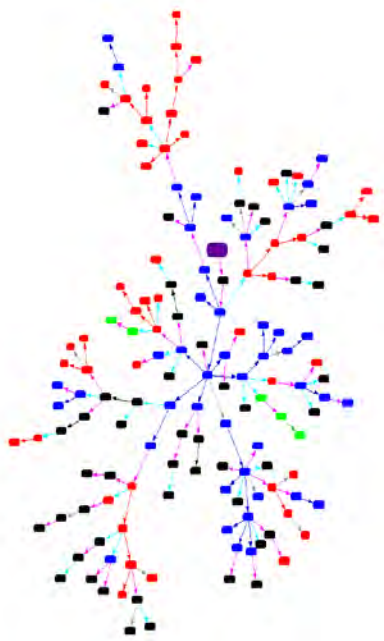
Effects of Healthcare Sites on Community Pandemic Influenza Transmission and Mitigation

Victoria J. Davey PhD MPH, Robert J. Glass PhD
Department of Veterans Affairs
Sandia National Laboratories



Infectious Disease Modeling Meeting
January 6-7, 2010

Outline

- Background
- Design Process
- Results
- Summary Points & Policy Implications

Healthcare settings and influenza transmission

- **Patients, staff, visitors** bring influenza into healthcare settings
  - Outbreaks cause morbidity and mortality among staff, inpatients, long term residents (Bridges 2003)
  - H5N1 transmission occurred in hospitals (Bridges 2000, Wang 2008, Writing Comm WHO 2008, Uyeki 2007)
- **Control measures in healthcare settings** include
  - Negative pressure rooms
  - Use of PPE
  - Screening
  - Voluntary home quarantine of exposed staff
  - Visitor limitations
  - Prophylactic medications, vaccine
- **Applied by severity/pathogenicity**
  - Could limit transmission in healthcare settings

Infection Control Management of Patients with Suspected or Confirmed Influenza

Suspected influenza: Patient has signs and symptoms suggestive of influenza, such as fever (≥ 100°F) and cough, muscle aches, headache, or sore throat

Confirmed influenza: When either a rapid influenza test or viral culture is positive for influenza A or B

Outpatients:
- Post signs reminding everyone to practice hand hygiene and respiratory etiquette.
- Provide alcohol-based hand rubs in all outpatient waiting rooms.
- Offer a mask and tissues to patients with coughs.
- Segregate patients with cough and/or fever in an area of the waiting room away from other patients.

Inpatients:
- Place patient in a private room. If a private room is not available, contact your facility's Infection Control Professional.
- Post a Droplet Precautions sign outside the door.
- Follow Droplet Precautions (in addition to Standard Precautions):
  - Wear a mask upon entering the room.
  - Remove your mask when leaving the patient's room and dispose of your mask in a regular waste container.
  - Have the patient wear a mask when being transported.

Decontaminate hands before and after contact with patients, and wear eye/face protection if performing cough-inducing procedures.

Suggested use: Post in clinical staff areas or use as a flyer. Do not post in patient rooms.

Infection: Don't Pass It On

www.publichealth.va.gov/InfectionDontPassItOn

Department of Veterans Affairs

Healthcare settings to communities

- **Few reports of transmission** of respiratory viruses from healthcare settings to communities
  - Biologically plausible

- **Exception: 2002-2003 SARS experience**:
  - Healthcare settings were high-risk environments for transmission
  - Healthcare settings were source of infection for large percentage of victims who transmitted to community members
  - A 'healthcare centered' epidemic (Lloyd-Smith 2003, Possamai 2007)

Purpose

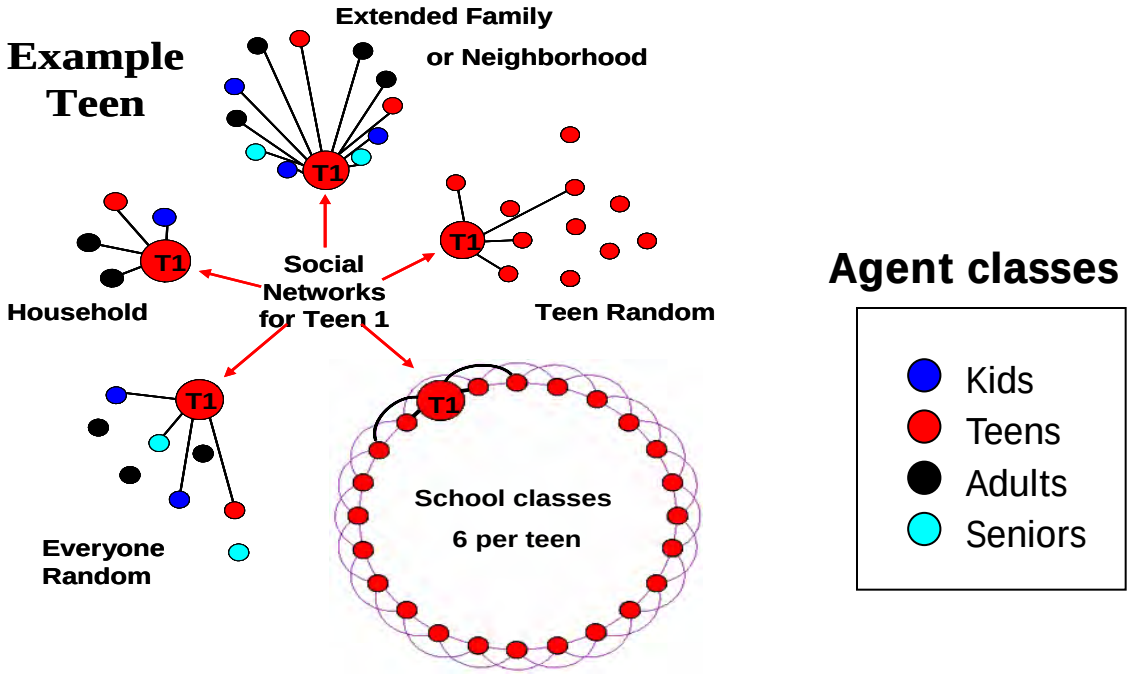
- Do healthcare settings serve as intensive transmission environments for influenza, increasing effects on community members?

- Do healthcare settings have effects on success of community-based mitigation strategies (school closing; children-teen social distancing; adult social distancing)?

- Do community-based + healthcare setting-based mitigation strategies limit epidemic effects?

Design Process

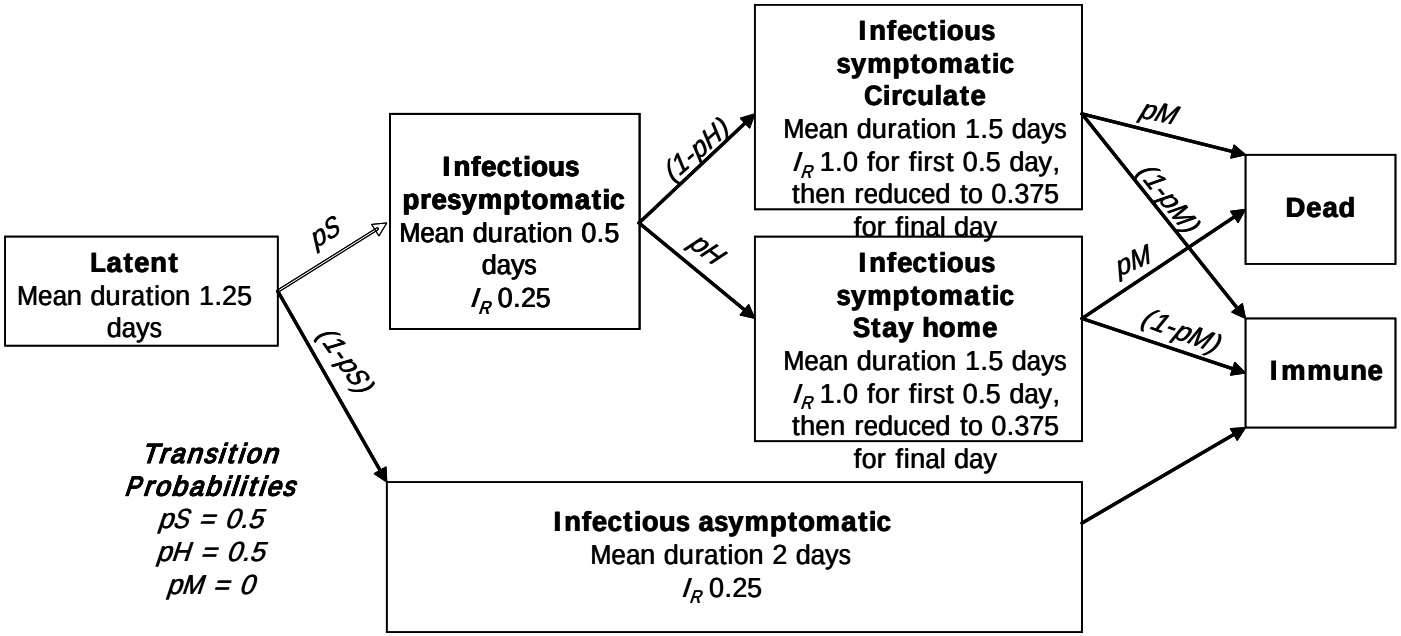
1. **Create a community** in a networked agent-based model:
   - Explicit social contact network
   - Stylized US community of 10,000
   - Agents: Children 18%, Teen 11%, Adult 59%, Senior 12% (US Census, 2000)
   - Agents in overlapping sub-networks: households, schools, workplaces, neighborhoods, extended families, senior gatherings, random



Design Process

2. Define influenza illness manifestation

- Scaled on 1957-58 influenza*
  - *pSymptomatic* = 0.5, *pHome* = 0.8, (*pDiagnosis* = 0.8,) *pDead* = 0.02
- Children 1.5 and teens 1.25 X more infectious & susceptible than adults & seniors
- Added 7 day noninfectious recovery period for ill



*after Ferguson (2005, 2006) except for 7 day recovery period

Design Process

3. Define probability of influenza transmission

- probability that a contact will occur, p_c in a small time interval, dt, along a link with contact frequency v_c is: $p_c = v_c dt$
- The percentage of total contacts between two linked individuals that actually result in transmission is given by $I_D * I_R * I_A * S_P * S_A$ where

  I_D =the infectivity of the disease

  I_R =the relative infectivity of the disease state

  I_A =the relative infectivity of the individual who is transmitting

  S_P =the susceptibility of people to the disease (here taken as 1.0)

  S_A =is the relative susceptibility of the individual being infected

- The probability of an influenza transmission event along a given link between an infectious and a susceptible individual, p_i , is:

$$p_i = I_D * I_R * I_A * S_P * S_A * v_c * dt$$

Design Process

4. Implement containment strategies:

- modify contact network for mitigation strategies
- modify agent's susceptibility given antiviral drugs or vaccine

S	**Close Schools**	Schools closed, **all school contacts reduced by 90%**, household contacts doubled
CTsd	**Social Distance Children and Teenagers**	Child & Teens social distancing, **all non-school and non-household contacts with or between children and teens reduced by 90%**, household contacts doubled
ASsd	**Social Distance Adults and Seniors**	Adults & Seniors social distancing, **all non-household non-work contacts with or between adults and seniors reduced by 90%, work contacts reduced by 50%**, household contacts doubled
Q	**Home Quarantine**	Household Quarantine for 10 days once an individual is diagnosed, **all non-household contacts for all household members reduced by 90%**, household contacts doubled
T	**Antiviral Treatment**	Antiviral Treatment, **90% of people** given antiviral course immediately after diagnosed, reduces infectivity by 60% (from Ferguson et al., 2006)
P	**Household antiviral prophylaxis**	Antiviral Prophylaxis, **90% of household members** given antiviral for 10 days immediately after individual is diagnosed, reduces susceptibility by 30%, and if they are infected: reduces probability of symptomatic by 65%, reduces infectivity by 60% (from Ferguson et al., 2006)
Pex	**Extended antiviral prophylaxis**	Extended Antiviral Prophylaxis, **90% of linked persons** within households, classes, work, and neighborhoods/extended families are given antiviral immediately for 10 days after person is diagnosed, reduces susceptibility by 30%, and if they are infected: reduces probability of symptomatic by 65%, reduces infectivity by 60% (from Ferguson et al., 2006)

Design Process

5. Define and run a core matrix of containment strategy combinations

- At 7 levels of pandemic severity (seasonal flu to twice 1918-like)
- 2 levels of compliance (60% or 90%)
- As if strategies applied regionally or only within the community
- Strategies implemented at 0.01% incident cases, rescinded at 0 cases/7 days, re-implemented if new cases reach 0.01% incidence

	None	ASsd	CTsd	CTsd, ASsd	S	S, ASsd	S, CTsd	S, CTsd ASsd
None	None							
T								
Q								
P								
Q, T								
Q, P								
PEx								
Q, PEx								All

Design Process

6. Determine a 'best strategy' from the core matrix for 1918-like pandemic, by examining the following outcomes:

- Number of simulations that yield epidemics
- Infection rate
- Illness attack (symptomatic) rate
- Deaths
- Peak infected
- Time to peak infected
- Peak symptomatic
- Time to peak symptomatic
- Epidemic duration (from implementation threshold to last diagnosed)
- Total time of effects (from initial seeding to last person recovered)
- Number of days strategies imposed
- Number of containment cycles needed
- Number of external infections
- Number of antiviral courses given
- Number of days adults are at home (either sick, quarantined, or tending sick or children sent home from school)

Design Process

7. Examine robustness and sensitivity of core matrix findings to model perturbations and extensions.

Core	▪ 7 levels of influenza severity (typical seasonal influenza to twice the transmissibility of 1918) ▪ 90% compliance or 60% compliance ▪ Regional mitigation or local-only mitigation ▪ Common to all: o Illness manifestation after Ferguson (2005, 2006) o Implementation of strategies at 10 cases in the community o Rescinding of strategies at 0 cases/7days and if epidemic recurs [10 cases], strategies are re-implemented
Perturbations	▪ Delay of implementation to 30 or 100 cases ▪ Rescinding of strategies at 3 cases/7 days; if epidemic recurs [with 10 cases], strategies are re-implemented
Extensions	▪ Longini-like disease manifestation ▪ Longini-like disease manifestation with extended infectious recovery period ▪ Similar transmission within children, teenagers and adults ▪ Augmented contact network ▪ Availability of pre-pandemic vaccine: 1) randomly, 2) targeted to children and teens, or 3) targeted to adults

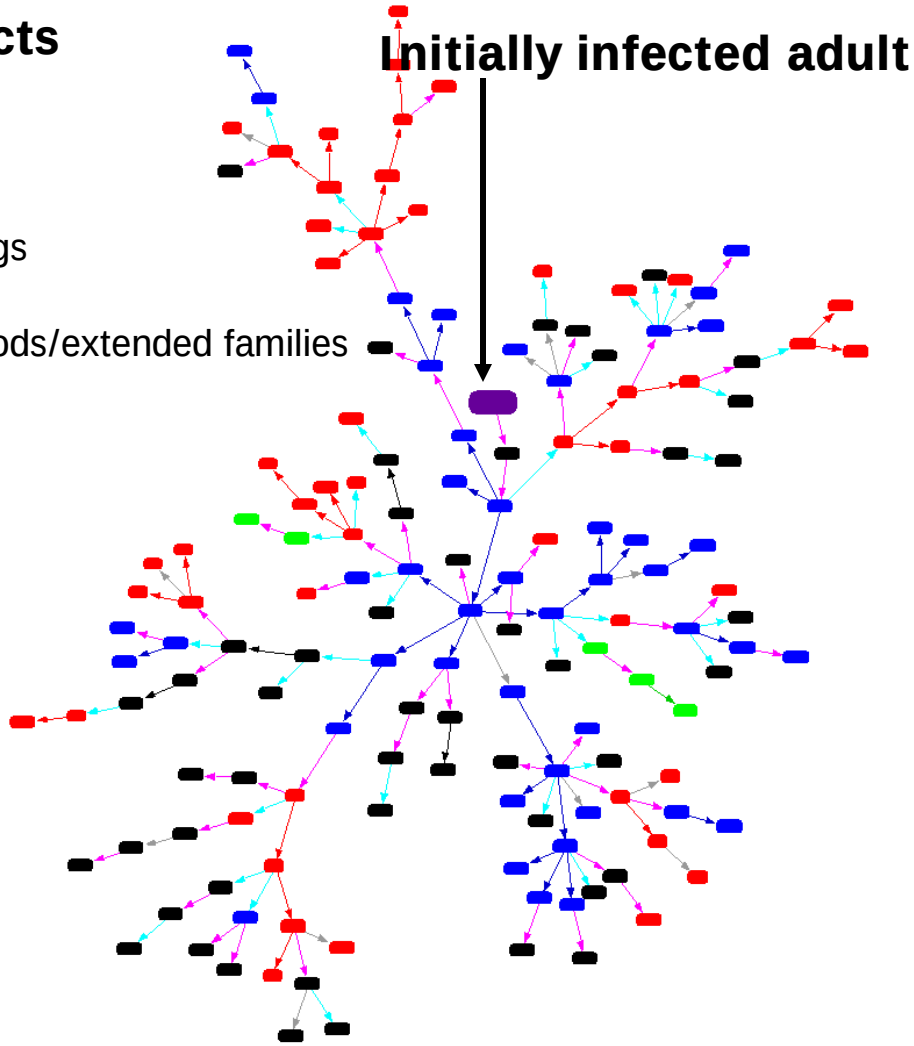
Initial Growth of Epidemic

Agents

- Initially infected adult
- child
- teenager
- adult
- senior

Infectious contacts

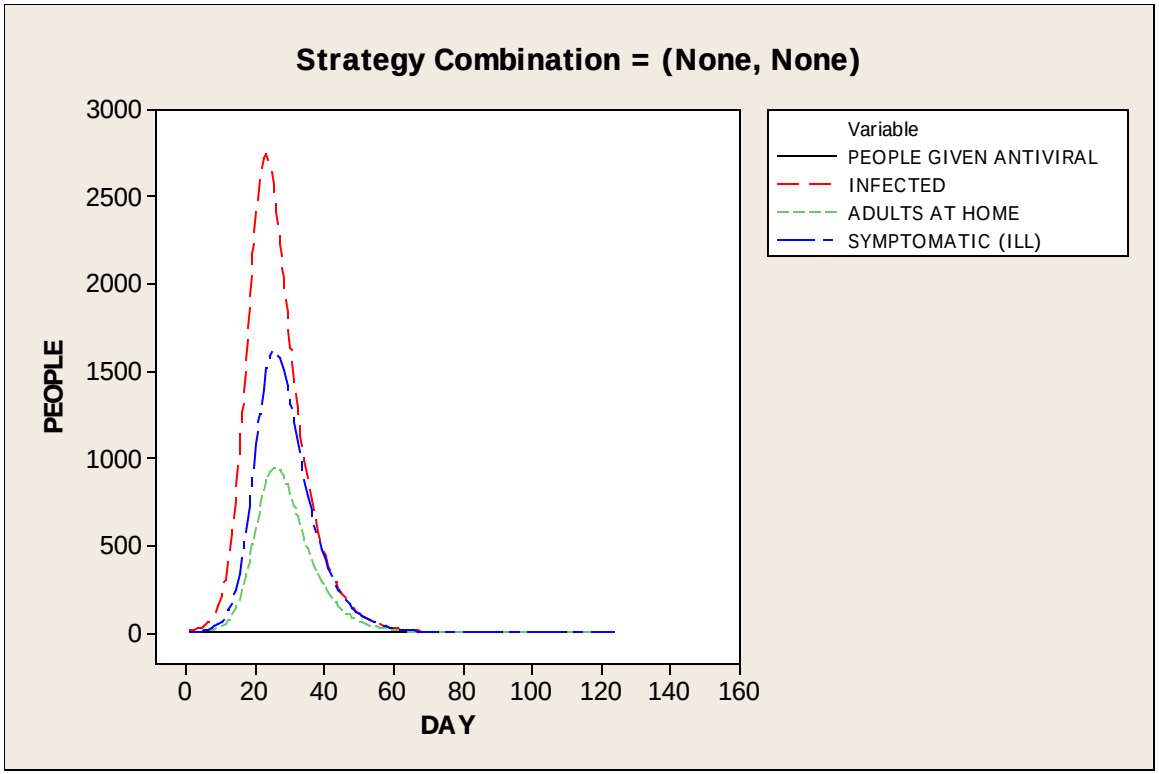
- Children School
- Teens School
- Adults Work
- Senior Gatherings
- Households
- Neighborhoods/extended families
- Random



Trace the transmission of influenza: from the initial seed, two household contacts (light purple arrows) bring influenza to the high school (blue arrows) where it spreads like wildfire. Children and teens form the backbone of the infectious contact network and are critical to its spread.

Results – Unmitigated 1918-Like Epidemic

- Pandemic severity index (PSI) 4-5, R_0 of ~ 2.0
- Early peak of 1500 symptomatic cases
- 9% of adults home from work at peak
- Epidemic effects end at day 60



Percent of Population Infected—1918-Like Epidemic

Network based

Case based	None	ASsd	CTsd	CTsd ASsd	S	S ASsd	S CTsd	S CTsd ASsd
None	71	56	65	53	61	50	17	5
T	65	50	57	45	51	39	5	2
Q	60	50	52	44	45	37	9	4
P	56	43	46	36	36	23	3	2
Q,T	53	43	43	35	34	23	3	2
Q,P	49	39	38	30	27	15	3	2
Pex	40	31	31	24	21	11	3	2
Q,Pex	35	27	24	16	13	7	3	2

T: antiviral Treatment
P: home antiviral Prophylaxis
Pex: Extended antiviral Prophylaxis
Q: home Quarantine

ASsd: Adult & Senior social distancing
CTsd: Child & Teen social distancing
S: School closure

Percent of Population Infected—1918-Like Epidemic

Network based

Case based	None	ASsd	CTsd	CTsd ASsd	S	S ASsd	S CTsd	S CTsd ASsd
None	71	56	65	53	61	50	17	5
T	65	50	57	45	51	39	5	2
Q	60	50	52	44	45	37	9	4
P	56	43	46	36	36	23	3	2
Q,T	53	43	43	35	34	23	3	2
Q,P	49	39	38	30	27	15	3	2
Pex	40	31	31	24	21	11	3	2
Q,Pex	35	27	24	16	13	7	3	2

T: antiviral Treatment
P: home antiviral Prophylaxis
Pex: Extended antiviral Prophylaxis
Q: home Quarantine

ASsd: Adult & Senior social distancing
CTsd: Child & Teen social distancing
S: School closure

Percent of Population Infected—1918-Like Epidemic

Network based

Case based	None	ASsd	CTsd	CTsd ASsd	S	S ASsd	S CTsd	S CTsd ASsd
None	71	56	65	53	61	50	17	5
T	65	50	57	45	51	39	5	2
Q	60	50	52	44	45	37	9	4
P	56	43	46	36	36	23	3	2
Q,T	53	43	43	35	34	23	3	2
Q,P	49	39	38	30	27	15	3	2
Pex	40	31	31	24	21	11	3	2
Q,Pex	35	27	24	16	13	7	3	2

T: antiviral Treatment
P: home antiviral Prophylaxis
Pex: Extended antiviral Prophylaxis
Q: home Quarantine

ASsd: Adult & Senior social distancing
CTsd: Child & Teen social distancing
S: School closure

Percent of Population Infected—1918-Like Epidemic

Network based

Case based	None	ASsd	CTsd	CTsd ASsd	S	S ASsd	S CTsd	S CTsd ASsd
None	71	56	65	53	61	50	17	5
T	65	50	57	45	51	39	5	2
Q	60	50	52	44	45	37	9	4
P	56	43	46	36	36	23	3	2
Q,T	53	43	43	35	34	23	3	2
Q,P	49	39	38	30	27	15	3	2
Pex	40	31	31	24	21	11	3	2
Q,Pex	35	27	24	16	13	7	3	2

T: antiviral Treatment
P: home antiviral Prophylaxis
Pex: Extended antiviral Prophylaxis
Q: home Quarantine

ASsd: Adult & Senior social distancing
CTsd: Child & Teen social distancing
S: School closure

Percent of Population Infected—1918-Like Epidemic

Network based

Case based	None	ASsd	CTsd	CTsd ASsd	S	S ASsd	S CTsd	S CTsd ASsd
None	71	56	65	53	61	50	17	5
T	65	50	57	45	51	39	5	2
Q	60	50	52	44	45	37	9	4
P	56	43	46	36	36	23	3	2
Q,T	53	43	43	35	34	23	3	2
Q,P	49	39	38	30	27	15	3	2
Pex	40	31	31	24	21	11	3	2
Q,Pex	35	27	24	16	13	7	3	2

T: antiviral Treatment
P: home antiviral Prophylaxis
Pex: Extended antiviral Prophylaxis
Q: home Quarantine

ASsd: Adult & Senior social distancing
CTsd: Child & Teen social distancing
S: School closure

Percent of Population Infected—1918-Like Epidemic

Network based

Case based	None	ASsd	CTsd	CTsd ASsd	S	S ASsd	S CTsd	S CTsd ASsd
None	71	56	65	53	61	50	17	5
T	65	50	57	45	51	39	5	2
Q	60	50	52	44	45	37	9	4
P	56	43	46	36	36	23	3	2
Q,T	53	43	43	35	34	23	3	2
Q,P	49	39	38	30	27	15	3	2
Pex	40	31	31	24	21	11	3	2
Q,Pex	35	27	24	16	13	7	3	2

T: antiviral Treatment
P: home antiviral Prophylaxis
Pex: Extended antiviral Prophylaxis
Q: home Quarantine

ASsd: Adult & Senior social distancing
CTsd: Child & Teen social distancing
S: School closure

Strategies Yielding Infection Rates of < 10% and < 25%

Infection rate < 10% Infection rate < 25%

Case based	None	ASsd	CTsd	CTsd ASsd	S	S ASsd	S CTsd	S CTsd ASsd
None	71	56	65	53	61	50	17	5
T	65	50	57	45	51	39	5	2
Q	60	50	52	44	45	37	9	4
P	56	43	46	36	36	23	3	2
Q,T	53	43	43	35	34	23	3	2
Q,P	49	39	38	30	27	15	3	2
Pex	40	31	31	24	21	11	3	2
Q,Pex	35	27	24	16	13	7	3	2

T: antiviral Treatment
P: home antiviral Prophylaxis
Pex: Extended antiviral Prophylaxis
Q: home Quarantine

ASsd: Adult & Senior social distancing
CTsd: Child & Teen social distancing
S: School closure

Strategies Yielding Infection Rates of < 10% and < 25%

Infection rate < 10% Infection rate < 25%

Case based	None	ASsd	CTsd	CTsd ASsd	S	S ASsd	S CTsd	S CTsd ASsd
None	71	56	65	53	61	50	17	5
T	65	50	57	45	51	39	5	2
Q	60	50	52	44	45	37	9	4
P	56	43	46	36	36	23	3	2
Q,T	53	43	43	35	34	23	3	2
Q,P	49	39	38	30	27	15	3	2
Pex	40	31	31	24	21	11	3	2
Q,Pex	35	27	24	16	13	7	3	2

T: antiviral Treatment
P: home antiviral Prophylaxis
Pex: Extended antiviral Prophylaxis
Q: home Quarantine

ASsd: Adult & Senior social distancing
CTsd: Child & Teen social distancing
S: School closure

What if Antivirals Were Ineffective or Unavailable?

Infection rate < 10 % Infection rate < 25 %

Case based	None	ASsd	CTsd	CTsd ASsd	S	S ASsd	S CTsd	S CTsd ASsd
None	71	56	65	53	61	50	17	5
~~T~~	~~65~~	~~50~~	~~57~~	~~45~~	~~51~~	~~39~~	~~5~~	~~2~~
Q	60	50	52	44	45	37	9	4
~~P~~	~~56~~	~~43~~	~~46~~	~~36~~	~~36~~	~~23~~	~~3~~	~~2~~
~~Q,T~~	~~53~~	~~43~~	~~43~~	~~35~~	~~34~~	~~23~~	~~3~~	~~2~~
~~Q,P~~	~~49~~	~~39~~	~~38~~	~~30~~	~~27~~	~~15~~	~~3~~	~~2~~
~~Pex~~	~~40~~	~~31~~	~~31~~	~~24~~	~~21~~	~~11~~	~~3~~	~~2~~
~~Q,Pex~~	~~35~~	~~27~~	~~24~~	~~16~~	~~13~~	~~7~~	~~3~~	~~2~~

T: antiviral Treatment
P: home antiviral Prophylaxis
Pex: Extended antiviral Prophylaxis
Q: home Quarantine

ASsd: Adult & Senior social distancing
CTsd: Child & Teen social distancing
S: School closure

What if Antivirals Were Ineffective or Unavailable?

Infection rate < 10 % Infection rate < 25 %

Case based	None	ASsd	CTsd	CTsd ASsd	S	S ASsd	S CTsd	S CTsd ASsd
None	71	56	65	53	61	50	17	5
~~T~~	~~65~~	~~50~~	~~57~~	~~45~~	~~51~~	~~39~~	~~5~~	~~2~~
Q	60	50	52	44	45	37	9	4
~~P~~	~~56~~	~~43~~	~~46~~	~~36~~	~~36~~	~~23~~	~~3~~	~~2~~
~~Q,T~~	~~53~~	~~43~~	~~43~~	~~35~~	~~34~~	~~23~~	~~3~~	~~2~~
~~Q,P~~	~~49~~	~~39~~	~~38~~	~~30~~	~~27~~	~~15~~	~~3~~	~~2~~
~~Pex~~	~~40~~	~~31~~	~~31~~	~~24~~	~~21~~	~~11~~	~~3~~	~~2~~
~~Q,Pex~~	~~35~~	~~27~~	~~24~~	~~16~~	~~13~~	~~7~~	~~3~~	~~2~~

T: antiviral Treatment
P: home antiviral Prophylaxis
Pex: Extended antiviral Prophylaxis
Q: home Quarantine

ASsd: Adult & Senior social distancing
CTsd: Child & Teen social distancing
S: School closure

What if Antivirals Were Ineffective or Unavailable?

Infection rate < 10 % Infection rate < 25 %

Case based	None	ASsd	CTsd	CTsd ASsd	S	S ASsd	S CTsd	S CTsd ASsd
None	71	56	65	53	61	50	17	5
~~T~~	~~65~~	~~50~~	~~57~~	~~45~~	~~51~~	~~39~~	~~5~~	~~2~~
Q	60	50	52	44	45	37	9	4
~~P~~	~~56~~	~~43~~	~~46~~	~~36~~	~~36~~	~~23~~	~~3~~	~~2~~
~~Q,T~~	~~53~~	~~43~~	~~43~~	~~35~~	~~34~~	~~23~~	~~3~~	~~2~~
~~Q,P~~	~~49~~	~~39~~	~~38~~	~~30~~	~~27~~	~~15~~	~~3~~	~~2~~
~~Pex~~	~~40~~	~~31~~	~~31~~	~~24~~	~~21~~	~~11~~	~~3~~	~~2~~
~~Q,Pex~~	~~35~~	~~27~~	~~24~~	~~16~~	~~13~~	~~7~~	~~3~~	~~2~~

T: antiviral Treatment
P: home antiviral Prophylaxis
Pex: Extended antiviral Prophylaxis
Q: home Quarantine

ASsd: Adult & Senior social distancing
CTsd: Child & Teen social distancing
S: School closure

Antiviral Coverage Requirements (percent coverage of population [# courses/10000]

Infected attack rate < 10% Infected attack rate < 25%

Case based

	None	ASsd	CTsd	CTsd ASsd	S	S ASsd	S CTsd	S CTsd ASsd
None	0	0	0	0	0	0	0	0
T	24	18	21	16	18	14	2	1
Q	0	0	0	0	0	0	0	0
P	54	43	45	36	36	23	3	2
Q,T	19	15	16	13	12	8	1	1
Q,P	49	39	38	30	27	15	3	2
Pex	149	128	142	117	106	61	13	9
Q,Pex	144	122	118	86	68	38	13	10

T: antiviral Treatment
P: home antiviral Prophylaxis
Pex: Extended antiviral Prophylaxis
Q: home Quarantine

ASsd: Adult & Senior social distancing
CTsd: Child & Teen social distancing
S: School closure

Adult Days at Home

Adults stay home when sick, tending sick or sent home from school children

Infected attack rate < 10 % | Infected attack rate < 25 % | ● ≤ 25 % Antiviral coverage

Case based

	None	ASsd	CTsd	CTsd ASsd	S	S ASsd	S CTsd	S CTsd ASsd
None	3	3	3	2	15	16	● 25	● 14
T	3	2	3	2	18	18	● 14	● 8
Q	6	5	5	4	20	21	● 19	● 12.3
P	2	2	2	1	20	● 21	● 9	● 6
Q,T	6	5	5	4	24	● 23	● 10	● 8
Q,P	5	4	4	3	24	● 21	● 9	● 7
Pex	1	1	1	1	25	20	● 8	● 6
Q,Pex	3	3	2	2	21	15	● 8	● 6

T: antiviral Treatment
P: home antiviral Prophylaxis
Pex: Extended antiviral Prophylaxis
Q: home Quarantine

ASsd: Adult & Senior social distancing
CTsd: Child & Teen social distancing
S: School closure

Adult Days at Home

Adults stay home when sick, tending sick or sent home from school children

Infected attack rate < 10 % | Infected attack rate < 25 % | ● ≤ 25 % Antiviral coverage

Case based	None	ASsd	CTsd	CTsd ASsd	S	S ASsd	S CTsd	S CTsd ASsd
None	3	3	3	2	15	16	● 25	● 14
T	3	2	3	2	18	18	● 14	● 8
Q	6	5	5	4	20	21	● 19	● 12.3
P	2	2	2	1	20	● 21	● 9	● 6
Q,T	6	5	5	4	24	● 23	● 10	● 8
Q,P	5	4	4	3	24	● 21	● 9	● 7
Pex	1	1	1	1	25	20	● 8	● 6
Q,Pex	3	3	2	2	21	15	● 8	● 6

T: antiviral Treatment
P: home antiviral Prophylaxis
Pex: Extended antiviral Prophylaxis
Q: home Quarantine

ASsd: Adult & Senior social distancing
CTsd: Child & Teen social distancing
S: School closure

Adult Days at Home

Adults stay home when sick, tending sick or sent home from school children

Infected attack rate < 10 % | Infected attack rate < 25 % | ● ≤ 25 % Antiviral coverage

Case based

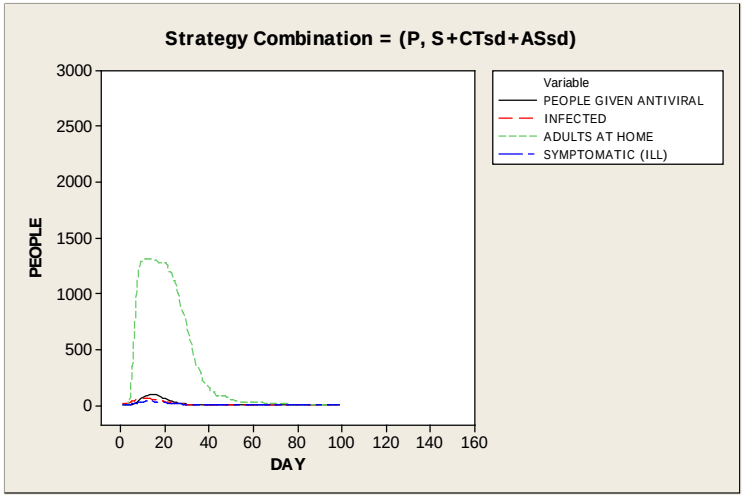
	None	ASsd	CTsd	CTsd ASsd	S	S ASsd	S CTsd	S CTsd ASsd
None	3	3	3	2	15	16	● 25	● 14
T	3	2	3	2	18	18	● 14	● 8
Q	6	5	5	4	20	21	● 19	● 12.3
P	2	2	2	1	20	● 21	● 9	● 6
Q,T	6	5	5	4	24	● 23	● 10	● 8
Q,P	5	4	4	3	24	● 21	● 9	● 7
Pex	1	1	1	1	25	20	● 8	● 6
Q,Pex	3	3	2	2	21	15	● 8	● 6

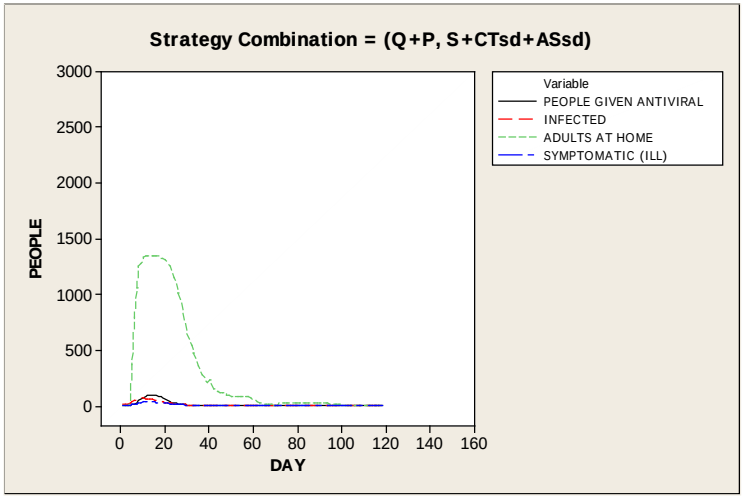
T: antiviral Treatment
P: home antiviral Prophylaxis
Pex: Extended antiviral Prophylaxis
Q: home Quarantine

ASsd: Adult & Senior social distancing
CTsd: Child & Teen social distancing
S: School closure

‘Best Strategy’ for a 1918-Like Pandemic

- Treatment of ill, prophylaxis of household members, Child/Teen social distancing & Adult social distancing
- Minimizes illness (2% infected), average adult days at home (6 days), requires low population coverage of antivirals (2%).
- Differs from US Community Mitigation Guidance by need for household member quarantine.





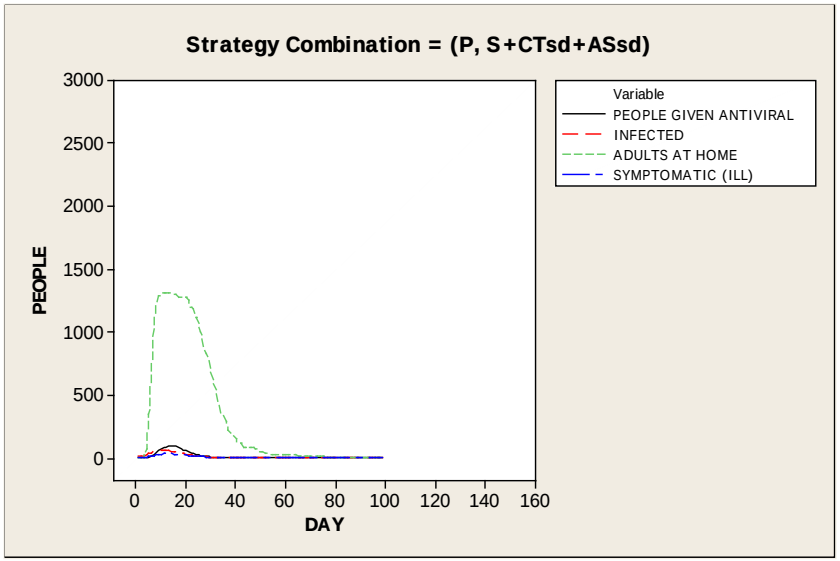
Sensitivities of 'Best Strategy' for a 1918-Like Pandemic

Perturbations	▪ **Delay of implementation to 30 or 100 cases** ▪ **Rescinding of strategies at 3 cases/7 days; if epidemic recurs [with 10 cases], strategies are re-implemented**
Extensions	▪ **Longini-like disease manifestation** ▪ **Longini-like disease manifestation with extended infectious recovery period** ▪ **Similar transmission within children, teenagers and adult** ▪ **Augmented contact network** ▪ **Availability of pre-pandemic vaccine: 1) randomly, 2) targeted to children and teens, or 3) targeted to adults**

- Across all perturbations and extensions, our finding of a best strategy did not change.
- Some perturbations erode efficacy more than others and demonstrate critical enablers of effective mitigation

Sensitivities of 'Best Strategy' for a 1918-Like Pandemic

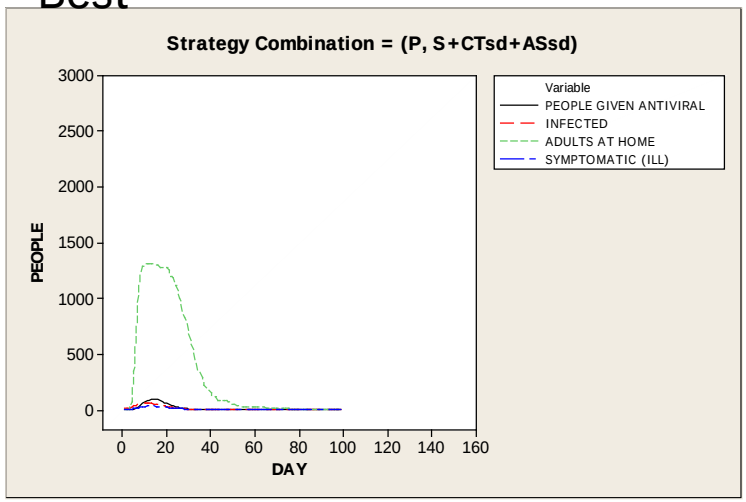
- Results of examination of sensitivities are ordered relative to descending influence on
  1. The percent population infected
  2. Other measures if percent population infected were the same.



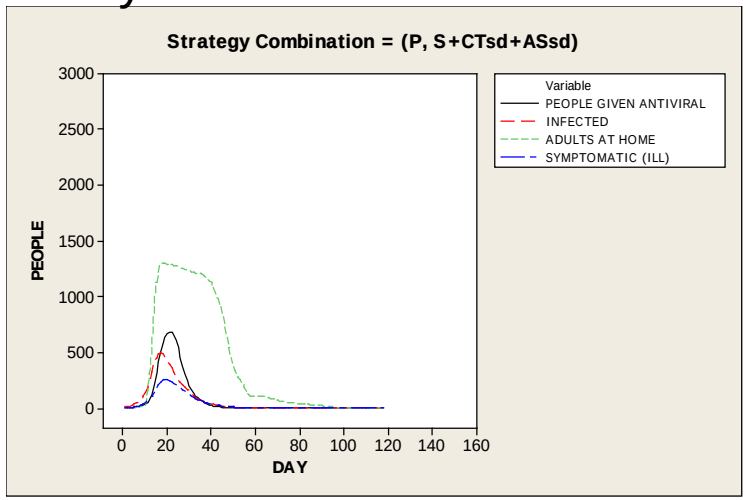
Sensitivities of 'Best Strategy' for a 1918-Like Pandemic

- Strategy Implementation Threshold
  - Delaying implementation until 100 cases are diagnosed increases
    - Infection rate to 13% (from 2%)
    - Adult days at home to 12 (from 6)
    - Antiviral coverage to 11% (from 2%)

Best



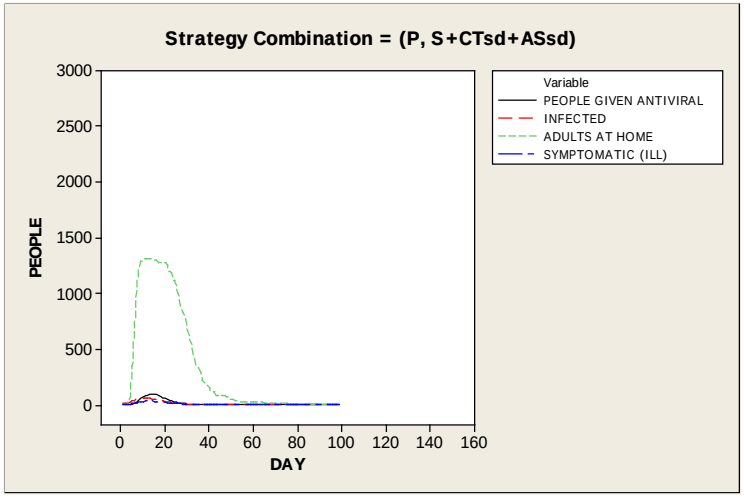
Delay – 100 cases



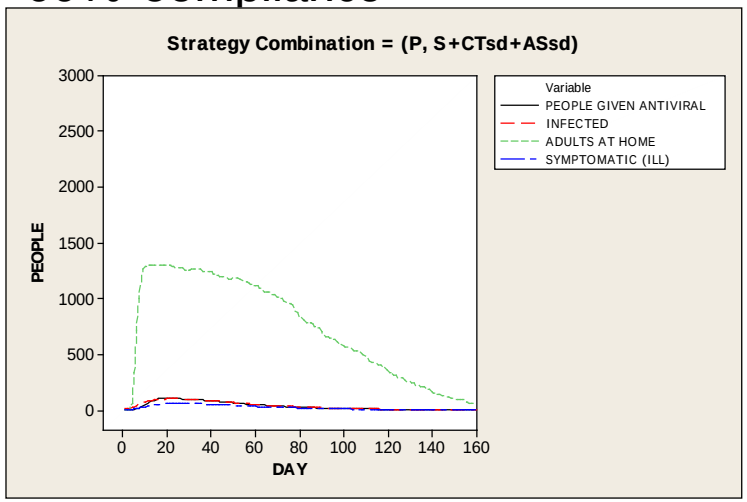
Sensitivities of 'Best Strategy' for a 1918-Like Pandemic

- Compliance
  - Decreasing compliance with strategies from 90% to 60% increases
    - Infection rate to 10% (from 2%)
    - Adult days at home to 21 (from 6)
    - Antiviral coverage to 7% (from 2%)

Best



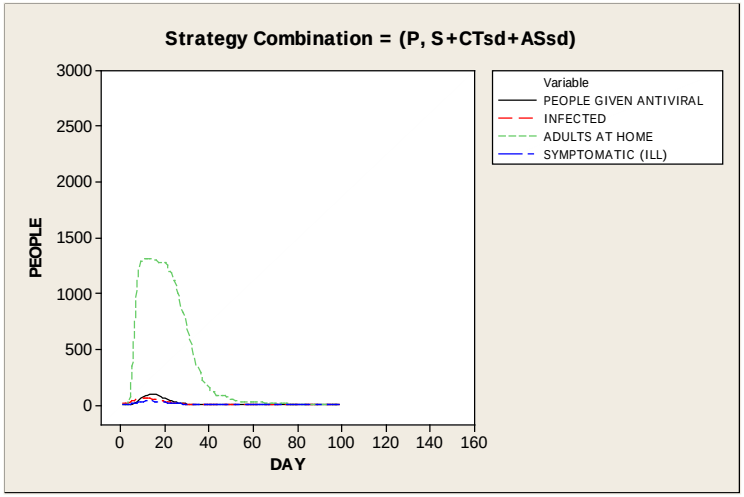
60% Compliance



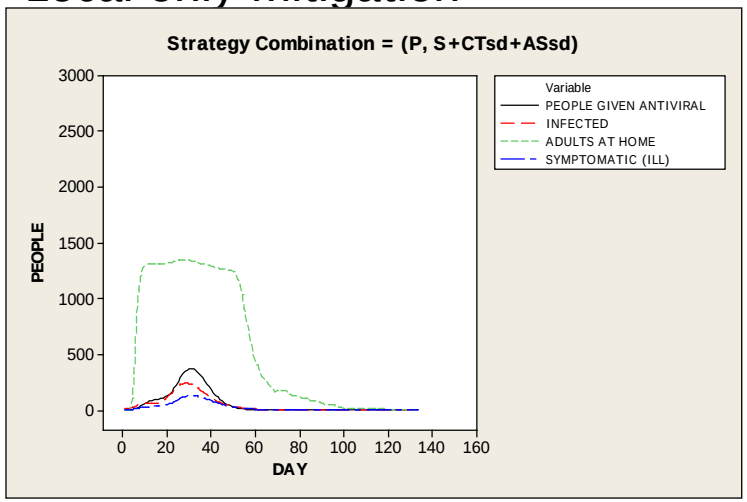
Sensitivities of 'Best Strategy' for a 1918-Like Pandemic

- Local-Only Mitigation
  - Where communities are embedded in regions doing nothing to mitigate the epidemic, measures increase:
    - Infection rate to 9% (from 2%)
    - Adult days at home to 12 (from 6)
    - Antiviral coverage to 9% (from 2%)

Best



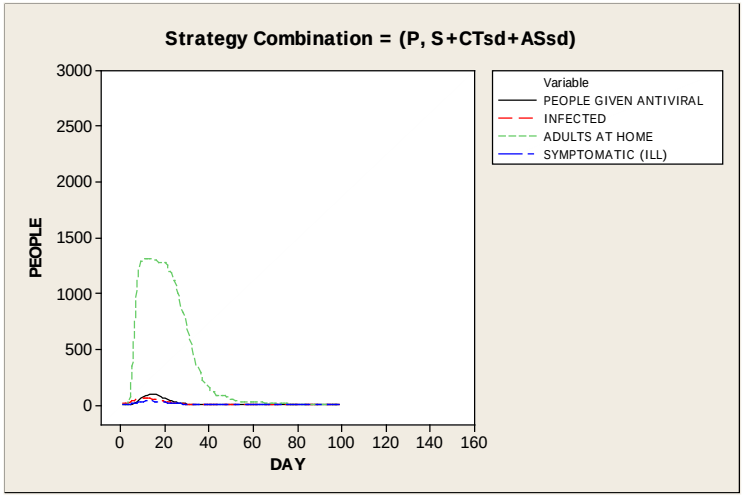
Local only mitigation



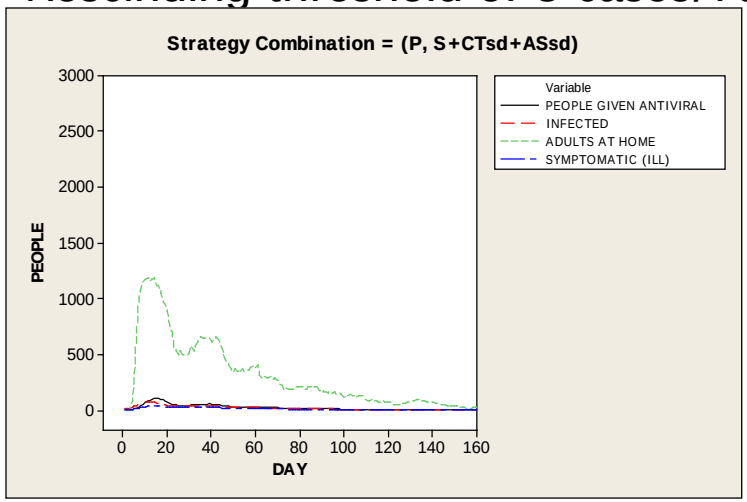
Sensitivities of 'Best Strategy' for a 1918-Like Pandemic

- Rescinding Threshold
  - Relaxing a rescinding threshold from 0 cases/ 7 days to 3 cases/ 7 days increases:
    - Infection rate to 5% (from 2%)
    - Adult days at home to 9 (from 6)
    - Antiviral coverage to 5% (from 2%)
    - Epidemic duration to 55 days (from 20)
    - Average # of mitigation cycles to 3 from 1

Best



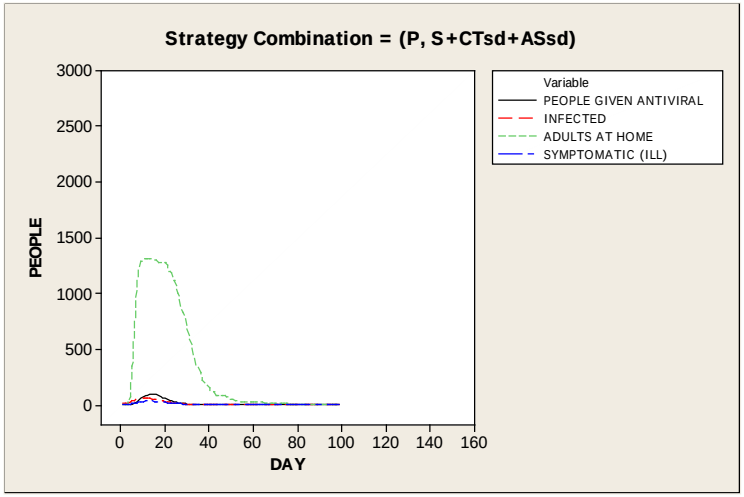
Rescinding threshold of 3 cases/7d



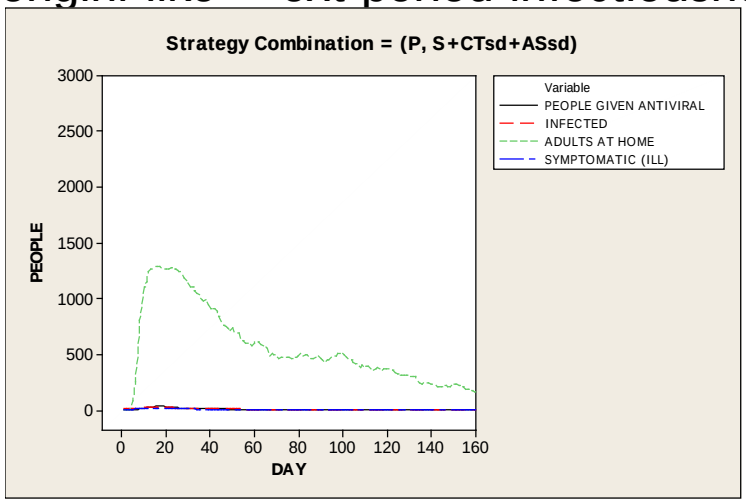
Sensitivities of 'Best Strategy' for a 1918-Like Pandemic

- Longini-like w/ extended infectious recovery period increases
  - Infection rate to 3% (from 2%)
  - Adult days at home to 24 (from 6)
  - Antiviral coverage to 3% (from 2%)
  - Epidemic duration to 117 days (from 20)

Best



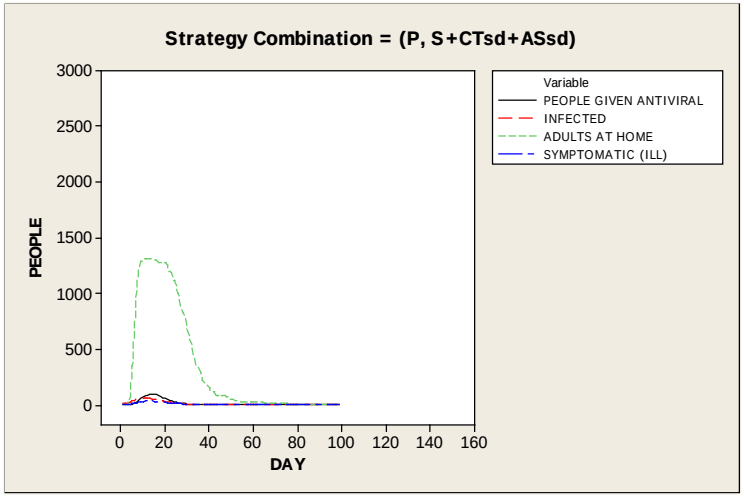
Longini-like + ext period infectiousness



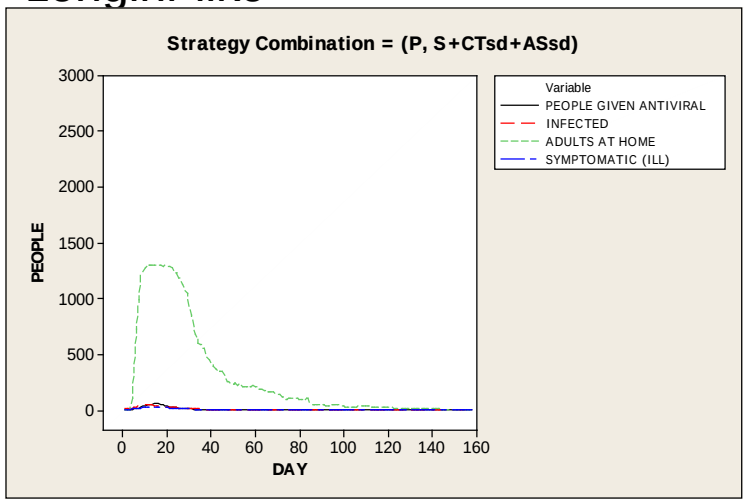
Sensitivities of 'Best Strategy' for a 1918-Like Pandemic

- Longini-like illness manifestation results in
  - Unchanged infection rate to (both 2%)
  - Adult days at home to 10 (from 6)
  - Antiviral coverage to 3% (from 2%)

Best



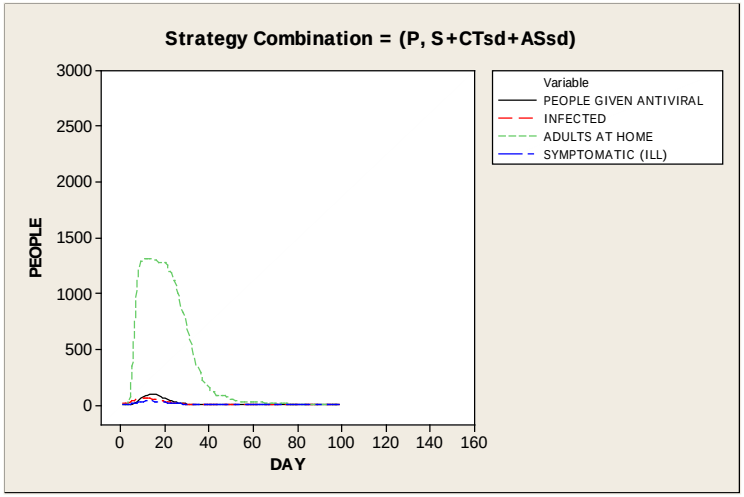
Longini-like



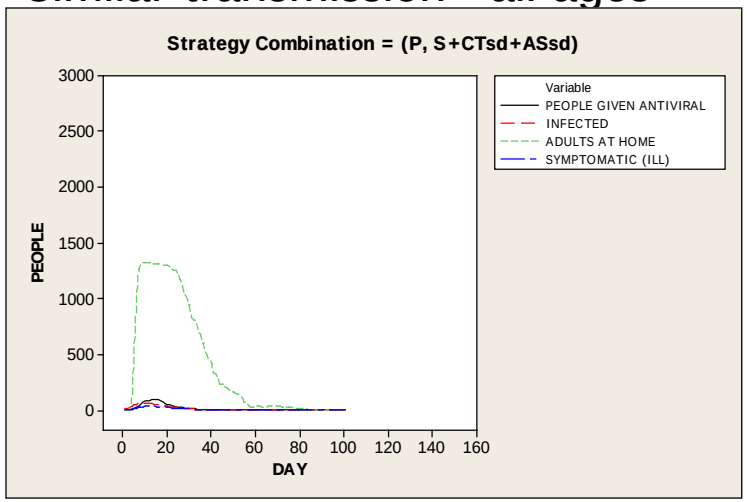
Sensitivities of 'Best Strategy' for a 1918-Like Pandemic

- Similar transmission for all age classes results in:
  - Unchanged infection rate (both 2%)
  - Adult days at home to 7 (from 6)
  - Unchanged antiviral coverage (both 2%)
  - Epidemic duration to 27 days (from 20)

Best



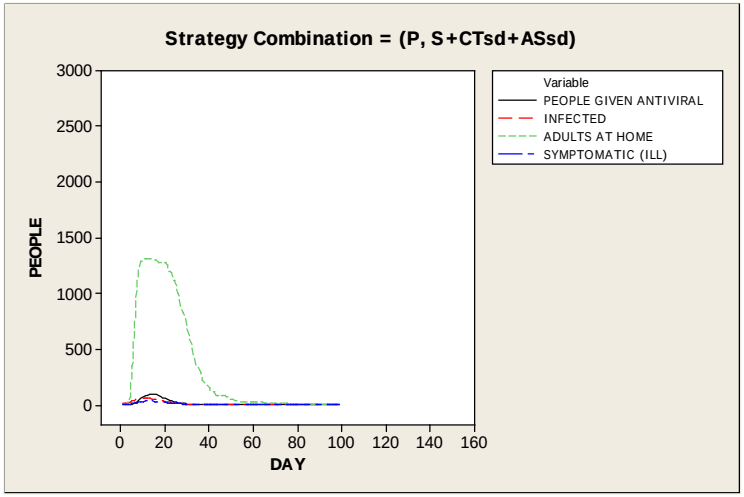
Similar transmission—all ages



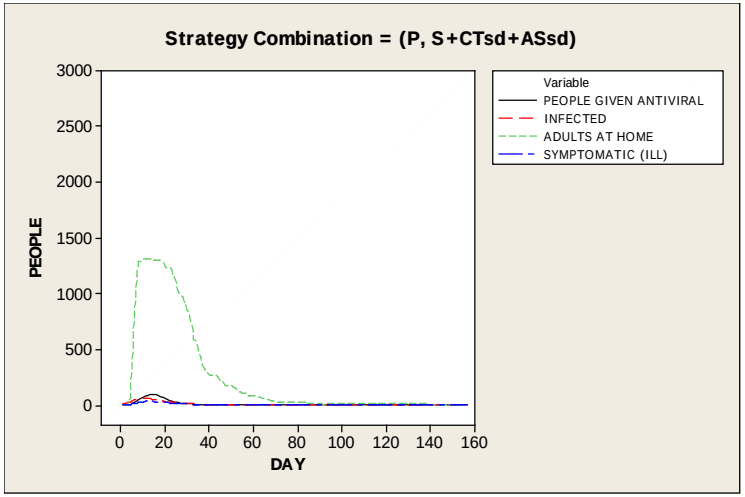
Sensitivities of 'Best Strategy' for a 1918-Like Pandemic

- Augmented social network for children and teenagers
  - Adds additional contact groups and results in
    - Unchanged infection rate (both 2%)
    - Adult days at home to 7 (from 6)
    - Unchanged antiviral coverage (both 2%)
    - Epidemic duration to 26 days (from 20)

Best



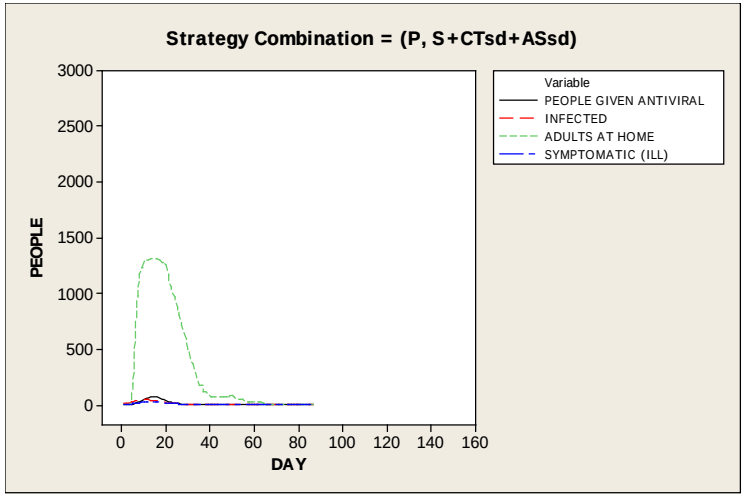
Augmented child and teen network



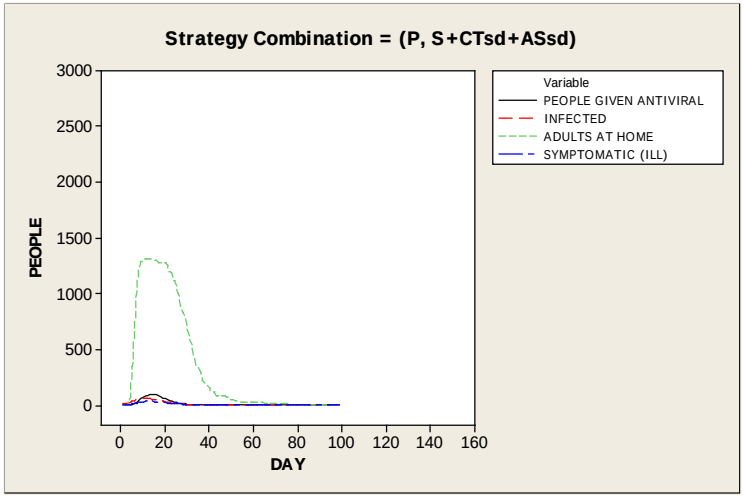
Sensitivities of 'Best Strategy' for a 1918-Like Pandemic

- Pre-pandemic Vaccine (50% effective at prevention of transmission; available for 7% of population)
  - Given to children and teenagers (24% coverage; 700 doses among 2900 children)
    - If no other mitigation strategies in place decreases infection rate in population from 71% to 64%
    - With the best mitigation strategies implemented, has no effect on infection rates, antiviral usage, or adult days at home

Best



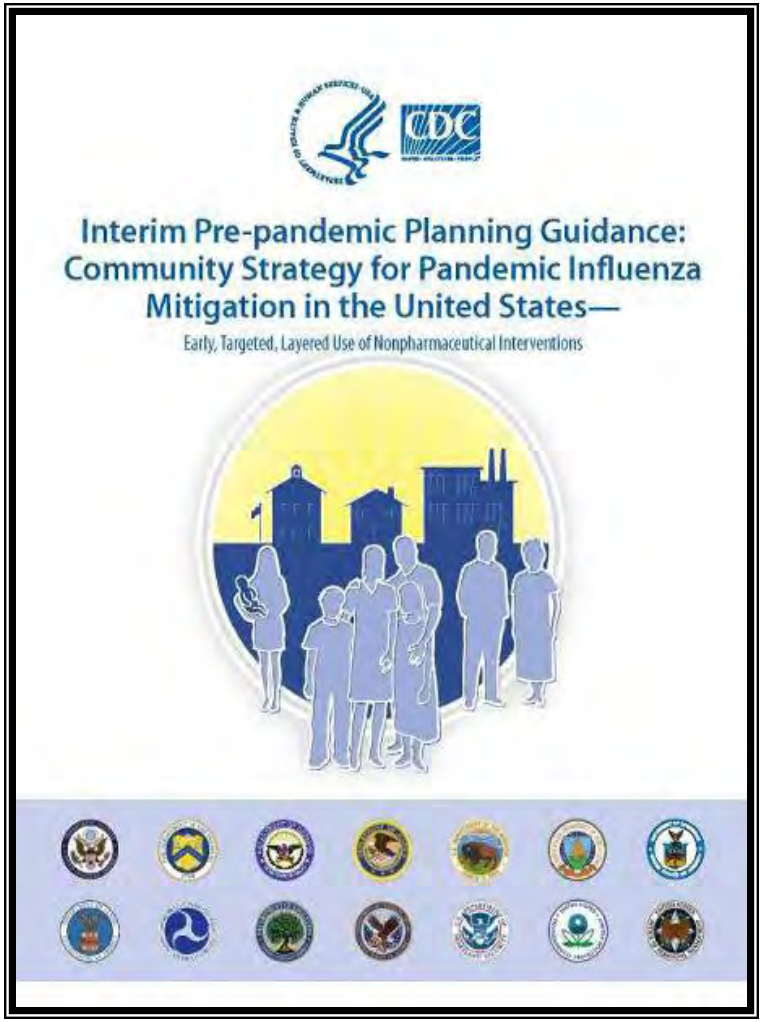
Pre-pandemic vaccine to children and teens



Summary Points & Policy Implications

- **Our study supports the US community mitigation guidance,** except for the need for household quarantine if antivirals are available and effective at treatment and transmission prevention

  Policy Implication: US Community mitigation guidance should be widely publicized and used for education and training



www.pandemicflu.gov

Summary Points & Policy Implications

Social distancing (network-based) mitigation strategies form the foundation of effective community containment

- Alone, they may contain a pandemic
- In combination with case based strategies (all of which are less effective alone) lost work days can be decreased
- But strategies must be implemented **quickly** and with **high compliance**

Policy Implication: Planning, education, and training should be designed for the effective implementation of social distancing measures ***first*** and case based strategies ***second***.

VA Photo: North Dallas VAMC Flu Shot Clinic, 2006

Summary Points & Policy Implications

- **Pre-pandemic vaccination** at current levels (7% coverage and 50% efficacy) did not significantly influence transmission in this stylized community

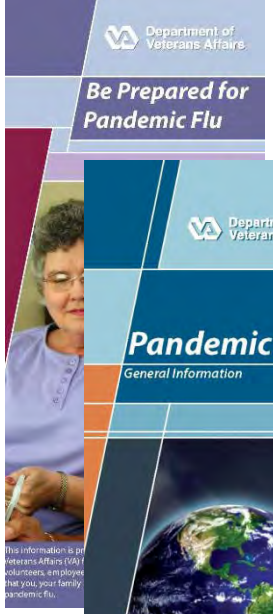
  Policy Implication: Pre-pandemic vaccine at low levels should be used to keep critical workers on the job.

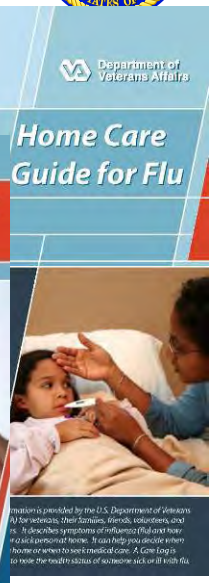
Summary Points & Policy Implications

- **Influx from neighboring communities** not applying similar mitigation strategies reduces effectiveness of community containment strategies and increases the time strategies must be applied.

  Policy Implication: Uniform national or regional policy could reduce epidemic effects for all.

http://images.google.com/imgres?imgurl=http://www.sleepwalking.org.uk/commuters





www.publichealth.va.gov/flu/pandemicflu.htm

www.publichealth.va.gov/infectiondontpassiton

www.pandemicflu.gov/