USAID
FROM THE AMERICAN PEOPLE

PREDICT
BANGLADESH

One Health in action (2009-2020)

10 years of PREDICT Bangladesh has built a cohort of One Health practitioners, deepening the region's capacity

BANGLADESH

The second phase of the PREDICT project (2015-2020) targeted high-risk sites within geographic 'hot spots' for emerging infectious diseases (areas where a confluence of risk factors may contribute to disease emergence and spread). The PREDICT project focused on wild animals (macaques, bat, rodents) and high-risk communities to enhance and advance the One Health approach to disease surveillance in Bangladesh. In addition to the animal, behavioral risk, and hospital-based syndromic surveillance, PREDICT/Bangladesh contributed to numerous outbreak investigations at the request of government partners. Four PREDICT project study sites in Dhaka, Madaripur, Faridpur, and Dinajpur were prioritized by identifying areas considered high-risk for human contact with a diversity of wildlife, many known to be associated with zoonotic viral diversity and with ecological and epidemiological conditions associated with disease emergence.

LOCAL PARTNERS

- Bangladesh Forest Department (BFD)
- Bangladesh Livestock Research Institute (BLRI)
- Chittagong Veterinary and Animal Sciences University (CVASU)
- Department of Livestock Services (DLS)
- Food and Agriculture Organization of the United Nations (FAO) Bangladesh
- International Centre for Diarrhoeal Disease Research, Bangladesh (iccdr,b)
- Institute of Epidemiology, Disease Control and Research (IEDCR)

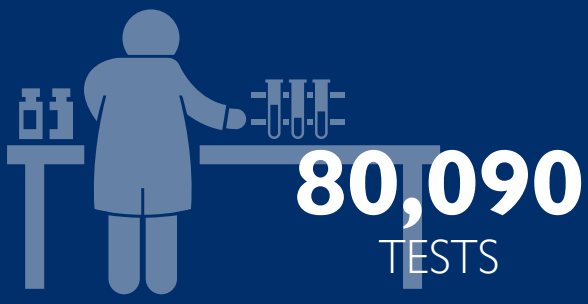
Global Health Security Agenda

DEVELOPED the One Health Workforce by training more than 140 people in Bangladesh.

OPERATIONALIZED One Health surveillance and sampled over 20.3K animals and people, helping minimize the spillover of zoonotic disease threats from animals into human populations.

LABORATORY STRENGTHENING

- Institute of Epidemiology, Disease Control & Research
- icddr,b



DETECTED 277 unique viruses in both animal and human populations.

ARIFUL ISLAM

Senior Scientest
EcoHealth Alliance

Dr. Ariful Islam is a veterinary epidemiologist and disease ecologist and works as a senior scientist at EcoHealth Alliance. As the Bangladesh Programs Coordinator at EcoHealth Alliance, Dr. Ariful coordinates all of EcoHealth Alliance's surveillance and capacity building efforts in Bangladesh.

Dr. Arif worked for more than a decade as the Bangladesh Country Coordinator for the PREDICT project. He has more than twelve years experience in conducting epidemiological studies, wildlife surveillance for emerging zoonotic disease threats, and behavioral risk characterization in high-risk communities in Bangladesh. His research focuses on understanding the drivers of zoonotic disease emergence and the ecology and evolution of bats and their associated viruses such as Nipah, Ebola, SARS, and Middle East Respiratory Syndrome (MERS) viruses at the animal, human, and ecosystem interface.

Dr. Ariful works closely with partners from the Institute of Epidemiology, Disease Control and Research (IEDCR), the Bangladesh Forest Department, the Department of Livestock Services, Bangladesh Livestock Research Institute (BLRI), the International Centre for Diarrhoeal Disease Research, Bangladesh (iccdr;b), and local universities to develop personnel and laboratory capacity and establish sustainable disease surveillance systems.

The mentorship Dr. Islam received through the PREDICT project has enabled him to tackle the challenges of conducting wildlife surveillance in Bangladesh. Additionally, the close relationships he has established with laboratory partners across the country have broadened Dr. Islam's understanding of molecular diagnostic assays. These honed skills have positioned Dr. Islam in the workforce that is working toward a Bangladesh that is more prepared for emerging disease threats.

ACHIEVEMENTS

- The PREDICT/Bangladesh team supported One Health emerging disease surveillance by sampling nearly 19,000 animals from over 60 different species.
- During phase two of the PREDICT project, the team significantly improved the country's understanding of viral diversity and circulation, detecting sequences from 40 unique viruses across 4 viral families.
- The PREDICT/Bangladesh team supported multiple disease outbreak investigations at the request of the government, including multiple crow mortality events, a leptospirosis outbreak, and three human outbreaks of encephalitis of unknown origin.
- The PREDICT/Bangladesh team identified varied temporal patterns of seropositivity against viruses in fruit bats suggesting the need to target mitigation activities throughout different times of the year. Additionally, PREDICT/Bangladesh found evidence of co-infection in bats. These patterns are based on the dynamics of Nipah virus, filovirus(es), and rubulaviruses in a single species of bat, *Pteropus medius*.
- The PREDICT/Bangladesh team identified MERS antibodies circulating in dromedary camels that were imported to and born in Bangladesh.
- The PREDICT/Bangladesh team supported in-service and pre-service training workshops for local academic and government institutions. PREDICT/Bangladesh supported a Master's thesis on the ecology of antimicrobial resistance in wildlife.
- The PREDICT/Bangladesh team identified high levels of antimicrobial resistant bacteria in wildlife suggesting that wildlife living in close proximity to human and livestock populations are frequently exposed to resistant bacteria.
- The team conducted detailed genome studies on *Pteropus medius* greatly expanding our understanding of the diversity of viruses in this fruit bat species. Sequences from bat Nipah viruses suggest that the virus changes little during spillover events suggesting that outbreak strains in humans are likely most similar to the strain of Nipah circulating in the local bat population.

ONE HEALTH SURVEILLANCE

Bangladesh has been identified as an emerging infectious disease hotspot where high human and livestock population densities, rapid landscape change, and deforestation have created multi-faceted human-animal interfaces. PREDICT/Bangladesh focused on four key locations that represent these critical human-animal interfaces: Madaripur, Dhaka, Dinajpur, and Faridpur.

- Madaripur District: *A rural-urban site with unique and evolving regulations regarding the local macaque populations. Macaques, once protected and fed by the government, are no longer provisioned with food and are now in direct competition for food and resources with people and livestock living in the area. These changes resulted in a large amount of human-macaque contact that is frequently aggressive in nature. This contact made it an important site to investigate viral sharing between wildlife, livestock, and people.*
- Dhaka District: *As the capital of Bangladesh, Dhaka is an urban site with increasing intensification of animal production to meet the demand of the ever-growing human population. This site was selected to understand whether increased anthropogenic and domestic animal pressure on urban dwelling macaque populations affects the likelihood of aggressive contact with people.*
- Dinajpur District: *This site is located on the border where regular livestock trading occurs between Bangladesh and India. At this site, the PREDICT/Bangladesh team coordinated with the FAO to monitor transboundary livestock trade routes and target surveillance in areas where wildlife, people, and livestock have frequent contact.*
- Faridpur District: *A rural site along the rural-urban land-use gradient (with Madaripur and Dhaka), where there are high levels of wildlife-human contact. This site also has a known history of Nipah virus spillover events in the local communities.*

Within these four locations, human disease surveillance focused on people living in close contact with wildlife, specifically city-dwelling macaques, and on people working within the livestock value chain. Syndromic surveillance of febrile patients was conducted at the Faridpur Medical College Hospital, which served the catchment area in and around the main PREDICT project sampling sites.

The PREDICT/Bangladesh One Health surveillance activities established a safe and secure biobank of 108,575 samples from 20,006 individuals. The team collected samples from humans, wildlife, and domestic animals which included whole blood, serum, oral and nasal swabs, urine, and feces.

LAB CAPACITY

IEDCR and icddr,b, the PREDICT partner laboratories in Bangladesh, are now equipped with the full capacity to conduct the complete range of activities required to safely detect priority zoonotic diseases and emerging viral threats. Samples from wildlife, humans, and domestic animals were tested using consensus PCR (cPCR) to screen for five priority viral families (corona-, flavi-, filo-, influenza, and paramyxo-viruses). Virus findings were confirmed through sequencing and interpreted to better understand the relationship of the detected sequence to those from known animal and human pathogens. Reports of the interrelated results were produced and shared with the One Health Secretariat and local government ministries. This joint approval process supported and catalyzed multi-sectoral linkages, One Health dialogue, information sharing, and collaboration between the animal and human health sectors in Bangladesh. Both laboratories continue to test animal and human samples and serve as key training centers for students and professionals, including government staff from the national laboratory system.

VIRUS TABLE

VIRAL FAMILY	VIRUS	SPECIES	SAMPLING LOCATION	# OF POSITIVE INDIVIDUALS		
				TOTAL	WET SEASON	DRY SEASON
Coronavirus	Betacoronavirus 1 (OC43)	Human	Dhaka, Dinajpur, Faridpur Medical College & Hospital (Faridpur & Madaripur)	7	1	6
	Coronavirus 229E (Human strain)	Human	Madaripur	2	0	2
	Human coronavirus HKU1	Human	Dhaka	4	0	4
	PREDICT_CoV-17	Indian Flying Fox	Bogra, Dhaka, Madaripur	8	4	4
	PREDICT_CoV-24	Greater Short-Nosed Fruit Bat, Lesser Short-Nosed Fruit Bat	Charmuguria, Dinajpur, Gazipur, Madaripur	7	7	0
	PREDICT_CoV-35	Greater Asian House Bat, Lesser Asian House Bat	Dhaka, Dinajpur, Thakurgaon	6	6	0
	PREDICT_CoV-56	Greater Short-Nosed Fruit Bat	Charmuguria, Gazipur	5	5	0
	PREDICT_CoV-68	Indian Flying Fox	Dhaka	1	0	1
	PREDICT_CoV-86	Lesser Bamboo Bat	Benapole	5	5	0
	PREDICT_CoV-88	Lesser Bamboo Bat	Benapole, Madaripur	7	6	1
	PREDICT_CoV-89	Blyth's Horseshoe Bat	Faridpur	1	1	0
	PREDICT_CoV-90	Greater Asian House Bat	Thakurgaon	3	3	0
	PREDICT_CoV-103	Greater False Vampire Bat, Greater Short-Nosed Fruit Bat, Lesser Asian House Bat, Unidentified Megaderma Bat	Benapole, Dinajpur, Faridpur, Madaripur, Sylhet	34	30	4
	Longquan Aa mouse coronavirus	Asian House Shrew, Lesser Bandicoot Rat	Dhaka	3	3	0
	Murine coronavirus	Black Rat, Greater Bandicoot Rat, House Mouse, Lesser Bandicoot Rat, Oriental House Rat, Unidentified Rat	Dhaka, Dinajpur, Madaripur	21	7	14
	Wencheng Sm shrew coronavirus	Asian House Shrew	Dinajpur	6	6	0
	Alphacoronavirus 1 (Canine coronavirus)	Domestic Dog	Dhaka, Pabna Sadar	3	0	3
	Duck coronavirus	Domestic Chicken, Domestic Duck, Domestic Goose, Domestic Muscovy Duck, Domestic Pigeon, Swan Goose	Dhaka, Rajshahi	35	0	35
	Infectious bronchitis virus (IBV)	Domestic Chicken, Domestic Duck, Domestic Goose, Domestic Muscovy Duck, Domestic Pigeon, Common Quail	Dhaka, Dhamrai, Rajshahi	34	0	34
	Pigeon-Dominant coronavirus	Domestic Pigeon	Dhaka, Savar	9	0	9

Paramyxovirus	Human parainfluenzavirus 1	Human	Dhaka, Madaripur	3	1	2
	Human parainfluenzavirus 2	Human	Madaripur	1	1	0
	Human parainfluenzavirus 3	Human	Madaripur	1	0	1
	Measles virus	Human	Faridpur Medical College & Hospital (Faridpur & Madaripur), Madaripur	5	1	4
	PREDICT_PMV-13	Lesser Asian House Bat	Dhaka	3	3	0
	PREDICT_PMV-103	Blyth's Horseshoe Bat	Faridpur	1	1	0
	PREDICT_PMV-104	Greater False Vampire Bat	Faridpur	1	1	0
	PREDICT_PMV-109	Naked-Rumped Pouched Bat	Faridpur	1	1	0
	PREDICT_PMV-117	Blyth's Horseshoe Bat	Madaripur	1	0	1
	PREDICT_PMV-20	Asian House Shrew, Black Rat, House Mouse, Unidentified Rat	Charmuguria, Madaripur	16	11	5
	PREDICT_PMV-58	Oriental House Rat, Unidentified Rat	Dinajpur, Madaripur	3	1	2
	PREDICT_PMV-145	Asian House Shrew	Dinajpur	3	3	0
	PREDICT_PMV-149	House Mouse	Dhaka	3	3	0
	Avian paramyxovirus 6	Domestic Chicken, Domestic Duck, Domestic Goose	Dhaka, Rajshahi	7	0	7
	Newcastle disease virus	Domestic Chicken, Domestic Duck, Domestic Goose, Domestic Pigeon	Dhaka, Rajshahi	23	0	23
	Peste des petits ruminants (PPR)	Domestic Sheep	Dhaka	4	4	0
Influenza virus	Influenza A	Human, Common Quail, House Crow, Large-Billed Crow, Domestic Goose, Domestic Pigeon, Domestic Chicken, Domestic Muscovy Duck, Domestic Duck	Dhaka, Dhamrai, Dinajpur, Madaripur, Faridpur Medical College and Hospital (Faridpur & Madaripur), Rajshahi, Savar	182	17	165
	Influenza B	Human	Dhaka, Faridpur Medical College and Hospital (Faridpur & Madaripur), Madaripur	14	8	6
Flavivirus	Dengue virus serotype 2	Human	Dhaka, Faridpur Medical College and Hospital (Faridpur & Madaripur)	6	5	1
	Dengue virus serotype 3	Human	Dhaka, Faridpur Medical College and Hospital (Faridpur & Madaripur)	2	2	0
Total				**481**	**147**	**334**

VIRUSES DETECTED IN ANIMALS

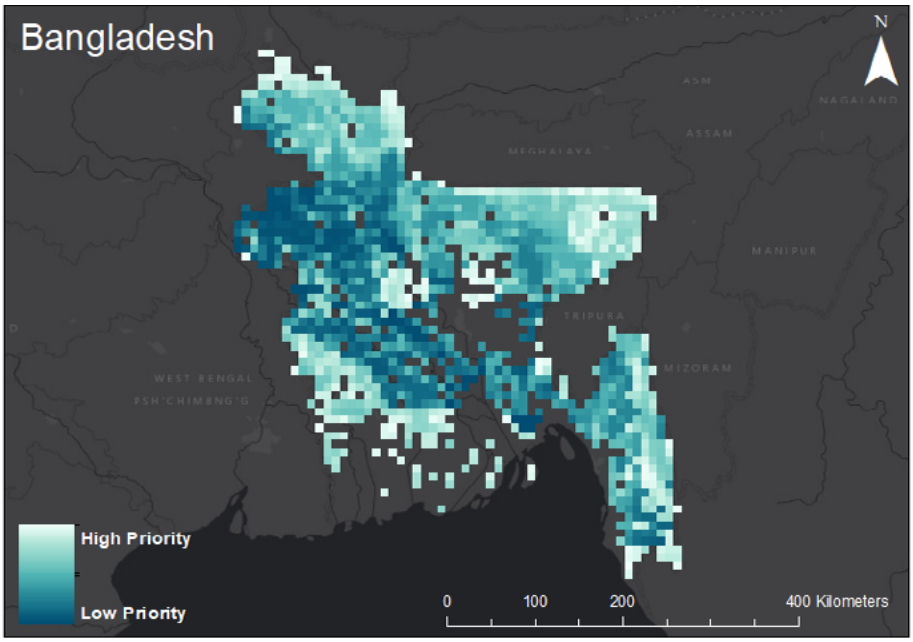
There were over 420 virus detections representing 40 unique viruses from four different viral families. Over 180 individual animals belonging to four different animal taxa (bats, rodents/shrews, birds, and carnivores) were positive for 17 unique coronaviruses, more than half of which were novel viruses. In addition, we detected Influenza A in over 160 different birds, most of which were from outbreak response. Finally, we detected 12 unique paramyxoviruses in wildlife and domestic animals, nine of which were novel viruses. The novel corona- and paramyxoviruses discovered in wildlife such as bats and rodents/shrews are not believed to pose a threat to human health.

VIRUSES DETECTED IN HUMANS

Ten known viruses representing four different viral families were detected in humans as a result of community and syndromic surveillance efforts. These include three coronaviruses known to cause respiratory illness in people (229E, OC43, and HKU1), four different paramyxoviruses including three types of human parainfluenza virus as well as Measles virus, Influenza B, and two serotypes of Dengue virus, a known flavivirus transmitted by mosquitoes. Viral summary heatmaps (next page) present the proportion of positive results and the number of PCR tests conducted across the five priority viral families at key transmission interfaces.

	Viral Test Type				
	Coronaviruses	Filoviruses	Flaviviruses	Influenzas	Paramyxoviruses
animal production	0% (1144)	0% (572)	0% (414)	0% (1144)	0.3% (572)
animal production; dwellings	0.6% (940)	0% (470)	0% (354)	0% (940)	0.2% (470)
animal production; outbreak	8.3% (12)	0% (6)	0% (6)	0% (12)	0% (6)
crop production	0% (78)	0% (39)	0% (39)	0% (78)	0% (39)
crop production; dwellings	1.1% (2113)	0% (1056)	0% (301)	0% (2113)	0.7% (1056)
dwellings	0.7% (10551)	0% (5276)	0% (1504)	0% (10551)	0.4% (5184)
dwellings; market and value chain	1.1% (1044)	0% (522)	0% (36)	0% (1044)	0.8% (522)
dwellings; market and value chain; outbreak	0% (234)	0% (117)	0% (84)	31.2% (234)	0% (117)
dwellings; outbreak	0.3% (1179)	0% (589)	0% (582)	4.4% (1179)	0% (589)
market and value chain	5.1% (448)	0% (224)	0% (222)	0% (448)	0.9% (224)
market and value chain; outbreak	16.1% (572)	0% (286)	0% (274)	7.7% (627)	10.5% (286)
natural areas	0.5% (620)	0% (310)	0% (279)	0% (620)	0% (310)
outbreak	0% (94)	0% (47)	0% (194)	19.7% (350)	0% (47)
zoos/sanctuaries	0% (4)	0% (2)	0% (2)	0% (4)	0% (2)

Virus data was integrated with published datasets to support resource allocation decisions for disease surveillance by the Government of Bangladesh. To do this, we combined data on the risk of virus spillover events with data on the relative cost of sampling and access to each site. We predicted optimal areas to target for future surveillance of zoonotic viruses in Bangladesh based on the highest return on investment for sampling. The sites of highest value to sample were ranked from most optimal (white) to least optimal (blue) based on the predicted number of unique zoonotic viruses and the relative cost of sampling and access to each site.



EPIDEMIOLOGICAL & BEHAVIORAL RISK

Bangladesh is a leader in applying the One Health approach to monitoring and mitigating emerging infectious diseases. One of the primary aims of the PREDICT project is to characterize the biological, ecological, and behavioral drivers that facilitate disease emergence and spillover from animals to humans. We performed community-based surveillance, conducting focus group discussions and questionnaires and collecting samples within communities. We also conducted syndromic surveillance in a hospital (Faridpur Medical College & Hospital) serving our primary communities to investigate causes and drivers of acute diseases of unknown origin.

Data indicated that there are high rates of animal contact among the study population across all sampling sites. Of note, participants reported frequent contact with rodents and poultry in the household: 90% of participants had contact with rodents in house, 79% noticed animal feces near food or food preparation areas, and 66% of participants raised poultry as a pet or for sustenance in or near their dwelling and reported cooking or handling poultry.

Known coronaviruses were identified in three patients presenting with influenza-like illness or with fevers of unknown origin (3/250; 1.2%). Interestingly, coronaviruses were detected in ten apparently healthy participants sampled from within the community (10/612; 1.6%). Detection of coronaviruses and/or paramyxoviruses in participants were not associated with age or gender of the participant. However, there was a higher odds of detecting these viruses during the dry season ($p < 0.001$). These results inspired a deeper investigation into the diversity of human coronaviruses found in Bangladesh.

In tandem with the questionnaires, the PREDICT/Bangladesh team conducted ethnographic interviews, focus group discussions, and community observations to gain a more in-depth understanding of behavioral risk. The team, composed of practitioners in anthropology, social, and clinical sciences, engaged community members from the four sites in discussions complementary to and expanding upon the topics covered in the questionnaire. From land-use change and perceptions of wildlife encroachment to valuations of risky and protective behaviors, team members encouraged respondents to share and expand upon their lived experiences in one of the world's recognized zoonotic disease hotspots.

A central theme in the semi-structured qualitative guides was the way in which the changing physical environment affected the lives of the respondents. Many of the respondents were long-term, if not lifelong, residents of the local areas, and could speak to years of environmental transformation. There was now more development, including roads, homes, and businesses. With the increased human population density, there was landscape change, including fewer trees, fewer ponds and canals (which had been filled-in), and changes in social dynamics. Among the respondents, there was a general sense that while many of these changes were positive, a price had been paid.

[T]he old houses are being replaced by high rising buildings. As Gandaria is a part of Old Dhaka, you know, the traditional houses of old Dhaka…they are being sold to the developers and the developers are making high rise buildings. This is quite a big change. There is a field here, named Dhupkhola ground. It was a big one. But right now that has not remained quite a field. You won't see any field now. What you are seeing right now was not like this before. The stalls you are seeing around this field were not here. There was a walkway instead. People used to walk there in the morning. In the afternoon snacks (chatpati, panipuri) were sold on both sides of the road. I mean the environment was quite different. A wonderful one. Now the whole place has been surrounded by walls. The place has not remained like before. The local boys do not play there anymore like before. That has been kept unused. So that is a huge change. And the old houses has also been replaced by the new ones which is also a noticeable change. This place did not have too much stalls, but now it has new stalls growing like fungus. Different stalls of fast foods, departmental stores...

27 YEAR OLD FEMALE
SERVICE HOLDER

40 YEAR OLD
FEMALE HOMEMAKER

I have heard about Nipah. Something related to bats, right? There were date tree on that house we lived previously. At that time Nipah came. People were talking about this disease. So we stopped taking raw date juice.

Insights from the respondents also demonstrated the ways in which wildlife such as macaques interacted with the community. Macaques were frequently described entering kitchens and other domestic areas, opening food and water containers, ruffling clothing, and stealing food. Physical contact with the macaques was reported with some regularity, including bites and scratches. Some attributed these macaque-human conflicts to a change in home ranges driven by deforestation. Nevertheless, the perceptions of the community members towards macaques varied, from regarding them as a nuisance and a danger, to a form of entertainment and something to be viewed with humor.

Understanding local practices, attitudes, and gaps in risk perception provided the basis of the questions asked over the course of the interviews. For example, probing on behaviors following outbreaks and the general disposal of dead animals revealed the tendency for many respondents to discard (possibly infected) carcasses into nearby ponds and rivers. The interviews suggest that a majority of participants visit local medical facilities when they have health concerns. However, certain individuals still seek out traditional medicine instead. The respondents' perceptions around Nipah virus and avian influenza virus were often inaccurate or incomplete, suggesting that previous educational campaigns had varying levels of success and thus identified potential areas for improvement in future risk communication initiatives.

The scope of this immense qualitative dataset was an achievement made only possible by the skill, experience, and tenacity of the transdisciplinary PREDICT/Bangladesh team. Covering diverse geographic regions, socioeconomic categories, gender, ages, and occupations, the data and findings stemming from this investigation will provide valuable resources for researchers and practitioners looking to build locally relevant, evidence-based interventions.

COMMUNITY ENGAGEMENT & RISK COMMUNICATION

The PREDICT/Bangladesh team was committed to raising awareness and improving knowledge of zoonotic disease threats while strengthening capacity for disease prevention and response at all levels. This required multi-faceted stakeholder engagement beginning at the community level. Prior to the initiation of sampling, community outreach events were held to introduce the project to the community and raise people's awareness of zoonoses and high-risk animal-human disease transmission interfaces. This community interaction is key to preventing outbreaks of zoonotic disease. The team engaged local communities to increase zoonotic disease awareness and sensitize them to the importance of One Health approaches. The PREDICT/Bangladesh team supported zoonotic disease sensitization through the *Living Safely with Bats* tool, a community resource developed by the PREDICT project.

The team continued to work with district and regional level animal and human health officers to transfer knowledge and advance disease surveillance skills. Findings were shared with One Health platform stakeholders to foster engagement at national and community levels and improve awareness of zoonotic diseases and transmission pathways, along with potential prevention and control strategies.

CAPACITY STRENGTHENING

The PREDICT/Bangladesh team supported government partners and the One Health Secretariat as the Government of Bangladesh expanded the national One Health platform. Through meetings, workshops, conferences, and in-service and pre-service training opportunities, the team contributed to the One Health framework and strengthened One Health workforce capacity in Bangladesh. PREDICT/Bangladesh worked closely with government partners, hospitals, and universities to successfully operationalize the One Health approach and further empower the national One Health platform. PREDICT project partnerships were built to support the One Health mission of the Government of Bangladesh, specifically through wildlife disease surveillance, disease outbreak investigation and response, human behavioral risk investigation, and syndromic surveillance. Additionally, data platforms were strengthened to improve the dissemination of animal and human epidemiological and ecological data, building capacity for zoonotic disease surveillance.

The PREDICT project enabled the surveillance of pathogens that could spillover from animal hosts to people by strengthening capacities to detect viruses circulating in wildlife and domestic animals. The PREDICT/Bangladesh team organized over 10 multi-day intensive field-training events for the Government of Bangladesh staff, including forest, BLRI, DLS, and IEDCR officers. The workshops included training on zoonotic diseases, safe sampling methodology, human and animal safety during wildlife capture, personal protective equipment (PPE) use during field sampling and laboratory testing, biosafety and zoonoses, outbreak response data collection and management, and laboratory methodology and safety. Laboratory training and capacity building was a specific focus to advance the portfolio of the internationally recognized work of icddr,b. This included improved capacity for viral discovery and surveillance to monitor spillover of viruses within key viral families (paramyxoviruses, coronaviruses, filoviruses, flaviviruses, and influenza viruses), from wildlife and livestock populations into human populations.

The PREDICT/Bangladesh team supported the government's mission to promote the health and welfare of all species, a One Health approach. The PREDICT Country Coordinator and subject matter experts supported the One Health Secretariat in building the national ability to monitor viral threats; investigate viruses with pandemic potential at high-risk interfaces; build the capacity for the detection and characterization of novel wildlife viruses; improve the understanding of the dynamics of zoonotic virus spillover, evolution, amplification, and spread in order to inform prevention strategies; and reduce the risk of disease emergence. The PREDICT team also supported the Government of Bangladesh's mission to build an outbreak response team through the many scenario-based, joint outbreak investigation training events led by the PREDICT Bangladesh team, and by supporting on-the-job training during disease outbreak investigations. PREDICT/Bangladesh supported the growth of the national One Health platform (through the One Health Secretariat) by increasing sub-national, national, and international networks; supporting strategic planning and disease prioritization; participating in health advocacy and communication; and facilitating information sharing between ministries.

The PREDICT/Bangladesh team supported One Health platform activities by leading workshops in collaboration with FAO Bangladesh at the National One Health Meetings and OHSA conferences. The PREDICT/Bangladesh team built regional and international partnerships within the One Health community. These partnerships were key for sharing knowledge, information, and data. To this end, the PREDICT/Bangladesh team worked with the PREDICT India team to capture, sample, and safely release wildlife, and train them in the use of personal protective equipment. These collaborative, cross-border activities have enhanced the workforce capacity to conduct wildlife disease surveillance in India. The PREDICT/Bangladesh team presented at a local PREDICT/Nepal meeting to share challenges and success stories in order to create collaborative opportunities at a regional level. Simultaneously, the PREDICT/Bangladesh team continued to build a network of One Health professionals through an increased presence within the international scientific community by participating in and presenting research findings at numerous international conferences

PRACTICAL IMPLICATIONS

- The PREDICT program used a collaborative One Health approach to build capacity for the detection and characterization of novel wildlife viruses and to improve the understanding of the dynamics of zoonotic virus spillover, evolution, amplification, and spread in order to inform prevention strategies and reduce the risk of disease emergence.
- The PREDICT/Bangladesh team identified important interfaces for disease transmission from animals to humans, including landscape-level changes, which were often associated with deforestation and changing agriculture and food production systems; wildlife hunting; trans-boundary animal trading; and unplanned commercial farming. These interfaces provide opportunities for pathogens to spillover from animals to humans, so identification is key for risk assessment and resource allocation.
- The support and training that the PREDICT/Bangladesh team provided in zoonotic outbreak response has improved the capacity for the Government of Bangladesh to mount a One Health response to outbreaks.
- The team's economics study has the potential to inform country action as well as encourage wider multi-sectoral accounting of disease outbreaks. These results will inform One Health approaches to emerging and endemic zoonotic disease management in the region and world.

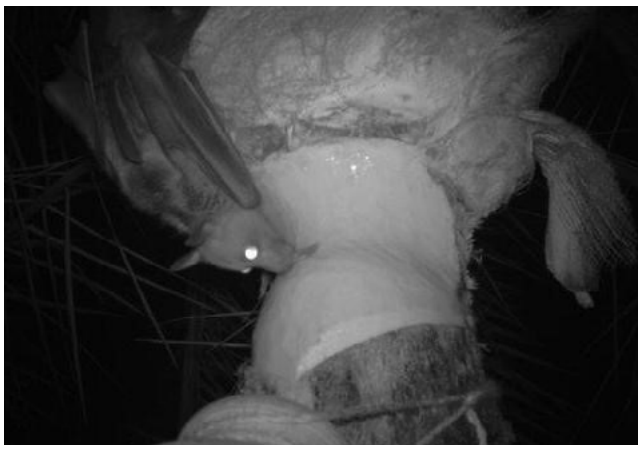
NIPAH IN BANGLADESH

WHEN EPIDEMICS BECOME ENDEMIC – EXCERPTS FROM AN ARTICLE PUBLISHED IN THE ONE HEALTH COMMUNICATOR, 2018

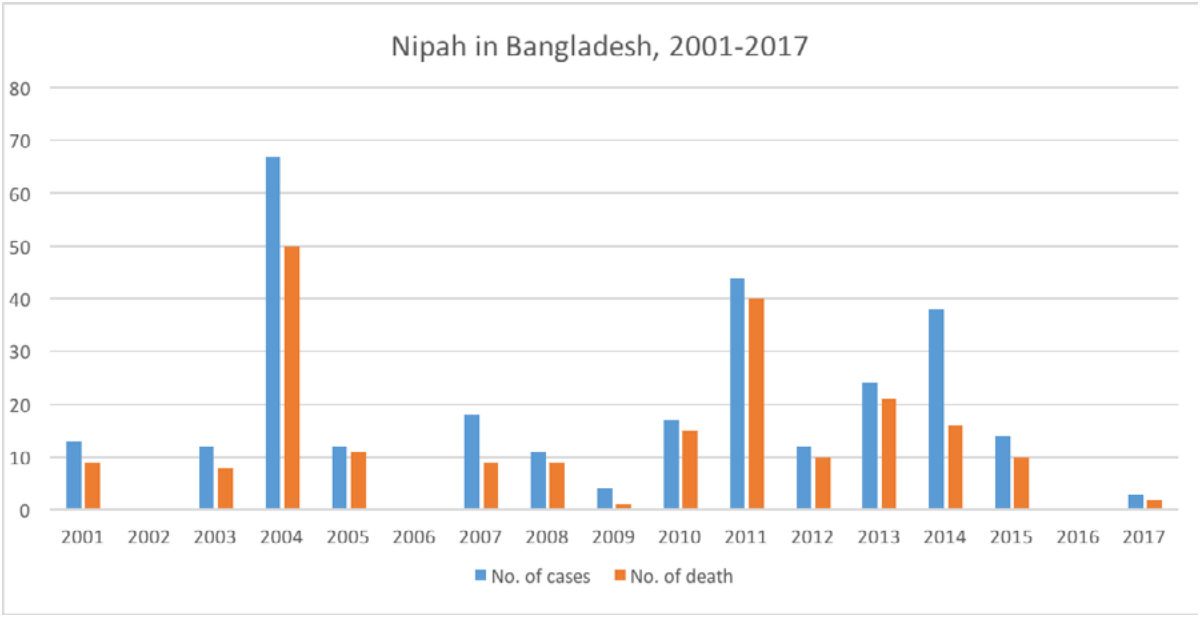
In Bangladesh, Nipah virus (NiV) causes seasonal encephalitis outbreaks during the winter months (November – April) and so far, cases have only been seen in the western part of the country – the "Nipah belt." Nipah virus outbreaks in Bangladesh on average have a 70% case fatality rate. The virus is a zoonotic paramyxovirus, carried by frugivorous bats throughout Asia. The virus doesn't make bats sick, but people and domestic animals get infected when they eat or drink food that has been contaminated by bat saliva or urine. Nipah virus can be spread from person to person, but not very efficiently, which is what has so far prevented larger epidemics. However, given its broad distribution, high mortality rate, lack of a vaccine or therapeutic, and continual spillover into people in one of the most populous regions on Earth, there is concern that a genetic strain may eventually spillover from bats into people that is more easily transmitted.

SWEET BUT RISKY DELICACY IN BANGLADESH

Drinking raw date palm sap during the winter season is a cherished custom in Bangladesh. The sap is harvested by shaving the bark from the upper trunk of date palm trees and allowing the sap to flow along the trunk into a clay collection pot overnight. Fruit bats, which also eat nectar, have learned to exploit this otherwise unavailable food by landing on the palm fronds and licking the sap as it flows, contaminating the sap with saliva and other excreta, such as when the bats urinate over the collecting pots. Most of the Nipah virus outbreaks in Bangladesh have been associated with drinking raw date palm sap. From 2001-2017, altogether 289 people were infected in Bangladesh among which 211 died. Survivors frequently suffer from prolonged nervous system disorders including muscular weakness, cognitive impairment, and personality change.



There is a robust surveillance system in place for Nipah virus in Bangladesh. The IEDCR of the Government of Bangladesh, in collaboration with the icddr,b and the United States Centers for Disease Control, conducts hospital-based surveillance in several hospitals within the Nipah belt. Suspected sporadic cases and case clusters that report to hospitals are tested and investigated, including case contacts, to determine the extent of the outbreak and to control its spread.



Hunting bats for human consumption, living nearby and under bat roosts, and sharing food resources could all result in NiV transmission. Furthermore, the risk of bat-borne zoonotic disease transmission encompasses complex, time-varying interactions between humans and their environment that are often driven by culture, climate, and economic development. Therefore, preventing bat-to-human transmission of NiV in Bangladesh is public health priority. In 2007, researchers persuaded the sap collectors, Gacchi, to cover the trunk of the date palm with a bamboo skirt (Bana), which prevents the bats from contaminating the sap. Some other effective preventive measures include broadcasting awareness messages on local TV, developing posters, increasing access to handwashing stations in hospitals, and reducing caregivers' exposure to infected patients' bodily secretions during care and traditional burial practices. Most importantly reducing human consumption of raw sap could reduce virus transmission and risk of disease emergence.

COEXISTING SAFELY WITH BATS:

Despite the zoonotic disease risk, bats are vital to our ecosystem because they pollinate flowers, disperse seeds, and eat insects. Therefore, it is imperative that we find a way to live safely with bats. This is especially important as most outbreaks of bat-borne zoonotic diseases are a consequence of human activities. As these tropical forest habitats for Nipah-carrying fruit bats have been converted into agricultural lands, the bats have sought out other sources of food. The bats have moved into areas that are closer to human dwellings and therefore present a higher risk of zoonotic disease transmission. Thus, we must coexist safely with bats as suggested in the *Living Safely with Bats* resource.

For more information view the interactive report at
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