Predicting Probabilities of Flu Vaccination and Commuting Methods Having Elevated Flu Transmission Probabilities in New York City

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OBJECTIVE

Agent-based models (ABMs) have been developed to simulate epidemics including smallpox (Longini et al.) and pandemic flu (Ferguson et al.). The ABM approach is an effective method to assess the potential impact of interventions on disease spread (Ferguson et al.). Integrating the ABM approach with syndromic surveillance data provides potential benefits such as permitting a realistic specification of some critical model contact parameters, and permitting synthetic outbreaks to be generated with extremely fine resolution (e.g., age, gender, and address). This would provide the ability to test various clustering detection algorithms – a key component of syndromic surveillance methods. RTI International (the Models of Infectious Disease Agent Study (MIDAS) informatics group) and NYC DOHMH (a premier syndromic surveillance research center) collaborated to create a NYC-ABM of flu transmission. This poster describes implementation of several features required for accurate model specification, including assigning immunization rates and subway ridership. Incorporating subway ridership is of great interest, because a large subway system, like the NYC system, has never been investigated as a contributor of disease spread.

BACKGROUND

Aerial transmission and direct contact are important factors for flu. Consequently, close contact with large groups of people, such as during mass transit, present opportunities for transmission. One protective method that decreases the probabilities of becoming ill is vaccination. The potential health impact of terminating subway service during a flu epidemic depends on both the potential for transmission and vaccination rates among riders. Mass transit, a major method of transit in NYC, exhibits a non-random distribution of riders based on demographics and socio-economic status. There is also a trend in vaccination rates by demography and socio-economic status. This analysis uses individual-based data on vaccination and ridership to separately predict vaccination and ridership for inclusion in agent-based models that can be used to assess impact of public health interventions.

METHODS

Using data from the 2006 NYC Community Health Survey (CHS), we fit a logistic model with the dichotomous dependent variable "received flu vaccine" and the categorical independent variables: United Hospital Fund neighborhood (based on ZIP codes), gender, education, race, income category, age group, marital status, and number of children in the household. To predict the probability of an individual's engaging in commuting with high transmission probability, we defined the dichotomous variable "mixing commute" as "1" if the subject commuted by subway, city bus, express bus or commuter train, and "0" if the subject did not commute or commuted by bicycle, walking, car, taxi or ferry. Then using data from the CHS, we fit a logistic model with the dichotomous dependent variable "mixing commute" and the same independent variables used above.

RESULTS

"Mixing commute" and vaccination rates differ considerably by geographic areas and socio-demographic characteristics. The logistic model for the "mixing commute" dependent variable had a significant result for testing the global model (p <0.0001). The goodness-of-fit test showed no evidence of a lack of fit (p=0.9351), and the max-rescaled R-square is 0.20. The logistic model for the dependent variable "received flu vaccine" had a significant result for testing the global model (p <0.0001). The goodness-of-fit test failed to produce evidence of a lack of fit (p= 0.4132), and the max-rescaled R-square is 0.17. Among other results, the analyses showed that only 20% of subjects with a "mixing commute" are vaccinated but 29% without a "mixing commute" are vaccinated.

CONCLUSIONS

We successfully predicted if NYC residents received flu vaccination and if they engaged in commuting behaviors with a relatively high probability of transmitting flu virus given neighborhood of residence and socio-economic characteristics. Both depend on socio-demographic and socio-economic factors. We will use this capability for the much larger endeavor of creating an agent based model for disease transmission in NYC.

REFERENCES

Longini IM, Halloran ME, Nizam A, et al. (2007). "Containing a large bioterrorist smallpox attack: a computer simulation approach." *International Journal of Infectious Diseases* 11: 98-108.

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