EARLY REPORTING OF PANDEMIC FLU AND THE CHALLENGE OF GLOBAL SURVEILLANCE: A LESSON FOR SOUTHEAST ASIA

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Abstract. An important issue at the start of the H1N1/2009 pandemic is global reporting of pandemic cases. Reports during the first few weeks of the pandemic showed spread of the disease from Mexico to many countries, but few cases were reported from low and middle income countries. Analysis of the data of international passengers departing from Mexican airports early in the H1N1/2009 outbreak shows a strong association between the number of passengers and reports of confirmed cases. In developing countries first case detection was slower and the chance of reporting the influenza cases after controlling for air traveller intensity was significantly lower. Delays in detection and reporting can jeopardize the success of a global response to a pandemic. A number of implications can be drawn from this, including the need to strengthen health system surveillance capacities in developing countries in Southeast Asia and globally for a better regional and global response.

Keywords: human influenza, pandemics, health system, surveillance, global health

INTRODUCTION

On 24 April 2009, the World Health Organization (WHO) first announced a new strain of influenza A (H1N1) virus detected in Mexico and the United States (WHO, 2009a). By 30 April, the number of countries affected had expanded to 11 countries with 257 reported cases, the countries were: the USA (109), Mexico (97), Austria (1), Canada (19), Germany (3), Israel (2), the Netherlands (1), New Zealand (3), Spain (13), Switzerland (1) and the United Kingdom (8) (WHO, 2009b). None of these countries other than Mexico, the epicenter of the outbreak, had low or middle income economies.

An epidemiological study of the H1N1/2009 influenza outbreak determined it probably started in Mexico in mid-January (Fraser *et al*, 2009), but did not come to international attention until it had spread to a second country, the United States. It is likely, given patterns of international travel from Mexico, a number of cases had travelled to other countries beyond the US during this period (Fraser *et al*, 2009).

Travellers fly from Mexico to low, middle and high income countries. Given

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the strong correlation between international airline passenger travel and the frequency of reports of confirmed cases in 11 high-income countries, the lack of cases reported from developing countries early in the outbreak of the H1N1/2009 pandemic is surprising (Khan *et al*, 2009). We investigated whether the reason for the lack of reports from low and middle income countries was due to low frequency of travel or failure to detect cases.

MATERIALS AND METHODS

We obtained the numbers of regular and charter flights, numbers of passengers on these flights and destination countries of all flights departing from all Mexico airports (Mexican Secretaria de Comunicaciones Y Transportes, 2009). We focused on the period from 1 January to 31 March 2009 where data were available because this was early in the outbreak when it was spreading largely unrecognized within Mexico. We compared the numbers of departing passengers and their destinations with numbers and countries where cases of H1N1/2009 influenza were reported to the World Health Organization (WHO, 2009a). Four dates (30 April, 5 May, 10 May, 15 May, 2009) were chosen to evaluate case reporting.

We also evaluated the role of surveillance in detecting H1N1/2009 influenza cases. We obtained data regarding each country's health spending per capita (in US Dollars) in 2006 to use as a proxy of its health system resource (and surveillance capacity). We then analyzed the significance of the surveillance capacity for detecting H1N1 cases and the number of cases reported using multiple regression analysis. A logistic model of binary outcomes (reporting a case or not) was used to analyze case reporting and a linear regression model was used to analyze the number of cases reported. Both models included two parameters: travel intensity and surveillance capacity.

RESULTS

Table 1 shows the countries with direct flights from Mexican airports from 1 January to 31 March 2009. During that period, there were 38,684 flights carrying over 3.8 million passengers to 31 destination countries. The United States accounted for over 70% of all flights and nearly 70% of total passengers. Canada received the second highest number of passengers and flights from Mexico. There were 17 other destination countries whose average number of travellers from Mexico was more than 100 per day.

The time to first case detection in these 31 destination countries varied. The first case reports in many Central and South American developing countries were several days to weeks later after other countries receiving similar numbers of passengers. These Latin American countries tended to have fewer health system resources, and likely poorer surveillance capacity, as evidenced by the relatively lower health care spending per capita (in 2006).

Logistic regression analysis of data from 201 countries where data were available showed a significantly positive relationship between the number of travellers from Mexico to a country and its chance of reporting an H1N1 influenza case ($p \leq 0.01$). As shown in Table 2, the coefficient of total air traveller is positive, which means the chance of reporting a first case increases with air travel intensity. The level of health resources for a country was also significantly associated with reporting a first case of H1N1 ($p \leq 0.01$). With

Table 1
International air travel from Mexico, reports of H1N1 cases at various dates, and health spending per capita of 31 countries with regular or charter flights from Mexico during 1 January - 31 March, 2009.

	Country	Number of passengers	Number of flights	Presence of H1N1 cases				Health spending per capita
				30 Apr	5 May	10 May	15 May	
1	United States	2,634,684	29,363	Y	Y	Y	Y	6,719
2	Canada	625,223	3,995	Y	Y	Y	Y	3,917
3	Spain	82,308	723	Y	Y	Y	Y	2,328
4	France	69,962	388	N	Y	Y	Y	3,937
5	United Kingdom	52,418	215	Y	Y	Y	Y	3,332
6	**Panama**	49,079	515	N	N	Y	Y	380
7	**Cuba**	37,784	638	N	N	N	Y	362
8	Netherlands	36,473	207	Y	Y	Y	Y	3,872
9	Germany	35,532	123	Y	Y	Y	Y	3,718
10	**Guatemala**	30,790	421	N	N	Y	Y	157
11	Italy	28,554	147	N	Y	Y	Y	2,813
12	Costa Rica	27,627	248	N	Y	Y	Y	402
13	**Chile**	23,241	177	N	N	N	N	473
14	**Argentina**	22,862	196	N	N	Y	Y	551
15	Colombia	22,483	311	N	Y	Y	Y	217
16	**Brazil**	18,966	165	N	N	Y	Y	427
17	**Peru**	16,666	154	N	N	N	N	149
18	El Salvador	14,395	180	N	Y	Y	Y	181
19	**Venezuela**	10,691	140	N	N	N	N	332
20	Japan	7,758	77	N	N	Y	Y	2,759
21	Belgium	5,568	29	N	N	N	Y	3,726
22	China	3,215	48	N	Y	Y	Y	94
23	Finland	2,512	12	N	N	N	Y	3,232
24	**Honduras**	2,365	78	N	N	N	N	99
25	Sweden	1,950	6	N	N	Y	Y	3,973
26	Switzerland	1,911	13	Y	Y	Y	Y	5,660
27	Portugal	1,638	8	N	Y	Y	Y	1,864
28	Belize	1,257	12	N	N	N	N	205
29	Nicaragua	944	30	N	N	N	N	92
30	Luxembourg	0	44	N	N	N	N	6,506
31	Ecuador	0	21	N	N	N	N	166
Total		3,868,856	38,684					

The scale of the difference for each indicator is shown in a color gradient from green to red, with dark green as the highest value and dark red as the lowest value.

Table 2
Estimates from logistic regression analysis of H1N1 case reports.

Case detection	30 April 2009
Total air passengers leaving Mexican airports during Jan-Mar 2009	0.000057
	(2.93)[a]
Health expenditure per capita (current USD) 2006	0.000723
	(3.53)[a]
Constant	-5.07
	(6.08)[a]
Number of observations (countries)	201

Absolute value of *t* statistics in parentheses; [a]significant at 1%

Table 3
Estimates from multiple regression analysis of H1N1 case reports.

Number of reported H1N1 cases	30 April 2009
Total air passengers leaving Mexican airports during Jan-Mar 2009	0.000041
	(100.42)[a]
Health expenditure per capita (current USD) 2006	0.000072
	-1.35
Constant	-0.05
	-0.54
Number of observations (countries)	201

Absolute value of *t* statistics in parentheses; [a]significant at 1%

greater health care resources, the chance of reporting a case was higher, but did not reach significance. Air travel passenger intensity had a significantly positive association with the number of reported cases ($p \leq 0.01$) (Table 3).

We calculated the probability of reporting a first influenza case on 30 April 2009 based on the logistic model used in Table 2. The results are shown in Table 4 based on the various scenarios of health spending given the same air passenger statistics. We found that if all 31 countries with direct flights from Mexico had the same level of health care spending as the USA, more countries would have reported their first case earlier, including France, Panama, Cuba, Guatemala, Italy, and Costa Rica, whose chance of reporting a case based on the model was higher than 80%.

DISCUSSION

We found that after controlling for the number of travellers, the chance of reporting an H1N1/2009 influenza case was significantly associated with the country's surveillance capacity, as determined by the level of health care spending per capita. Countries with a greater surveillance capacity had a higher case

Table 4
Predicted probability of H1N1/2009 influenza case reporting based on actual level of health spending and three additional scenarios of health spending.

Country	Presence of case on 30 April 2009	Probability of case reporting based on a model in Table 2			
		Actual level of health spending	Scenario A (health spending ≥ 1,000)	Scenario B (health spending ≥ 2,000)	Scenario C (health spending = US level)
United States	1	1.00	1.00	1.00	1.00
Canada	1	1.00	1.00	1.00	1.00
France	0	0.86	0.86	0.86	0.98
Spain	1	0.79	0.79	0.79	0.99
United Kingdom	1	0.58	0.58	0.58	0.94
Netherlands	1	0.45	0.45	0.45	0.87
Germany	1	0.41	0.41	0.41	0.86
Luxembourg	0	0.41	0.41	0.41	0.45
Switzerland	1	0.29	0.29	0.29	0.47
Italy	0	0.20	0.20	0.20	0.81
Panama	0	0.12	0.18	0.31	0.93
Belgium	0	0.11	0.11	0.11	0.53
Sweden	0	0.11	0.11	0.11	0.47
Finland	0	0.07	0.07	0.07	0.48
Japan	0	0.07	0.07	0.07	0.56
Cuba	0	0.07	0.10	0.19	0.88
Guatemala	0	0.04	0.07	0.13	0.82
Costa Rica	0	0.04	0.06	0.11	0.80
Argentina	0	0.03	0.05	0.09	0.75
Chile	0	0.03	0.05	0.09	0.75
Colombia	0	0.03	0.04	0.09	0.75
Portugal	0	0.03	0.03	0.03	0.47
Brazil	0	0.02	0.04	0.07	0.71
Peru	0	0.02	0.03	0.06	0.68
El Salvador	0	0.02	0.03	0.06	0.65
Venezuela, RB	0	0.01	0.02	0.05	0.60
China	0	0.01	0.02	0.03	0.49
Belize	0	0.01	0.01	0.03	0.46
Honduras	0	0.01	0.01	0.03	0.48
Nicaragua	0	0.01	0.01	0.03	0.46
Ecuador	0	0.01	0.01	0.03	0.45

For scenario A and B, the predicted probabilities of case reporting were calculated using health spending of USD1,000 and USD2,000, respectively. The level of health spending was USD1,000 if the existing level was lower.

detection/reporting capacity. The results are significant since the coefficients for traveller intensity and health care spending per capita were positive for dates other than April 30 (three additional time spots where case detection data were utilized in the analysis are 5 May 2009, 10 May 2009, 15 May 2009). The use of historical travel statistics and health spending avoids the potential influence of behavioral change after the first cases came to international attention.

There are a number of implications from this analysis. First, the global spread of H1N1 may be substantially greater than the early case reports to the WHO in terms of numbers of people infected and geographic reach. Second, if international spread to low and middle income countries occurs, ahead of spread to high income countries, delays in detection and reporting may result. Third, despite substantial investment in building national and global surveillance systems following SARS, the re-emergence of influenza H5N1 and the commitment to meeting the obligations of International Health Regulations for 2005, national surveillance in low and middle income countries remains a challenge.

This study had a number of limitations. The analysis was based on available international transport data accessible by the authors, which did not contain detailed statistics of passenger travel on connecting flights. It also assumes all travellers were at similar risk for contracting H1N1. Surveillance capacity for each country as measured by average level of health spending per capita is a concept that is multidimensional and difficult to measure. However, earlier studies of pandemic influenza preparedness demonstrated that surveillance capacities correlate with a country's economic resources and health spending (Mounier-Jack and Coker, 2006; Mensua *et al*, 2009).

Previous studies have shown intensive surveillance early during emerging pandemics is necessary if containment is to be a realistic aspiration (Ferguson *et al*, 2005; Kernéis *et al*, 2008). Delays in transmission or even elimination of emergent pandemics may be possible if effective policy is implemented quickly enough to contain the spread of disease (Kernéis *et al*, 2008). Surveillance systems with poor capacity to detect outbreaks in developing countries challenge global preparedness, especially in containment and monitoring. In Mexico, a lack of diagnostic equipment could be a reason for delayed reporting with this virus (Nightingale *et al*, 2009).

Countries in Southeast Asia have great diversity in economic, social, and health development (Chongsuvivatwong *et al*, 2011). It is a region with many risk factors for new and emerging infectious diseases, including those with pandemic potential (Coker *et al*, 2011). The capacities of health systems and surveillance systems in the region vary greatly. Despite large amounts of external support to strengthen surveillance capacities among low resource countries in the region (Coker *et al*, 2011), our findings raise important concerns regarding the effectiveness of the overall regional surveillance system and early response when there are weak links in the chain.

Several strategies to strengthen surveillance capacity globally have been proposed (Moore *et al*, 2008; Ortiz *et al*, 2009). The challenge is to implement those strategies effectively. The World Health Organization sees the world as being better prepared for influenza pandemic with stockpiling of antiviral drugs in many countries and "greatly strengthened" International Health Regulations (Katz,

2009; WHO, 2009). However, if health systems, especially surveillance and diagnostic capacities, remain frail, response capacity is threatened. Enhanced regional cooperation and continuing support to strengthen core public health systems and disaster preparedness, particularly among low resource countries, are necessary to effectively address this regional and global challenge.

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