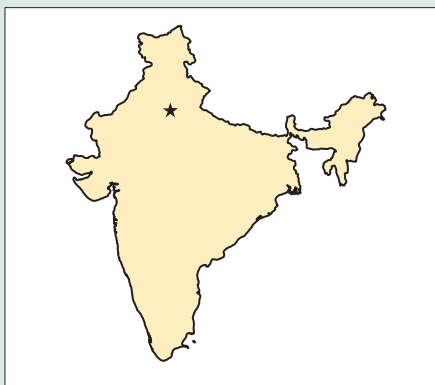


India



- **Capital:** New Delhi
- **Area:** 3,287,263 sq km
- **Population:** 1,205,073,612 (July 2012 est.)
- **Age Structure:** 0-14 years: 29.7% (male 187,450,635/ female 165,415,758); 15-64 years: 64.9% (male 398,757,331/female 372,719,379); 65 years and over: 5.5% (male 30,831,190/ female 33,998,613) (2011 est.)
- **Life Expectancy at Birth:** Total population: 67.14 years; male: 66.08 years; female: 68.33 years (2012 est.)
- **Infant Mortality Rate:** Total: 46.07 deaths/1,000 live births; male: 44.71 deaths/1,000 live births; female: 47.59 deaths/1,000 live births (2012 est.)
- **Literacy Rate:** Total population: 61%; male: 73.4%; female: 47.8% (2001 census)
- **GDP:** \$4.463 trillion (2011 est.)
- **GDP per Capita:** \$3,700 (2011 est.)

Highlights

- The India surveillance network uploaded data on influenza viral characteristics from nine sites throughout India to the World Health Organization (WHO) FluNet site in real time.
- Re-emerging influenza A (H3N2) viruses were genetically characterized and surveillance for A (H1N1)pdm09 viruses continued.
- Data on seasonality of influenza viruses identified the need to change the timing of influenza vaccination efforts. These findings have persuaded the Drug Controller of Government of India (the equivalent of the U.S. Food and Drug Administration) to permit importation of Southern Hemisphere vaccine for spring time vaccination.
- Sites collecting information on influenza disease burden contributed data for global pandemic influenza-related mortality estimates.
- Longitudinal data with pandemic influenza incidence rates for rural communities of India suggest that the public health response to a pandemic should consider targeted interventions for children during the early pandemic period, and targeted interventions for adults in later phases of the pandemic.

U.S. CDC Direct Country Support

The U.S. Centers for Disease Control and Prevention (CDC), in coordination with other U.S. government agencies, supports response measures against seasonal, avian and pandemic influenza in India through the following cooperative agreements and collaborative programs:

- *Development of Influenza Surveillance Networks in India:* This cooperative agreement is in the sustainability phase. A network of 10 influenza surveillance sites contribute data for surveillance of seasonal, pandemic and avian influenza for timely characterization (genetic and antigenic) of influenza isolates for inclusion in global vaccine selection.
- *Addressing Emerging Infectious Diseases in the Republic of India: Influenza Disease:* This cooperative agreement is established for five years to estimate population-based multi-site burden of disease related to influenza virus infection in India.
- *Direct and Indirect Protection by Influenza Vaccine Given to Children in India:* This cooperative agreement is established for three years to determine direct and indirect effects of immunization of young children with trivalent influenza vaccine in three rural villages near Delhi. This is a collaborative study between the University of Alabama, the All India Institute of Medical Sciences and CDC.
- *Understanding Host Innate Immune Responses against Influenza A Virus:* This bilateral research collaborative program between the International Center for Genetic Engineering and Biotechnology and CDC was initiated to study host-viral interactions for a better understanding of innate pathways involved in viral infection.

Surveillance

The Indian Council of Medical Research conducts sentinel surveillance at nine surveillance sites throughout India which are generating crucial epidemiological and virological data. Three new sites were added to the network at Srinagar, Lucknow and Allapuzha, improving geographical representation and providing crucial insight into the geographical and seasonal variation of influenza transmission within India. The National Influenza Center (NIC) at Pune has been sending timely isolates to CDC for antigenic analysis and has contributed cumulative weekly influenza surveillance data to the World Health Organization (WHO) FluNet web site.

Surveillance efforts have documented that influenza seasonality varied across India with peak influenza



A visit to the Serum Institute of India in August 2011. From left to right: Marc-Alain Widdowson (Team Lead, International Epidemiology and Response Team, CDC), Michael Shaw (Associate Director, Laboratory Science, CDC), Katie Lafond (Epidemiologist, CDC), Renu Lal (Influenza Coordinator, CDC), Rajeev Dhere (Executive Director, Serum Institute), Nancy Cox (Director, Influenza Division, CDC), and Leena Yeolekar (Consultant, Serum Institute).

activity occurring during January–March in the northern-most tip of the country and during the rainy season (August–October) in the rest of the country. Previously, India was only using Northern Hemisphere influenza vaccine, but these findings have led to importation of Southern Hemisphere vaccine.

Surveillance Activities

- In 2011, several isolates were identified with the H275Y in the neuraminidase gene that confers oseltamivir resistance among influenza A (H1) isolates and resistance to adamantines (S31N) in some influenza A (H3N2) isolates.
- The NIC at the National Institute of Virology (NIV) in Pune submits virological and epidemiological data to the Global Influenza Surveillance and Response System (GISRS)/FluNet.
- An extensive analysis of four years of seasonal influenza data has shown that seasonality varies according to geographical location of the site:
 - Extreme North India demonstrates peak activity in winter and limited activity during rains.
 - North (Delhi), Eastern and Western India demonstrate highest activity during rains and limited activity in winter.
 - South India demonstrates a peak in the cooler season, during rains.
- Data from two different sites participating in a study in India on influenza disease burden have established that the influenza-like illness (ILI) and severe acute respiratory infection (SARI) case definitions that include measured or reported fever provide an optimal balance between sensitivity and specificity for the identification of patients hospitalized with influenza.

Laboratory

Indian surveillance network members have trained extensively with CDC scientists on typing, sub-typing, PCR, real-time PCR, and reverse genetics techniques. The Indian network of surveillance sites now has ten sites equipped with RT-PCR to detect seasonal and influenza A (H1N1)pdm09 viruses. Four of these laboratories are also equipped to handle avian influenza.

Genetic characterization of viruses is carried out mostly at the NIC. All India Institute of Medical Sciences (AIIMS) has developed capacity to carry out virus neutralization assays and testing for cell-mediated immunity (CMI) and nutritional factors as part of the vaccine study.

CDC-developed technologies for individual respiratory virus detection and multi-pathogen detection using TaqMan Low Density Array (TLDA) have been transferred to AIIMS. Laboratory studies of molecular mechanisms of influenza A and host cell interactions conducted with the International Centre for Genetic Engineering and Biotechnology (ICGEB) are leading to identification of unique host cell factors that may be manipulated by influenza A viruses.

Laboratory Activities

- The sentinel surveillance sites together processed 9,033 samples during the year: 1,021 tested positive, including 264(26%) positive for influenza A(H1N1)pdm09, 566(55%) for influenza A (H3N2) and 191(19%) for influenza B.
- Genetic characterization of circulating strains of influenza A(H1N1)pdm09 from India belong to clade 7 with minimal changes observed in recent isolates.
- Comprehensive databases with full-length HA and NA sequences for influenza A (H3) and influenza B have been generated and data analysis is underway. Additional scientific discussions have led to expanded genetic characterization of influenza viruses among longitudinal collection.

- Establishment of cytometry-based assays to measure cell-mediated immune response has been carried out at AIIMS with hands-on training from CDC. The protocol has been standardized, with titrations of antigens and staining with antibodies using influenza-vaccinated normal blood volunteers. Blood collection from study participants is underway to assess CMI response among vaccinated children.
- The collaborative work has been established on a bilateral exchange basis, with long-term hands-on training of ICGEB partners at CDC.

Preparedness

CDC activities have focused on supporting pandemic influenza preparedness programs and helping advance the field of influenza research (seasonal, pandemic and avian) in India. Many of the preparedness activities related to increased awareness and response to minimize the spread of human infections and disease were carried out with Ministry of Health and Family Affairs (National Center for Disease Control and the Indian Council of Medical Research) and WHO partners prior to 2009. These efforts contributed to India's ability to respond to the 2009 H1N1 pandemic. CDC continues to provide technical and laboratory support for ongoing surveillance activities.

Current activities are focused on influenza vaccination strategies, and increasing awareness and acceptance of influenza vaccine among health care providers. Support from the U.S. Biomedical Advanced Research and Development Authority (BARDA) has led to increased influenza manufacturing capacity. Studies are being planned to look at the efficacy of indigenously produced live attenuated vaccine in India.

Preparedness Activities

Current efforts have had policy effects in at least three major areas:

- First, evidence-based data on influenza seasonality has led to licensure to import Southern Hemisphere vaccine for vaccination prior to the influenza peak.
- Initial surveys in a tertiary care hospital revealed very low acceptance rates, due primarily to limited knowledge about influenza vaccines. Discussions are underway to provide influenza vaccinations to all health care providers within the federal government.
- The HHS-WHO supported Serum Institute of India (SII) in Pune led production of live attenuated influenza vaccine (LAIV), monovalent influenza A (H1N1)pdm09 vaccine, and is now in the process of producing trivalent LAIV. CDC-AIIMS, in collaboration with SII, are in the process of establishing the surveillance site to undertake an efficacy trial of indigenously produced LAIV.



Entrance to the Vadu Rural Health Program outside Vadu Hospital, near Pune, India.

Efforts were made to maintain capacity for detection of both known and unknown viruses. To this effect two trainings were carried out:

- Hands-on laboratory training was provided in virus culture and real-time PCR to expand the surveillance network capacity piloted by the National Center for Disease Control (NCDC), Delhi. Two participants from each of the 13 network laboratories attended the workshop. CDC staff also participated in the workshop as faculty.
- The second workshop was an intense two-week hands-on training for phylogenetic characterization of human and avian influenza viruses at the NIC, Pune. The main focus was to enable countries to capture unusual variants of known viruses that may emerge during their routine surveillance.

Training

Consultations/Presentations:

- Consultation on influenza program meetings with AIIMS and WHO: March 14–18, 2011.
- Invited talk “Evolution of Influenza Viruses: Seasonal Epidemics and Pandemics” at the Third Annual Conference on Microbial Evolution-Adaptation and Challenges, AIIMS, New Delhi, March 26, 2011.
- CDC-India Influenza Program update, presented at “Strategic Planning Briefing”, CDC, June 15, 2011.
- The CDC Director and Congressional staff members traveled to India. The trip included a visit to Ballabgarh site, August 8–9, 2011.
- Influenza vaccine-related collaboration took place at the Serum Institute of India, August 10–12, 2011.

Trainings and Workshops:

- Scientific writing workshop (three Indian participants), Bangkok, January 10–14, 2011.
- Hands-on laboratory training for seasonal influenza surveillance, NCDC, Delhi, April 25–29, 2011.
- Regional bioinformatics workshop on the molecular evolution of influenza viruses, NIV, Pune, May 23–June 3, 2011.
- Long-term training of three pre-doctoral fellows from ICGEB at CDC.
- Training of two AIIMS staff members in TLDA technology at CDC, August 9–11, 2011.

Publications

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- Koul PA, Muneer M A , Bali N K, Chawla-Sarkar M, Sarkar M, Kaushik S, Khan UH, Ahmad F, Garten R, Lal RB, Broor S. Pandemic and seasonal influenza viruses among patients with acute respiratory illness in Kashmir (India). *Influenza and Other Respiratory Viruses*. 2011;5(6):e521-527.

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A street vendor in New Delhi, India.