

**Supporting Information 2** – Summary information from articles included in systematic literature review.

**1) Centers for Disease Control and Prevention [16].**

*Type of report/study:* Outbreak investigation

*Mass gathering*

Setting: Camp

State: New York

Size of gathering: 541 (including campers and staff)

Approximate dates: June 28 to August 18, 2005

*Disease information*

Etiology: Mumps (virus)

Mode of transmission: Person-to-Person

Number of case-patients: 31 (including 5 laboratory confirmed), 12 among campers and 19 among staff

Onset date of index case: June 30, 2005 (staff member)

Age of case-patients: 10 to 41 years

Attack rate: 5.7%

*Major factors contributing to outbreak*

International importation of infectious case-patient (unvaccinated counselor from United Kingdom)

Close social mixing and contact in communal housing (cabins) and during camp activities

Delayed recognition, diagnosis, and reporting

**2) Schaffzin JK, et al. [17] (same outbreak as above).**

*Type of report/study:* Retrospective cohort and vaccine effectiveness study

*Mass gathering*

Setting: Camp

State: New York

Size of gathering: 541 (368 youth campers - aged 7 to 15 years, and 173 staff – aged 14 to 65 years)

Approximate dates: June 30 to September 9, 2005 (1- or 2-month overnight summer camp)

*Disease information*

Etiology: Mumps (virus)

Mode of transmission: Person-to-Person

Number of case-patients: 31 (5 - laboratory confirmed), 12 campers and 19 staff members

Onset date of index case: June 30, 2005

Age of case-patients: 10 to 41 years

Attack rate: 5.7%

Vaccine effectiveness: 92% for two doses of MMR, 80% for 1 dose of MMR

*Major factors contributing to outbreak*

International importation of infectious case-patient (unvaccinated staff from United Kingdom)

Close social mixing and contact in communal housing (cabins) and during camp activities

Delayed recognition, diagnosis, and reporting

**3) Centers for Disease Control and Prevention (CDC) [18].**

*Type of report/study:* Case review - Outbreak investigation

*Mass gathering*

Setting: International sporting event (participants/spectators from Canada, China, Taiwan, Curacao, Japan, Netherlands, Mexico, Saudi Arabia, United States, and Venezuela)

State: Pennsylvania

Size of gathering: 265,000 (including 471 participants and staff)

Approximate dates: August 17 to August 26, 2007

*Disease information*

Etiology: Measles (virus)

Mode of transmission: Person-to-Person

Number of case-patients: 7 (including index case, all laboratory confirmed), 1 exposed to index case in Japan, 2 co-workers at Detroit airport, and 1 exposed to index case at sporting event, and leading to second generation of 2 cases in Texas.

Onset date of index case: August 15, 2007 (rash onset – infected in Japan)

Hospitalizations: 1

Age of case-patients: 12 to 53 years

Attack rate: Unknown

*Major factors contributing to outbreak*

International importation of infectious case-patient (unvaccinated participant from Japan)

Transmission during airline-travel and in shared participant housing

Low measles vaccination coverage among participants and staff

**4) Chen TH, et al. [19] (same outbreak as above).**

*Type of report/study:* Outbreak investigation-case report

*Mass gathering*

Setting: International sporting event (participants/spectators from Canada, China, Taiwan, Curacao, Japan, Netherlands, Mexico, Saudi Arabia, United States, and Venezuela)

State: Pennsylvania

Size of gathering: 265,000 (471 event participants)

Approximate dates: August 17 to August 26, 2007

*Disease information*

Etiology: Measles (virus)

Mode of transmission: Person-to-Person

Number of case-patients: 7 (including index case, all laboratory confirmed), 1 exposed to index case in Japan, 2 co-workers at Detroit airport, and 1 exposed to index case at sporting event, and leading to second generation of 2 cases in Texas.

Onset date of index case: August 15, 2007 (rash onset – infected in Japan)

Age of case-patients: 12 to 53 years

Attack rate: Unknown

*Major factors contributing to outbreak*

International importation of infectious case-patient (unvaccinated participant from Japan)  
Transmission during airline-travel and in shared participant housing  
Low measles vaccination coverage and/or immunity among participants (41% of 471 participants lacking evidence of measles immunity, including 94 US-resident adults, 19 non-US-resident adults, and 80 non-US children)

5) **Killian ML, et al. [20].**

*Type of report/study:* Laboratory investigation

*Mass gathering*

Setting: County Fair  
State: Ohio  
Size of gathering: Unknown  
Approximate dates: August 2007

*Disease information*

Etiology: Influenza A H1N1 (3SIV)  
Mode of transmission: Zoonotic  
Number of case-patients: 24 (including 2 laboratory confirmed)  
Onset date of index case:  
Age of case-patients: Unknown  
Attack rate: Unknown

*Major factors contributing to outbreak*

Close contact between humans and swine at county fair  
Both humans and swine ill with identical virus – indicating virus was transmitted from swine to humans or from humans to swine

6) **Shinde V, et al. [21].**

*Type of report/study:* Case review (Influenza A H1 3SIV viruses)

*Mass gathering*

Setting: County Fair  
State: Ohio (same confirmed case-patients as above), Illinois, and Michigan  
Size of gathering: Unknown  
Approximate dates: August 2007

*Disease information*

Etiology: Influenza A H1 (3SIV)  
Mode of transmission: (presumed) Zoonotic  
Number of case-patients: 4 (All laboratory confirmed)  
Onset date of index case:  
Age of case-patients: 16 months to 48 years  
Attack rate: Unknown

*Major factors contributing to outbreak*

Direct contact with swine at fair (as exhibitors) in Ohio, where ill swine were present  
Visited fair, close proximity or near vicinity of swine (Illinois and Michigan)

**7) Centers for Disease Control and Prevention (CDC) [22].**

*Type of report/study:* Case review (Oseltamivir-Resistant 2009 Pandemic Influenza A H1N1 cases)

*Mass gathering*

Setting: Camp

State: North Carolina

Size of gathering: 1,000 (1<sup>st</sup> session), 650 (2<sup>nd</sup> session)

Approximate dates: June 14 to August 7, 2009 (2 sessions)

*Disease information*

Etiology: Pandemic Influenza A H1N1 (virus)

Mode of transmission: Person-to-Person

Number of case-patients: 67 with influenza-like-illness (including 2 confirmed with Oseltamivir-resistant influenza virus during second session)

Onset date of index case: June 18, 2009

Age of case-patients: Majority (n = 63, including 2 with Oseltamivir resistant infection) were adolescent campers, 4 were camp staff members

Attack rate: Unknown

*Major factors contributing to outbreak*

Close social mixing and contact in communal housing (cabins) and during camp activities.

Case-patients with Oseltamivir resistant infection were cabin mates – either due to transmission of resistant virus from one case-patient to another, transmission to both case-patients from a 3<sup>rd</sup> unidentified person with resistant infection, or independent mutation in both case-patients resulting in Oseltamivir resistance (possibly due to sub-therapeutic dose when symptomatic).

**8) Doyle TJ, et al. [23].**

*Type of report/study:* Cross-sectional survey (of campers returning home)

*Mass gathering*

Setting: Camp

State: North Carolina

Size of gathering: 700 (212 followed after camp ended and used for estimating number of ill patients and attack rate)

Approximate dates: June 7 to June 13, 2009

*Disease information*

Etiology: Pandemic Influenza A H1N1 (virus)

Mode of transmission: Person-to-Person

Number of case-patients: 49 cases occurring at camp (including 12 laboratory confirmed cases), 3 additional secondary cases in households following return of ill camper

Onset date of index case: Unknown

Age of case-patients: 10 to 16 years, and adult staff  
Attack rate: 23% (among campers and staff), 3.5% (secondary household attack rate – variable exposure time to ill campers)

*Major factors contributing to outbreak*

Close social mixing and contact in communal housing and during camp activities. Ill campers returned home while still infectious (though after peak infectivity), resulting in secondary transmission

9) **Morrison C, et al. [24].**

*Type of report/study: Outbreak investigation and cross-sectional survey (of campers and staff)*

*Mass gathering*

Setting: Camp (for children with hematologic and oncologic conditions – and siblings)

State: Louisiana

Size of gathering: 217 (101 children campers and 116 staff)

Approximate dates: July 26, 2009 (closed on day 5, July 31, due to number of ill campers)

*Disease information*

Etiology: Pandemic Influenza A H1N1 (virus)

Mode of transmission: Person-to-Person

Number of case-patients: 59 with probable influenza-like-illness (including 10 laboratory confirmed cases – 2 tested at camp, 8 tested at outside facility)

Onset date of index case: July 27, 2009

Age of case-patients: 5 to 69 years

Attack rate: 35.8% (28.7% in healthy campers/staff, 46.9% in campers/staff with underlying condition)

*Major factors contributing to outbreak*

Close social mixing and contact in communal housing (bunkhouses) and during camp activities. Increased risk of symptomatic infection among campers with hematologic and oncologic condition

10) **Robinson S, et al. [25].**

*Type of report/study: Retrospective (web-based) survey*

*Mass gathering*

Setting: Camps

State: Maine

Size of gathering: Range from 10 to 500 campers and 2 to 280 staff per camp

Approximate dates: June 1 to August 30, 2009

*Disease information*

Etiology: 2009 Pandemic Influenza A H1N1 (virus)

Mode of transmission: Person-to-Person

Number of case-patients: Variable across 19 camps reporting influenza outbreak ( $\geq 3$  confirmed cases)

Onset date of index case: Unknown

Age of case-patients: Unknown (both campers and staff confirmed with influenza)

Attack rate: Variable

*Major factors contributing to outbreak*

Close social mixing and contact in communal (cabins) and during camp activities

Larger number of campers per session and per cabin associated with greater risk of influenza outbreak.

**11) Kimberlin D, et al. [26].**

*Type of report/study: Prospective intervention study (prophylactic course of Oseltamivir and hand hygiene/environmental cleaning on influenza transmission)*

*Mass gathering*

Setting: Camp

State: Alabama

Size of gathering: ~800 (across 4 two-week sessions), 4<sup>th</sup> session included 246 (171 campers and 75 staff/counselors)

Approximate dates: June - July 2009, 4<sup>th</sup> session July 19 to July 31, 2009

*Disease information*

Etiology: Pandemic Influenza A H1N1 (virus)

Mode of transmission: Person-to-Person

Number of case-patients: In 3<sup>rd</sup> session, 12 cases with influenza-like-illness (including 4 laboratory confirmed cases). In 4<sup>th</sup> session, 3 cases were laboratory confirmed

Onset date of index case: July 15, 2009 (before start of 4<sup>th</sup> session)

Age of case-patients: 8 to 14 years in 4<sup>th</sup> session

Attack rate: 1.8% in 4<sup>th</sup> session

*Major factors contributing to outbreak*

Close social mixing and contact in communal housing and during camp activities

Importation of influenza into camp from outside exposures

Intervention of prophylactic use of Oseltamivir with good hand hygiene practices and environmental cleaning may be able to slow transmission in camp setting.

**12) Tsalik EL, et al. [27].**

*Type of report/study: Prospective camp-based intervention study*

*Mass gathering*

Setting: University-based camp(s)

State: North Carolina

Size of gathering: 7,906 participants in 73 residential camps (academic, athletic, and single social reunion) across 3 campuses

Approximate dates: May 2 – August 2009 (camps ranging from 3 to 73 days in duration)

*Disease information*

Etiology: Pandemic Influenza A H1N1 (virus)

Mode of transmission: Person-to-Person

Number of case-patients: Total = 119

- Cluster 1 = 60 (across 3 camps), 4 additional case-patients identified but not epidemiologically linked to cluster (June 15 to July 2). Of 64, 27 were laboratory confirmed.

- Cluster 2 = 47, 8 additional case-patients identified but not linked to other case-patients (July 13 to July 24). Of 55, 40 were laboratory confirmed.

Onset date of index case: Cluster 1 = June 14, Cluster 2 = July 13

Age of case-patients: 9 to 68 years

Attack rate: Among participants in Cluster 1 = 14.9%, among participants in Cluster 2 = 15%

*Major factors contributing to outbreak*

Close social mixing and contact in communal housing and during camp activities (prolonged close contact in and out of the classroom during academic camps, transmission linked to social interactions outside of class and housing)

Delay in seeking medical attention early after symptom onset

Implementation of infection control activities at may be insufficient to control influenza transmission at large university-based camp

**13) Tsalik EL, et al. [28] (same outbreak as above).**

*Type of report/study: Case review (of ILI among participants/staff of university-based camp)*

*Mass gathering*

Setting: University-based camp(s)

State: North Carolina

Size of gathering: 7,906 participants in 73 residential camps (academic, athletic, and single social reunion) across 3 campuses

Approximate dates: May 2 – August 2009 (camps ranging from 3 to 73 days in duration)

*Disease information*

Etiology: Pandemic Influenza A H1N1 (virus)

Mode of transmission: Person-to-Person

Number of case-patients: Total = 119

- Cluster 1 = 60 (across 3 camps), 4 additional case-patients identified but not epidemiologically linked to cluster (June 15 to July 2). Of 64, 27 were laboratory confirmed.
- Cluster 2 = 47, 8 additional case-patients identified but not linked to other case-patients (July 13 to July 24). Of 55, 40 were laboratory confirmed.

Onset date of index case: Cluster 1 = June 14, Cluster 2 = July 13

Age of case-patients: 9 to 68 years

Attack rate: Among participants in Cluster 1 = 14.9%, among participants in Cluster 2 = 15%

*Major factors contributing to outbreak*

Close social mixing and contact in communal housing and during camp activities

Inclusion of multiple ILI symptoms in the diagnostic algorithm could help to identify and differentiate influenza infections compared to other causes of ILI

**14) Sugimoto JD, et al. [29].**

*Type of report/study: Retrospective survey (to assess affect of age group on susceptibility to symptomatic disease and to estimate transmissibility of pandemic Influenza A H1N1)*

*Mass gathering*

Setting: Camp

State: Washington

Size of gathering: 145 (111 6<sup>th</sup>-grade students, and 35 teachers and staff)

Approximate dates: April 25 – 30, 2009

*Disease information*

Etiology: Pandemic Influenza A H1N1 (virus)

Mode of transmission: Person-to-Person

Number of case-patients: 49 camp participants (from 96 campers responding to survey), 11 additional cases among household contacts (among 136 household contacts from 41 households with an ill camper)

Onset date of index case: Unknown

Age of case-patients: Majority of ill campers ≤ 17 years of age

Attack rate: 51% (according to survey respondents) for influenza-like-illness. Secondary household attack rate = 6% for influenza-like-illness (according to survey respondents).

*Major factors contributing to outbreak*

Close social mixing and contact in communal housing and during camp activities

Intense mixing between children (often at greater risk of influenza infection) in congregate settings such as camps provide greater opportunities for transmission than within households (number of susceptible children will often be depleted due infection at other settings)

**15) Centers for Disease Control and Prevention [30].**

*Type of report/study: Outbreak report – case review*

*Mass gathering*

Setting: Camp

State: New York

Size of gathering: 400

Approximate dates: June - August 2009

*Disease information*

Etiology: Mumps (virus)

Mode of transmission: Person-to-Person

Number of case-patients: 25 at camp, 79 additional cases in community following end of camp

Onset date of index case: June 28

Age of case-patients: 9 to 30 years at camp, 8 months to 84 in community

Attack rate: 6% at camp

*Major factors contributing to outbreak*

International importation of infectious case-patient 11-year old from United Kingdom

Close social mixing and contact in communal housing (cabins) and during camp activities

Waning or lack of immunity for mumps: Among 24 camp participants with known vaccination status, 20 (83%) were age-appropriately vaccinated, one (4%) was partially vaccinated, and three (13%) were unvaccinated.

**16) Centers for Disease Control and Prevention (same outbreak as above - update) [31].**

*Type of report/study: Outbreak report-case review*



*Mass gathering*

Setting: Camp

State: New York

Size of gathering: 400

Approximate dates: June - August 2009

*Disease information*

Etiology: Mumps (virus)

Mode of transmission: Person-to-Person

Number of case-patients: 25 at camp, 1,521 total between June 2009 and January 2010

Onset date of index case: June 28, 2009

Age of case-patients: 3 months to 90 years (includes camps participants/staff and subsequent cases from community)

Attack rate: Unknown

*Major factors contributing to outbreak*

International importation of infectious case-patient 11-year old from United Kingdom

Close social mixing and contact in communal housing (cabins) and during camp activities

Prolonged close contact in other congregate settings such as school and larger mean household size (in impacted communities)

Waning of lack of mumps immunity

**17) Cox CH, et al. [32].**

*Type of report/study: Case report*

*Mass gathering*

Setting: Fair

State: Kansas

Size of gathering: Unknown

Approximate dates: July 2009

*Disease information*

Etiology: Influenza A H3N2 (SIV)

Mode of transmission: Zoonotic

Number of case-patients: 1

Onset date of index case: July 28, 2009

Age of case-patients: 12 years

Attack rate: Unknown

*Major factors contributing to outbreak*

Close contact swine at county fair

**18) Centers for Disease Control and Prevention [33].**

*Type of report/study: Case report*

*Mass gathering*

Setting: Fair

State: Pennsylvania

Size of gathering: Unknown

Approximate dates: August 2011

*Disease information*

Etiology: Influenza A H3N2v

Mode of transmission: Zoonotic

Number of case-patients: 1

Onset date of index case: August 20, 2011

Age of case-patients: < 5 years

Attack rate: Unknown

*Major factors contributing to outbreak*

Close contact with swine at county fair

**19) Wong KK, et al. [34].**

*Type of report/study: Outbreak investigation and retrospective cohort study*

*Mass gathering*

Setting: Fair

State: Pennsylvania

Size of gathering: 70,000

Approximate dates: August 2011

*Disease information*

Etiology: Influenza A H3N2v

Mode of transmission: Zoonotic

Number of case-patients: 89 (3 confirmed, 4 probable, and 82 suspected)

Onset date of index case: Unknown

Age of case-patients: ≤ 13 years (confirmed and probable cases)

Attack rate: Unknown

*Major factors contributing to outbreak*

Close contact with swine at county fair

Co-circulation of human and swine influenza viruses at agricultural fairs providing opportunities for emergence of novel strains

**20) Centers for Disease Control and Prevention [35].**

*Type of report/study: Outbreak report-case review*

*Mass gathering*

Setting: Fair

State: Indiana

Size of gathering: Unknown

Approximate dates: July 8 to July 14, 2012

*Disease information*

Etiology: Influenza A H3N2v

Mode of transmission: Zoonotic

Number of case-patients: 4 (all laboratory confirmed)

Onset date of index case: July 12, 2012

Age of case-patients: Unknown

Attack rate: Unknown

*Major factors contributing to outbreak*

Close contact with swine as exhibitors or family members of exhibitors

**21) Jhung MA, et al. [36].**

*Type of report/study: Outbreak investigation-summary case report*

*Mass gathering*

Setting: Fairs

State: Multiple – Illinois, Indiana, Maryland, Michigan, Minnesota, Ohio, Pennsylvania, and Wisconsin

Size of gathering: 22,000 to 1.7 million (estimates only)

Approximate dates: Fairs held during summer and fall 2012

*Disease information*

Etiology: Influenza A H3N2v

Mode of transmission: Zoonotic (limited person-to-person transmission)

Number of case-patients: Ranging from 1 to 73 across 38 fairs reporting cases (15 additional cases through person-to-person transmission)

Onset date of index case: July 9, 2012

Age of case-patients: 3 months to 74 years

Attack rate: Unknown

*Major factors contributing to outbreak*

Efficient transmission of H3N2v among swine

Direct or indirect human contact with swine at agricultural fairs

Presence of M gene from pdm09 H1N1 identified in H3N2v viruses, possibly facilitating transmission