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Estimating the transmissibility and severity of pandemic influenza

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Background

- Estimating the transmissibility and severity of pandemic H1N1 was a priority in the early stages of the epidemic.
- Estimates of transmissibility may aid decisions about the potential impact of control measures, and also the effectiveness of those measures already implemented.
- Estimates of severity may aid decisions about ‘how hard’ to try to control transmission.
- But there are difficulties in obtaining these estimates . . .

First wave in Hong Kong

- Kindergarten and primary schools closed June 12 - early July.
- Summer holidays for all schools from early July onwards.
- 43 secondary schools closed after 1+ case confirmed.

Acknowledgments

- Collaborators in Hong Kong: Joe Wu, Steven Riley, Gabriel Leung, Eric Lau, Malik Peiris
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Modelling the impact of closures/vacations

- We used an age-structured S-I-R model to account for the non-linear transmission dynamics underlying the rising phase of the first wave of H1N1.
- We accounted in our model for the likely change in case identification rate as epidemic progressed and the public health response changed.
- We quantified transmissibility via the reproductive number R.

Fitted model

- \( R \sim 1.7 \) before June 11
- \( R \sim 1.5 \) between June 12 and July 10
- \( R \sim 1.1 \) after July 10
- Predicted illness attack rate of 2.5% (180,000 cases) by the end of August.
Unknown proportion of population infected

- Objective – to track dynamically H1N1 transmissibility through the first wave.
- Problem – reporting delays lead to biases in estimates in recent days . . .

Methods – inferred infection networks

Figure: Wallinga and Teunis’ infection network extended by Cauchemez to include cases not yet observed (i.e. to permit real-time analysis).

Real-time $R_t$ in Hong Kong

Figure: Real-time $R_t$ by Cauchemez method (gray) and adjusting for reporting delays (black) using a data augmentation approach.
### Background

Problem 1: Changing fractions of cases notified

Problem 2: Reporting delays

Problem 3: Unknown denominators

### Discussion

**Serologic surveillance**

- JT Wu, BJ Cowling, JSM Peiris, Hong Kong Red Cross.
- Blood donors at 4 fixed centers across Hong Kong invited to provide sera for H1N1 antibody testing.
- ~750 specimens collected every week since June 12, 2009.
- Serum specimens also collected from children participating in a community study, and medical and pediatric outpatients.
Serologic surveillance

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- Blood donors at 4 fixed centers across Hong Kong invited to provide sera for H1N1 antibody testing.
- ~ 750 specimens collected every week since June 12, 2009.
- Serum specimens also collected from children participating in a community study, and medical and pediatric outpatients.
- We can track the attack rate through time by studying the changes in prevalence of individuals with antibody titers ≥ 1 : 40 (very low before first wave).
- Comparison with H1N1-associated admissions, deaths allows us to infer severity.

First wave attack rate and severity

**Figure:** Left: Estimated attack rate (blue). Right: Estimated severity.

- Pre-first-wave seroprevalence
- First wave attack rate
- Infection attack rate by paired-serology
- Post-first-wave seroprevalence
- Case-confirmation rate
- Case-hospitalization rate
- Case-ICU rate
- Case-fatality rate

Comments – impact of H1N1

- School closures and vacations were associated with substantial reductions in H1N1 transmissibility.
- Around 50% of school-age children infected in Hong Kong, but low attack rates in older adults.
- Severe illness much more common (per infection) with increasing age.

Implications for pandemic planning

- Routine laboratory testing of a defined subset of hospitalized cases for example all patients hospitalized with severe ARI in a subset of hospitals (Lipsitch et al. 2009 Lancet).
- Prospective cross-sectional serologic surveillance could allow timely information on transmissibility and severity, provided testing capacity exists.