Differences in Influenza Seasonality by Latitude, Northern India

Parvaiz A. Koul,[1] Shobha Broor,[1,2] Siddhartha Saha, John Barnes, Catherine Smith, Michael Shaw, Mandeep Chadha, and Renu B. Lal

The seasonality of influenza in the tropics complicates vaccination timing. We investigated influenza seasonality in northern India and found influenza positivity peaked in Srinagar (34.09°N) in January–March but peaked in New Delhi (28.66°N) in July–September. Srinagar should consider influenza vaccination in October–November, but New Delhi should vaccinate in May–June.

Annual and pandemic influenza are sources of considerable illness and death worldwide (*1*). Human influenza infection rates peak during the winter months in temperate regions; however, the pattern of influenza is different in tropical and subtropical areas, with year-round circulation in some areas and biannual peaks in others (*2–5*). The complex seasonality of influenza in the tropics complicates appropriate vaccination recommendations, particularly the timing of vaccination campaigns in tropical regions (*3*,*4*).

India has discrete seasons that vary greatly from north to south. Jammu and Kashmir, the northernmost state of India, has severe winters from December to March, whereas Delhi, the capital region, has milder winters. Sentinel surveillance for influenza in India has shown distinct influenza peaks in India (*6–8*). We undertook influenza surveillance during 2011–2012 in 2 cities in northern India, Srinagar and New Delhi, which are ≈500 km apart, and found evidence for discrete seasonality related to the latitudes of these cities, a finding that has implications for influenza vaccination policy and timing.

The Study

For the study, we enrolled patients who attended the outpatient clinics at the All India Institute of Medical Sciences, New Delhi, and Sheri-Kashmir Institute of Medical Sciences, Srinagar, during 2011–2012 who had influenza-like illness (ILI; defined as sudden onset or history of fever >38°C, cough or sore throat and/or rhinorrhea) (*6*). We collected 5–10 nasopharyngeal samples from these patients each week and tested them for influenza viruses by type and subtype (*9*,*10*). A confirmed case-patient was defined as a patient meeting the ILI case definition who had positive results for influenza by reverse transcription PCR. Sanger sequencing of the hemagglutinin and neuraminidase genes was completed, and consensus was used to construct a Kimura 2-parameter neighbor-joining tree (online Technical Appendix Figure 1, http://wwwnc.cdc.gov/EID/article/20/10/14-0431-Techapp1.pdf). Sequences from New Delhi and Srinagar were compared with those of vaccine strains and with published cognate sequences of corresponding genes (online Technical Appendix Table 1), including those from India (*10*).

Surveillance for influenza viruses revealed that overall influenza positivity was 17.6% (375 confirmed cases from 2,126 ILI patients) in Srinagar and 9.46% (239/2,526) in New Delhi (Table). Discrete winter time peaks were observed during January–March (epidemiologic weeks [EW] 1–12) in Srinagar, whereas New Delhi had peaks of influenza circulation during July 2011 and September 2012 (EW 26–36) (Figure 1). Influenza A was the predominant type in Srinagar (275/375; 72.9%), whereas influenza B dominated in New Delhi (154/239; 64.4%). Circulation of influenza A(H3N2) during the monsoon season of 2011 in New Delhi was followed by predominance of H3N2 during winter 2012 in Srinagar (Figure 1).

Phylogenetic analysis of the hemagglutinin and neuraminidase genes from selected samples from New Delhi and Srinagar revealed no notable differences between circulating viruses (online Technical Appendix Figure 1). Furthermore, circulating influenza strains were closely related to the selected influenza vaccine strains, A/California/7/2009 (H1N1), A/Perth/16/2009 (H3N2), and B/Brisbane/60/2008, which remained unchanged for 2011–2012 for the Northern and Southern Hemisphere formulations (online Technical Appendix Figure 2). The 2012–2013 Northern Hemisphere formulation changed the H3N2 strain to A/Victoria/361/2011 and the influenza B strain to B/Wisconsin/1/2010, but sequence information from 2013 circulating viruses from Srinagar was not available to assess vaccine similarity.

Analysis of meteorologic factors (i.e., rainfall, temperature, relative humidity, vapor pressure, and dew point)

Author affiliations: Sheri-Kashmir Institute of Medical Sciences, Srinagar, India (P.A. Koul); All India Institute of Medical Sciences, New Delhi, India (S. Broor); Centers for Disease Control and Prevention, Atlanta, Georgia, USA (S. Saha, J. Barnes, C. Smith, M. Shaw, R.B. Lal); and National Institute of Virology, Pune, India (M. Chadha)

DOI: http://dx.doi.org/10.3201/eid2010.140431

[1]These authors contributed equally to this article.

[2]Current affiliation: INCLEN Foundation, New Delhi, India.

Table. Influenza surveillance, Srinagar and Delhi, India, 2011–2012

City	No. (%) persons		
	2011	2012	Total
Srinagar (34.09°N)			
Tested	768	1,371	2,139
Influenza positive	162 (21)	215 (15.7)	377 (17.6)
Influenza type*			
A(H1N1)pdm09	95 (58.6)	57 (26.5)	152 (40.3)
A(H3N2)	38 (23.5)	85 (39.5)	123 (32.6)
B	29 (17.9)	73 (34.0)	102 (27.1)
New Delhi (28.66°N)			
Tested	1,007	1,519	2,526
Influenza positive	74 (7.3)	165 (10.8)	239 (9.46)
Influenza type*			
A(H1N1)pdm09	3 (4.1)	44 (26.7)	47 (19.7)
A(H3N2)	38 (51.4)	0	38 (15.9)
B	33 (44.6)	121 (73.3)	154 (64.4)

*Percentages are of all influenza-positive test results in category.

showed that the monthly proportion of influenza positivity correlated with decreased temperature and dew point in Srinagar and with rainfall amount in New Delhi (data not shown). Cumulative data over the 2-year surveillance period revealed differences in seasonality by latitude; influenza positivity peaked during December–February in Srinagar (34.09°N) but in July–September in New Delhi (28.66°N) (Figure 2). Influenza seasonality indicates that New Delhi would likely benefit from springtime vaccination (May–June), whereas vaccination in the fall (October–November) would be better for Srinagar (Figure 2). We recently illustrated that India and most other tropical countries in Asia exhibit influenza seasonality that coincides with the monsoon season, June–October (*11*).

Conclusions

We identified discrete patterns of influenza circulation in India. In Srinagar, a city in the northernmost region of India, influenza positivity rates peaked in winter (December–March), whereas in New Delhi, a city just ≈500 km south of Srinagar, influenza peaked during the monsoon season (July–September). The winter peak in Srinagar is similar to the timing of influenza circulation observed for most countries in Europe and United States in the Northern Hemisphere (*4*,*5*). By contrast, the data on influenza seasonality in New Delhi corroborate findings which showed

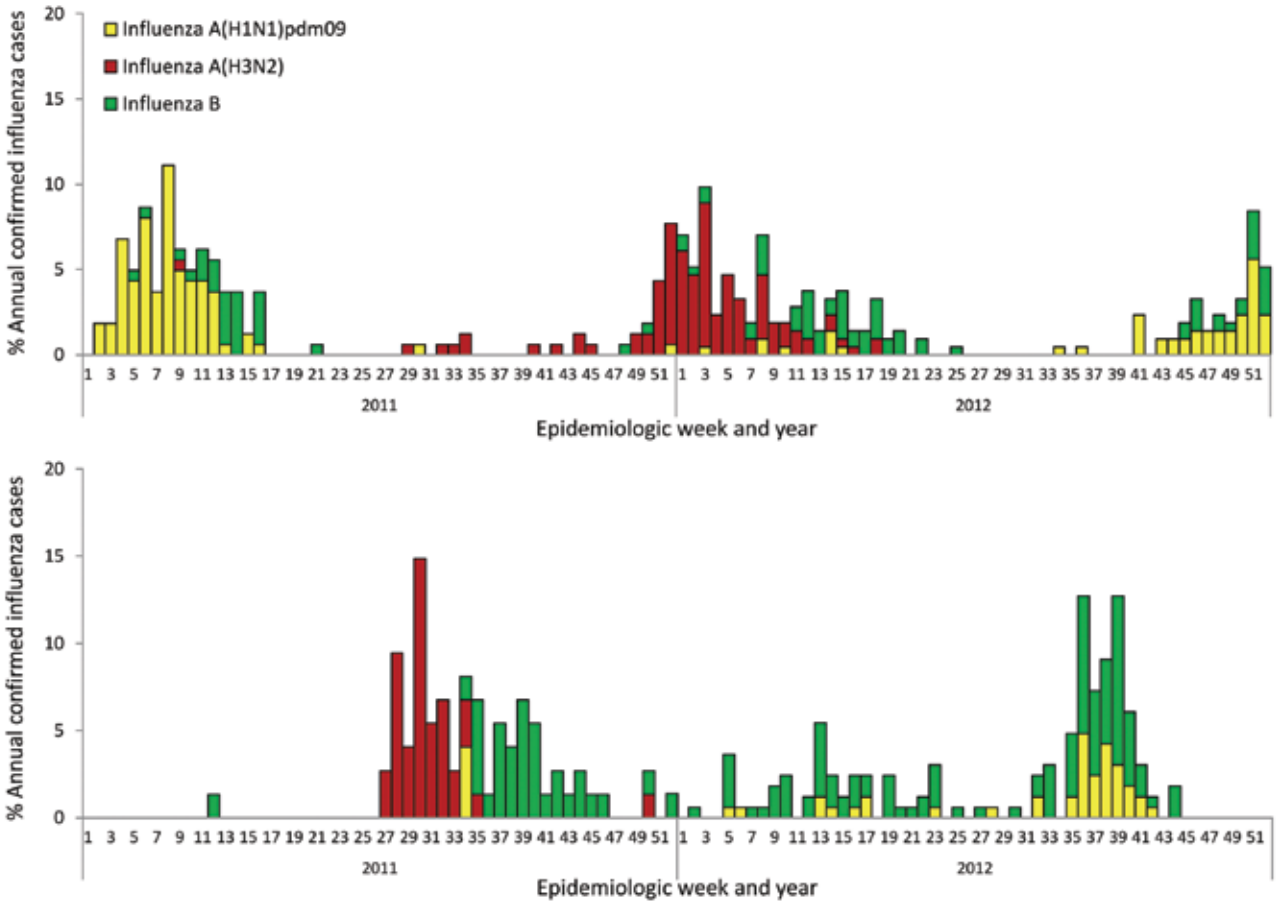


Figure 1. Weekly trends and proportion of annual numbers of positive influenza cases, by epidemiologic week and influenza type, Srinagar (A) and New Delhi (B), India, 2011–2012. Clear seasonal peaks are seen in January–March (weeks 1–16) for Srinagar and in July and September (weeks 28–40) for New Delhi.

that many countries in tropical regions (e.g., Brazil, India, Vietnam) experience high influenza transmission rates during the rainy season (*6*,*11*–*13*). Overall, influenza A and B viruses co-circulated throughout the surveillance period in Srinagar and New Delhi; however, the types and subtypes varied.

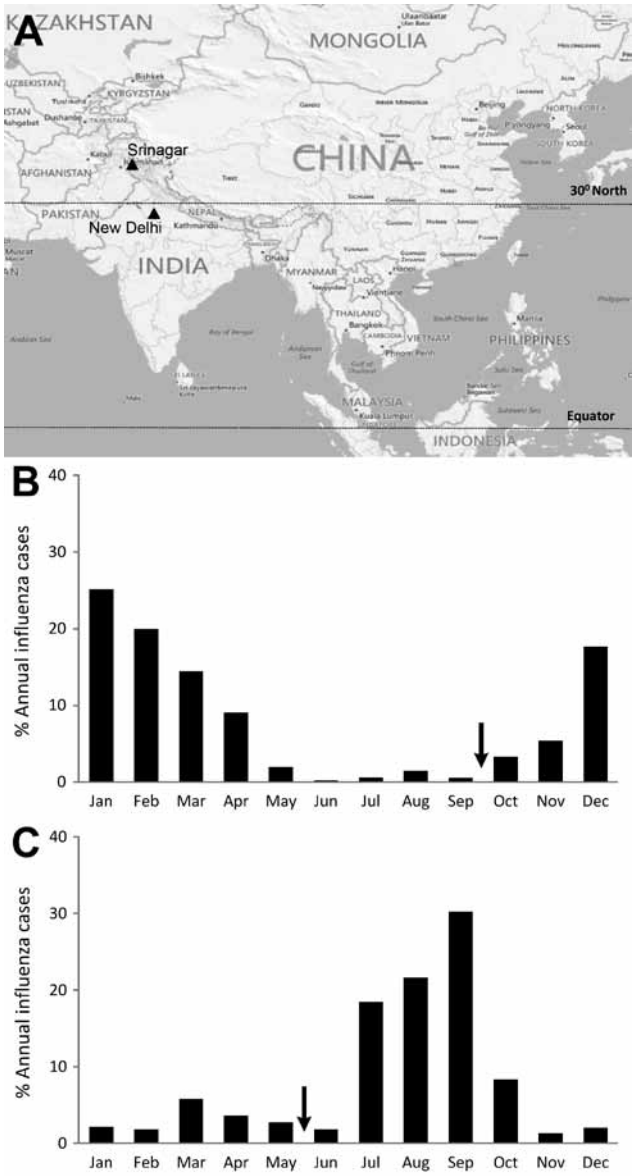


Figure 2. Comparison of latitudes of Srinagar and New Delhi, India, and distribution of influenza virus infections, 2011–2012. A) Locations of Srinagar and New Delhi (black triangles), with vertical lines indicating 30°N latitude and equator. B) Monthly distribution of cases of influenza virus infection in Srinagar (34.0°N latitude). C) Monthly distribution of cases of influenza virus infection in New Delhi (28.7°N latitude). Arrows indicate proposed vaccination timing; latitude of each city is shown. Map created in Epi-Map in Epi Info 7 (Centers for Disease Control and Prevention, Atlanta, GA, USA).

Peaks of influenza circulation in Srinagar and New Delhi show seasonal patterns that depend on factors such as temperature, rainfall, humidity, and latitude (*2*,*3*). Srinagar, at >30°N latitude, has influenza seasonality that coincides with lower temperature and low dew points during winter, whereas New Delhi, at <30°N latitude, has a peak of influenza circulation that coincides with the rainy season. Seasonal influenza activity coinciding with the humid, rainy season at lower latitudes has also been observed in large areas of Central and South America and southern Asia (*11*,*13*). In contrast, cold, dry weather was predictive of influenza peaks at higher latitudes, as observed for Srinagar. The latitude dependence of influenza circulation observed in this study is similar to such dependence observed in Brazil and China (*13*,*14*) and collectively suggests that decisions on the timing of influenza vaccination should not be based only on the hemisphere a country is in but also on the types of seasonal patterns that exist within a country (*15*). These latitudinal differences in influenza seasonality in India have implications for influenza vaccine timing and vaccine formulation.

Influenza vaccine induces a neutralizing antibody response that wanes over time. Thus, the timing of vaccination has a direct effect on vaccine effectiveness. In the northernmost part of India, peak influenza circulation occurs during the winter months; therefore, vaccination during October–November using the Northern Hemisphere vaccine formulation may be appropriate. However, this practice would not be appropriate in the Delhi metropolitan region, where influenza peaks in July–September. In addition, whereas our data points to an approximate latitude where temperate and tropical patterns for influenza peaks diverge, more robust data with multiple surveillance sites in tropical, subtropical, and temperate regions in India and China are needed to define the exact latitude points for influenza circulation patterns.

Our study has limitations. First, comparative data were available only for 2 years. Additional surveillance data for multiple years and many cities around the latitude gradient are required to further corroborate these observations. Furthermore, validation of vaccine formulation will require tracking of additional circulating influenza strains over several epidemic periods.

In summary, we identified 2 distinct seasons for influenza circulation in 2 cities in India. We recommend that policy makers in India review circulation patterns closely before implementing influenza intervention plans. Our data suggest that cities in India located north of 30°N latitude can continue vaccination in the winter, but those south of 30°N, including New Delhi, should consider vaccination in May–June (*15*). Collectively, these data should help decision makers, especially regulatory authorities, choose vaccines and vaccination schedules best suited for each region.

Acknowledgment

We acknowledge the authors and originating and submitting laboratories of the sequences from the GISAID EpiFlu Database (http://www.gisaid.org), presented in the Technical Appendix.

This study was supported in part by cooperative agreement 5U51IP 000333 from the US Centers for Disease Control and Prevention (Atlanta, GA, USA).

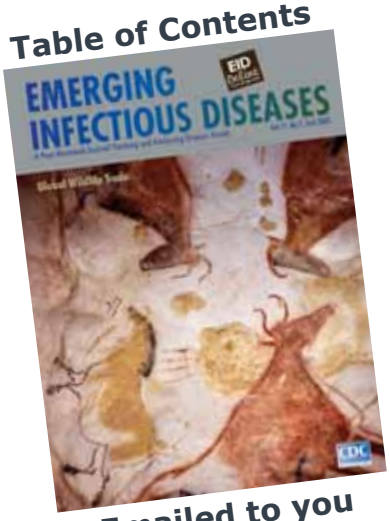
Prof Koul heads the Internal and Pulmonary Medicine department in SheriKashmir Institute of Medical Sciences, Srinagar, India. His current research interests include pulmonary disease and respiratory infections, especially influenza and influenza vaccination.

References

1. Simonsen L. The global impact of influenza on morbidity and mortality. Vaccine. 1999;17(Suppl 1):S3–10. http://dx.doi.org/10.1016/S0264-410X(99)00099-7
2. Tamerius JD, Shaman J, Alonso WJ, Bloom-Feshbach K, Uejio CK, Comrie A, et al. Environmental predictors of seasonal influenza epidemics across temperate and tropical climates. PLoS Pathog. 2013;9:e1003194. http://dx.doi.org/10.1371/journal.ppat.1003194
3. Azziz Baumgartner E, Dao CN, Nasreen S, Bhuiyan MU, Mah EMS, Al Mamun A, et al. Seasonality, timing, and climate drivers of influenza activity worldwide. J Infect Dis. 2012;206:838–46. http://dx.doi.org/10.1093/infdis/jis467
4. Viboud C, Alonso WJ, Simonsen L. Influenza in tropical regions. PLoS Med. 2006;3:e89. http://dx.doi.org/10.1371/journal.pmed. 0030089
5. Park AW, Glass K. Dynamic patterns of avian and human influenza in east and southeast Asia. Lancet Infect Dis. 2007;7:543–8. http://dx.doi.org/10.1016/S1473-3099(07)70186-X
6. Chadha MS, Broor S, Gunasekaran P, Potdar VA, Krishnan A, Chawla-Sarkar M, et al. Multisite virological influenza surveillance in India: 2004–2008. Influenza Other Respir Viruses. 2012;6:196–203. http://dx.doi.org/10.1111/j.1750-2659.2011.00293.x
7. Broor S, Krishnan A, Roy DS, Dhakad S, Kaushik S, Mir MA, et al. Dynamic patterns of circulating seasonal and pandemic A(H1N1) pdm09 influenza viruses from 2007–2010 in and around Delhi, India. PLoS ONE. 2012;7:e29129. http://dx.doi.org/10.1371/journal.pone.0029129
8. Koul PA, Mir MA, Bali NK, Chawla-Sarkar M, Sarkar M, Kaushik S, et al. Pandemic and seasonal influenza viruses among patients with acute respiratory illness in Kashmir (India). Influenza Other Respir Viruses. 2011;5:e521. http://dx.doi.org/10.1111/j.1750-2659.2011.00261.x
9. Centers for Disease Control and Prevention. CDC protocol of real-time RTPCR for swine influenza A(H1N1). 2009 Apr 28 [cited 2013 Jun 25]. http://www.who.int/csr/resources/publications/swineflu/CDCrealtimeRTPCRprotocol_20090428.pdf
10. Potdar VA, Chadha MS, Jadhav SM, Mullick J, Cherian SS, Mishra AC. Genetic characterization of the influenza A pandemic (H1N1) 2009 virus isolates from India. PLoS ONE. 2010;5:e9693. http://dx.doi.org/10.1371/journal.pone.0009693
11. Saha S, Chadha M, Mamun AA, Rahman M, Sturm-Ramirez K, Chittaganpitch M, et al. Influenza seasonality and vaccination timing in tropics and subtropics of south and south-east Asia. Bull World Health Organ. 2014;92:318–30. http://dx.doi.org/10.2471/BLT.13.124412
12. Western Pacific Region Global Influenza Surveillance and Response System. Epidemiological and virological characteristics of influenza in the Western Pacific Region of the World Health Organization, 2006–2010. PLoS ONE. 2012;7:e37568. http://dx.doi.org/10.1371/journal.pone.0037568
13. Moura FE, Perdigao AC, Siqueira MM. Seasonality of influenza in the tropics: a distinct pattern in northeastern Brazil. Am J Trop Med Hyg. 2009;81:180–3.
14. Yu H, Alonso WJ, Feng L, Tan Y, Shu Y, Yang W, et al. Characterization of regional influenza seasonality patterns in china and implications for vaccination strategies: spatio-temporal modeling of surveillance data. PLoS Med. 2013;10:e1001552. http://dx.doi.org/10.1371/journal.pmed.1001552
15. Cox N. Influenza seasonality: timing and formulation of vaccines. Bull World Health Organ. 2014;92:311. http://dx.doi.org/10.2471/BLT.14.139428

Address for correspondence: Parvaiz A. Koul, Department of Internal & Pulmonary Medicine, Sheri-Kashmir Institute of Medical Sciences, Soura, Srinagar 190011, India; email: parvaizk@gmail.com

Table of Contents



Emailed to you

GovDelivery

Manage your email alerts so you only receive content of interest to you.

Sign up for an Online Subscription:
wwwnc.cdc.gov/eid/subscribe.htm

Article DOI: http://dx.doi.org/10.3201/eid2010.140431

Differences in Influenza Seasonality by Latitude, Northern India

Technical Appendix

Technical Appendix Table. Influenza strains and gene segments from GISAID EpiFlu database used in this study*

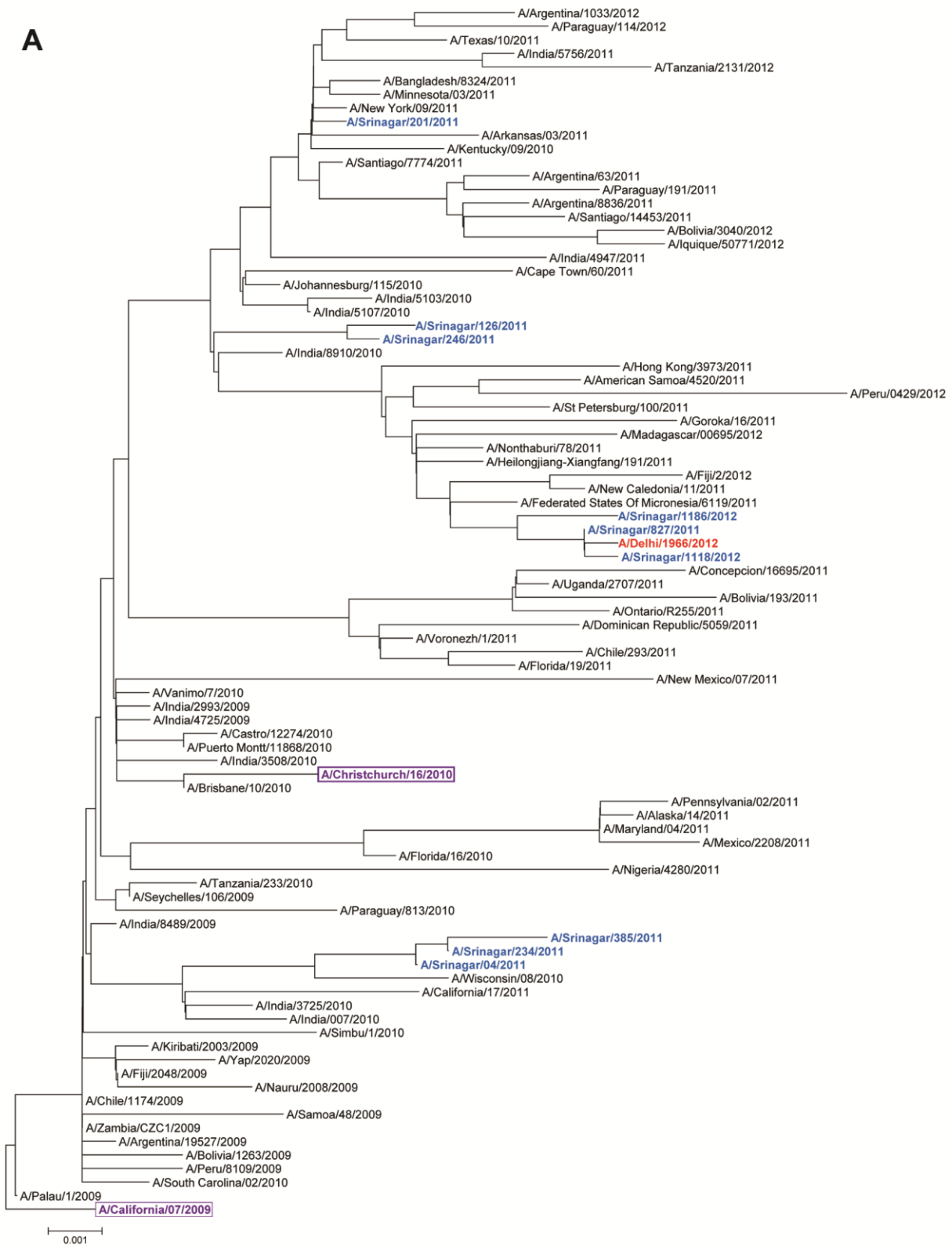
EPI-Segment-ID	Segment	Length	Strain
EPI332607	HA	1701	A/Alaska/14/2011
EPI215877	NA	1410	A/Alaska/14/2011
EPI325551	HA	1701	A/American Samoa/4520/2011
EPI325575	NA	1410	A/American Samoa/4520/2011
EPI404814	HA	1701	A/Argentina/1033/2012
EPI331203	NA	1410	A/Argentina/1033/2012
EPI267876	HA	1701	A/Argentina/19527/2009
EPI331206	NA	1410	A/Argentina/19527/2009
EPI331198	HA	1701	A/Argentina/63/2011
EPI273913	NA	1410	A/Argentina/63/2011
EPI335786	HA	1701	A/Argentina/8836/2011
EPI319996	NA	1410	A/Argentina/8836/2011
EPI330987	HA	1701	A/Arkansas/03/2011
EPI215722	NA	1410	A/Arkansas/03/2011
EPI331201	HA	1701	A/Bangladesh/8324/2011
EPI273910	NA	1410	A/Bangladesh/8324/2011
EPI215724	NA	1410	A/Barbados/104/2011
EPI194113	HA	1701	A/Bolivia/1263/2009
EPI319991	NA	1410	A/Bolivia/1263/2009
EPI341964	HA	1701	A/Bolivia/193/2011
EPI320120	NA	1410	A/Bolivia/193/2011
EPI404834	HA	1701	A/Bolivia/3040/2012
EPI325559	NA	1410	A/Bolivia/3040/2012
EPI280335	HA	1701	A/Brisbane/10/2010
EPI273896	NA	1410	A/Brisbane/10/2010
EPI273609	HA	1701	A/California/07/2009
EPI325587	NA	1410	A/California/07/2009
EPI316335	HA	1701	A/California/17/2011
EPI331040	HA	1701	A/Cape Town/60/2011
EPI325572	NA	1410	A/Cape Town/60/2011
EPI273914	HA	1701	A/Castro/12274/2010
EPI331209	NA	1410	A/Castro/12274/2010
EPI186253	HA	1701	A/Chile/1174/2009
EPI325566	NA	1410	A/Chile/1174/2009
EPI325567	HA	1701	A/Chile/293/2011
EPI331041	NA	1410	A/Chile/293/2011
EPI280341	HA	1701	A/Christchurch/16/2010
EPI325578	NA	1410	A/Christchurch/16/2010
EPI335801	HA	1701	A/Concepcion/16695/2011
EPI331215	NA	1410	A/Concepcion/16695/2011
EPI397078	NA	1410	A/Connecticut/08/2011
EPI537424	NA	1410	A/Delhi/1717/2012
EPI537425	NA	1410	A/Delhi/1938/2012
EPI537426	NA	1410	A/Delhi/1939/2012
EPI537428	HA	1701	A/Delhi/1966/2012
EPI537427	NA	1410	A/Delhi/1966/2012
EPI320011	HA	1701	A/Dominican Republic/5059/2011
EPI370247	NA	1410	A/Dominican Republic/5059/2011
EPI271947	NA	1410	A/Dominican Republic/5145/2011
EPI325588	HA	1701	A/Federated States Of Micronesia/6119/2011
EPI335800	NA	1410	A/Federated States Of Micronesia/6119/2011
EPI370248	HA	1701	A/Fiji/2/2012
EPI320010	NA	1410	A/Fiji/2/2012
EPI215725	HA	1701	A/Fiji/2048/2009

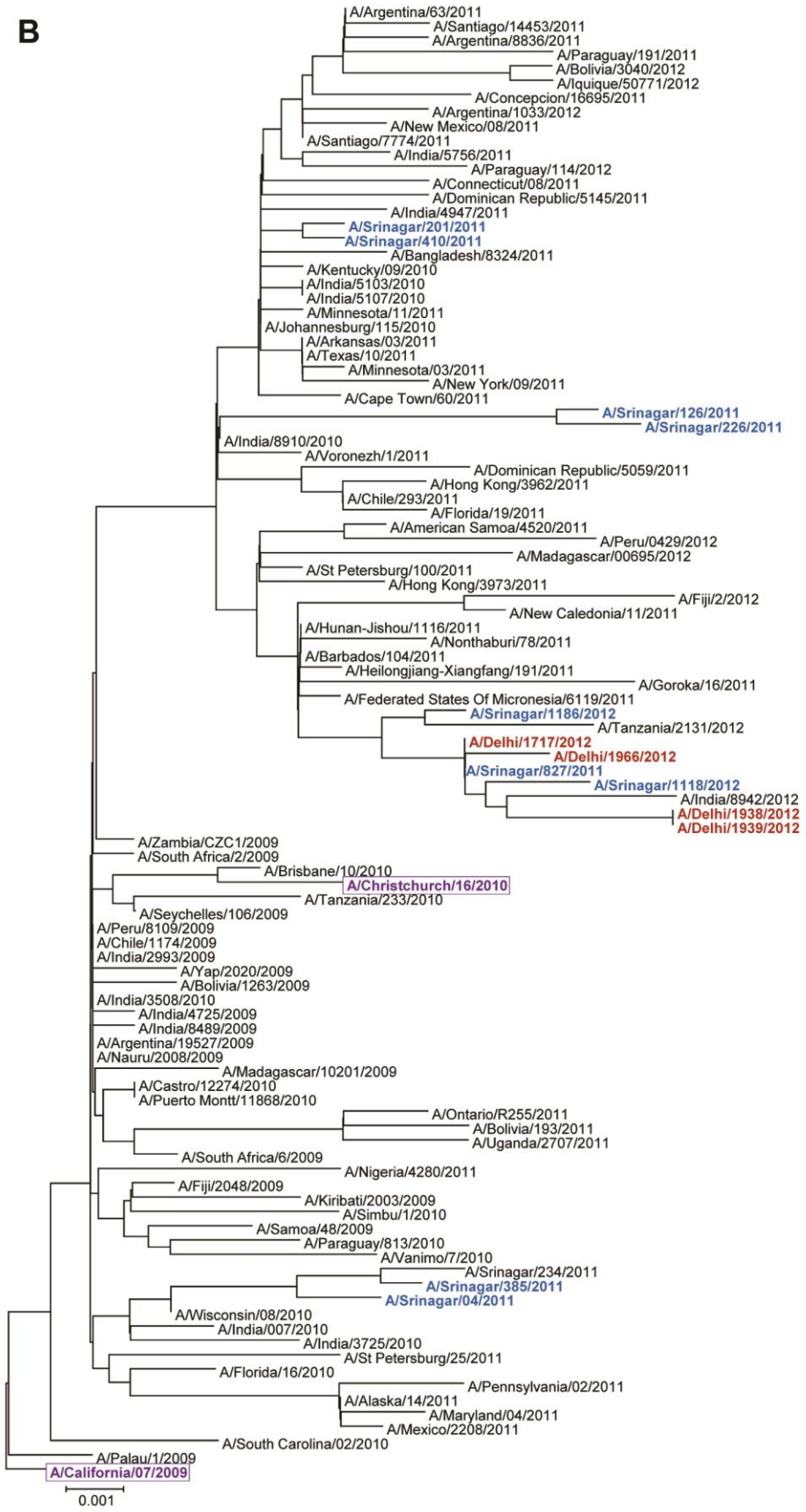
EPI-Segment-ID	Segment	Length	Strain
EPI331218	NA	1410	A/Fiji/2048/2009
EPI342420	HA	1701	A/Florida/16/2010
EPI341963	NA	1410	A/Florida/16/2010
EPI331204	HA	1701	A/Florida/19/2011
EPI186252	NA	1410	A/Florida/19/2011
EPI379530	HA	1701	A/Goroka/16/2011
EPI320013	NA	1410	A/Goroka/16/2011
EPI325576	HA	1701	A/Heilongjiang-Xiangfang/191/2011
EPI426452	NA	1410	A/Heilongjiang-Xiangfang/191/2011
EPI294253	NA	1410	A/Hong Kong/3962/2011
EPI331207	HA	1701	A/Hong Kong/3973/2011
EPI404813	NA	1410	A/Hong Kong/3973/2011
EPI194114	NA	1410	A/Hunan-Jishou/1116/2011
EPI278875	HA	1701	A/India/007/2010
EPI254552	NA	1410	A/India/007/2010
EPI227676	HA	1701	A/India/2993/2009
EPI280334	NA	1410	A/India/2993/2009
EPI295462	HA	1701	A/India/3508/2010
EPI353908	NA	1410	A/India/3508/2010
EPI273897	HA	1701	A/India/3725/2010
EPI227675	NA	1410	A/India/3725/2010
EPI254551	HA	1701	A/India/4725/2009
EPI342419	NA	1410	A/India/4725/2009
EPI325579	HA	1701	A/India/4947/2011
EPI267878	NA	1410	A/India/4947/2011
EPI295459	HA	1701	A/India/5103/2010
EPI278870	NA	1410	A/India/5103/2010
EPI278871	HA	1701	A/India/5107/2010
EPI232917	NA	1410	A/India/5107/2010
EPI353396	HA	1701	A/India/5756/2011
EPI272731	NA	1410	A/India/5756/2011
EPI232918	HA	1701	A/India/8489/2009
EPI280340	NA	1410	A/India/8489/2009
EPI278873	HA	1701	A/India/8910/2010
EPI295458	NA	1410	A/India/8910/2010
EPI280325	NA	1410	A/India/8942/2012
EPI397079	HA	1701	A/Iquique/50771/2012
EPI325584	NA	1410	A/Iquique/50771/2012
EPI286990	HA	1701	A/Johannesburg/115/2010
EPI332584	NA	1410	A/Johannesburg/115/2010
EPI342434	HA	1701	A/Kentucky/09/2010
EPI409911	NA	1410	A/Kentucky/09/2010
EPI215723	HA	1701	A/Kiribati/2003/2009
EPI386048	NA	1410	A/Kiribati/2003/2009
EPI390481	HA	1701	A/Madagascar/00695/2012
EPI332597	NA	1410	A/Madagascar/00695/2012
EPI243975	NA	1410	A/Madagascar/10201/2009
EPI309970	HA	1701	A/Maryland/04/2011
EPI278872	NA	1410	A/Maryland/04/2011
EPI331210	HA	1701	A/Mexico/2208/2011
EPI387971	NA	1410	A/Mexico/2208/2011
EPI310015	HA	1701	A/Minnesota/03/2011
EPI278874	NA	1410	A/Minnesota/03/2011
EPI273850	NA	1410	A/Minnesota/11/2011
EPI215717	HA	1701	A/Nauru/2008/2009
EPI273608	NA	1410	A/Nauru/2008/2009
EPI349252	HA	1701	A/New Caledonia/11/2011
EPI309969	NA	1410	A/New Caledonia/11/2011
EPI320095	HA	1701	A/New Mexico/07/2011
EPI194243	NA	1410	A/New Mexico/08/2011
EPI331213	HA	1701	A/New York/09/2011
EPI349351	NA	1410	A/New York/09/2011
EPI332598	HA	1701	A/Nigeria/4280/2011
EPI404833	NA	1410	A/Nigeria/4280/2011
EPI332585	HA	1701	A/Nonthaburi/78/2011
EPI335785	NA	1410	A/Nonthaburi/78/2011
EPI325560	HA	1701	A/Ontario/RV1255/2011
EPI286989	NA	1410	A/Ontario/RV1255/2011
EPI215653	HA	1701	A/Palau/1/2009

EPI-Segment-ID	Segment	Length	Strain
EPI310014	NA	1410	A/Palau/1/2009
EPI387972	HA	1701	A/Paraguay/114/2012
EPI316434	NA	1410	A/Paraguay/114/2012
EPI349352	HA	1701	A/Paraguay/191/2011
EPI316438	NA	1410	A/Paraguay/191/2011
EPI301698	HA	1701	A/Paraguay/813/2010
EPI316467	NA	1410	A/Paraguay/813/2010
EPI320121	HA	1701	A/Pennsylvania/02/2011
EPI272299	NA	1410	A/Pennsylvania/02/2011
EPI409912	HA	1701	A/Peru/0429/2012
EPI320094	NA	1410	A/Peru/0429/2012
EPI243881	HA	1701	A/Peru/8109/2009
EPI331212	NA	1410	A/Peru/8109/2009
EPI273911	HA	1701	A/Puerto Montt/11868/2010
EPI316334	NA	1410	A/Puerto Montt/11868/2010
EPI233072	HA	1701	A/Samoa/48/2009
EPI331197	NA	1410	A/Samoa/48/2009
EPI335825	HA	1701	A/Santiago/14453/2011
EPI320084	NA	1410	A/Santiago/14453/2011
EPI325573	HA	1701	A/Santiago/7774/2011
EPI390482	NA	1410	A/Santiago/7774/2011
EPI194242	HA	1701	A/Seychelles/106/2009
EPI320097	NA	1410	A/Seychelles/106/2009
EPI271948	HA	1701	A/Simbu/1/2010
EPI319998	NA	1410	A/Simbu/1/2010
EPI210545	NA	1410	A/South Africa/2/2009
EPI272732	HA	1701	A/South Carolina/02/2010
EPI342433	NA	1410	A/South Carolina/02/2010
EPI537430	HA	1701	A/Srinigar/04/2011
EPI537429	NA	1410	A/Srinigar/04/2011
EPI537444	HA	1701	A/Srinigar/1118/2011
EPI537443	NA	1410	A/Srinigar/1118/2011
EPI537446	HA	1701	A/Srinigar/1186/2011
EPI537445	NA	1410	A/Srinigar/1186/2011
EPI537434	HA	1701	A/Srinigar/126/2011
EPI537433	NA	1410	A/Srinigar/126/2011
EPI537432	HA	1701	A/Srinigar/201/2011
EPI537431	NA	1410	A/Srinigar/201/2011
EPI537435	NA	1410	A/Srinigar/226/2011
EPI537437	HA	1701	A/Srinigar/234/2011
EPI537436	NA	1410	A/Srinigar/234/2011
EPI537439	HA	1701	A/Srinigar/385/2011
EPI537438	NA	1410	A/Srinigar/385/2011
EPI537440	NA	1410	A/Srinigar/410/2011
EPI537442	HA	1701	A/Srinigar/827/2011
EPI537441	NA	1410	A/Srinigar/827/2011
EPI316435	HA	1701	A/St. Petersburg/100/2011
EPI233071	NA	1410	A/St. Petersburg/100/2011
EPI215652	NA	1410	A/St. Petersburg/25/2011
EPI440929	HA	1701	A/Tanzania/2131/2012
EPI320021	NA	1410	A/Tanzania/2131/2012
EPI273851	HA	1701	A/Tanzania/233/2010
EPI332609	NA	1410	A/Tanzania/233/2010
EPI331216	HA	1701	A/Texas/10/2011
EPI301697	NA	1410	A/Texas/10/2011
EPI331219	HA	1701	A/Uganda/2707/2011
EPI243880	NA	1410	A/Uganda/2707/2011
EPI294254	HA	1701	A/Vanimo/7/2010
EPI342433	NA	1410	A/Vanimo/7/2010
EPI316468	HA	1701	A/Voronezh/1/2011
EPI215716	NA	1410	A/Voronezh/1/2011
EPI280326	HA	1701	A/Wisconsin/08/2010
EPI295461	NA	1410	A/Wisconsin/08/2010
EPI215878	HA	1701	A/Yap/2020/2009
EPI325544	NA	1410	A/Yap/2020/2009
EPI272184	HA	1701	A/Zambia/CZC1/2009
EPI331200	NA	1410	A/Zambia/CZC1/2009

*http://www.gisaid.org.

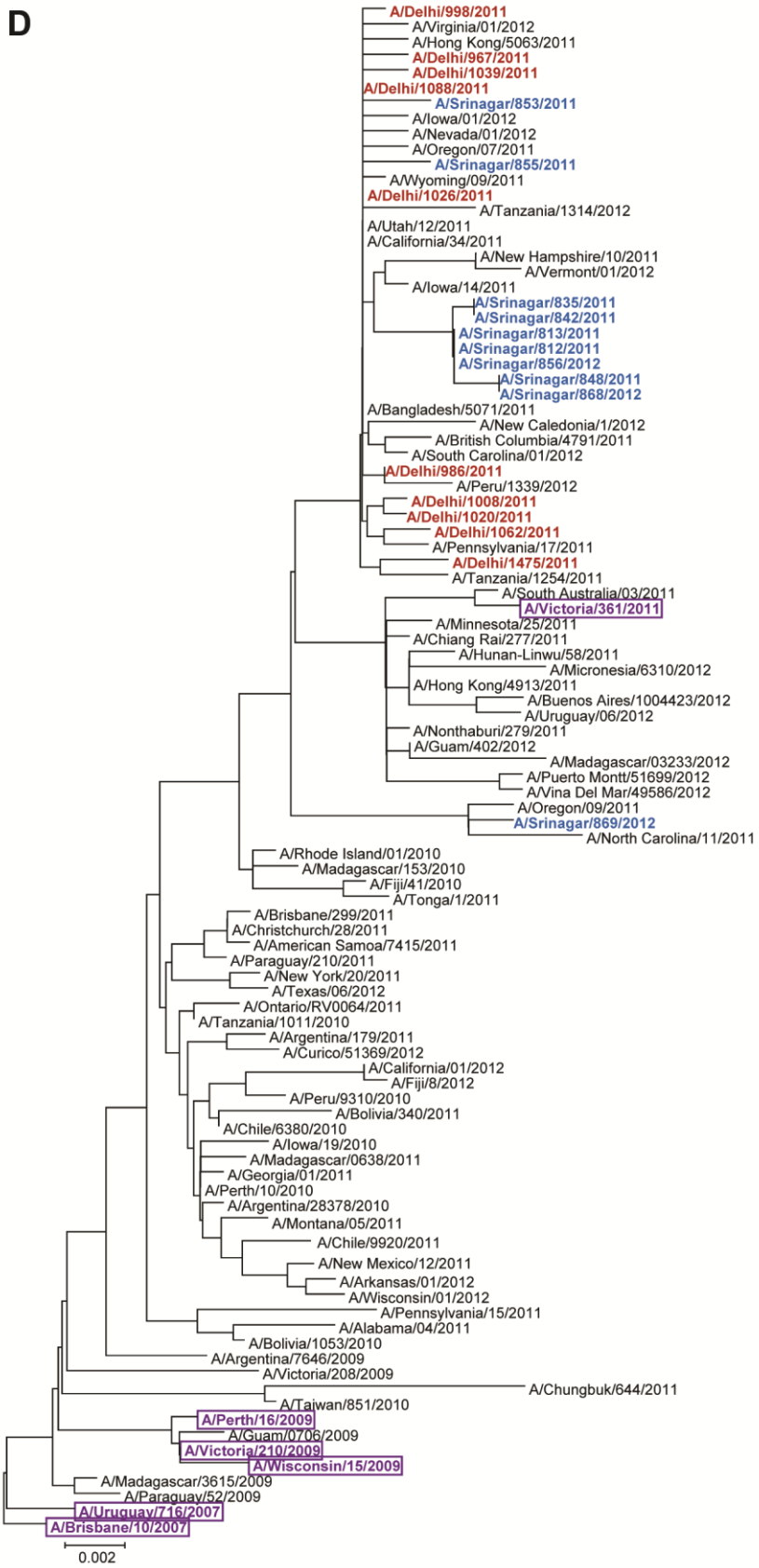
Technical Appendix Figure 1 (following pages). Phylogenetic analysis of hemagglutinin (HA) and neuraminidase (NA) gene sequences of influenza virus strains from Srinagar and New Delhi, India, compared with published sequences and corresponding vaccine strains. Strains from Srinagar are shown in blue, from Delhi in red, and from influenza vaccine in purple; other strains are from published sequences, including those from India. A) Influenza A(H1N1)pdm09 HA gene; B) influenza A(H1N1)pdm09 NA gene; C) influenza A(H3N2) HA gene; D) influenza A(H3N2) NA gene; E) influenza B Victoria lineage HA gene; F) influenza B Victoria lineage NA gene; G) influenza B Yamagata lineage HA gene; and H) influenza B Yamagata lineage NA gene. HA-1 and NA genes were amplified and PCR products were sequenced using the dideoxynucleotides chain termination method using Big-Dye Terminator Chemistry (Life Technologies, Grand Island, NY, USA). A neighbor-joining tree was generated by using pairwise gap deletion and maximum composite likelihood using the Tamura-Nei nucleotide model in MEGA4 (http://www.megasoftware.net).

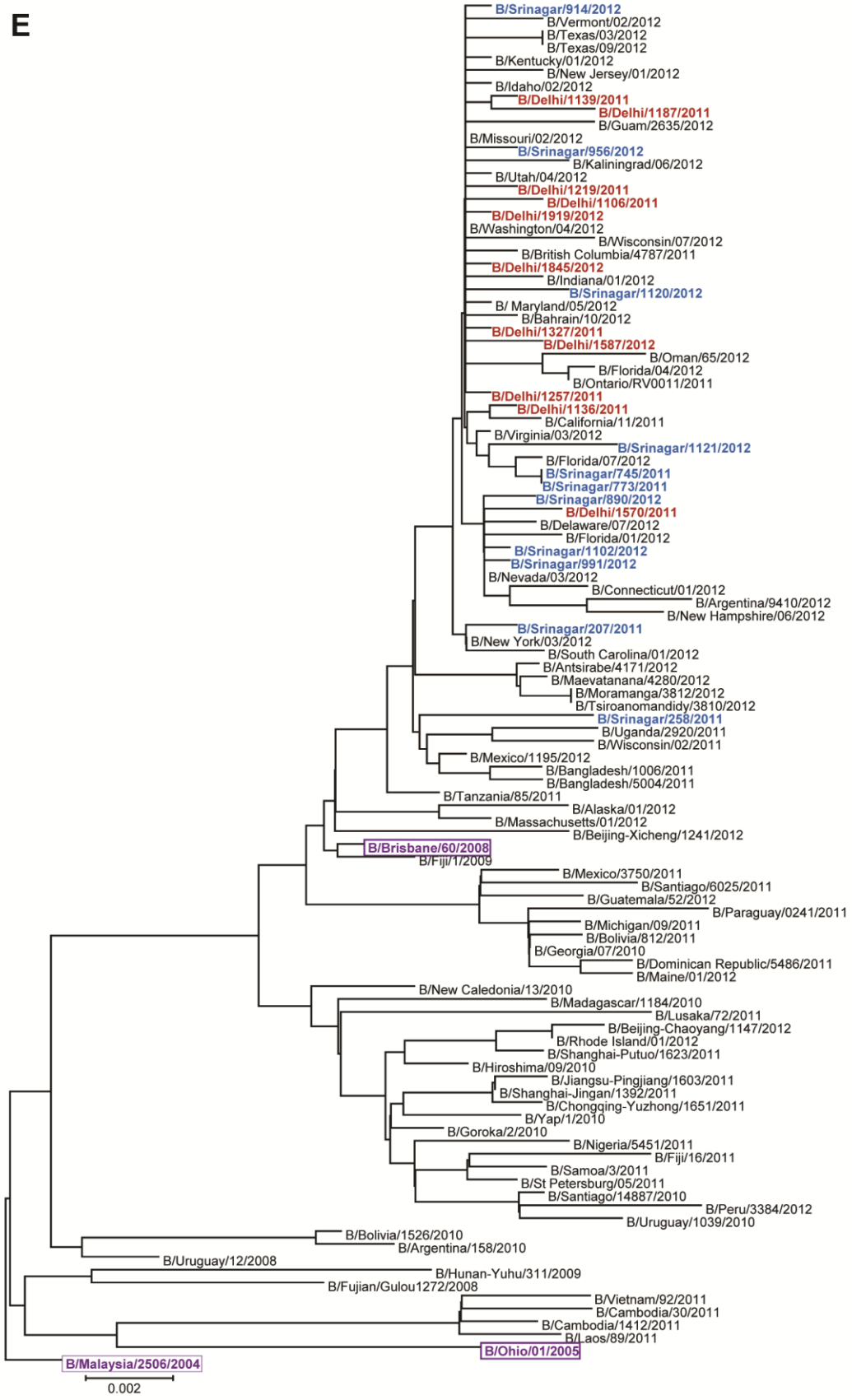

A
A/Argentina/1033/2012
A/Paraguay/114/2012
A/Texas/10/2011
A/India/5756/2011
A/Tanzania/2131/2012
A/Bangladesh/8324/2011
A/Minnesota/03/2011
A/New York/09/2011
A/Srinagar/201/2011
A/Arkansas/03/2011
A/Kentucky/09/2010
A/Santiago/7774/2011
A/Argentina/63/2011
A/Paraguay/191/2011
A/Argentina/8836/2011
A/Santiago/14453/2011
A/Bolivia/3040/2012
A/Iquique/50771/2012
A/India/4947/2011
A/Cape Town/60/2011
A/Johannesburg/115/2010
A/India/5103/2010
A/India/5107/2010
A/Srinagar/126/2011
A/Srinagar/246/2011
A/India/8910/2010
A/Hong Kong/3973/2011
A/American Samoa/4520/2011
A/Peru/0429/2012
A/St Petersburg/100/2011
A/Goroka/16/2011
A/Madagascar/00695/2012
A/Nonthaburi/78/2011
A/Heilongjiang-Xiangfang/191/2011
A/Fiji/2/2012
A/New Caledonia/11/2011
A/Federated States Of Micronesia/6119/2011
A/Srinagar/1186/2012
A/Srinagar/827/2011
A/Delhi/1966/2012
A/Srinagar/1118/2012
A/Concepcion/16695/2011
A/Uganda/2707/2011
A/Bolivia/193/2011
A/Ontario/R255/2011
A/Dominican Republic/5059/2011
A/Voronezh/1/2011
A/Chile/293/2011
A/Florida/19/2011
A/New Mexico/07/2011
A/Vanimo/7/2010
A/India/2993/2009
A/India/4725/2009
A/Castro/12274/2010
A/Puerto Montt/11868/2010
A/India/3508/2010
A/Christchurch/16/2010
A/Brisbane/10/2010
A/Pennsylvania/02/2011
A/Alaska/14/2011
A/Maryland/04/2011
A/Mexico/2208/2011
A/Florida/16/2010
A/Nigeria/4280/2011
A/Tanzania/233/2010
A/Seychelles/106/2009
A/Paraguay/813/2010
A/India/8489/2009
A/Srinagar/385/2011
A/Srinagar/234/2011
A/Srinagar/04/2011
A/Wisconsin/08/2010
A/California/17/2011
A/India/3725/2010
A/India/007/2010
A/Simbu/1/2010
A/Kiribati/2003/2009
A/Yap/2020/2009
A/Fiji/2048/2009
A/Nauru/2008/2009
A/Chile/1174/2009
A/Samoa/48/2009
A/Zambia/CZC1/2009
A/Argentina/19527/2009
A/Bolivia/1263/2009
A/Peru/8109/2009
A/South Carolina/02/2010
A/Palau/1/2009
A/California/07/2009
0.001


B
A/Argentina/63/2011
A/Santiago/14453/2011
A/Argentina/8836/2011
A/Paraguay/191/2011
A/Bolivia/3040/2012
A/Iquique/50771/2012
A/Concepcion/16695/2011
A/Argentina/1033/2012
A/New Mexico/08/2011
A/Santiago/7774/2011
A/India/5756/2011
A/Paraguay/114/2012
A/Connecticut/08/2011
A/Dominican Republic/5145/2011
A/India/4947/2011
A/Srinagar/201/2011
A/Srinagar/410/2011
A/Bangladesh/8324/2011
A/Kentucky/09/2010
A/India/5103/2010
A/India/5107/2010
A/Minnesota/11/2011
A/Johannesburg/115/2010
A/Arkansas/03/2011
A/Texas/10/2011
A/Minnesota/03/2011
A/New York/09/2011
A/Cape Town/60/2011
A/Srinagar/126/2011
A/Srinagar/226/2011
A/India/8910/2010
A/Voronezh/1/2011
A/Dominican Republic/5059/2011
A/Hong Kong/3962/2011
A/Chile/293/2011
A/Florida/19/2011
A/American Samoa/4520/2011
A/Peru/0429/2012
A/Madagascar/00695/2012
A/St Petersburg/100/2011
A/Hong Kong/3973/2011
A/Fiji/2/2012
A/New Caledonia/11/2011
A/Hunan-Jishou/1116/2011
A/Nonthaburi/78/2011
A/Barbados/104/2011
A/Heilongjiang-Xiangfang/191/2011
A/Goroka/16/2011
A/Federated States Of Micronesia/6119/2011
A/Srinagar/1186/2012
A/Tanzania/2131/2012
A/Delhi/1717/2012
A/Delhi/1966/2012
A/Srinagar/827/2011
A/Srinagar/1118/2012
A/India/8942/2012
A/Delhi/1938/2012
A/Delhi/1939/2012
A/Zambia/CZC1/2009
A/South Africa/2/2009
A/Brisbane/10/2010
A/Christchurch/16/2010
A/Tanzania/233/2010
A/Seychelles/106/2009
A/Peru/8109/2009
A/Chile/1174/2009
A/India/2993/2009
A/Yap/2020/2009
A/Bolivia/1263/2009
A/India/3508/2010
A/India/4725/2009
A/India/8489/2009
A/Argentina/19527/2009
A/Nauru/2008/2009
A/Madagascar/10201/2009
A/Castro/12274/2010
A/Puerto Montt/11868/2010
A/Ontario/R255/2011
A/Bolivia/193/2011
A/Uganda/2707/2011
A/South Africa/6/2009
A/Nigeria/4280/2011
A/Fiji/2048/2009
A/Kiribati/2003/2009
A/Simbu/1/2010
A/Samoa/48/2009
A/Paraguay/813/2010
A/Vanimo/7/2010
A/Srinagar/234/2011
A/Srinagar/385/2011
A/Srinagar/04/2011
A/Wisconsin/08/2010
A/India/007/2010
A/India/3725/2010
A/St Petersburg/25/2011
A/Florida/16/2010
A/Pennsylvania/02/2011
A/Alaska/14/2011
A/Maryland/04/2011
A/Mexico/2208/2011
A/South Carolina/02/2010
A/Palau/1/2009
A/California/07/2009
0.001

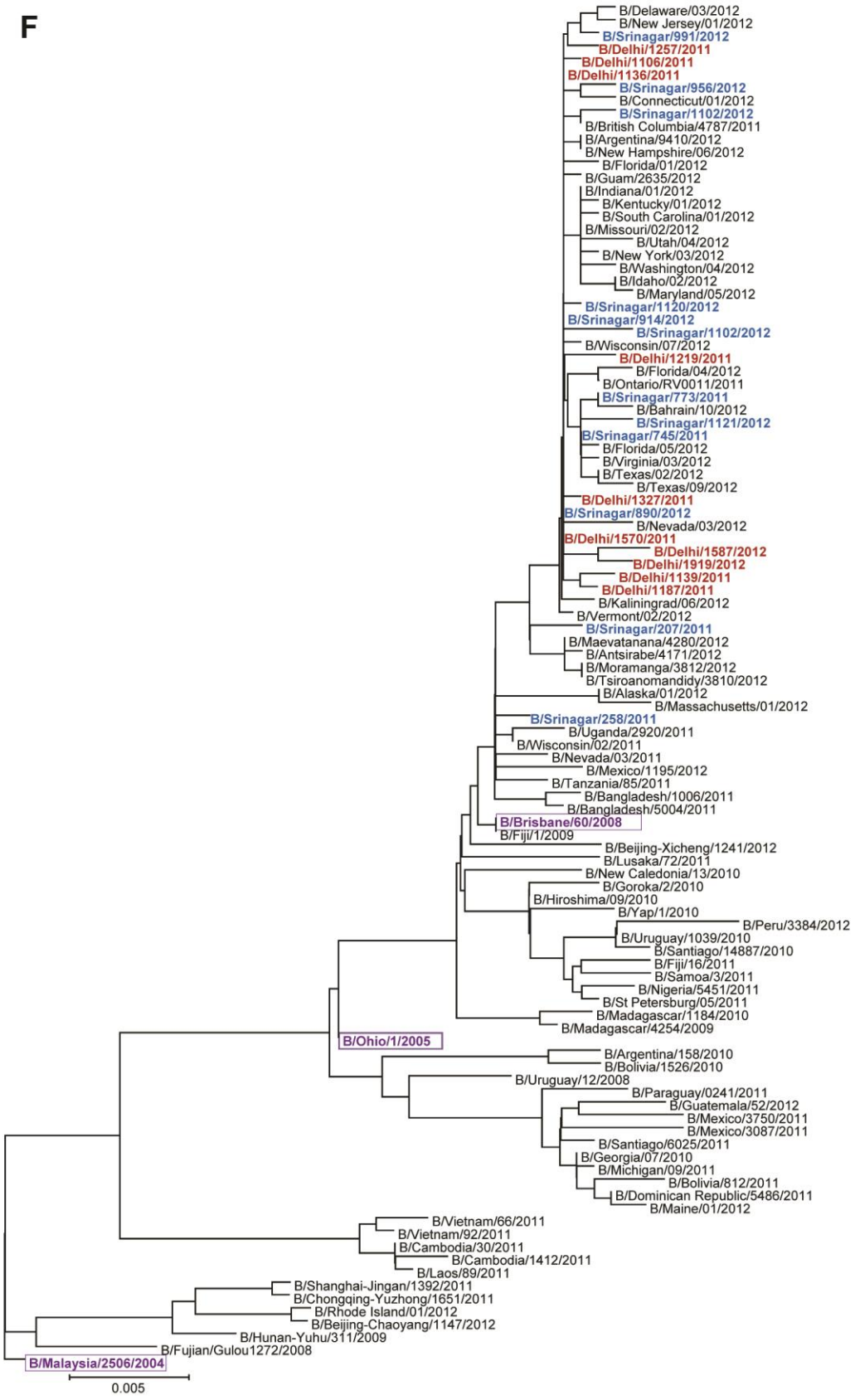
C
A/Srinagar/842/2011
A/Srinagar/856/2012
A/Srinagar/835/2011
A/Srinagar/848/2011
A/Srinagar/868/2012
A/Srinagar/812/2011
A/Srinagar/813/2011
A/California/33/2011
A/Delhi/998/2011
A/Srinagar/855/2011
A/Delhi/1088/2011
A/New Hampshire/10/2011
A/Vermont/01/2012
A/Iowa/01/2012
A/California/34/2011
A/New Caledonia/1/2012
A/Srinagar/853/2011
A/Bangladesh/5071/2011
A/Hong Kong/5063/2011
A/Delhi/1026/2011
A/Delhi/986/2011
A/Peru/1339/2012
A/Delhi/1039/2011
A/Delhi/1062/2011
A/Delhi/1475/2011
A/Virginia/01/2012
A/British Columbia/4791/2011
A/South Carolina/01/2012
A/Utah/12/2011
A/Iowa/14/2011
A/Tanzania/1254/2011
A/Delhi/1020/2011
A/Delhi/967/2011
A/Delhi/1008/2011
A/Tanzania/1314/2012
A/Nevada/01/2012
A/Wyoming/09/2011
A/Oregon/07/2011
A/Srinagar/869/2012
A/North Carolina/11/2011
A/South Australia/03/2011
A/Victoria/361/2011
A/Micronesia/6310/2012
A/Uruguay/06/2012
A/Guam/402/2012
A/Hong Kong/4913/2011
A/Hunan-Linwu/58/2011
A/Puerto Montt/51699/2012
A/Vina Del Mar/49586/2012
A/Buenos Aires/1004423/2012
A/Chiang Rai/277/2011
A/Madagascar/03233/2012
A/Minnesota/25/2011
A/Nonthaburi/279/2011
A/Georgia/09/2011
A/Pennsylvania/15/2011
A/Rhode Island/01/2010
A/Tonga/1/2011
A/Fiji/41/2010
A/Alabama/04/2011
A/Bolivia/1053/2010
A/Victoria/208/2009
A/Chile/6380/2010
A/Bolivia/340/2011
A/Madagascar/0638/2011
A/Montana/05/2011
A/Ontario/RV0064/2011
A/Perth/10/2010
A/Peru/9310/2010
A/California/01/2012
A/Fiji/8/2012
A/Tanzania/1011/2010
A/Chile/64/2011
A/Chile/9920/2011
A/Arkansas/01/2012
A/Wisconsin/01/2012
A/New Mexico/12/2011
A/Kentucky/05/2011
A/Curico/51369/2012
A/Argentina/179/2011
A/Argentina/28378/2010
A/New York/20/2011
A/Texas/06/2012
A/Paraguay/210/2011
A/Georgia/01/2011
A/Iowa/19/2010
A/American Samoa/7415/2011
A/Brisbane/299/2011
A/Christchurch/28/2011
A/Chungbuk/644/2011
A/Taiwan/851/2010
A/Victoria/210/2009
A/Perth/16/2009
A/Wisconsin/15/2009
A/Guam/0706/2009
A/Paraguay/52/2009
A/Argentina/7646/2009
A/Uruguay/716/2007
A/Brisbane/10/2007
0.002

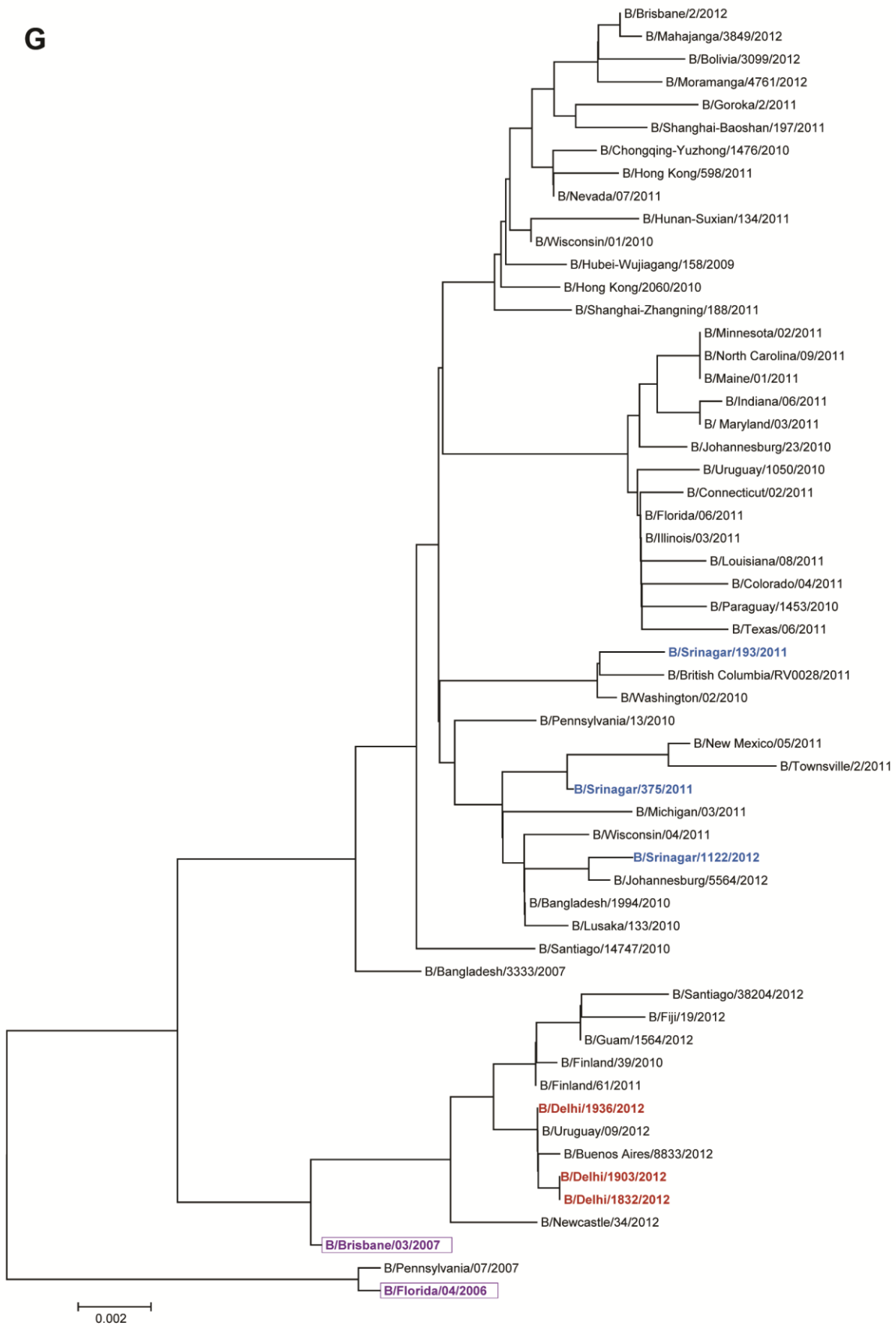
D

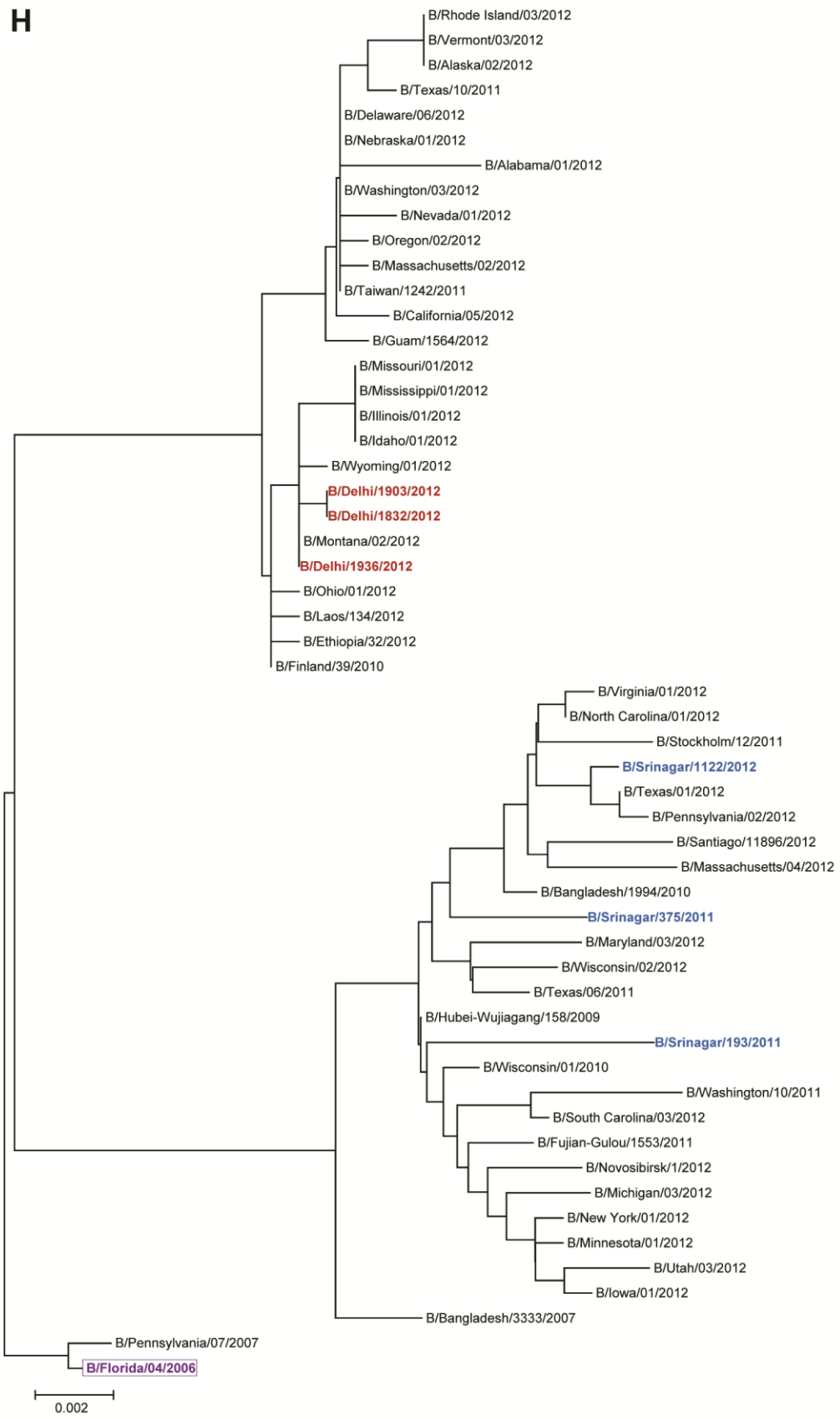

A/Delhi/998/2011
A/Virginia/01/2012
A/Hong Kong/5063/2011
A/Delhi/967/2011
A/Delhi/1039/2011
A/Delhi/1088/2011
A/Srinagar/853/2011
A/Iowa/01/2012
A/Nevada/01/2012
A/Oregon/07/2011
A/Srinagar/855/2011
A/Wyoming/09/2011
A/Delhi/1026/2011
A/Tanzania/1314/2012
A/Utah/12/2011
A/California/34/2011
A/New Hampshire/10/2011
A/Vermont/01/2012
A/Iowa/14/2011
A/Srinagar/835/2011
A/Srinagar/842/2011
A/Srinagar/813/2011
A/Srinagar/812/2011
A/Srinagar/856/2012
A/Srinagar/848/2011
A/Srinagar/868/2012
A/Bangladesh/5071/2011
A/New Caledonia/1/2012
A/British Columbia/4791/2011
A/South Carolina/01/2012
A/Delhi/986/2011
A/Peru/1339/2012
A/Delhi/1008/2011
A/Delhi/1020/2011
A/Delhi/1062/2011
A/Pennsylvania/17/2011
A/Delhi/1475/2011
A/Tanzania/1254/2011
A/South Australia/03/2011
A/Victoria/361/2011
A/Minnesota/25/2011
A/Chiang Rai/277/2011
A/Hunan-Linwu/58/2011
A/Micronesia/6310/2012
A/Hong Kong/4913/2011
A/Buenos Aires/1004423/2012
A/Uruguay/06/2012
A/Nonthaburi/279/2011
A/Guam/402/2012
A/Madagascar/03233/2012
A/Puerto Montt/51699/2012
A/Vina Del Mar/49586/2012
A/Oregon/09/2011
A/Srinagar/869/2012
A/North Carolina/11/2011
A/Rhode Island/01/2010
A/Madagascar/153/2010
A/Fiji/41/2010
A/Tonga/1/2011
A/Brisbane/299/2011
A/Christchurch/28/2011
A/American Samoa/7415/2011
A/Paraguay/210/2011
A/New York/20/2011
A/Texas/06/2012
A/Ontario/RV0064/2011
A/Tanzania/1011/2010
A/Argentina/179/2011
A/Curico/51369/2012
A/California/01/2012
A/Fiji/8/2012
A/Peru/9310/2010
A/Bolivia/340/2011
A/Chile/6380/2010
A/Iowa/19/2010
A/Madagascar/0638/2011
A/Georgia/01/2011
A/Perth/10/2010
A/Argentina/28378/2010
A/Montana/05/2011
A/Chile/9920/2011
A/New Mexico/12/2011
A/Arkansas/01/2012
A/Wisconsin/01/2012
A/Pennsylvania/15/2011
A/Alabama/04/2011
A/Bolivia/1053/2010
A/Argentina/7646/2009
A/Victoria/208/2009
A/Chungbuk/644/2011
A/Taiwan/851/2010
A/Perth/16/2009
A/Guam/0706/2009
A/Victoria/210/2009
A/Wisconsin/15/2009
A/Madagascar/3615/2009
A/Paraguay/52/2009
A/Uruguay/716/2007
A/Brisbane/10/2007
0.002


E
B/Srinagar/914/2012
B/Vermont/02/2012
B/Texas/03/2012
B/Texas/09/2012
B/Kentucky/01/2012
B/New Jersey/01/2012
B/Idaho/02/2012
B/Delhi/1139/2011
B/Delhi/1187/2011
B/Guam/2635/2012
B/Missouri/02/2012
B/Srinagar/956/2012
B/Kaliningrad/06/2012
B/Utah/04/2012
B/Delhi/1219/2011
B/Delhi/1106/2011
B/Delhi/1919/2012
B/Washington/04/2012
B/Wisconsin/07/2012
B/British Columbia/4787/2011
B/Delhi/1845/2012
B/Indiana/01/2012
B/Srinagar/1120/2012
B/ Maryland/05/2012
B/Bahrain/10/2012
B/Delhi/1327/2011
B/Delhi/1587/2012
B/Oman/65/2012
B/Florida/04/2012
B/Ontario/RV0011/2011
B/Delhi/1257/2011
B/Delhi/1136/2011
B/California/11/2011
B/Virginia/03/2012
B/Srinagar/1121/2012
B/Florida/07/2012
B/Srinagar/745/2011
B/Srinagar/773/2011
B/Srinagar/890/2012
B/Delhi/1570/2011
B/Delaware/07/2012
B/Florida/01/2012
B/Srinagar/1102/2012
B/Srinagar/991/2012
B/Nevada/03/2012
B/Connecticut/01/2012
B/Argentina/9410/2012
B/New Hampshire/06/2012
B/Srinagar/207/2011
B/New York/03/2012
B/South Carolina/01/2012
B/Antsirabe/4171/2012
B/Maevatanana/4280/2012
B/Moramanga/3812/2012
B/Tsiroanomandidy/3810/2012
B/Srinagar/258/2011
B/Uganda/2920/2011
B/Wisconsin/02/2011
B/Mexico/1195/2012
B/Bangladesh/1006/2011
B/Bangladesh/5004/2011
B/Tanzania/85/2011
B/Alaska/01/2012
B/Massachusetts/01/2012
B/Beijing-Xicheng/1241/2012
B/Brisbane/60/2008
B/Fiji/1/2009
B/Mexico/3750/2011
B/Santiago/6025/2011
B/Guatemala/52/2012
B/Paraguay/0241/2011
B/Michigan/09/2011
B/Bolivia/812/2011
B/Georgia/07/2010
B/Dominican Republic/5486/2011
B/Maine/01/2012
B/New Caledonia/13/2010
B/Madagascar/1184/2010
B/Lusaka/72/2011
B/Beijing-Chaoyang/1147/2012
B/Rhode Island/01/2012
B/Shanghai-Putuo/1623/2011
B/Hiroshima/09/2010
B/Jiangsu-Pingjiang/1603/2011
B/Shanghai-Jingan/1392/2011
B/Chongqing-Yuzhong/1651/2011
B/Yap/1/2010
B/Goroka/2/2010
B/Nigeria/5451/2011
B/Fiji/16/2011
B/Samoa/3/2011
B/St Petersburg/05/2011
B/Santiago/14887/2010
B/Peru/3384/2012
B/Uruguay/1039/2010
B/Bolivia/1526/2010
B/Argentina/158/2010
B/Uruguay/12/2008
B/Hunan-Yuhu/311/2009
B/Fujian/Gulou1272/2008
B/Vietnam/92/2011
B/Cambodia/30/2011
B/Cambodia/1412/2011
B/Laos/89/2011
B/Ohio/01/2005
B/Malaysia/2506/2004
0.002

F


B/Delaware/03/2012
B/New Jersey/01/2012
B/Srinagar/991/2012
B/Delhi/1257/2011
B/Delhi/1106/2011
B/Delhi/1136/2011
B/Srinagar/956/2012
B/Connecticut/01/2012
B/Srinagar/1102/2012
B/British Columbia/4787/2011
B/Argentina/9410/2012
B/New Hampshire/06/2012
B/Florida/01/2012
B/Guam/2635/2012
B/Indiana/01/2012
B/Kentucky/01/2012
B/South Carolina/01/2012
B/Missouri/02/2012
B/Utah/04/2012
B/New York/03/2012
B/Washington/04/2012
B/Idaho/02/2012
B/Maryland/05/2012
B/Srinagar/1120/2012
B/Srinagar/914/2012
B/Srinagar/1102/2012
B/Wisconsin/07/2012
B/Delhi/1219/2011
B/Florida/04/2012
B/Ontario/RV0011/2011
B/Srinagar/773/2011
B/Bahrain/10/2012
B/Srinagar/1121/2012
B/Srinagar/745/2011
B/Florida/05/2012
B/Virginia/03/2012
B/Texas/02/2012
B/Texas/09/2012
B/Delhi/1327/2011
B/Srinagar/890/2012
B/Nevada/03/2012
B/Delhi/1570/2011
B/Delhi/1587/2012
B/Delhi/1919/2012
B/Delhi/1139/2011
B/Delhi/1187/2011
B/Kaliningrad/06/2012
B/Vermont/02/2012
B/Srinagar/207/2011
B/Maevatanana/4280/2012
B/Antsirabe/4171/2012
B/Moramanga/3812/2012
B/Tsiroanomandidy/3810/2012
B/Alaska/01/2012
B/Massachusetts/01/2012
B/Srinagar/258/2011
B/Uganda/2920/2011
B/Wisconsin/02/2011
B/Nevada/03/2011
B/Mexico/1195/2012
B/Tanzania/85/2011
B/Bangladesh/1006/2011
B/Bangladesh/5004/2011
B/Brisbane/60/2008
B/Fiji/1/2009
B/Beijing-Xicheng/1241/2012
B/Lusaka/72/2011
B/New Caledonia/13/2010
B/Goroka/2/2010
B/Hiroshima/09/2010
B/Yap/1/2010
B/Peru/3384/2012
B/Uruguay/1039/2010
B/Santiago/14887/2010
B/Fiji/16/2011
B/Samoa/3/2011
B/Nigeria/5451/2011
B/St Petersburg/05/2011
B/Madagascar/1184/2010
B/Madagascar/4254/2009
B/Ohio/1/2005
B/Argentina/158/2010
B/Bolivia/1526/2010
B/Uruguay/12/2008
B/Paraguay/0241/2011
B/Guatemala/52/2012
B/Mexico/3750/2011
B/Mexico/3087/2011
B/Santiago/6025/2011
B/Georgia/07/2010
B/Michigan/09/2011
B/Bolivia/812/2011
B/Dominican Republic/5486/2011
B/Maine/01/2012
B/Vietnam/66/2011
B/Vietnam/92/2011
B/Cambodia/30/2011
B/Cambodia/1412/2011
B/Laos/89/2011
B/Shanghai-Jingan/1392/2011
B/Chongqing-Yuzhong/1651/2011
B/Rhode Island/01/2012
B/Beijing-Chaoyang/1147/2012
B/Hunan-Yuhu/311/2009
B/Fujian/Gulou1272/2008
B/Malaysia/2506/2004
0.005


G
B/Brisbane/2/2012
B/Mahajanga/3849/2012
B/Bolivia/3099/2012
B/Moramanga/4761/2012
B/Goroka/2/2011
B/Shanghai-Baoshan/197/2011
B/Chongqing-Yuzhong/1476/2010
B/Hong Kong/598/2011
B/Nevada/07/2011
B/Hunan-Suxian/134/2011
B/Wisconsin/01/2010
B/Hubei-Wujiagang/158/2009
B/Hong Kong/2060/2010
B/Shanghai-Zhangning/188/2011
B/Minnesota/02/2011
B/North Carolina/09/2011
B/Maine/01/2011
B/Indiana/06/2011
B/ Maryland/03/2011
B/Johannesburg/23/2010
B/Uruguay/1050/2010
B/Connecticut/02/2011
B/Florida/06/2011
B/Illinois/03/2011
B/Louisiana/08/2011
B/Colorado/04/2011
B/Paraguay/1453/2010
B/Texas/06/2011
B/Srinagar/193/2011
B/British Columbia/RV0028/2011
B/Washington/02/2010
B/Pennsylvania/13/2010
B/New Mexico/05/2011
B/Townsville/2/2011
B/Srinagar/375/2011
B/Michigan/03/2011
B/Wisconsin/04/2011
B/Srinagar/1122/2012
B/Johannesburg/5564/2012
B/Bangladesh/1994/2010
B/Lusaka/133/2010
B/Santiago/14747/2010
B/Bangladesh/3333/2007
B/Santiago/38204/2012
B/Fiji/19/2012
B/Guam/1564/2012
B/Finland/39/2010
B/Finland/61/2011
B/Delhi/1936/2012
B/Uruguay/09/2012
B/Buenos Aires/8833/2012
B/Delhi/1903/2012
B/Delhi/1832/2012
B/Newcastle/34/2012
B/Brisbane/03/2007
B/Pennsylvania/07/2007
B/Florida/04/2006
0.002


H
B/Rhode Island/03/2012
B/Vermont/03/2012
B/Alaska/02/2012
B/Texas/10/2011
B/Delaware/06/2012
B/Nebraska/01/2012
B/Alabama/01/2012
B/Washington/03/2012
B/Nevada/01/2012
B/Oregon/02/2012
B/Massachusetts/02/2012
B/Taiwan/1242/2011
B/California/05/2012
B/Guam/1564/2012
B/Missouri/01/2012
B/Mississippi/01/2012
B/Illinois/01/2012
B/Idaho/01/2012
B/Wyoming/01/2012
B/Delhi/1903/2012
B/Delhi/1832/2012
B/Montana/02/2012
B/Delhi/1936/2012
B/Ohio/01/2012
B/Laos/134/2012
B/Ethiopia/32/2012
B/Finland/39/2010
B/Virginia/01/2012
B/North Carolina/01/2012
B/Stockholm/12/2011
B/Srinagar/1122/2012
B/Texas/01/2012
B/Pennsylvania/02/2012
B/Santiago/11896/2012
B/Massachusetts/04/2012
B/Bangladesh/1994/2010
B/Srinagar/375/2011
B/Maryland/03/2012
B/Wisconsin/02/2012
B/Texas/06/2011
B/Hubei-Wujiagang/158/2009
B/Srinagar/193/2011
B/Wisconsin/01/2010
B/Washington/10/2011
B/South Carolina/03/2012
B/Fujian-Gulou/1553/2011
B/Novosibirsk/1/2012
B/Michigan/03/2012
B/New York/01/2012
B/Minnesota/01/2012
B/Utah/03/2012
B/Iowa/01/2012
B/Bangladesh/3333/2007
B/Pennsylvania/07/2007
B/Florida/04/2006
0.002

Technical Appendix Figure 2. World Health Organization recommended vaccines by season and hemisphere, 2006–2014.

Northern Hemisphere				Southern Hemisphere		
Season	Recommended Strain	alternates	Subtype	Season	Recommended Strain	alternates
2006-07	Wisconsin/67/2005	Hiroshima/52/2005	**H3N2**	2007	Wisconsin/67/2005	Hiroshima/52/2005
	New Caledonia/20/99		**H1N1**		New Caledonia/20/99	
	Malaysia/2506/2004	Ohio/1/2005	**B Victoria**		Malaysia/2506/2004	
			B Yamagata			
2007-08	Wisconsin/67/2005	Hiroshima/52/2005	**H3N2**	2008	Brisbane/10/2007	
	Solomon Islands/1513/2006		**H1N1**		Solomon Islands/1513/2006	
	Malaysia/2506/2004		**B Victoria**			
			B Yamagata		Florida/4/2006	
2008-09	Brisbane/10/2007		**H3N2**	2009	Brisbane/10/2007	Uruguay/716/2007
	Brisbane/59/2007		**H1N1**		Brisbane/59/2007	South Dakota/6/2007
			B Victoria			
	Florida/4/2006		**B Yamagata**		Florida/4/2006	Brisbane/3/2007
2009-10	Brisbane/10/2007	Uruguay/716/2007	**H3N2**	2010	Perth/16/2009	
	Brisbane/59/2007	South Dakota/6/2007	**H1N1**	H1pdm	California/7/2009	
	Brisbane/60/2008	Brisbane/33/2008	**B Victoria**		Brisbane/60/2008	
			B Yamagata			
2010-11	Perth/16/2009	Wisconsin/15/2009	**H3N2**	2011	Perth/16/2009	Wisconsin/15/2009 Victoria/210/2009
	California/7/2009		**H1N1pdm**		California/7/2009	
	Brisbane/60/2008		**B Victoria**		Brisbane/60/2008	
			B Yamagata			
2011-12	Perth/16/2009		**H3N2**	2012	Perth/16/2009	
	California/7/2009		**H1N1pdm**		California/7/2009	
	Brisbane/60/2008		**B Victoria**		Brisbane/60/2008	
			B Yamagata			
2012-13	Victoria/361/2011		**H3N2**	2013	Victoria/361/2011	Brisbane/6/2012 Ohio/2/2012 Maryland/2/2012 South Australia/30/2012 Brisbane/1/2012 Christ Church/16/2010
	California/7/2009		**H1N1pdm**		California/7/2009	
			B Victoria		Brisbane/60/2008	
	Wisconsin/1/2010		**B Yamagata**			
2013-14	Victoria/361/2011	Texas/50/2012	**H3N2**	2014	Texas/50/2012	
	California/7/2009	Christ Church/10/2010	**H1N1pdm**		California/7/2009	Christ Church/10/2010
	Brisbane/60/2008		**B Victoria**		Brisbane/60/2008	
	Massachussetts/2/2012		**B Yamagata**		Massachussetts/2/2012	