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Modelling for containment at the source

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Powering research
to prevent epidemics

Containing Pandemic Influenza at the Source

It is optimal to stop or at least slow down a potential pandemic influenza strain at the source if possible

Ferguson, *et al*. Strategies for containing an emerging influenza pandemic in Southeast Asia. *Nature* **437**, 209-14 (2005). https://www.nature.com/articles/nature04017

Longini, *et al.* Containing pandemic influenza at the source. *Science* **309**, 1083-7 (2005). https://www.science.org/doi/abs/10.1126/science.1115717

Resources needed

- Targeted antiviral prophylaxis with mobile stockpile of antiviral agents
- Non pharmaceutical measures: Quarantine, social distancing, school closing, travel restrictions
- Pre or rapid vaccination with a possibly poorly matched vaccine

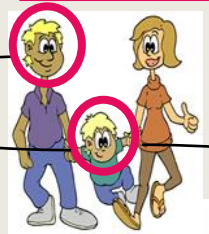
TAP: Targeted antiviral prophylaxis

Treat casesand give exposed a single course

CONTACTS
Household
Household cluster
Preschool/daycare
School
Workplace

xx% ascertainment

xx% school



xx% household + HH cluster

xx% workplace

xx% preschool

Efficacy of oseltamivir: AVE_{SD} = 0.86, AVE_{I} = 0.62

Basic Reproductive Number: R_0

- $R_0 > 1$ for sustained transmission
- For pandemic influenza: $1 < R_0 \leq 2$
  4. A(H1N1) 2009, $R_0 \approx 1.5$
  3. A(H3N2) 1968-69, $R_0 \approx 1.7$
  2. A(H2N2) 1957-58, $R_0 \approx 1.8$
  1. A(H1N1) 1918, second wave, $R_0 \approx 2.0$
- New variant, early spread: $1 < R_0 \leq 1.6$

The four key elements of our model

- Disease natural history model and parameters
- Community-level transmission between people, through various contact groups (household, work group, school, ….)
- Census demographics (where people live) and worker flow data (where they work), at tract-level resolution
- Transportation statistics on long-distance travel

Goal of Modeling (Longini, et al. 2005)

- Contain a reassorted or mutated strain of influenza at the source
- Avian A(H5N1) is the most likely virus
- Source could be in SE Asia

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Rural population of 500,000 in Thailand

Population matched to non-municipal area household-size and age distributions.*

*Population and Housing Census 2000 data used where available (www.nso.go.th); other National Statistical Office reports and tables used as necessary.

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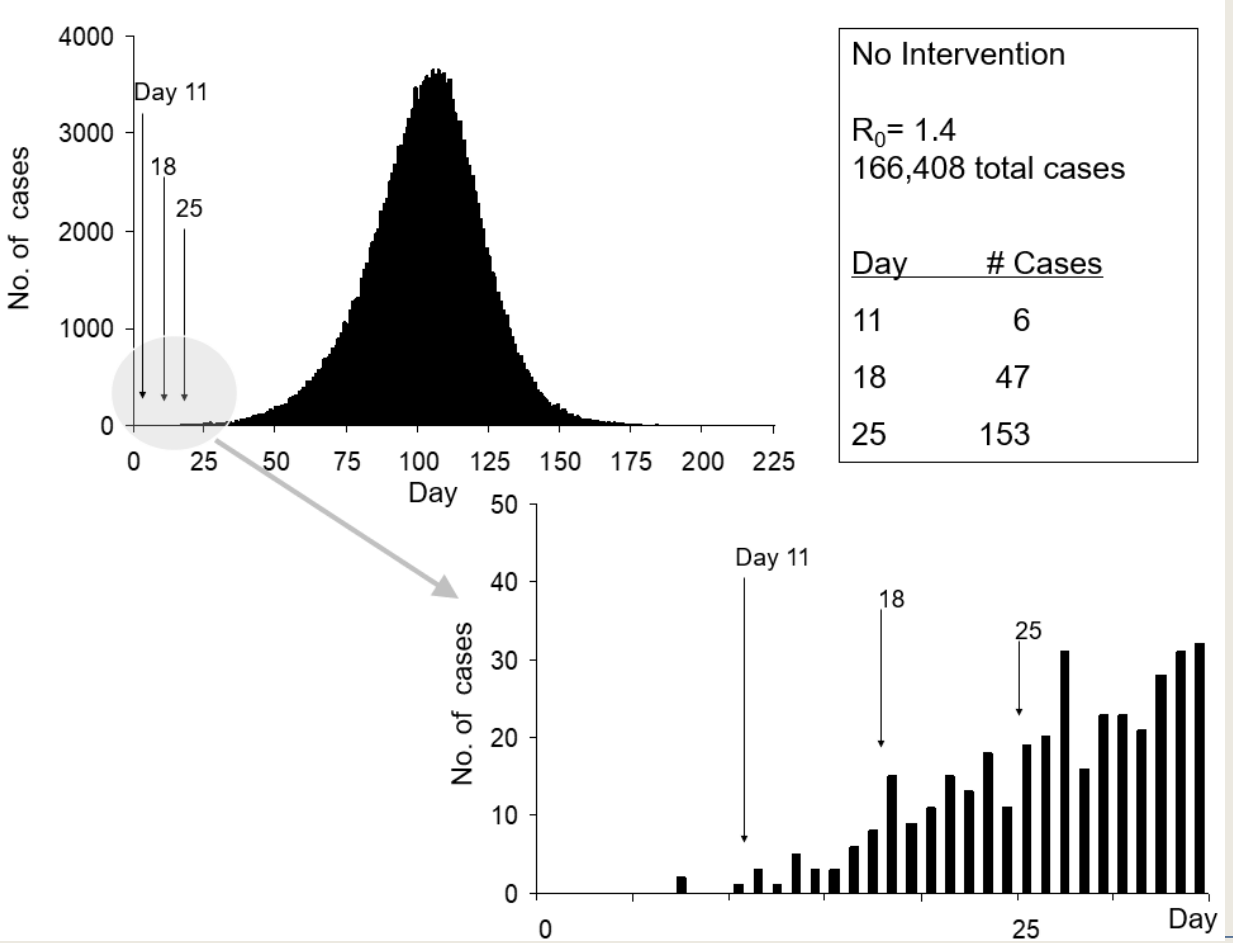
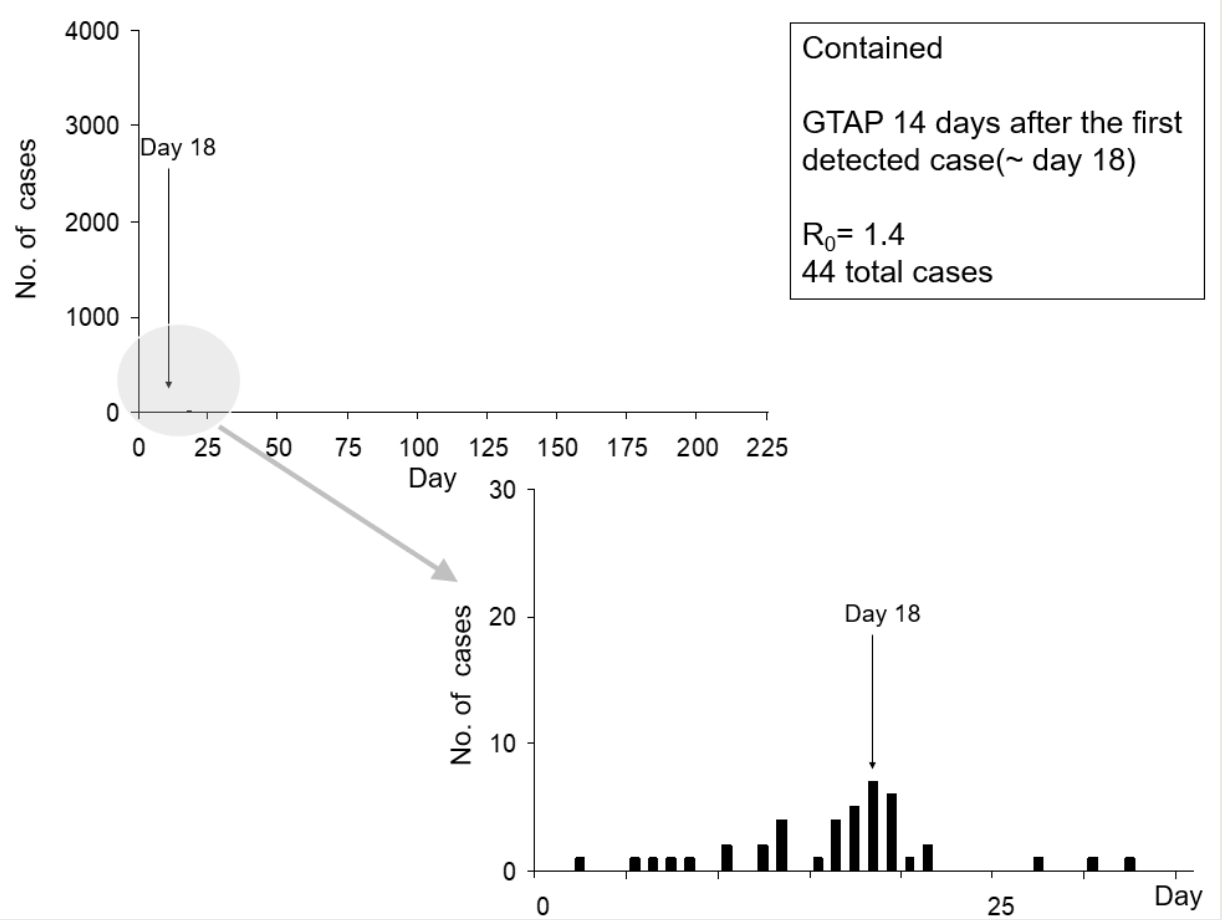
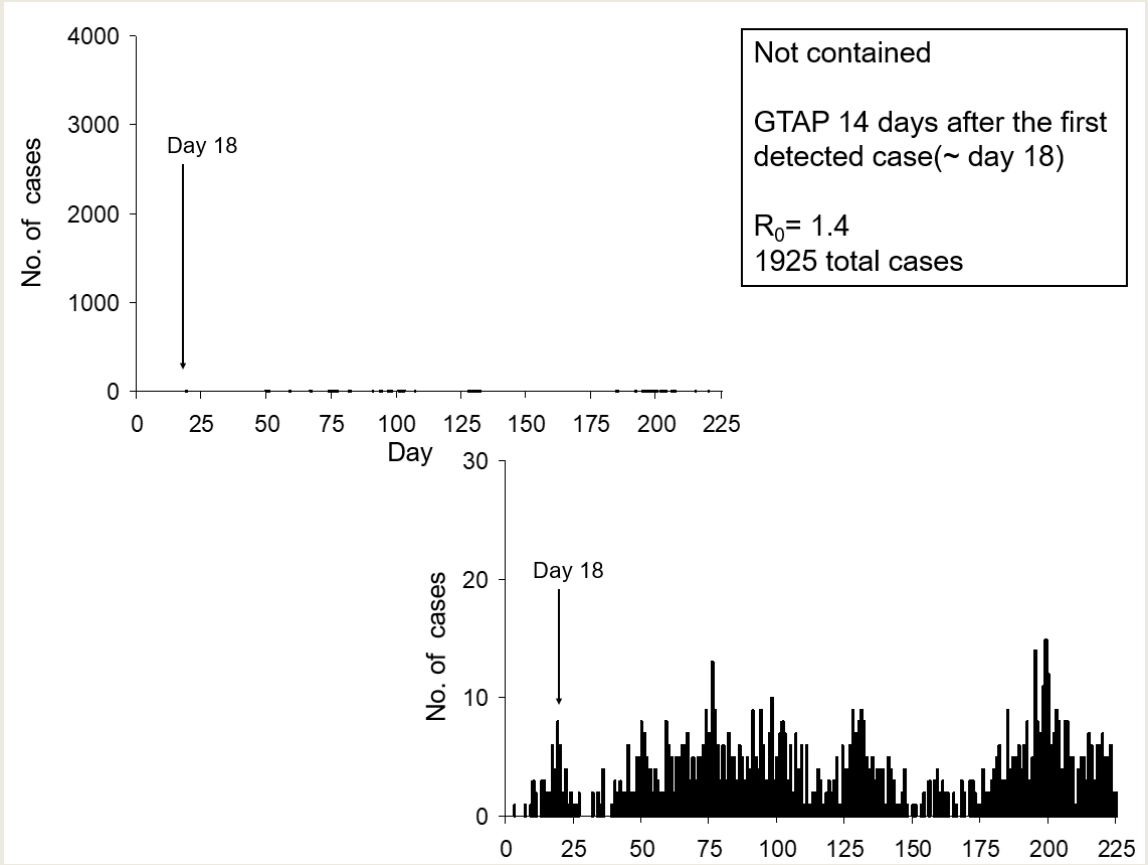
Interventions considered

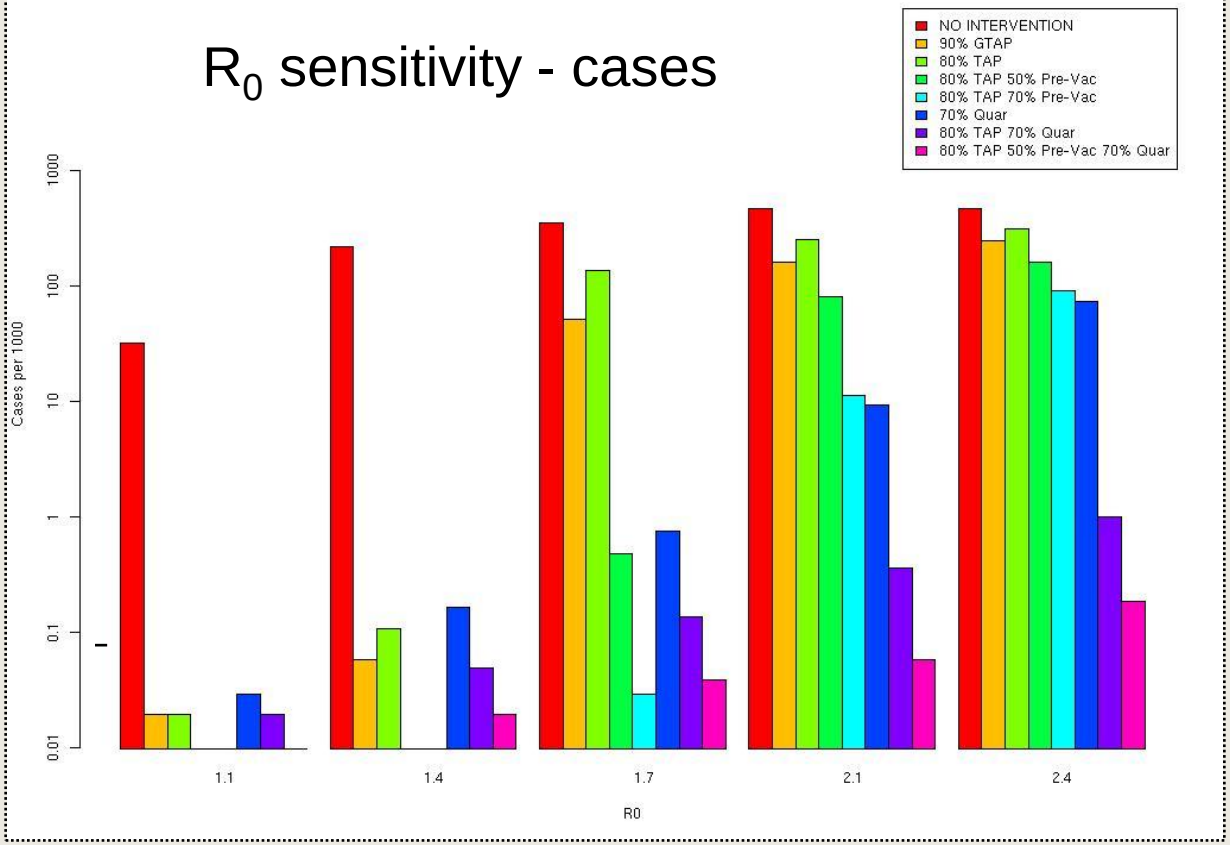
- All interventions carried out in the localities as triggered
- 80% targeted antiviral prophylaxis (TAP)
- 90% geographically targeted antiviral prophylaxis (GTAP)
- Localized household and household cluster quarantine. Lifted when there are no more local cases.


No Intervention
R_0= 1.4
166,408 total cases
Day # Cases
11 6
18 47
25 153
No. of cases
Day
Day 11
18
25
4000
3000
2000
1000
0
0 25 50 75 100 125 150 175 200 225
50
40
30
20
10
0
25


Contained
GTAP 14 days after the first detected case(~ day 18)
R_0= 1.4
44 total cases
No. of cases
Day 18
Day
No. of cases
Day 18
Day


Not contained
GTAP 14 days after the first detected case(~ day 18)
R_0= 1.4
1925 total cases
No. of cases
Day 18
Day
No. of cases
Day 18

R_0 sensitivity - cases



Policy Implications

- A mobile stockpile of antivirals should be created and deployed quickly after the initial infection cluster is detected.

  Five million course stockpile should be sufficient.

- The outbreak is containable with TAP if transmissibility is reasonably low ($R_0 \leq 1.4$) and intervention occurs with 21 days of first detected case.
- Localized quarantine and other social distancing measures would be important for containment for viruses with higher transmissibility ($R_0 \geq 1.7$)
- Prevaccination of the population with a low efficacy vaccine makes a big difference, even at the 50% coverage level

Policy Implications Continued

The development and deployment of vaccine for potential pandemic strains for at-risk populations should move forward as quickly as possible.

Surveillance and detection of early pandemic influenza transmission is extremely important in all potentially at-risk regions of the world.

More modeling needs to done in a variety of at-risk populations and under different scenarios.

Thank you