Ramu, Jaldhaka, Domar, and Pirganj
28. RMO (2), Cox,s Bazar and Nilphamari District Hospitals

29. Statisticians (5), Nilphamari District Civil Surgeon Office, Domar UHC, Pirganj UHC, Ramu UHC and Cox's Bazar District Hospital

Annexure 2. Topic Guide

- What is disease surveillance?
- What's the present condition of disease surveillance in Bangladesh?
- What is current surveillance system for _____
- Which type of data is collected?
- Who collects the data and how?
- How analysis and interpretation is done?
- Who use this data and how?
- Give examples of use of data?
- Is there any early warning system established?
- Challenges you face?
- Do you have capacities for proper analysis interpretation and use of data?
- Comment about quality of data in terms of regularity, completeness and accuracy?
- Recommendations / suggestions
- How to strengthen early warning systems?

Annexure 3. Surveillance sites:

AMR Surveillance sites:	9 sentinel sites:	• Mymensingh Medical College & Hospital, Mymensingh • Uttara Adhunik Medical College & Hospital, Dhaka • Rajshahi Medical College & Hospital, Rajshahi • Rangpur Medical College & Hospital, Rangpur • Bangladesh Institute of Tropical and Infectious Disease (BITID), Chattogram • Dhaka Medical College & Hospital, Dhaka • Sylhet MAG Osmani Medical College & Hospital, Sylhet • Khulna Medical College & Hospital, Khulna • Cox's Bazar Medical College & Sadar Hospital, Cox's Bazar
Influenza Surveillance sites: National Influenza surveillance:		

	8 district hospitals 2 tertiary hospitals	• Thakurgaon District Hospital • Joypurhat District Hospital • Naogaon District Hospital • Habiganj District Hospital • Narshindi District Hospital • Shatkhira District Hospital • Patuakhali District Hospital • Cox's Bazar District Hospital • Gazipur Medical College Hospital • Dhaka Medical College Hospital
Hospital Based Influenza Surveillance:		
	8 tertiary hospitals 1 district hospital	• MA Rahim Medical College and Hospital • Jalalabad Ragib-Rabeya Medical College and Hospital • Jahurul Islam Medical College and Hospital • Rajshahi Medical College and Hospital • Comilla Medical College and Hospital • Khulna Medical College and Hospital • Sher-e-Bangla Medical College and Hospital • Chattagram Medical College and Hospital • Jashore General Hospital
Anthrax surveillance:		
	5 Surveillance sites	• Bogra sadar upzilla of Bogra district • Doulatpur upzilla of Khushtia district • Gangni upzilla of Meherpur district • Santhia upzilla of Pabna district • Shahjadpur upzilla of Sirajganj district
Meningoencephalitis Surveillance		
	3 governmental tertiary care hospitals	• Rangpur Medical College and Hospital • Faridpur Medical College Hospital • Rajshahi medical college and hospital
Respiratory illness surveillance:		

	12 districts (six governmental and six private tertiary care hospitals)	• Rajshahi medical college and hospital • Khulna Medical College and Hospital • Chattagram Medical College and Hospital • Mymensingh Medical College & Hospital • Dinajpur Medical College & Hospital • Barisal Medical College & Hospital • Jashore General Hospital • Comilla Medical College and Hospital • Kishorgnj • bogra
Hospital Based Rotavirus surveillance:		
	6 tertiary care hospitals 1 district hospital	• Rajshahi Medical College Hospital (RMCH) • Jahurul Islam Medical College Hospital (JIMCH) • Jalalabad Ragib-Rabeya Medical College Hospital (JRRMCH) • Sher-e- Bangla Medical College Hospital (SBMCH) • Rangpur Medical College Hospital (RpMCH) • Chattogram Medical College Hospital (CMCH) • Jashore General Hospital
Foodborne disease surveillance:		
	7 district hospitals 2tertiary level hospitals BITID	• Habiganj district hospital • Narshingdi district hospital • Cox's Bazar district hospital • Naogoan district hospital • Patuakhali district hospital • Thakurgaon district hospital • Satkihra district hospital • Dhaka Medical College Hospital • Uttara Adhunic Medical College Hospital • Bangladesh Institute of Tropical and Infectious Disease