

FluSurge

Software to Estimate the Impact of an Influenza Pandemic on
Hospital Surge Capacity

FluSurge2.0 Beta Test Version



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AUTHORS:

Xinzhi Zhang, Martin I. Meltzer, Pascale Wortley

Centers for Disease Control and Prevention, U.S. Department of Health and Human Services, Atlanta, GA.

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DISCLAIMERS

The numbers generated through FluSurge are not to be considered predictions of what *will* actually occur during an influenza pandemic. Rather, they should be treated as estimates of what *could* happen.

The findings and conclusions in this manual and the accompanying software (FluSurge) are those of the authors and do not necessarily represent the views of the funding agency.

Note: Influenza virus photo on the cover is an electron micrograph magnified 150,000 times over normal size. We thank Dr. Nancy J. Cox for providing this photo.

SYSTEM REQUIREMENTS

FluSurge uses the Windows* operating system (Microsoft Windows 2000 or higher) and Excel (Microsoft Office 2000 or higher). We recommend using a computer with at least a 486 Pentium processor and at least 128MB RAM. FluSurge requires up to 2 megabytes of storage space on the computer's hard drive.

*Microsoft Windows and Office are copyrighted products produced by Microsoft Corporation, WA. Use of trade names and commercial sources is for identification only and does not imply endorsement by the U.S. Department of Health and Human Services.

Before loading and starting FluSurge, you must change Excel's security level by doing the following steps (see LOAD and START for details):

- 1). Open a blank Excel spreadsheet.
- 2). Click Tools and then click Macro, choose Security
- 3). Set Security Level to Medium.
- 4). Click OK.
- 5). Double click and open FluSurge file.
- 6). When asked to Disable Macros or Enable Macros, click Enable Macros.

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INTRODUCTION

Planning ahead in preparation for an influenza pandemic, with its potentially very high morbidity and mortality rates, is essential for hospital administrators and public health officials. To this end, FluSurge helps you estimate the impact of an influenza pandemic on your community. It has been designed to demonstrate the need to plan for a surge in demand for hospital services during the next pandemic, and to provide a method to estimate demand for these services, which can be used to plan the allocation of scarce resources.

Based on census data and estimates of hospital resources (non-ICU [Intensive Care Unit] hospital beds, ICU beds, and mechanical ventilators) provided by you in a given area (e.g., a city, a state), FluSurge estimates the number of hospitalizations and deaths of an influenza pandemic (whose length and virulence are determined by you) and compares the number of persons hospitalized, the number of persons requiring ICU care, and the number of persons requiring ventilator support during a pandemic with existing hospital capacity.

BACKGROUND

Influenza pandemics can overwhelm a community, causing very serious public health, social, and economic problems. Approximately 110,000 hospitalizations per year are related to influenza (1). Researchers estimate that during the next influenza pandemic, 15% - 35% of the U.S. population will become clinically ill with the influenza virus (2, 3). Because this would create a large surge in demand for hospital-based services, pre-planning is extremely important to successfully reduce pandemic-related morbidity and

mortality, and to efficiently allocate scarce hospital resources. FluSurge can help local public health officials and hospital administrators better understand and prepare for the next influenza pandemic.

We ran FluSurge using metro Atlanta as an example to illustrate the impact of an 8-week influenza pandemic with a 25% gross clinical attack rate. In this example, the demand on hospital resources peaked in week 5, with a maximum of 412 hospital admissions per day. FluSurge estimated that during this week, 2,013 persons would be hospitalized, 583 would require use of the ICU, and 292 would need mechanical ventilation (these numbers, respectively, translate to 28% of all hospital beds, 77% of total ICU capacity, and 42% of all ventilators in metro Atlanta). Such an influenza pandemic would most likely result in 13,918 hospital admissions (ranging from 4,627 to 18,843) and 2,516 deaths (ranging from 1,173 to 4,530). These sample results from FluSurge illustrate how the next influenza pandemic may overwhelm existing hospital resources, given that hospitals increasingly operate at nearly full capacity. Public health officials and hospital administrators must plan for surges in demand for hospital services during the next pandemic.

METHODS

Microsoft Excel/Visual Basic was used to construct FluSurge. Part of FluAid 2.0 was built into FluSurge and was used to estimate numbers of deaths and persons hospitalized due to an influenza pandemic (4). You need to provide estimates of your local population in three age groups (0-19, 20-64, and 65+ years) and your available hospital resources (non-ICU beds, ICU beds, and mechanical ventilators). You then select

the duration of a pandemic (6, 8, or 12 weeks) and the gross clinical attack rate (15%, 25%, or 35%). Based on these data, FluSurge estimates numbers of persons hospitalized, bed capacity needed, ICU capacity needed, and ventilator usage over the course of the pandemic.

LOAD AND START

Before loading and starting FluSurge, you must make sure Excel's security level is set appropriately. Because FluSurge uses Excel macro technology, you must first do the following steps:

- 1). Open a blank Excel spreadsheet.
- 2). Click Tools and then click Macro, choose Security
- 3). Set Security Level to Medium.
- 4). Click OK.
- 5). Double click and open FluSurge file.
- 6). When asked to Disable Macros or Enable Macros, click Enable Macros.

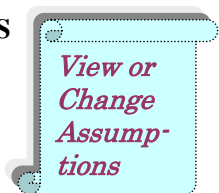
You **must** open a **blank** Excel spreadsheet to change the security level. Changing security level with FluSurge open won't make software work. From the "Tools" menu item, scroll down until you reach the option labeled "Macros." A sidebar of options associated with "Macros" will open up. From that sidebar, select the option labeled "Security." This will cause a little box titled "Security" to pop up. The first sheet in this box is titled "Security level." Select either "medium" (recommended) or "low." If you select/leave the security level at high, the macro programming (sets of commands) in FluSurge will be disabled and the software will not run.

Once you have selected the security level, click on the “OK” button. You are now ready to open FluSurge. If you selected “medium” security level, a pop-up box will appear and tell you that the spreadsheet you are opening (FluSurge) contains macros and ask you if you want to disable or enable the macros. You must select/click on “Enable Macros.” If you select “Disable Macros” FluSurge will not work. Once you have selected “Enable Macros,” the software will quickly load and you are ready to click

START to go to **Main Menu** and begin to run FluSurge.

ASSUMPTIONS

Clicking



will lead you to FluSurge’s underlying assumptions.

These assumptions are as follows:

- No. 1 Average length of non-ICU hospital stay for influenza-related illness is 5 days.
- No. 2 Average length of ICU stay for influenza-related illness is 10 days.
- No. 3 Average length of ventilator usage for influenza-related illness is 10 days.
- No. 4 Average proportion of admitted influenza patients will need ICU care is 15%.
- No. 5 Average proportion of admitted influenza patients will need ventilators is 7.5%.
- No. 6 Average proportion of influenza deaths assumed to be hospitalized is 70%.
- No. 7 Daily percentage increase in cases arriving compared to previous day is 3%.

DATA INPUT

1. Enter the population of the area you want FluSurge to work with, broken down into three age groups:

Age Group	Population
0-19 yrs	1,350,707
20-64 yrs	2,906,171
+ 65 yrs	353,154

The total population of the state or locality being modeled is divided into three age groups: school-aged children, working adults, and retirees. A set of numbers that you or previous users typed in last time will automatically appear. All data you type in will be automatically saved when you exit FluSurge. To change the previous values, simply type over them.

You may wish to consult one of the following sources to get population estimates:

- a. State estimates
 - U.S. Census Bureau (www.census.gov)
- b. Regional estimates
 - Vital Statistics office

If the area of interest is outside the United States, contact the regional or national census office for population estimates.

2. Enter numbers of basic hospital resources:

Total licensed non-ICU beds:	7,300
% licensed non-ICU beds staffed:	100%
Total staffed non-ICU beds:	7,300
Total licensed ICU beds:	759
% licensed ICU beds staffed:	100%
Total Staffed ICU beds:	759
Total number of ventilators:	691
% ventilators available:	100%
Total number of ventilators available:	691

Again, a set of numbers that you or previous users typed in last time will automatically appear. To change these previously entered values, simply type over them. All data you type in will be automatically saved when you exit FluSurge.

You may wish to consult the person coordinating the Health Resources and Services Administration’s (HRSA) National Bioterrorism Hospital Preparedness Program for hospital resource information. FluSurge2.0 allows users to change the proportion of capacity staffed (or available).

3. Choose the duration and gross clinical attack rate of the pandemic:

Duration:

Attack rate:

Duration refers to the number of weeks you expect the pandemic to last; you may select 6, 8, or 12 weeks from the drop-down box. Gross clinical attack rate refers to the percentage of the population that becomes clinically ill due to influenza; a clinical case of

influenza is one that causes some measurable economic impact, such as one-half day of work lost, or a visit to a physician's office. Default values (6, 8, or 12 weeks, and 15%, 25% or 35%) given here are taken from the work of Meltzer MI, Cox NJ, and Fukuda K (2, 3).

RESULTS

Click [Click to View Results](#) to see your final results, which are organized

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into two parts. The first part provides the total estimated number of persons needing hospitalization (or hospital admission) and total estimated deaths in different scenarios ("minimum," "most likely," and "maximum") due to the influenza pandemic. This part also includes a graph and a table showing the weekly distribution of hospital admissions in three scenarios.

The second part of the results contains a graph showing the daily distribution of hospital patient admissions due to the influenza pandemic. There is also a table showing weekly and peak daily admissions, staffed bed capacity needed, ICU capacity needed, ventilator usage, and deaths from influenza. This table only includes estimates from the most likely scenario.

Results Part I

1. In the first part of your results, you will see a table, similar to the one below, showing the total estimated hospital admissions and total deaths due to the influenza pandemic:

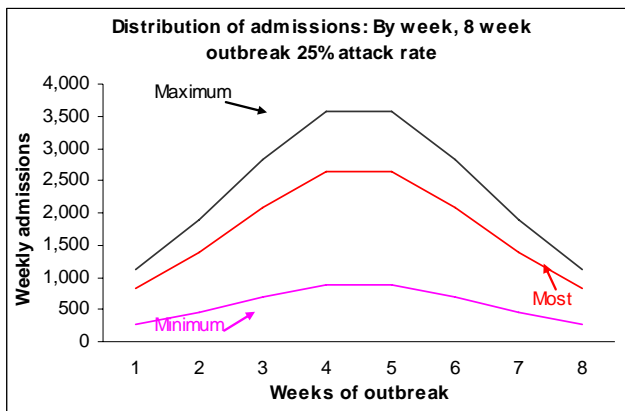
Pandemic Influenza Impact / Attack Rate	25%
Total Hospital Admissions	
Most Likely Scenario	13,918
Minimum Scenario	4,627
Maximum Scenario	18,843
Total Deaths	
Most Likely Scenario	2,516
Minimum Scenario	1,173
Maximum Scenario	4,530

The estimated number of hospital admissions is based on death rates and hospitalization rates provided by FluAid. Hospitalization rates are estimated to create three scenarios of pandemic impact: minimum (the best case scenario), which estimates the fewest possible number of hospitalizations; mean (the most likely scenario), which estimates the number of hospitalizations most likely to occur; and maximum (the worst case scenario), which estimates the largest number of hospitalizations. Here, for example, an influenza pandemic with an 8-week duration and a 25% gross clinical attack rate will most likely result in 13,918 hospital admissions (ranging from 4,627 to 18,843) and 2,516 deaths (ranging from 1,173 to 4,530).

The estimates of hospital admissions, total bed capacity used, total ICU capacity used, total ventilators used, and deaths will markedly increase as the assumed gross clinical attack rate increases. These estimates of impact may also range widely over the

three scenarios. For a given gross clinical attack rate, the extensive range between the minimum and maximum estimates is due to the uncertainty of how the next pandemic will spread through society, as well as to the lack of data regarding the impact of influenza in previous pandemics (2,3). Such uncertainty, and the resultant wide ranges in estimated impact, should serve as a warning to planners not to be overconfident in using a single estimate of impact when preparing their plans.

2. You will also see a graph and a table, like the one below, illustrating the weekly distribution of hospital admissions of influenza pandemic patients:



Hosp Adm. / Week	1	2	3	4	5	6	7	8
Most Likely Scenario	835	1,392	2,088	2,644	2,644	2,088	1,392	835
Minimum Scenario	278	463	694	879	879	694	463	278
Maximum Scenario	1,131	1,884	2,826	3,580	3,580	2,826	1,884	1,131

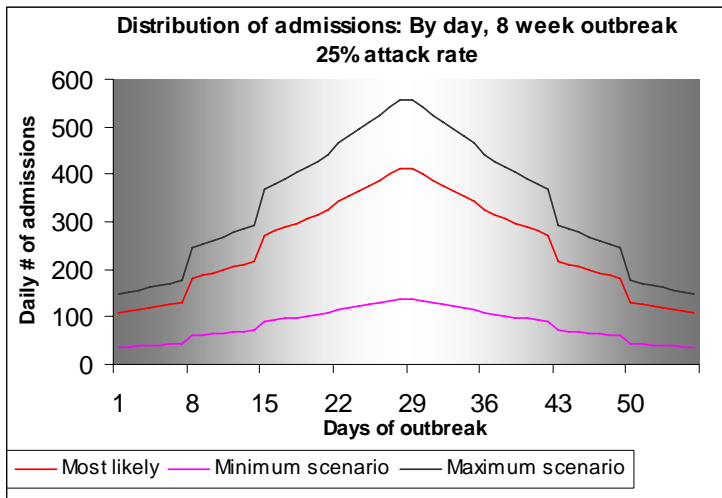
The above weekly distribution of hospital admissions due to the influenza pandemic was based on an 8-week duration and a 25% clinical gross clinical attack rate. The peak number of hospital admissions arrived at the 4th and 5th week for all scenarios,

with 2,644 patients admitted per week in the most likely scenario. This result ranged from 879 admissions in the minimum scenario to 3,580 admissions in the maximum scenario.

Results Part II

Click [Go to Next Page](#) to go to the second part of the results.

1. In the second part of your results, you will see a graph, similar to the one below, showing the daily distribution of hospital admissions of influenza pandemic patients:



This graph shows the daily distribution of numbers of people hospitalized due to an influenza pandemic with an 8-week duration and a 25% gross clinical attack rate. As this graph and the table below demonstrate, FluSurge estimates that the peak daily admission of influenza patients will reach 412 per day in the 4th and 5th weeks. This will result in a huge demand for hospital resources, as shown in the table below.

2. Next you will see a table, similar to the one below, showing the impact of the influenza pandemic on hospital resources:

Pandemic Influenza Impact / Weeks		1	2	3	4	5	6	7	8	9	10
Hospital Admission	Weekly admissions	835	1,392	2,088	2,644	2,644	2,088	1,392	835		
	Peak admissions/day				412	412					
Hospital Capacity	# of influenza patients in hospital	614	1,023	1,535	1,944	2,013	1,769	1,357	890		
	% of hospital capacity needed	8%	14%	21%	27%	28%	24%	19%	12%		
ICU Capacity	# of influenza patients in ICU	125	266	408	539	583	567	451	311		
	% of ICU capacity needed	17%	35%	54%	71%	77%	75%	59%	41%		
Ventilator Capacity	# of influenza patients on ventilators	63	133	204	269	292	284	225	156		
	% usage of ventilator	9%	19%	30%	39%	42%	41%	33%	23%		
Deaths	# of deaths from influenza			151	252	377	478	478	377	252	151
	# of influenza deaths in hospital			106	176	264	335	335	264	176	106

This table presents the results from the calculations using the data that you entered. It presents the estimates, by specified pandemic duration (e.g., 8 weeks) and gross clinical attack rate (e.g., 25%), of the impact of pandemic influenza on hospital resources. The hospital admission category includes the total number of weekly hospital admissions of influenza patients and peak admission per day. The hospital capacity category presents the maximum total number of influenza patients in the hospital and relevant hospital capacity needed. ICU capacity category shows the maximum total number of influenza patients in the ICU, and relevant ICU capacity needed. The ventilator capacity category provides the maximum total number of ventilators used and related percentage of use. The death category provides estimates of the total number of deaths and total number of influenza patients who would die in the hospital due to influenza pandemic in a week.

- Weekly admission: The total number of influenza patients admitted to the hospital during each pandemic week.

- **Peak admission/day:** The peak number of daily hospital admissions of influenza patients and the week in which the peak occurs.
- **# of influenza patients in hospital:** The maximum daily number of influenza patients hospitalized in a given week. The maximum number of influenza patients in the hospital in a week is lower than the number of weekly admissions because we assume a 5-day stay in general wards (10-day stay in the ICU and 10-day use of a ventilator). For example, patients admitted at the beginning of the first week will not be in the hospital during the second week.
- **% of hospital capacity needed:** The proportion of all staffed non-ICU hospital beds that would be occupied by influenza patients. For example, 2,013 influenza patients in the hospital is equivalent to 28% of the hospitals' total capacity, that is, 28% of total staffed beds will be required. Many hospitals do not have such surplus capacity available.
- **# of influenza patients in ICU:** The maximum daily number of influenza patients requiring ICU care in a given week.
- **% of ICU capacity needed:** The proportion of all staffed ICU beds that would be occupied by influenza patients. For example, 583 influenza patients in the ICU is equivalent to 77% of the ICU's total capacity.
- **# of influenza patients on ventilators:** The maximum daily number of influenza patients requiring ventilator support in a given week.

- % usage of ventilator: The proportion of all mechanical ventilators that would be used by influenza patients. For example, 292 influenza patients using ventilators is equivalent to 42% usage of the total ventilators available.
- # of deaths from influenza: The total number of influenza patients that died during each pandemic week. Here, we assume that deaths start at the beginning of the 3rd week.
- # of influenza deaths in hospital: The total number of influenza patients that died in hospitals during each pandemic week.

Therefore, in this case, an 8-week influenza pandemic with a 25% gross clinical attack rate will consume 28% of the total hospital capacity, 77% of the total ICU capacity, and 42% of total ventilators during the pandemic's peak (the 5th week). Moreover, two weeks later, 478 people would die, and 335 of these deaths would occur in the hospital.

TECHNICAL NOTES

Note I. Total Hospital Admissions

Total hospitalizations and total deaths are estimated using FluAid. We assume 70% of deaths happen in hospital. Therefore, total hospital admissions (*in FluSurge*) = total hospitalizations (*in FluAid*) + 70% * total deaths (*in FluAid*). In this version, you are able to change this rate (percentage of deaths assumed to be hospitalized).

Note II. Distribution of Hospital Admissions




Because FluAid only provides estimates of total hospitalizations and total deaths occurring during an influenza pandemic, we have to distribute total number of hospitalizations and total number of deaths into different weeks. We first assumed an approximate normal distribution for weekly distribution of hospital admission and death of influenza patients. Then, within each week, we assumed a 3% daily increase in patients arriving compared to previous day before the peak and a 3% daily decrease in patients arriving compared to previous day after the peak. Therefore, you are expected to see some little bumps in the daily distribution graph. In the model, you are also able to change the daily increase and decrease rate (3%). In this way, you can change the shape of the daily distribution.

PRINTING

In order to print your results on a single page, you must change the printing page setup to Landscape format. To do so,

- 1). Click File and then choose Page Setup.
- 2). In the Orientation section, change Portrait to Landscape.
- 3). Click OK.

EXIT

Click  to go to the **Main Menu** if you want to change any data you typed in, or to select a different pandemic duration and/or gross clinical attack rate. Click  in the **Main Menu** to close all programs and go to the front page. Click  to save input data and results while exiting FluSurge.

CONTACT

For additional help or feedback, please email your comments or questions to Xinzhi Zhang M.D., Ph.D. (xzhang4@cdc.gov) or Martin I Meltzer M.S., Ph.D. (MMeltzer@cdc.gov).

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