Dynamic model for prediction of the epidemic wave of flu A/H1/N1. Why we have made a mistake?

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Background and objectives

In spring of 2009 it is detected in Mexico a new strain of type A influenza virus that it expands quickly. We think about to predict the number of cases, of hospital complications and deaths in Spain.

Methods

We design a dynamic (compartmental) model with six groups: susceptible; people in the state of latency; people that will develop the illness in a symptomatic and asymptomatic way; those that die for complications and those recovered. The pattern was validated with the last ten years of the Spanish Influenza Sentinel Surveillance Systems (SISSS) We developed two scenarios: of low transmission (S1), similar to the seasonal influenza (Ro=1 ,8) and (S2) of high transmission (Ro=3)

Figure 1. Dynamic model

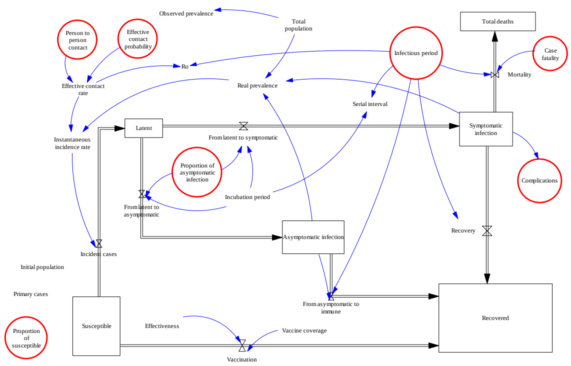


Table 1. Parameters of the model

Parameters of the model	Incubation period (days)	Infectious period (days)	Case fatality	Asymptomatic infection (%)	Person to person contact per day	Effective contact probability	Events that need hospitalization (%)
Scenario 1	2	6	0.002	50	3	0.1	3
Scenario 2	2	4	0.002	50	3	0.25	3

Results

In July of 2009 the model was validated and it allowed us to predict that the epidemic wave could produce 3,400,000 (S1*) and 10,900,000 (S2*) cases in Spain. SISSS has registered about 1,450,000 during the whole season. They were considered 100,000 (S1) and 327,000 (S2) hospital complications. The real data are ignored. They were considered 6,700 (E1) and 21,700 (E2) deaths supposing that the case fatality would be of 2 for thousand, when in fact it has been observed that it was of 0.2 for thousand. Table 2 and Figure 2 show the predictions made before the appearance of cases. Figure 3 shows the predictions made from data from the SISSS of 20-39 weeks with the final result of the epidemic.

Table 2. Scenarios versus real data

	Scenario_1*	Scenario_1_1	Scenario_1_2	Scenario_1_3	Scenario_2*	Scenario_2_1	Scenario_2_2	Scenario_2_3	Real data
Percentage of susceptible population will be infected	20 percent (50% develop symptoms)	30 percent (50% develop symptoms)	40 percent (50% develop symptoms)	50 percent (50% develop symptoms)	20 percent (50% develop symptoms)	30 percent (50% develop symptoms)	40 percent (50% develop symptoms)	50 percent (50% develop symptoms)	Spanish Influenza Sentinel Surveillance Systems
Week beginning of the epidemic curve	20	20	20	20	20	20	20	20	20
Cases per 100,000 in the week beginning of the epidemic curve	0,11	0,11	0,11	0,11	0,56	0,56	0,56	0,56	4,63
Week with more cases	37	38	39	39	26	26	27	27	46
Cases per 100,000 in the week with more cases	1.060,74	1.617,83	2.127,85	2.699,32	3.981,87	5.518,20	6.772,19	9.169,40	371,68
Total accumulated at the end of the curve. Cases per 100,000	7.315,43	10.970,65	14.624,36	18.276,61	9.439,34	14.148,81	18.863,15	23.585,98	2.994,27
Last week of the epidemic curve	51	51	51	51	36	36	37	37	51
Cases per 100,000 in the last week of the epidemic curve	2,74	5,81	9,91	15,00	0,01	0,02	0,01	0,02	40,80
Observed attack rate of symptomatic (%)	7,32	10,97	14,62	18,28	9,44	14,15	18,86	23,59	2,99
Real attack rate (including symptomatic and asymptomatic) (%)	14,63	21,94	29,25	36,55	18,88	28,30	37,73	47,17	5,99
Generation of transmission observed	19,05	19,74	20,23	20,61	10,42	10,79	11,05	11,26	
Generation of real transmission	20,23	20,92	21,41	21,79	11,05	11,42	11,68	11,89	

Figure 2. Scenarios versus real data

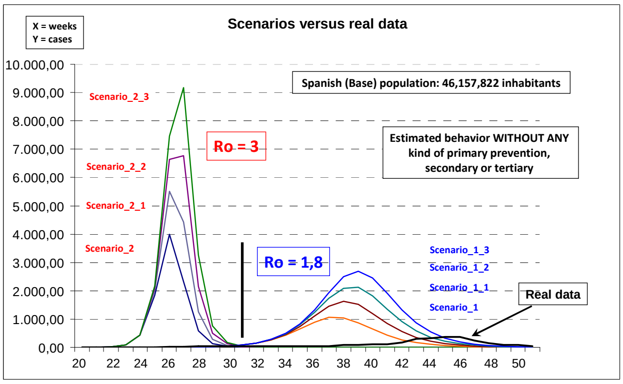
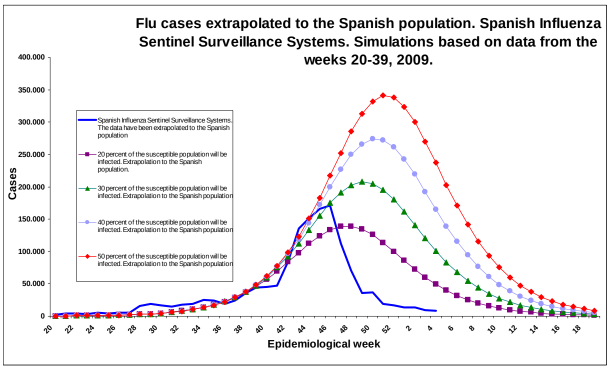


Figure 3. Final result of the epidemic versus predictions



Conclusions and recommendations

The discrepancies among the estimated and observed values can be due to: 1. Different information is compared; the models predict total number of cases, SISSS estimates through a sampling the number of cases. 2. Lack in the knowledge of the natural history (red circle in figure 1): Which is the proportion of asymptomatic cases? Which is the pattern of contacts among the susceptible ones? Which is the probability of effective contact? Which is susceptible population's percentage? Which is the proportion of complications among the sick persons? Which is the case fatality? (According to the source it can oscillate among 2 for a hundred, 2 for thousand or 0,2 for thousand)

3.- The model didn't consider any type of measure of primary, secondary or tertiary prevention, what forces us to wonder. 4. - The infectious period of the virus has not been as high as it was considered at the beginning of the pandemic. 5.- Other aspects to consider: vaccination, immune population's bag and the role of the mass media. Recommendations: 1) to Pay special attention to the contacts of the cases to be able to estimate the percentage of asymptomatic cases. b) to Extend the use of the clinical electronic history to diagnose the cases and this way to avoid possible errors of sampling of SISSS. c) to Make pursuit study in a sample of cases to estimate case fatality values and hospital complications.

No conflicts of interest reported