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## Estimating Weekly Call Volume to a National Nurse Telephone Triage Line in an Influenza Pandemic

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### Abstract

Telephone nurse triage lines, such as the Centers for Disease Control and Prevention's (CDC) Flu on Call®, a national nurse triage line, may help reduce the surge in demand for health care during an influenza pandemic by triaging callers, providing advice about clinical care and information about the pandemic, and providing access to prescription antiviral medication. We developed a Call Volume Projection Tool to estimate national call volume to Flu on Call® during an influenza pandemic. The tool incorporates 2 influenza clinical attack rates (20% and 30%), 4 different levels of pandemic severity, and different initial "seed numbers" of cases (10 or 100), and it allows variation in which week the nurse triage line opens. The tool calculates call volume by using call-to-hospitalization ratios based on pandemic severity. We derived data on nurse triage line calls and call-to-hospitalization ratios from experience with the 2009 Minnesota FluLine nurse triage line.

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Assuming a 20% clinical attack rate and a case hospitalization rate of 0.8% to 1.5% (1968-like pandemic severity), we estimated the nationwide number of calls during the peak week of the pandemic to range from 1,551,882 to 3,523,902. Assuming a more severe 1957-like pandemic (case hospitalization rate = 1.5% to 3.0%), the national number of calls during the peak week of the pandemic ranged from 2,909,778 to 7,047,804. These results will aid in planning and developing nurse triage lines at both the national and state levels for use during a future influenza pandemic.

## Keywords

Pandemic influenza; Telephone triage; Public health preparedness/response

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Influenza pandemics result when a novel influenza virus emerges, becomes adapted to humans, and rapidly and efficiently spreads from person to person. Influenza pandemics have been characterized by rapid and large increases in the number of people ill with influenza-related symptoms compared to nonpandemic influenza seasons.<sup>1</sup> These increases in clinically ill individuals can create a surge in demand for healthcare services that, during a severe pandemic, would likely overwhelm the capacity of the healthcare system.<sup>2</sup>

The Centers for Disease Control and Prevention (CDC), in collaboration with United Way Worldwide and other partners, is establishing a national nurse triage line called Flu on Call® to be staffed by information specialists and healthcare professionals; it is designed to be used during a severe influenza pandemic.<sup>3</sup> The information specialists will be trained professionals who will assess the needs of callers and provide accurate information or answer questions using a database of information provided by CDC, or transfer the caller to a medical professional, if needed. Nurses and other healthcare professionals who staff Flu on Call® would use standardized CDC-developed clinical protocols for evaluating and managing callers based on their signs and symptoms and medical history. Registered nurses, working under protocols and physician direction, will be able to provide access to antiviral medications for callers meeting certain criteria (eg, callers not experiencing a life-threatening condition or symptoms of influenza complications and having ILI symptoms for 72 hours or less). Flu on Call® could thus play an important role in managing and reducing the demand for healthcare services during a pandemic.<sup>3</sup> This national effort uses an architecture similar to the Minnesota FluLine, which was activated during the 2009 H1N1 influenza pandemic.<sup>4</sup> It was estimated that among the more than 27,000 callers safely served during its 6-month operation, approximately 11,000 in-person healthcare encounters were averted through the use of this nurse triage line.<sup>3,4</sup>

To assist in planning and scaling up a national-level influenza pandemic nurse triage line system such as Flu on Call®, we created a mathematical model to estimate the potential number of calls the system would receive if it were activated. These estimates will allow public health officials and healthcare managers to plan a pandemic response, design an effective nurse triage line system for both national systems such as Flu on Call® and any state or local systems, and prepare for Flu on Call® staffing requirements.

## Methods

### Modeling Approach and Assumptions

We developed a spreadsheet-based tool, called the Call Volume Projection Tool, using Microsoft Excel, to estimate the expected number of calls per week to a national-level nurse triage line system during an influenza pandemic (see Appendix 1, supplemental material, at <https://www.liebertpub.com/doi/suppl/10.1089/hs.2018.0061>). Rather than use historical influenza pandemic data, the tool uses data from a hypothetical H7N9 influenza pandemic.<sup>5</sup> The use of a hypothetical pandemic allows a user flexibility to simultaneously alter the gross clinical attack rate (ie, 20% or 30%), the seed or starter number of cases, and the level of severity (4 levels defined by rates of hospitalization among those clinically ill from the circulating pandemic strain).

We assumed that a national-level system would be set up to receive calls in a manner similar to the nurse triage line operated in Minnesota during the 2009 H1N1 influenza pandemic.<sup>4</sup> We built the tool to provide a range of estimates of the expected number of calls during the next influenza pandemic. This model uses call data from the Minnesota FluLine nurse triage line to calculate the ratio of nurse triage line calls to the number of pandemic influenza-related hospitalizations in that state. We provide data input values and sources in Table 1. Tool users can alter default values.

### Pandemic Scenarios

To allow for an array of pandemic scenarios and resultant calls to a nurse triage line, we built the tool so that users can assume either a 20% or 30% clinical attack rate (see Appendix 2, supplemental material). Note that the lower attack rate, and thus slower transmission, results in longer duration of the pandemic, with a 20% attack rate pandemic lasting approximately 31 weeks, and a 30% attack rate pandemic lasting approximately 19 weeks (Appendix 2). We also built into the tool the option to choose either 10 or 100 “seed” (or initial) cases that initiate the start of the pandemic in the US population. The number of seed cases affects the time-to-pandemic-peak. With a 20% clinical attack rate, 10 seed cases are associated with a pandemic peak week that is 3 weeks later than would be seen with an initial 100 seed cases. With a 30% attack rate, this difference due to number of initial seeds decreases to 2 weeks (Appendix 2).

We further refined the estimated number of calls to a nurse triage line by allowing call volume levels to vary due to different levels of severity of pandemic. We defined levels of pandemic severity by using case-hospitalization rates as developed by Reed et al.<sup>6</sup> Four levels of influenza severity are built into the tool as follows:

- a mild to nonpandemic season (2006–07), with hospitalization rates of 0.1% to 0.5%;
- a 2009-like pandemic with hospitalization rates of 0.5% to 0.8%;
- a 1968-like pandemic with hospitalization rates of 0.8% to 1.5%; and
- a 1957-like pandemic with hospitalization rates of 1.5% to 3.0% (Table 1).

The results presented here are based on 10 initial cases (Appendix 2), epidemic curves for either 20% or 30% clinical attack rates, and pandemic severity levels similar to the 1968 and 1957 influenza pandemics (levels 3 and 4, respectively, Table 1), for a total of 4 pandemic scenarios.<sup>5</sup> These pandemic severity levels were selected because, to organizers of nurse triage lines like Flu on Call®, they will likely present some of the largest organizational and resource-allocation challenges, such as rapidly obtaining and training a sufficient number of information specialists and healthcare professionals to answer the telephone inquiries.

We present the number of calls that would be expected nationwide, based on the call-to-hospitalization rate, for each week of the pandemic. We based the estimates presented here on the total US population as of July 2016.<sup>7</sup> Tool users can alter any of these, as well as other, assumptions.

### Call-to-Hospitalization Ratio

For this model, we first calculated the ratios of the weekly number of calls to the Minnesota FluLine to the weekly number of hospitalized influenza cases in Minnesota during the 2009 H1N1 pandemic (Appendix 5, supplemental material)—that is, the call-to hospitalization ratio. We used the 25th and 75th percentiles from these weekly ratios to provide the lower and upper bounds in the model (19.9 and 24.1, respectively). Note that the call-to-hospitalization ratios are independent of population size and thus can be used for any size population. We assumed a direct relationship between severity-specific hospitalization rate and the call-to-hospitalization ratio (Appendix 3, supplemental material). That is, a more severe pandemic will cause more cases to be hospitalized, and we assumed that more people would be seeking care (compared with a less severe pandemic), resulting in a larger number of calls to a nurse triage line system (Appendix 3, supplemental material). To calculate the total number of calls in a given week, we multiplied the estimated number of clinical cases based on attack rate and population size (Appendix 2, supplemental material) by the severity-based hospitalization rate (Table 1) to get the estimated number of hospitalized cases. We then multiplied the estimated number of hospitalized cases by the call-to-hospitalization ratio (Table 1) (Appendix 3, supplemental material, for further details).

Based on the data and experience of the Minnesota FluLine, we built an algorithm into the tool that allows users to account for a surge in calls, for whatever reason, that is added to the calls calculated using just the call-to-hospitalization ratio (additional details in Appendix 3, supplemental material). Since we present results here in which we assume that the nurse triage line would open 1 week prior to pandemic peak, we have not included any additional surge-related effect.

### Classification of Type of Calls

We divided the calls into 3 categories based on the experience of the Minnesota FluLine:<sup>4</sup> We assumed that 22.4% of callers would end their calls after either hearing a standard recorded message with information about influenza and available resources, or the callers would hang up (ie, call ended prematurely). We assumed that another 37.4% of calls would be from people seeking additional influenza information or calls that were either duplicate or non-influenza-related calls, and 40.2% of calls would be from people with influenzalike

illness (ILI) symptoms or reported exposure to someone with influenzalike illness symptoms who would receive further evaluation (Table 1). The number of calls in these last 2 categories are those calls that will need to be handled by information specialists and healthcare professionals. The calls that ended after hearing a recorded message or ended prematurely add to the phone call traffic volume that the nurse triage line telephone system must be configured to handle (Table 1).

## Results

We estimated that a 1968-like pandemic, assuming a 20% attack rate, would generate between 1,551,882 and 3,523,902 total calls nationally per week at the peak week (Table 2). Corresponding estimates (3,905,009 and 8,867,215 total calls) due to a 30% clinical attack rate can be found in Table 3. For a 1957-like pandemic (severity level 4), the equivalent estimates were 2,909,778 and 7,047,804 calls to the nurse triage line at peak pandemic week. Approximately 78% of calls would require a response from either an information specialist or a healthcare professional (ie, callers seeking additional pandemic-related information, or symptomatic callers seeking advice about clinical care for a 1957-like pandemic) (Table 2). The total number of calls during the pandemic will depend on the week chosen for the opening of the nurse triage line system. To determine the total number of calls received during a pandemic, users can either use the tool or add the number of calls listed for each week of the nurse triage line system operations in Tables A1 to A4 in the online supplemental material. We show the distributions of calls over the duration of the pandemic in Figure 1.

## Discussion

Using the call-to-hospitalization ratios model, we estimated that between 10.1 million (low estimate, 20% clinical attack rate, 1968-like pandemic) and 67.9 million (high estimate, 30% clinical attack rate, 1957-like pandemic) total calls could be placed to a national nurse triage line system during an influenza pandemic, depending on how early in the pandemic the system is implemented. Estimates of the nationwide number of calls at the peak week ranged from 1.6 million (1968-like pandemic) to 17.7 million (1957-like pandemic). Based on data from the Minnesota FluLine, current plans for Flu on Call® should expect that approximately 78% (1.01 million and 11.15 million, respectively) would require an information specialist response or both a specialist and healthcare professional response (ie, for callers seeking additional pandemic-related information, or symptomatic callers seeking advice about clinical care).

Our study has several limitations. First, we estimated nationwide call volumes based on hypothetical influenza pandemic curves that were produced to assess the impact of a potential 2013 H7N9 influenza pandemic threat.<sup>5</sup> In addition, we did not factor in local differences in the incidence of disease and the use of interventions, such as prepandemic vaccine, school closings, isolation and treatment of patients with antiviral drugs, and mass vaccination campaigns that may reduce the number of influenza cases and ultimately reduce the call volume.

Third, we based the model on the experience of the Minnesota FluLine nurse triage line, which opened at the peak of the mild to moderate 2009 pandemic and may not accurately reflect call volume during a more severe pandemic. In addition, the Minnesota FluLine operated in a way in the past that may differ from how Flu on Call® will operate in a future pandemic due to the technological changes in communication and healthcare delivery systems.

Fourth, the experience of the Minnesota population may not be generalizable to the entire US population due to the variation in socioeconomic composition of the population. For example, areas with large Hispanic populations might need to plan for bilingual staff.

Fifth, the numbers estimated from this model for the first weeks of operation after activation of the triage line may be conservative, since initial media attention and public announcements might increase interest in the call line and thus increase the number of calls received in those weeks.

Sixth, social media and other influencing factors may have an impact on the uptake of nurse triage line services. However, based on a paucity of such information, these drivers were not included in the model. We were unable, due to lack of suitable data, to estimate the number of personnel needed to operate such a call center. This will require a separate study.

Finally, as mentioned, we were unable to account for any potential surge in calls during the system's initial weeks of operation that may occur because of marketing efforts and media attention to either the influenza pandemic or the Flu on Call® opening.

Despite these limitations, the study and the tool provide initial estimates of the potential demand on a national nursing triage line and can inform the level of preparedness and planning for the next influenza pandemic. Further, users of the tool can easily adjust and adapt these estimates as new information becomes available.

The demand for healthcare services during the next influenza pandemic, particularly if it causes severe illness, will likely be considerable. A national nurse triage line like Flu on Call® will be an essential component of the public health response to ensure timely treatment of sick people and to mitigate possible surges on healthcare facilities.<sup>8,9</sup> The model presented here provides large estimates of the calls that would likely be received nationwide over the course of a pandemic emergency. Based on these estimates, a very large number of staff would be required to operate a national nurse triage line.

However, other methods of managing calls and contacts besides live conversation with an agent are currently being used by medical call centers, including multichannel tools and self-service methods. Meeting the needs of callers through a national nurse triage line at the height of a severe pandemic may need to include the use of self-guided web-based tools, text messaging or chat communications between callers and healthcare professionals, use of nonmedical agents who strictly follow an approved script to manage sick callers,<sup>9</sup> and other strategies that could serve a large number of people in a safe and efficient manner. In addition, these estimates support the rationale for further development of a national nurse triage line for the next influenza pandemic.

## Supplementary Material

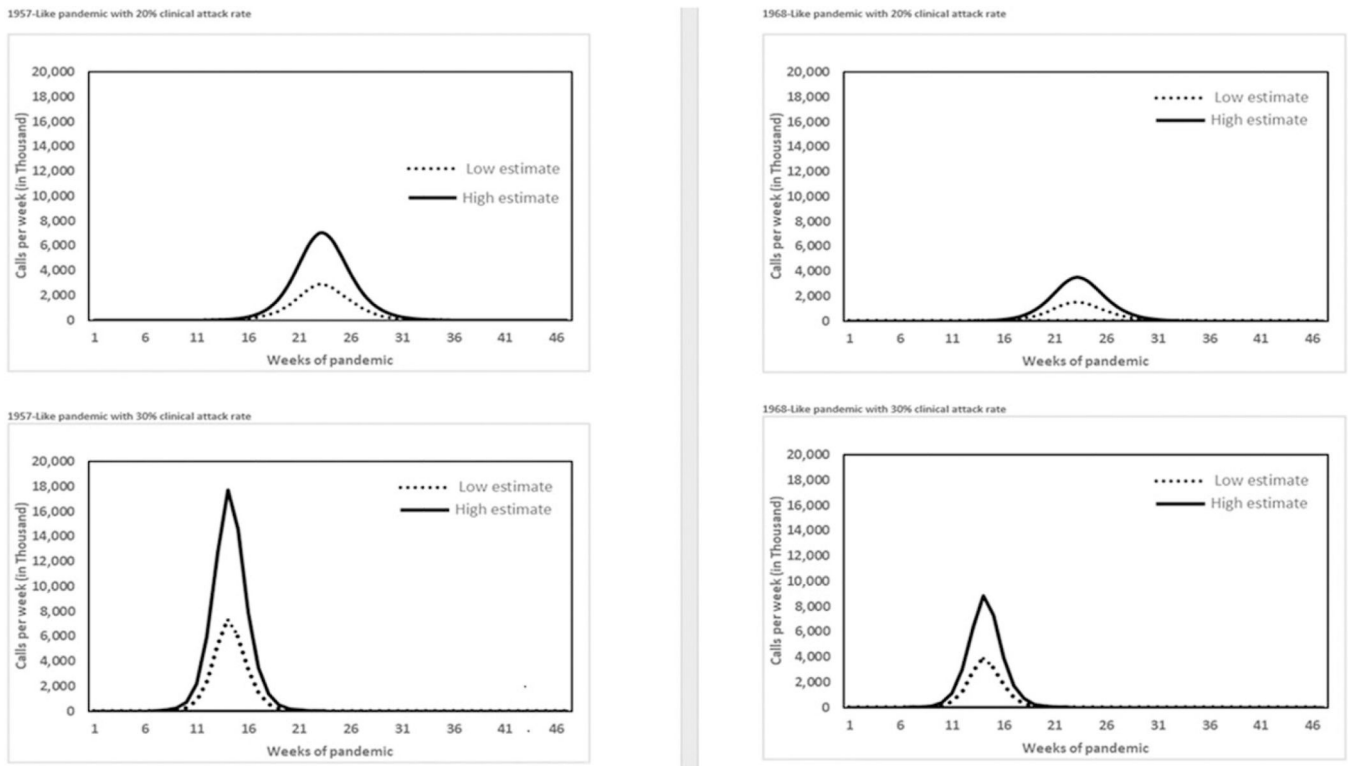
Refer to Web version on PubMed Central for supplementary material.

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**Figure 1.**  
Distribution of Weekly Call Volume in Different Pandemic Scenarios



**Table 1.**

List of model inputs to estimate the call volume to a national nurse triage line during an influenza pandemic

Model Inputs	Parameters	Comment	Source (Ref. #)
<b>Baseline parameters</b>			
Minnesota population	5,303,925	2009 estimate	(7,10)
US population	323,100,000	July 2016 estimate	(7)
Influenza attack rates	20%, 30%	Total % population becoming clinically ill from influenza	(5,7)
Seed (initial) number of influenza cases	10 or 100 cases	Number of clinically ill that initiate the pandemic	(5)
Percentage of calls from symptomatic patients	37.4%	Clinically ill callers seeking care	(4)
Percentage of calls seeking information	40.2%	Callers seeking information about the influenza	(4)
Percentage of calls ended after recorded message or ended prematurely	22.4%	Callers listen to a recorded message, incomplete calls, prank calls, etc.	(4)
<b>Influenza-related parameters</b>			
Influenza severity level (case hospitalization rate)	Severity Level	Descriptor	Case Hospitalization Rate
	Severity (1)	Mild nonpandemic season (2006–07)	0.1%–0.5%
	Severity (2)	2009-like pandemic	0.5%–0.8%
	Severity (3)	1968-like pandemic	0.8%–1.5%
Ratio of calls to nurse triage line to hospitalization	Severity (4)	1957-like pandemic	1.5%–3.0%
	19.9–24.1		Low and high values are 25th and 75th percentiles, respectively, of case hospitalization rate ratios from 2009 Minnesota FluLine
Duration of pandemic (weeks)	29–45 weeks	Shorter duration for 30% clinical attack rate, longer duration for 20% attack rate	Appendix 2

Note. The clinical attack rate in Minnesota due to the 2009 H1N1 pandemic was about 20%,<sup>4,6</sup> For the other pandemic scenarios, in which the clinical attack rate is 30%, we adjusted the number of calls by multiplying them by a factor of 1.5 (ie, assumed a 50% increase in calls compared to what would occur with a 20% attack rate).

Estimated weekly call volume to a national nurse triage line (20% attack rate; 1968- and 1957-like pandemics)<sup>a</sup>

**Table 2.**

Types of Calls	Calls, by Type, at Peak Week of Pandemic			
	1968-like Pandemic <sup>b</sup>		1957-like Pandemic <sup>b</sup>	
	Low Estimate <sup>a,c</sup>	High Estimate <sup>a,c</sup>	Low Estimate <sup>a,c</sup>	High Estimate <sup>a,c</sup>
Information only calls	623,856	1,416,609	1,169,731	2,833,217
Symptomatic calls	580,404	1,317,939	1,088,257	2,635,879
Subtotals: Calls requiring response from information specialist or healthcare professional <sup>d</sup>	1,204,260	2,734,548	2,257,988	5,469,096
Calls ended after recorded message or ended prematurely	347,621	789,354	651,790	1,578,708
Totals all calls at peak	1,551,882	3,523,902	2,909,778	7,047,804

<sup>a</sup> Using a seed starting of 10 cases, duration of pandemic lasts up to 45 weeks, for a 20% attack rate (Appendix 2). Estimates based on US population size of approximately 323 million (Table 1).

<sup>b</sup> 1968-like pandemic = severity level 3; 1957-like pandemic = severity level 4 (Table 1).

<sup>c</sup> Low and high estimates for call-to-hospitalization ratio model derived from lower and upper estimates of hospitalization rates, which depend on influenza severity rate, or pandemic type (Table 1).

<sup>d</sup> Subtotals represent those calls to a national nurse triage line for caller seeking either additional information regarding pandemic influenza or those with symptoms seeking advice regarding treatment. Such calls require operator assistance and response.

Estimated weekly call volume to a national nurse triage line (30% attack rate; 1968- and 1957-like pandemics)<sup>a</sup>

**Table 3.**

Types of Calls	Calls, by Type, at Peak Week of Pandemic					
	1968-like Pandemic <sup>b</sup>		1957-like Pandemic <sup>b</sup>			
	Low Estimate <sup>a,c</sup>	High Estimate <sup>a,c</sup>	Low Estimate <sup>a,c</sup>	High Estimate <sup>a,c</sup>	Low Estimate <sup>a,c</sup>	High Estimate <sup>a,c</sup>
Information-only calls	1,569,814	3,564,621	2,943,400	7,129,241		
Symptomatic calls	1,460,473	3,316,339	2,738,387	6,632,677		
Subtotals: Calls requiring response from information specialist or healthcare professional <sup>d</sup>	3,030,287	6,880,959	5,681,788	13,761,918		
Calls ended after recorded message or ended prematurely	874,722	1,986,256	1,640,104	3,972,513		
Totals all calls at peak	3,905,009	8,867,215	7,321,892	17,734,431		

<sup>a</sup>Using a seed starting of 10 cases, duration of pandemic lasts up to 32 weeks for a 30% attack rate (Appendix 2). Estimates based on US population size of approximately 323 million (Table 1).

<sup>b</sup>1968-like pandemic = severity level 3; 1957-like pandemic = severity level 4 (Table 1).

<sup>c</sup>Low and high estimates for call-to-hospitalization ratio model derived from lower and upper estimates of hospitalization rates, which depend on influenza severity rate, or pandemic type (Table 1).

<sup>d</sup>Subtotals represent those calls to a national nurse triage line for caller seeking either additional information regarding pandemic influenza or those with symptoms seeking advice regarding treatment. Such calls require assistance and response from an information specialist or healthcare professional.