PREDICT
SENEGAL

One Health in action (2017-2020)

One Health surveillance in Senegal

SENEGAL

With numerous outbreaks occurring in the region, such as the 2014 Ebola Outbreak, and Lassa Fever outbreaks in Nigeria and Sierra Leone, Senegal has been actively working to enhance its capacity for surveillance, and for detection of and response to emerging and re-emerging infectious diseases, 75% of which are of animal origin. The Senegalese government has undertaken several innovative actions in this direction, most notably adopting a One Health approach as a central aspect of their preparedness strategy. In this context, PREDICT brought together a multidisciplinary team of professionals in human, animal and environmental health from the Interstate School of Veterinary Science and Medicine (EISMV), the Cheikh Anta Diop University of Dakar, and the Senegalese Institute of Agricultural Research/Laboratory for Animal Husbandry and Veterinary Research (ISRA/LNERV) to implement One Health surveillance activities at high-risk human-animal interfaces between January 2017 and September 2019. These activities were designed to strengthen capacity for detection of emerging viral threats and to assess risk of zoonotic diseases in communities with close and frequent animal contact.

Through analysis of project data and findings, the PREDICT team was able to identify risks and educate communities and health professionals on behavior change and intervention strategies designed to protect people and wildlife from disease threats.

LOCAL PARTNERS

- Cabinet du Premier Ministre, Sénégal
- Defense Threat Reduction Agency/ Cooperative Biological Engagement Program
- Direction des Parcs Nationaux
- Institut Pasteur de Dakar, Dakar
- Ministère de l'Agriculture et de l'Equipment Rural
- Ministère de l'Elevage et des Productions animales
- Ministère de l'Environnement et du Développement Durable

- Ministère de la Santé et de l'Action Sociale
- Organisation des Nations Unies pour l'Alimentation et l'Agriculture (FAO), Dakar
- Organisation Mondiale de la Santé Sénégal (WHO), Dakar
- REDISSE (World Bank), Dakar
- UCAD/Hôpital Aristide le Dantec, Dakar
- US CDC, Dakar
- USAID EPT One Health Workforce
- Réserve de Bandia

>70

DEVELOPED the One Health Workforce by training more than 70 people in Senegal.

>1.6K

OPERATIONALIZED One Health surveillance and sampled over 1.6K animals and people, to identify ways to help minimize the spillover of zoonotic disease threats from animals into human populations.

LABORATORY STRENGTHENING

- Cheikh Anta Diop University of Dakar (UCAD)
- Senegalese Institute of Agricultural Research/Laboratory for Animal Husbandry and Veterinary Research (ISRA/LNERV)

23,511
TESTS

5 PREDICT   **9** KNOWN
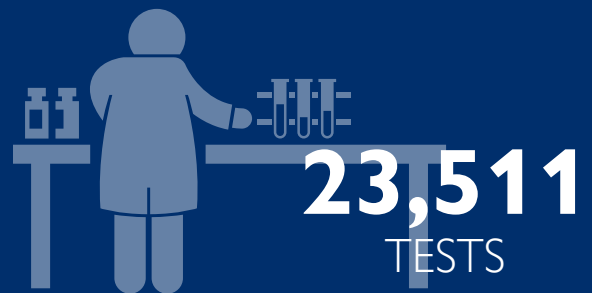
DETECTED 14 unique viruses in both animal and human populations.

Global Health Security Agenda

MODOU MOUSTAPHA LO

ISRA PI

Institut Sénégalais de Recherches Agricoles

"PREDICT has been the most involved program in the implementation of the One Health approach in Senegal. The PREDICT/Senegal team, representing the three main Senegalese human, animal and environmental health structures in Senegal, has been involved in 4 out of the 6 priority zoonotic diseases in the country."

MAME CHEIKH SECK

Human Sampling Lead

Université Cheikh Anta Diop de Dakar

"The One Health approach became a reality in Senegal. Thanks to PREDICT, different health professionals (doctors, veterinarians and ecologists) united efforts to monitor, detect and respond to endemic threats in the 'human-wildlife' interface."

AMADOU ALASSANE N'DIAYE

Sampling Lead

Interstate School of Veterinary Science and Medicine (EISMV)

"PREDICT has given me the opportunity to get deeply involved in research, community awareness and capacity building. PREDICT has a lasting impact on the consolidation of the One Health approach in Senegal. I have had an incredible work experience with PREDICT which will serve me well during my career."

ACHIEVEMENTS

- Trained the first multidisciplinary team (medical doctors, veterinarians, environmentalists, biologists, etc.) to safely conduct wildlife surveillance in Senegal.
- Established an operational workforce to monitor priority viral pathogens that may emerge from wildlife.
- Sampled 823 humans in clinics and in the community.
- Sampled 874 wild animals (bats, rodents and non-human primates).
- Tested 11,520 human samples at the UCAD laboratory.
- Tested 11,991 wildlife samples at the ISRA laboratory.
- Trained 26 National Parks, Water and Forest officers in wildlife monitoring and sampling following strict biosafety and biosecurity measures.
- Trained 25 technicians and students on laboratory techniques to identify viruses with epidemic potential following strict biosafety and biosecurity measures.
- Engaged 865 people (notables, village chiefs, religious guides, youth and women's associations, workers and students) in community outreach activities to reduce risk of virus spillover including providing information on how to live safely with wildlife.
- Human Coronavirus 229E was identified in bat samples.
- Organized a One Health simulation exercise on how to react to the potential discovery of a filovirus of pandemic potential in wildlife, bringing together 45 diverse stakeholders: administrators, technical ministries, locally elected representatives, universities, technical partners and donor agencies.

ONE HEALTH SURVEILLANCE

Together with in-country partners, the PREDICT project identified and characterized multiple animal-human high-risk interfaces including agricultural intensification, hunting, and ecotourism within the Sindia region. Given the proximity of these interfaces to heavily populated areas, including the capital city of Dakar, and the potential for pathogen spillover and spread, partners collectively agreed to focus concurrent One Health surveillance efforts in and around the regional health clinics in the Sindia region and the Bandia Reserve, a privately-owned wildlife reserve open to tourism, and surrounding villages (Fig. 1).

Concurrent animal and human surveillance took place between May 2017 and October 2018. Wildlife surveillance targeted three taxa, namely bats, rodents and non-human primates (NHP). While NHP were only sampled at the Bandia Reserve, bat and rodent samples were collected at all sites within the Sindia Prefecture. Human surveillance occurred in regional health clinics (syndromic surveillance) as well as within the surrounding communities that sought care from these clinics (community-based surveillance). Syndromic surveillance took place within two regional health clinics and targeted malaria negative patients that presented with various symptoms including fever of unknown origin, encephalitis and hemorrhagic fever. Patient sampling was safely conducted and included collecting biological specimens (oral, rectal, nasal swabs and blood) and completing a standardized qualitative questionnaire on demographics, risk perceptions, behaviors and interactions with animals.
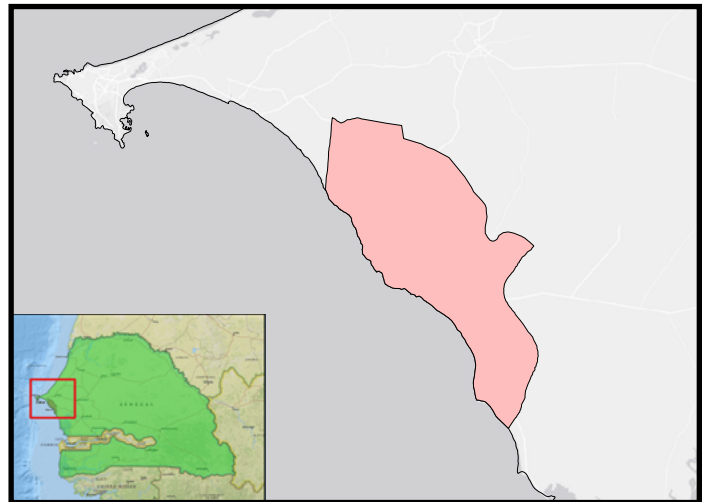

Figure 1: Concurrent One Health surveillance area in Sindia Prefecture, Senegal
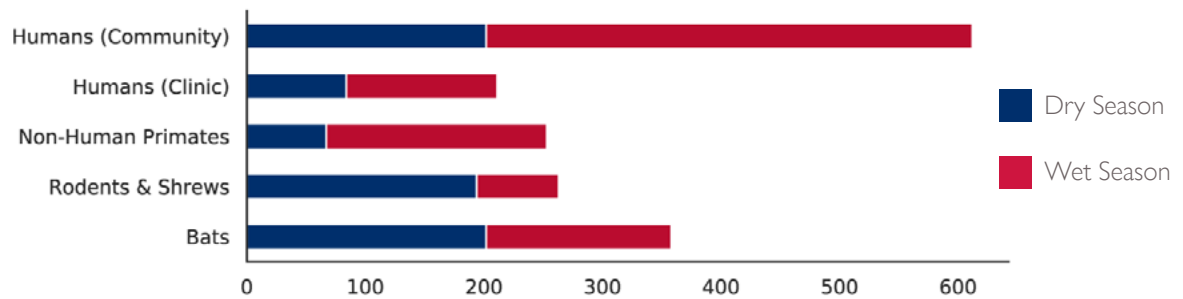

HUMAN SURVEILLANCE

A total of 824 participants were enrolled. The majority were recruited in the villages (62%) with 219 (26%) sampled in the clinics. Study participants were mostly females (62%) with a median age of 26. Most people enrolled reported no education (30%) or indicated primary school as their highest educational level (36%). Specific demographics by site and season are presented in Table 1.

ANIMAL SURVEILLANCE

Throughout the PREDICT project, we safely and humanely sampled 874 wild animals, including 358 bats, 263 rodents, and 253 NHP. Genetic barcoding to confirm the host species identification was performed on all virus-positive individuals, and as possible on virus-negative animals. Insectivorous bats, such as Sundevall's roundleaf bat (*Hipposideros caffer*) and Noack's roundleaf bat (*Hipposideros ruber*) composed 57% of the bats sampled, while two fruit bat species, the straw-coloured fruit bat (*Eidolon helvum*) and the Egyptian fruit bat (*Rousettus aegyptiacus*), represented the remaining 43% sampled. House mice (*Mus musculus*) were the predominant rodent species sampled (68%), followed by black rats (*Rattus rattus*; 22%) and unidentified shrew species belonging to the Soricidae family (9%). Additionally, we sampled one African grass rat (*Arvicanthis niloticus*) and one giant pouched rat (*Cricetomys emini*). All NHP sampled were Green monkeys (*Chlorocebus sabaeus*).

PARTICIPANT CHARACTERISTICS ACROSS ALL SURVEILLANCE SITES

SITE CHARACTERISTICS				PARTICIPANT DEMOGRAPHICS & SAMPLE CHARACTERISTICS					
SITE NAME	HUMAN DENSITY	SAMPLING TYPE	TOTAL	GENDER		SEASON		SPECIMENS COLLECTED	
				FEMALE (n)	MALE (n)	DRY (n)	WET (n)	NASAL SWABS (n)	ORAL SWABS (n)
SINDIA NORTH EAST	RURAL	COMMUNITY	196	116	80	61	135	196	196
SINDIA CENTRAL NORTH	RURAL	COMMUNITY	197	136	61	61	136	197	197
CLINIC - SINDIA WEST	PERI-URBAN	SYNDROMIC	7	3	4	3	4	7	7
CLINIC - SINDIA CENTRAL	PERI-URBAN	SYNDROMIC	211	113	98	78	133	211	211
SINDIA NORTH	RURAL	COMMUNITY	213	144	69	74	139	213	213

Numbers of individuals sampled by taxa group in Senegal

SURVEILLANCE FINDINGS

Searching for viruses in wildlife before they emerge in humans is core to the PREDICT project's One Health surveillance approach. We used broadly reactive consensus PCR supplemented with high throughput sequencing to screen for priority zoonotic viral diseases and emerging threats such as filoviruses (Ebola and Marburg), Influenzas, coronaviruses, paramyxoviruses and flaviviruses. These powerful tools produce specific, high-resolution data, allowing for detection of known and new potential pathogens.

In total, PREDICT laboratory partners at UCAD and ISRA/LNERV safely tested 23,511 specimens, of which 11,991 were collected from wildlife (5,859 bats, 4,361 rodents and 1,771 NHP) and 11,520 were collected from humans.

VIRUS TABLE

VIRAL FAMILY	VIRUS	SPECIES	SAMPLING LOCATION	# OF POSITIVE INDIVIDUALS		
				TOTAL	WET SEASON	DRY SEASON
Coronavirus	Betacoronavirus 1 (OC43)	Human	Clinic (Sindia Central)	2	0	2
	Bat coronavirus Hipposideros	Noack's Roundleaf Bat, Sundevall's Roundleaf Bat, Straw-Coloured Fruit Bat	Bandia Reserve, Sindia Northeast	15	1	14
	Coronavirus 229E (Bat strain)	Sundevall's Roundleaf Bat	Bandia Reserve	1	0	1
	Eidolon bat coronavirus	Straw-Coloured Fruit Bat	Ngaparou, Sindia Central	7	7	0
	Murine coronavirus	House Mouse	Sindia Central-north	1	0	1
Paramyxovirus	Human parainfluenzavirus 1	Human	Clinic (Sindia Central)	1	0	1
	Mumps virus	Human	Clinic (Sindia Central)	1	1	0
	PREDICT_PMV-174	Sundevall's Roundleaf Bat	Bandia Reserve	5	0	5
	PREDICT_PMV-167	Black Rat	Sindia Central	1	0	1
	PREDICT_PMV-169	Unidentified Crocidura Shrew	Sindia Central-north	1	0	1
	PREDICT_PMV-172	African Grass Rat	Sindia Central-north	1	0	1
	PREDICT_PMV-173	House Mouse	Bandia Reserve	1	0	1
Influenza virus	Influenza A	Human	Sindia Northeast, Sindia Central-north, Sindia North, Clinic (Sindia Central)	50	48	2
	Influenza B	Human	Clinic (Sindia Central)	6	6	0
Total				**93**	**63**	**30**

VIRUS DETECTION IN HUMANS

Of the 824 human participants, 7% (n=60) were positive for at least one virus. In total, 5 known viruses were confirmed, including strains of Betacoronavirus 1 (OC43), Influenza A, Influenza B, Human Parainfluenzavirus 1 and Mumps virus (see Virus Table). 65% (n=40) of participants that were found to be positive for a virus came from the syndromic surveillance at clinics. The majority of the positive cases were women, 67% (n= 40) and were sampled during the wet season 92% (n= 55). There were no positives from the clinic in the Sindia west region. Positive participants reporting previous contact with animals included 8% (n=5) having contact with rodents, 50% (n= 30) with poultry and other fowl and only 1% (n= 1) with a NHP. Interestingly, none of the positive participants reported having contact with bats.

VIRUS DETECTION IN WILDLIFE

In wildlife, we found 9 viruses in 33 animals, 4 are known viruses and 5 are previously unknown (see Virus Table). In rodents, a murine coronavirus and multiple new paramyxoviruses were confirmed. A new paramyxovirus and multiple strains of coronaviruses such as the alphacoronavirus Coronavirus 229E were found in bats. No viruses were detected in NHP.

KEY SURVEILLANCE FINDINGS THAT SUPPORT THE ONE HEALTH APPROACH

- Two sites, Sindia central and Sindia north east, were unique in several aspects, including being the sites with the most viral discoveries in both animals and people. They were also the only sites with positive samples from three taxa: bats, humans and rodents. Further studies are needed to understand whether the same viruses are shared across taxa. These two sites were the only sites with positive samples for three of our target virus families, influenza viruses, coronaviruses, and paramyxoviruses.

- More samples collected during the wet season were found to be positive than those collected in the dry season. Influenza was mostly detected in the rainy season, whereas coronaviruses and paramyxoviruses were predominantly detected

BEHAVIORAL RISK

Contact with animals either directly or indirectly was highly prevalent among people surveyed, with nearly all reporting interactions within the last year, both in the community and health clinic groups. 60% of the interviewees reported to have pets in their dwellings, and some mentioned sharing water (10%) or food (3%) with these animals. Most participants (79%) did not report to know what the main source of diseases in their communities are, but suggested climate (5%), fatigue (5%), contact with sick people, and (3%) other factors. People's perception of disease transmission risk from live animals (wild and domestic) sold at their local markets was divided, with 56% of people reporting concern about sick animals. Interestingly, raw meat or meat originating from a sick animal is not regularly consumed, with only 4% of people reporting engaging in this risky behavior. When asked about contact with wildlife, 31% reported to have contact with rodents, 3% had contact with bats and only 0.3% had contact with NHPs. However, reported contact varied from one surveillance site to another. For example, the highest contact with rodents was reported from Sindia north east, a semi urban area (20%), and the highest reported contact with bats was in Sindia north, a rural area (14%). The majority of people working in close animal-human contact interfaces were in the animal production (n = 83) and crop (n = 83) industries. Areas with crop production appear to be hotspots for potential animal to human disease transmission, with 72% of workers reporting that livestock and wildlife often frequent the farms, thus providing opportunities for contamination of products that are for human consumption. A small proportion of participants reported that they hunted animals (1% within the last year, and 8% over their lifetime). However, approximately a quarter of people whose livelihoods were linked to animals, such as crop farmers (25%) and animal production workers (19%) stated that bushmeat was available to consume on or near their work site.

Awareness of risk of disease transmission via bodily fluids through direct contact when slaughtering animals or through bites and scratches was uncommon (45% responded not being aware of a risk). However, although most people do not butcher or slaughter their own meat (76%), those that do (n = 202) said they are likely to either visit a doctor (47%) if injured and/or self-clean a wound (42%), with only 8% taking no action. Most people interviewed seek health care from the local clinic (90%) or community health worker (12%). Of those that seek help from a traditional healer (6%, n=49), use was more common by women (76%).

STRENGTHENING CAPACITY

The PREDICT project convened various trainings in the field and laboratory, providing opportunities to strengthen skills across the full spectrum of surveillance, detection, and response. The PREDICT project deliberately designed a One Health approach that encouraged hands-on development of core skills lacking in the current animal and human health workforce in Senegal, as identified through the Joint External Evaluation. These trainings directly strengthened the capability of the current workforce to successfully and safely conduct core functions of their job on the frontlines of zoonotic disease surveillance and response in Senegal. A highlight of this effort was the first-ever One Health tabletop simulation exercise for "Detection and Response to a Filovirus Outbreak in Sindia". This event was co-organized with the Senegal Government's Emergency Operations Center (COUS) and involved 45 advisors from the Prime Minister's Office; the General Director of the Ministry of Health; representatives from the Ministries of Agriculture, Health and the Environment; CDC; WHO; and other Global Health Security Agenda

PRACTICAL IMPLICATIONS

The PREDICT project strengthened Senegal's ability to detect and respond to zoonotic disease threats. EISMV, ISRA/LNERV and UCAD have collaborated with key stakeholders and government partners to implement a One Health approach to disease surveillance.

Investigation into risky behaviors of individuals at the human-animal interface showed that contact with live animals is highly prevalent, but few people understand or acknowledge that this contact may lead to disease transmission. Community engagement activities targeting how to live safely with wildlife should be continued.

In terms of viral findings in Senegal, coronaviruses and paramyxoviruses were found in all sample types across both humans and animals. This is of potential interest for further viral investigations.

Linking the outcomes from the behavioral questionnaire with viral findings, there were no participants positive for a virus that self-reported having contact with bats, although the majority of PREDICT project sites included homes with bats roosting in them. It may be important to highlight this interface as a potential risk to the communities when continuing engagement activities.

For more information
view the interactive report at
p2.predict.global