





Modelling impact of pandemic influenza: interim report on use of empirical model in Ireland

December 2006





Ex	ecutiv	e summary	1				
1	Background						
2	Mod	Model applied to Irish situation					
	2.1 2.1.1 2.1.2 2.1.3	Clinical Attack Rate: Scenario 1 Clinical Cases: Scenario 1 Clinical Cases: Scenario 1 Clinical Cases: Scenario 1 Hospitalisations: Scenario 1 Clinical Cases: Scenario 1 Deaths: Scenario 1 Clinical Cases: Scenario 1	3 3 4 4				
	2.2 2.2.1 2.2.2 2.2.3	Clinical Attack Rate: Scenario 2 5 Clinical Cases: Scenario 2 6 Hospitalisations: Scenario 2 6 Deaths: Scenario 2 6	5 5 5 6				
3	Mod	el evaluation	6				
	3.1	Limitations	6				
	3.2	Strengths	7				
4	Refe	erences	7				



Executive summary

- Various different mathematical models can be used in preparing for an influenza pandemic. For estimating health impact, an empirical model of pandemic influenza, based on the profile of previous UK pandemics, can be used in Ireland.
- This model can be used to predict the number of clinical cases, hospitalisations and deaths that will occur in Ireland during each week of a 15-week single wave pandemic, in the absence of any interventions.
- In the first scenario considered, a 25% clinical attack rate is assumed, yielding a total of 1,058,731 clinical cases in Ireland in the course of the pandemic with a peak of 228,200 predicted during week six.
 - Under scenario 1 assumptions, the model predicts a minimum total of 5,800 influenza-related hospitalisations over the 15 weeks with a peak of 1,250 predicted during week six.
 - Under scenario 1 assumptions, the model predicts a minimum total of 3,900 influenza-related deaths over the 15 weeks with a peak of 840 predicted during week six.
- In the second or worst case scenario, a 50% clinical attack rate is assumed, yielding a total of 2,117,463 clinical cases in Ireland in the course of the pandemic with a peak of 456,400 predicted during week six.
 - Under scenario 2 assumptions, the model predicts a minimum total of 78,300 influenza-related hospitalisations over the 15 weeks with a peak of 16,900 predicted during week six.
 - Under scenario 2 assumptions, the model predicts a minimum total of 52,937 influenza-related deaths over the 15 weeks with a peak of 11,400 predicted during week six.



1 Background

The Health Protection Agency (HPA) in the United Kingdom has adopted an empirical model of pandemic influenza for planning purposes.⁽¹⁾ The model is derived using data from three previous UK pandemics (1918, 1957, 1969/70).

The main assumption of the empirical model is that the next influenza pandemic will take place over a single wave of 15 weeks and will have a profile similar to what has occurred during previous pandemics. The shape of the modelled epidemic curve can be seen in Figure 1 below:



Figure 1 Proportion of total cases, consultations, hospitalisations and deaths that will occur each week during single wave pandemic

The profile is a weighted average of influenza deaths in England and Wales during the 1969/70 and 1957 pandemics and London during the 1918 pandemic. The weights used were based on the overall mortality rate of each pandemic. The 1918 pandemic therefore had a strong influence on the shape of the curve since the highest death rate occurred in this pandemic. Figure 1 is a generic curve that can be applied to break down by week the total number of cases, GP consultations, hospitalisations and deaths that would be expected in the course of the pandemic. For example, the model predicts that 22% of all cases will occur during week six of the pandemic and 8% of cases will occur during week ten. Similarly, 22% of total hospitalisations and deaths will occur during week six and 8% of hospitalisations and deaths will occur during week ten.



2 Model applied to Irish situation

Two different scenarios have been considered when deriving predictions from the empirical model. The first considers a clinical attack rate of 25%, a hospitalisation rate of 0.55% and a mortality rate of 0.37%. In the second or worst case scenario a clinical attack rate of 50%, a hospitalisation rate of 3.7% and a mortality rate of 2.5% are considered. All calculations in this section are based on the preliminary results of the 2006 census, which indicated a total Irish population of 4,234,925

2.1 Clinical Attack Rate: Scenario 1

A clinical attack rate of 25% has been assumed in scenario 1 to derive the predictions from the model. This is approximately equal to the clinical attack rates of the last three pandemics (1918, 1957, 1969).

2.1.1 Clinical Cases: Scenario 1

Assuming a 25% clinical attack rate yields a total of 1,058,731 cases in the Irish population. When the total number of cases is broken down by week in accordance with the proportions shown in Figure 1, the number of cases in one week peaks during week six at 228,189 (Table 1). The number of weekly cases rises sharply from 33,041 in week four to 111,705 in week five.

Week	% Total	Cases	Cases per	Hospitalisations	Deaths
	cases	per week	100,000 pop	per week	per week
1	0.1%	1,521	36	8	6
2	0.2%	2,164	51	12	8
3	0.8%	8,675	205	48	32
4	3.1%	33,041	780	182	122
5	10.6%	111,705	2,638	614	413
6	21.6%	228,189	5,388	1,255	844
7	21.2%	224,036	5,290	1,232	829
8	14.3%	151,089	3,568	831	559
9	9.7%	102,843	2,428	566	381
10	7.5%	79,863	1,886	439	295
11	5.2%	55,386	1,308	305	205
12	2.6%	27,574	651	152	102
13	1.6%	16,580	392	91	61
14	0.9%	9,128	216	50	34
15	0.7%	6,939	164	38	26
Total	100%	1,058,731	25,000	5,823	3,917

Table 1: Weekly numbers of cases, hospitalisations and deaths as predicted by the empirical model assuming a 25% attack rate, a hospitalisation rate of 0.55% and a mortality rate of 0.37%



2.1.2 Hospitalisations: Scenario 1

The HPA have used a hospitalisation rate of 0.55% of clinical cases. This should be considered as the minimum rate of hospitalisations associated with pandemic influenza as it was derived using hospitalisation data from interpandemic years; the actual rate may be higher than 0.55%.

Based on the minimal hospitalisation rate of 0.55%, the total number of hospitalisations expected during a pandemic with a clinical attack rate of 25% would be 5,823 over the 15-week period (Table 1). The model predicts that approximately 1,250 hospitalisations would occur during both weeks six and seven of the pandemic (Table 1).

2.1.3 Deaths: Scenario 1

The empirical model as defined by the HPA assumes that 0.37% of clinical cases will die (similar to UK rates in 1990s epidemics and the 1957 pandemic). It is emphasised that this assumption will predict the minimum number of deaths that would occur, as the mortality rates seen in other pandemics were markedly higher than 0.37%.

If 0.37% of cases result in death there would be 3,917 deaths in Ireland during a pandemic with a 25% clinical attack rate (Table 1).



2.2 Clinical Attack Rate: Scenario 2

A worst case clinical attack rate of 50% has been assumed in scenario 2 to derive the predictions from the model.

2.2.1 Clinical Cases: Scenario 2

Assuming a 50% clinical attack rate yields a total of 2,117,463 cases in the Irish population. When the total number of cases is broken down by week in accordance with the proportions shown in Figure 1, the number of cases in one week peaks during week six at 456,377 (Table 2). The number of weekly cases rises sharply from 66,082 in week four to 223,410 in week five.

Week	% of total cases	No. cases	Cases per 100,000 pop	Hospitalisations	Deaths
1	0.1%	3,042	72	113	76
2	0.2%	4,327	102	160	108
3	0.8%	17,351	410	642	434
4	3.1%	66,082	1,560	2,445	1,652
5	10.6%	223,410	5,275	8,266	5,585
6	21.6%	456,377	10,777	16,886	11,409
7	21.2%	448,072	10,580	16,579	11,202
8	14.3%	302,178	7,135	11,181	7,554
9	9.7%	205,686	4,857	7,610	5,142
10	7.5%	159,725	3,772	5,910	3,993
11	5.2%	110,772	2,616	4,099	2,769
12	2.6%	55,147	1,302	2,040	1,379
13	1.6%	33,160	783	1,227	829
14	0.9%	18,255	431	675	456
15	0.7%	13,879	328	514	347
All weeks	100%	2,117,463	50,000	78,346	52,937

Table 2: Weekly numbers of cases, hospitalisations and deaths as predicted by the empirical model assuming a 50% attack rate, a hospitalisation rate of 3.7% and a mortality rate of 2.5%

2.2.2 Hospitalisations: Scenario 2

The HPA Influenza Pandemic Contingency Plan states that the numbers of hospitalisations and deaths predicted by the model under Scenario 1 should be considered the minimum expected for pandemic flu.⁽³⁾

Based on a worst case hospitalisation rate of 3.7%, the total number of hospitalisations expected during a pandemic with a clinical attack rate of 50% would be 78,346 over the 15-week period (Table 2). The model predicts that



approximately 16,700 hospitalisations would occur during both weeks six and seven of the pandemic (Table 2).

2.2.3 Deaths: Scenario 2

If 2.5% of cases result in death there would be 52,937 deaths in Ireland during a pandemic with a 50% clinical attack rate (Table 2).

3 Model evaluation

3.1 Limitations

Limitations to this model include the following

- The pandemic is modelled as a single wave, and in reality more than one wave might occur.
- No attempt is made to quantify the impact of anti virals on the pandemic profile – it is likely that the use of anti virals would flatten the peak and widen the curve.⁽²⁾ Other interventions may also have an effect on the model.
- No information is provided as to what proportion of deaths will occur in hospitals versus elsewhere i.e. the degree of overlap between hospitalisations and deaths is not addressed.
- This model assumes that next pandemic will mirror previous pandemics. Scenario 1, which incorporates the average clinical attack rate seen in the past three pandemics, is simple to apply and useful for planning purposes. However, it is important not to rely solely on this scenario, as it is not possible to predict what the clinical attack rate, hospitalisation rate or mortality will be. A range of impacts, up to the worst case scenario should be considered and planned for.
- No allowance has been made for the time lag between becoming clinically ill and being hospitalised/dying. All peak during week six whereas we may expect there would be a lag between the maximum number of cases and the maximum number of deaths.
- The curve is based on mortality data and in reality peak mortality may occur slightly later than the clinical peak.



3.2 Strengths

- This model is straightforward to use for different attack rates, hospitalisation and death rates.
- No assumptions are made regarding the nature of the virus itself in terms of infectivity etc.

This report was prepared by Kate Hunter, Dr Derval Igoe and Dr Darina O'Flanagan, HPSC.

4 References

- 1. Health Protection Agency. Influenza Pandemic Contingency Plan. <u>www.hpa.org.uk</u> . 2005.
- 2. Department of Health. UK operational framework for stockpiling, distributing and using antiviral medicines in the event of pandemic influenza. 2006.
- 3. Department of Health. UK Health Departments' Influenza pandemic contingency plan. <u>www.doh.gov.uk/pandemicflu</u> . 2005.