Los Angeles County Pandemic Flu Hospital Surge Planning Model

Findings Report

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Executive Summary

Recent concern over potential acute and unpredictable public health threats have led local disaster officials to consider the healthcare service implications of such emergencies. Despite this concern, there have been few planning tools which quantify the number of patients who cannot receive hospital care due to overwhelming demand (unmet need). To address this gap, a Pandemic Flu Hospital Surge Planning Model (the model) was developed and tested in the Los Angeles (LA) County hospital market.

In the model, two potential 25 week flu pandemic scenarios are considered: moderate and severe. To determine the impact of potential hospital interventions on reducing unmet need, three interventions are modeled: 1) Reduce Elective Admissions (REA), 2) Increase Acute Respiratory Bed Supply (IARBS), and 3) Ignore Insurance Status (IIS). [1] Interventions were modeled as two sets: the first set included two interventions REA and IARBS (two intervention option) the second set added the IIS intervention (three intervention option).

The following summarizes key findings.

Utilization

- Emergency department (ED) visits increase substantially during a pandemic.
- Over a 25 week period, patient days are predicted to increase nearly 10% in a moderate flu scenario and 20% in a severe flu scenario.
- Either intervention option results in a 1% reduction in ED utilization in both moderate and severe flu scenarios.
- The three intervention option results in maximum use of countywide adult intensive care unit (ICU) bed capacity due to the ignore insurance status policy.
- There is greater capacity to serve pediatric patients requiring ICU care than adults; this is due to the availability of pediatric ICU beds at baseline.
- Either intervention option reduces adult medical/surgical (med/surg) bed occupancy rates below baseline values.
- Pediatric med/surg occupancy rates are not affected by either intervention option.
- Compared to baseline, double the number of patients would require ventilators in a severe flu pandemic if all patients needing ICU care were able to receive it.

Unmet need

- 204,000 patients have unmet need during a moderate flu pandemic and 555,000 during a severe pandemic.
- Two intervention (REA + IARBS) option resulted in 14% and 11% reductions in unmet need during moderate and severe flu pandemics respectively.
- In the three intervention option, when the IIS is added, 19% and 12% reductions in unmet need occur during a moderate and severe flu pandemic respectively.
- During a moderate flu pandemic, about 8% of ED patients requiring admission are unable to find a bed compared to 25% during a severe flu scenario.

[1] These interventions were selected by the project's Technical Advisory Committee based on their feasibility and potential for reducing unmet need in LA County.

- Unscheduled adult ICU and pediatric med/surg patients are least likely to find a bed compared to unscheduled patients requiring other bed types.
- In moderate and severe flu scenarios, 13% and 29% of ED patients leave without treatment respectively.

In summary, the flatness of the epidemic curve in the first 6 weeks of the pandemic gives hospitals time to enact the proposed interventions. Absent any intervention, hundreds of thousands of LA County residents will require hospital care during a flu pandemic when no hospital supply is available. The proposed policy interventions are able to decrease unmet need by between 11% and 19% depending on the severity of the pandemic and whether or not all intervention policies are implemented. However, the interventions modeled are not adequate to address the surge in demand caused by a pandemic influenza. The lack of a more substantial impact from the proposed interventions suggests the hospital system alone cannot meet the increase in demand expected during a flu pandemic. Consequently, policymakers need to pursue early, aggressive, targeted and layered community interventions.

Acknowledgments

Technical Advisory Committee

National Health Foundation would like to thank the following members of the LA County Pandemic Flu Hospital Surge Planning Model Technical Advisory Committee for generously lending their expertise and time on this project.

Department of Health Services Los Angeles County: Irene Dyer, Kay Fruhwirth, Jeff Guterman, Peter Katona, Loren Miller & Tamiza Teja

Department of Public Health Los Angeles County: Dee Ann Bagwell, David Dassey, Brandon Dean, Jonathan Freedman, Brit Oiulfstad, Sadina Reynaldo, Virginia Huang Richman, & Wendy Schiffer

Hospital Surge Planning Personnel: Ryan Burgess (Hospital Association of Southern California), Amy Kaji (Harbor-UCLA Medical Center), Julie Kakuda (Kaiser Permanente), Connie Lackey (Providence Health & Services), Charles Pickering (City of Hope Medical Center), & Kathy Stevenson (Childrens Hospital Los Angles)

Introduction

Growing concerns over acute, unpredictable public health emergencies have led to emergency planning at the local health care services and governmental levels. Shocks to hospital systems, like a pandemic flu, may cause temporary surges in demand for hospital care in excess of current supply (e.g., staff, beds, equipment). However, quantifying demand in excess of supply and how surge planning policies can mitigate unmet need has been absent from many preparedness efforts. To address this gap, a Los Angeles County Pandemic Flu Hospital Surge Planning Model (the model) was developed by National Health Foundation (NHF) for Los Angeles (LA) County. Specifically, the LA County Department of Public Health (the County) funded NHF to quantify numbers of residents that will be unable to receive hospital services due to lack of hospital supply as well as test a set of interventions the County may implement during an outbreak to maximize resources and reduce unmet need.

Methods and Assumptions

Model Overview

Constructed using Extend 5.0 simulation software[2], the model simulates how flu and non-flu patients access care at emergency departments (ED) and inpatient wards in more than 100 LA County hospitals.[3] A systems approach is taken in the model. Congestion at one facility can spill over to other facilities as patients move from one hospital to another to get care.

A Technical Advisory Committee (TAC) included representatives from the LA County Departments of Public Health and Health Services as well as hospital surge planning personnel from public and private hospitals in LA County. The TAC reviewed all aspects of the model development. This included discussions about data sources, model assumptions and patient routing rules.

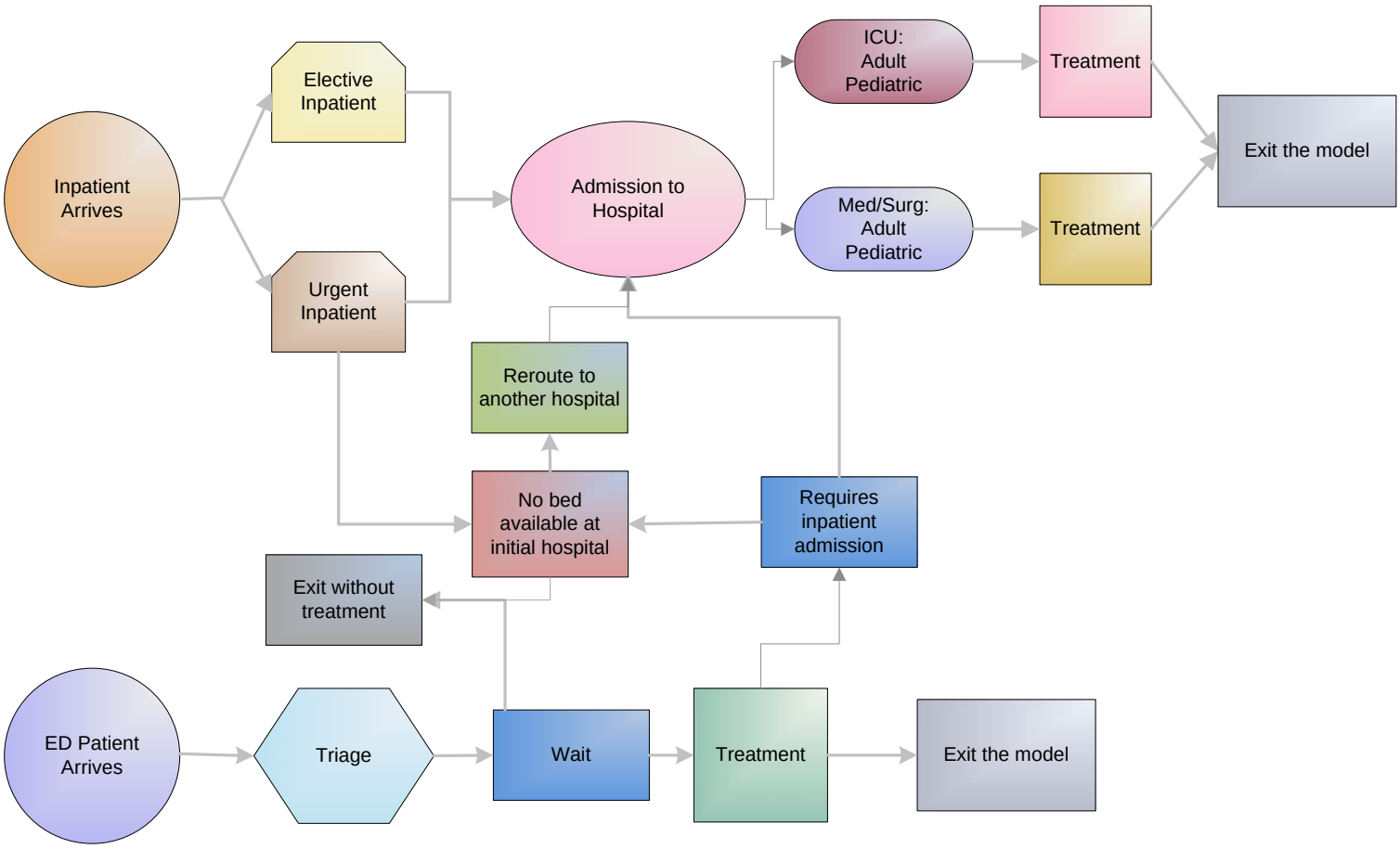
Model Assumptions

In the model, patients arrive at EDs requiring different levels of care or arrive directly at inpatient wards needing scheduled or urgent services (Figure 1). If the hospital can treat the patients immediately, then they will be treated. If not, patients will wait to be treated, or if they require urgent care, will be rerouted to a less congested facility if one exists. The model uses patient-level, hospital-level, and geographic-level data, to route patients to hospitals in the system

[2] Extend 5.0, from Imagine That! Inc., is professional simulation software used to model events occurring in systems and allows users to test the effects of changing system conditions on outcomes.
[3] The current pan flu model was adapted from an earlier model of the LA hospital system called the Impact Model. NHF's Impact Model assessed the consequences of implementing Scenario III of the 2002 Los Angeles County's Department of Health Services' Restructuring Recommendations. Specifically, the Impact model simulated the effect of closing public hospital beds on utilization at hospitals throughout the LA County system. More information on the Impact Model can be found at http://www.nhfca.org/publication.aspx

according to historical utilization patterns, patient demographics and payer type, bed type required, hospital bed capacity, and hospital payer preferences. The model also incorporates weekly flu incidence estimates in Los Angeles County by age and geography from the University of Washington (UW) Community Mitigation Model.[4]

Figure 1. Patient Flow Diagram



Three 25 week models are created: 1) a baseline model in which no pandemic flu occurs, 2) a moderate pandemic (25% of the LA County population becomes ill) and 3) a severe pandemic (35% of the population becomes ill and a greater proportion requires hospital care than in the moderate scenario). In both pandemic flu scenarios, all patients with the flu arrive at the ED. The ED was selected by the TAC as the only initial entry point for flu patients to simplify the model. Flu patients were modeled as having higher acuity, on average, than those without the flu. Also, patients with the flu who required admission to inpatient wards were admitted into either ICU or medical/surgical (med/surg) beds and had longer lengths of stay (LOS), on

[4] The UW Community Mitigation Model was and epidemiologic pandemic flu model funded by the Department of Public Health in Los Angeles County.

average, than patients without the flu, and higher probabilities of requiring a ventilator. The numbers and age distributions of flu patients arriving at EDs and requiring admission each week differ between the moderate and severe flu scenarios but the bed assignment probabilities, LOS, and ventilator probabilities were equivalent.

Staff attrition during a pandemic flu due to illness of hospital personnel and their family members was not explicitly modeled because reliable data on staffing at hospitals was not available. The TAC agreed that during a surge event any available beds would be filled with patients. This assumes that staffing ratios would be relaxed during a surge event and implies standards of care would decline as the ratio of patients to staff increases.[5]

Policy Interventions

Three policies were modeled to determine the impact of hospital interventions on reducing the number of patients who cannot receive hospital care due to overwhelming demand.[6]

1. Reduce Elective Admissions (REA) - Upon reviewing the diagnoses of elective admissions at LA area hospitals, the TAC agreed that 54% of these admissions could be deferred or receive treatment outside the inpatient hospital setting during a crisis (e.g., rehabilitation, knee or hip replacement). When the REA intervention is implemented in the model, 54% of elective admissions arriving at each hospital are denied entry to create more inpatient capacity to serve flu patients.

2. Increase Acute Respiratory Bed Supply (IARBS) - The TAC agreed that adding acute respiratory support beds to hospitals could increase capacity for flu patients. Specifically, half of the difference between hospitals' staffed and licensed med/surg beds were instantaneously added to hospitals during the IARBS intervention during the first week of the flu. These additional beds remained available for use throughout the 25 week pandemic.

3. Ignore Insurance Status (IIS) – Because some patients with inadequate insurance may have difficulty accessing available beds at private hospitals, the IIS intervention was also modeled. In this intervention, if no inpatient bed is available at a hospital, a patient can be rerouted to any nearby hospital with an available bed regardless of their insurance status.

These policies were combined into two sets with each set modeled separately in order to understand differences in the ability of the interventions to reduce unmet need during a pandemic outbreak. The two sets of interventions modeled were: 1) a two intervention option where only the REA and IARBS interventions are enacted (REA+IARBS) and 2) a three intervention option where all proposed interventions are enacted (REA+IARBS+IIS). The IIS

[5] Further information regarding pan flu patient attributes and decision rules used in the model to route patients and other model details are available in the companion Technical Report (http://www.nhfca.org/publication.aspx).

[6] More detailed discussions of the assumptions and methods employed to model the policy interventions can be found in the companion Technical Report (http://www.nhfca.org/publication.aspx).

intervention was added to understand the benefit of potential County mandates that hospitals accept all inpatients during an emergency regardless of their insurance status.

Data Sources

Data sources include the Office of Statewide Hospital Planning and Development (OSHPD) 2006 Utilization, Patient Discharge, and Annual Financial Data sets, 2000 US Census, California Department of Finance Demographic Research Data Files, 2005 Los Angeles Health Survey, University of Washington Los Angeles County Community Mitigation Model, and the Center for Disease Control and Prevention's Flu Surge 2.0 and Flu Aid models (Table 1).

Table 1. Model Data Sources

Data Sources	**Data Used For**
2006 OSHPD Patient Discharge Data	Patient demographic characteristics, inpatient discharges, scheduled status, type of care, insurance status, LOS values
2006 OSHPD Annual Hospital Financial Data	Number and type of hospital beds, ED treatment bays, LOS values
2006 OSHPD Utilization Data	ED visits
2000 US Census SF1 and SF3 Files	Population counts stratified by age, sex, race, ethnicity, income
California Department of Finance Demographic Research Data Files	2006 population estimates stratified by age, sex, race, and ethnicity
NHF 2002 Hospital and ED Survey	Number and type of hospital beds, ED treatment bays, inpatient discharges, ED visits, ED waiting times, ED disposition, and LOS values
2005 Los Angeles Health Survey	Insurance payer status stratified by age, race, sex, and Service Planning Area (SPA) weighted by 2007 Population Estimates Program data
University of Washington Los Angeles County Community Mitigation Model	Weekly incidence of influenza cases by age and SPA
Center for Disease Control and Prevention Flu Aid Model	Age distributions of influenza-related hospitalizations and outpatient visits
Center for Disease Control and Prevention Flu Surge 2.0	Distribution of influenza-related hospital admissions, ICU bed demand and ventilator demand
Census 2000 TIGER/Line® Data17 L.A. County boundaries, 2000	2000 LA County Census block boundaries
ESRI Data and Maps CD, distributed with ArcView® version 8	1999 Zip code boundaries for California
Los Angeles Department of Health Services	SPA boundaries, 2002 Hospital street addresses (geocoded using ArcView® version 8)

Outcomes

Model outcomes can be divided into two categories: 1) Measures of Utilization, and 2) Measures of Unmet Need during a flu pandemic (see Table 2). Measures of utilization included numbers of ED visits, patient days, inpatient occupancy rates, and numbers of patients requiring ventilators. Unmet need measures included numbers of ED and unscheduled patients needing a bed when none are available, and numbers of ED patients leaving the ED without being seen. The model outcomes presented in this report are at the county-level. [7]

Table 2. Model Outcomes

Measures of Utilization	Measures of Unmet Need
1. Total ED visits by acuity 2. Patient-days by bed type 3. Inpatient occupancy rates by bed type 4. Number of patients requiring ventilators by adult/pediatric status	1. Number of ED patients requiring an inpatient bed when none are available by bed type 2. Number of unscheduled patients requiring an inpatient bed when none are available by bed type 3. Number of patients who leave the ED without being treated by acuity

Findings

To understand the impact of a pandemic influenza outbreak on hospital services, this section compares flu scenario estimates (i.e. moderate or severe) to a baseline (i.e. no flu). The baseline scenario was modeled as a 25 week period during 2006 when no pandemic flu occurs. Comparisons during flu scenarios when interventions are implemented (i.e. REA+IARBS or REA+IARBS+IIS) to flu scenarios when no interventions occur are also reported to examine the effect of the intervention policies on utilization and reducing unmet need.

Utilization

ED Utilization

Both pandemic flu scenarios cause large increases in ED utilization volume (Figure 2).[8] Visits to LA County hospital EDs are predicted to increase by 201,800 (15%) in a moderate flu (mod flu) scenario over 25 weeks when no interventions are enacted compared to 2006 LA County hospital utilization (baseline). However, the interventions modeled had minimal impact on

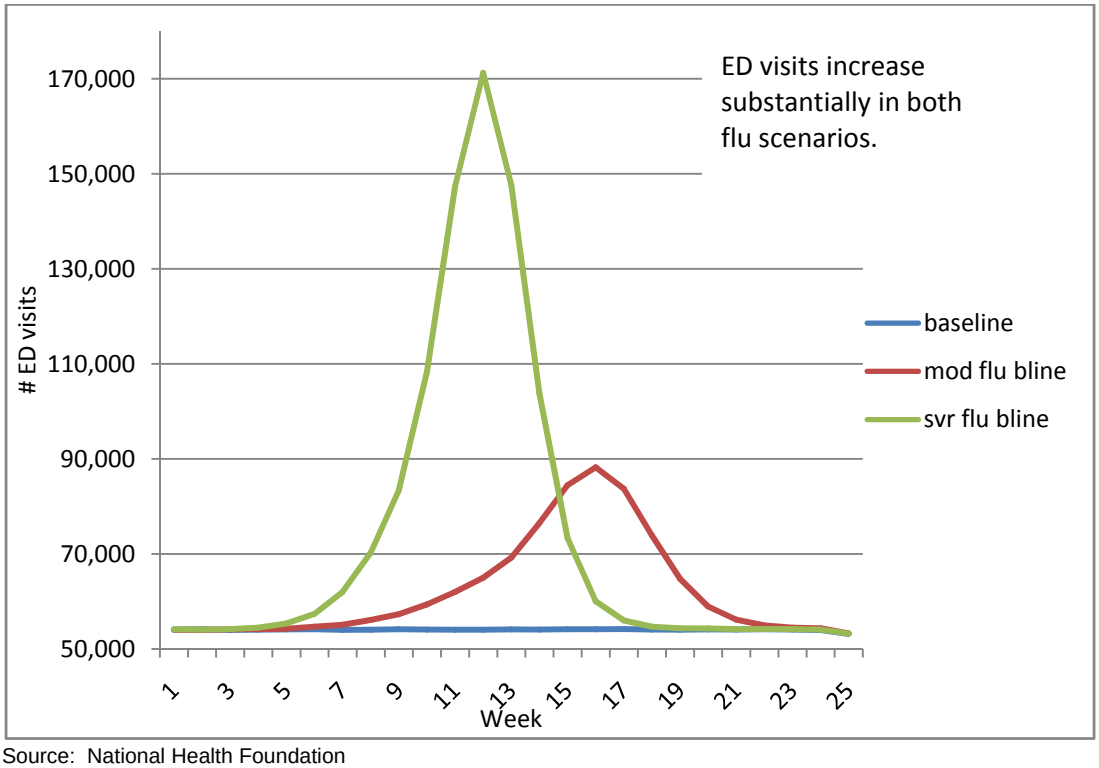
[7] Model outcomes were also analyzed at the service planning area (SPA) and Emergency Medical Services Disaster Resource Center (EMS DRC) level to aid public health and private hospital planners in their disaster preparedness efforts.
[8] Means and 90% confidence intervals for data discussed in the findings section can be found in Appendix A.

reducing ED demand by flu patients. Employing all three intervention options yields a 1% (10,700) reduction in total new ED visits caused by a moderate flu pandemic.

ED visits increased by 494,700 (37%) in the severe flu (svr flu) scenario over 25 weeks with no interventions compared to baseline. Interventions in the severe flu pandemic scenario cause 1% (19,800) reduction in new ED visits.

Estimated increases in ED visits in both scenarios may be overstated if patients stop cycling through EDs when they are looking for care during the later weeks of the flu. This may occur because patients are too sick to go to another ED or because they will be kept and treated in the hospital they visit first. However, the model did not include "worried well", healthy individuals who arrive at EDs believing they are infected with the flu, which could create additional demand for emergency department services. Further, ambulatory care centers and community clinics may close in a pandemic flu, introducing additional demand into the system. The net effect of these are unclear but suggests model estimates of demand may be conservative if the increase of the latter two examples above outweighs any potential decrease in utilization caused when patients are unable to cycle through the ED system during the peak of the flu.

Figure 2. Total ED Visits by Flu Week



Source: National Health Foundation

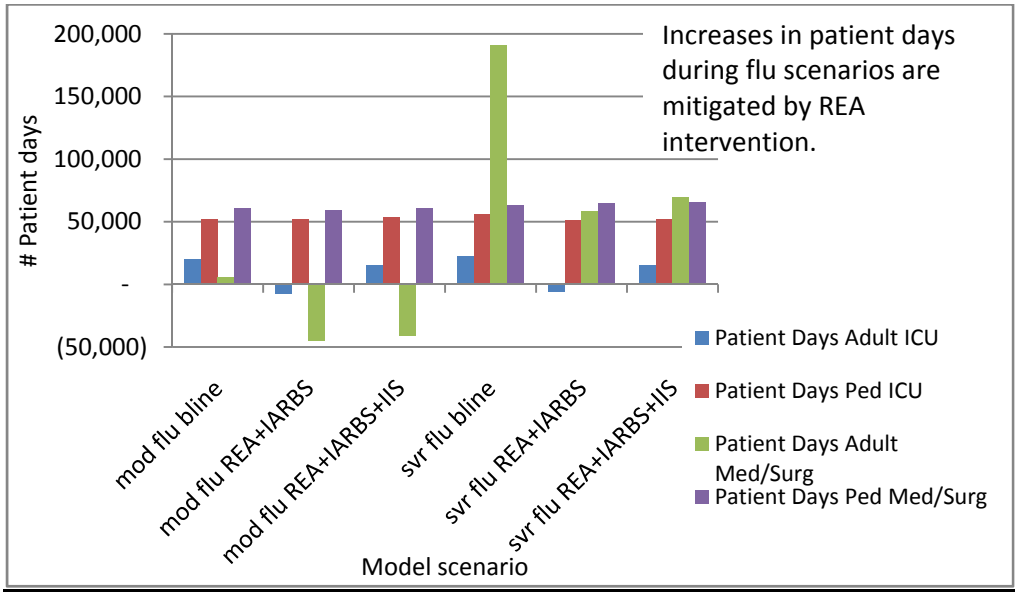
Inpatient Utilization

Total patient days for ICU and med/surg beds increase 138,900 (8%) in a moderate flu scenario over 25 weeks with no intervention compared to baseline (Figure 3). Total patient days for ICU

and med/surg beds increase 332,000 (19%) in the severe flu scenario over 25 weeks with no intervention compared to baseline.

The two intervention option results in 4% (80,100) and 8% (163,500) reductions in patient days during moderate and severe flu scenarios compared to flu scenarios with no intervention. The reductions in patient days when interventions are enacted occur because the REA policy removes 54% of elective patients from the system. Adding the IIS option causes reductions in patient days to diminish as access to available beds increases. Consequently, patient days in the three intervention option are reduced by 2% (48,900) and 6% (129,700) during moderate and severe flu scenarios compared to flu scenarios with no intervention.

Figure 3. Patient Days by Bed Type



Source: National Health Foundation

Inpatient Occupancy Rates

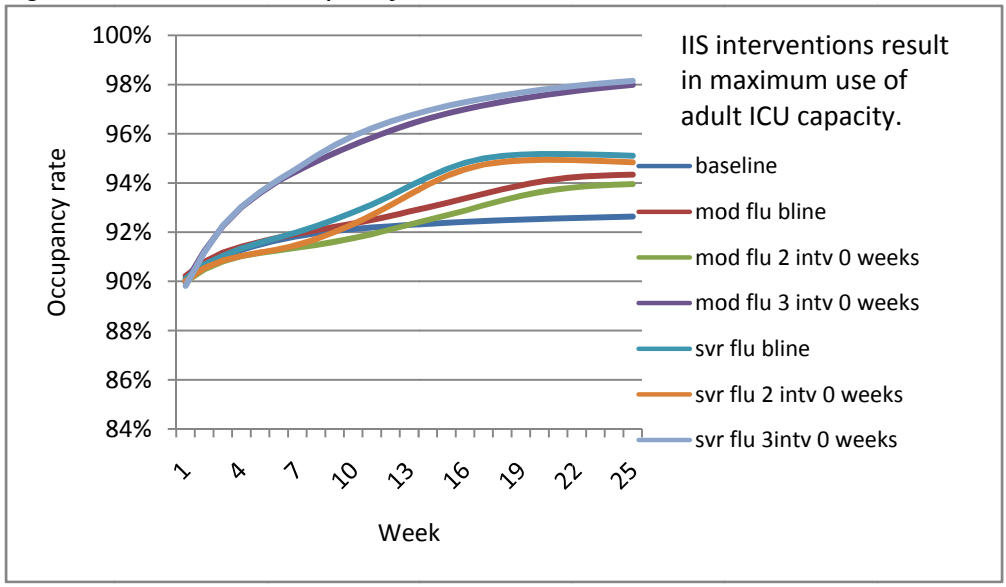
The following figures depict occupancy rates during a moderate and severe flu pandemic for adult ICU, pediatric ICU, adult med/surg, and pediatric med/surg beds.

Adult ICU Beds

Occupancy rates of adult ICU beds in LA County are above 90% at baseline indicating capacity is already near maximum before the flu pandemic begins (Figure 4). The reduce elective admissions (REA) intervention only results in occupancy rate decreases of approximately 0.5% over the course of the pandemic. When the ignore insurance status (IIS) intervention is added, occupancy rates rise rapidly as patients who would not normally present to private hospitals due to insurance mismatches are directly admitted to ICU beds at these hospitals. Patients who normally would have to wait for admission to an ICU bed or would have to travel farther due to their insurance status are able to access beds closer to their arriving hospital and in less time. The result is maximum use of countywide ICU capacity that rises throughout the pandemic, although it is still inadequate to treat all patients requiring ICU level care. Finally, due to long

lengths of stay for ICU patients and congestion in the hospital system in accessing adult ICU beds, occupancy rates in all tested scenarios remain above baseline rates at the end of the pandemic.

Figure 4. Adult ICU Occupancy Rates

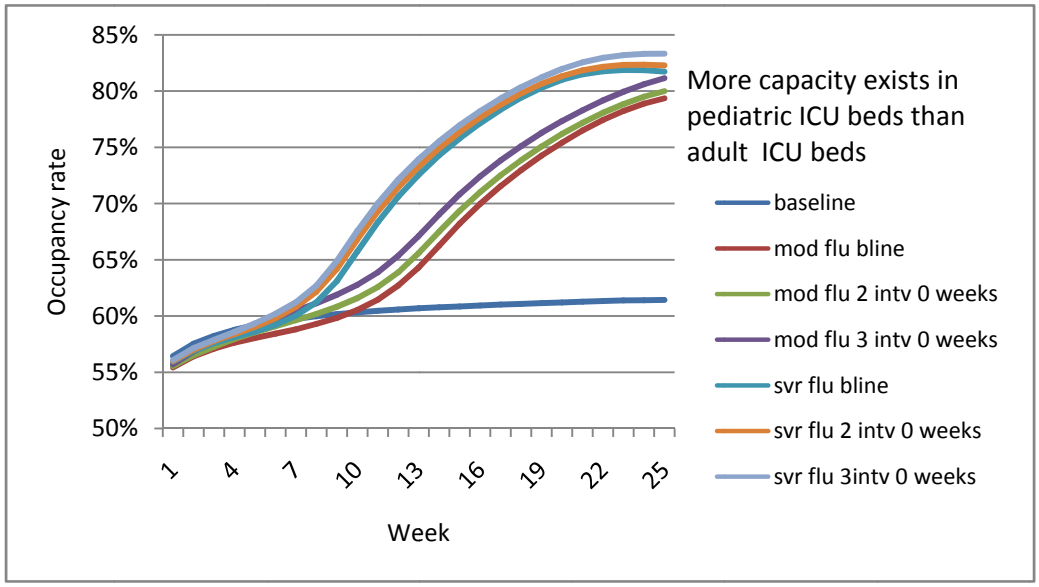


Source: National Health Foundation

Pediatric ICU Beds

Baseline occupancy rates in pediatric ICU beds are lower than adult ICU beds (Figure 5). Unlike adult ICU beds, including the ignore insurance status intervention does not result in occupancy rate increases in the early stages of the pandemic. This suggests there are fewer restrictions to access pediatric ICU beds that arise due to insurance status.

Figure 5. Pediatric ICU Occupancy Rates

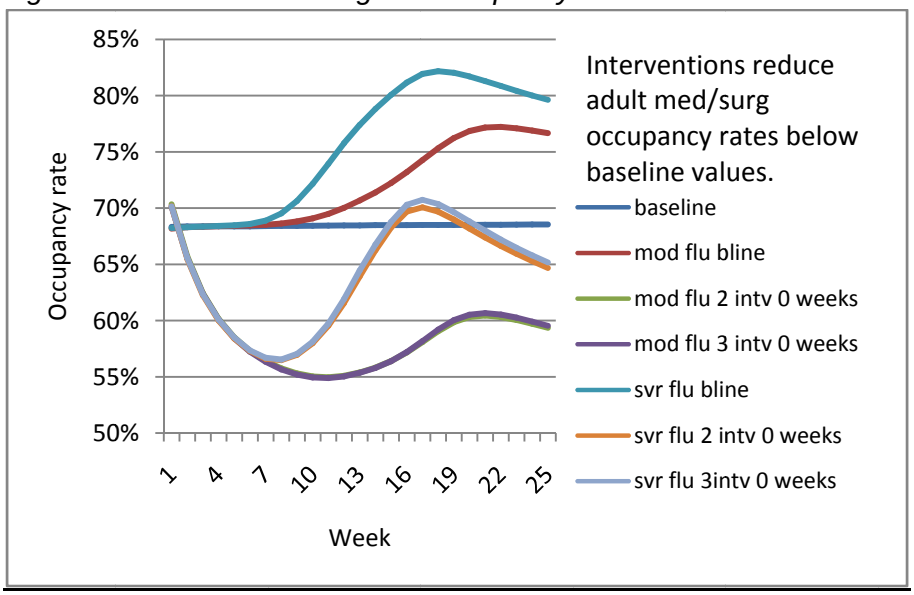


Source: National Health Foundation

Adult Medical/Surgical Beds

During either a moderate or severe flu pandemic without any intervention, adult med/surg occupancy rates peak around 80% (Figure 6). The increase bed supply intervention adds med/surg like beds. These beds, named "acute respiratory support" beds, are added at week zero of the flu to hospitals reporting a discrepancy to OSHPD between their staffed and licensed med/surg beds. As a result, large reductions (10-15%) in adult med/surg occupancy rates occur in intervention scenarios, with resulting occupancy rates at or below baseline values.[9]

Figure 6. Adult Medical/Surgical Occupancy Rates



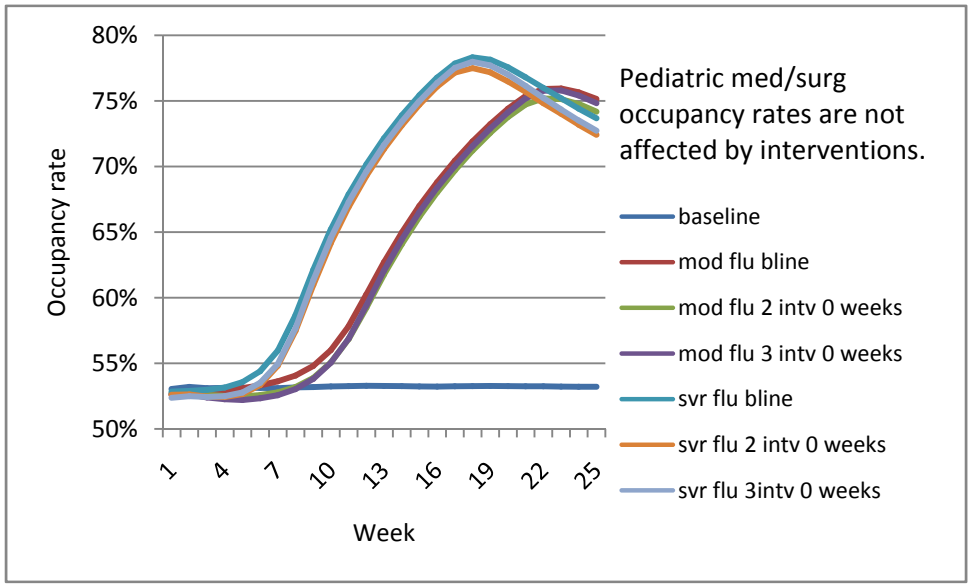
Source: National Health Foundation

Pediatric Medical/Surgical Beds

Few hospitals report differences in the staffed and licensed pediatric med/surg beds. As a result, the intervention of increasing bed supply has little effect on the occupancy rate of this bed type (Figure 7).

[9] However, the denominator of occupancy rates has changed since additional beds are added to the system.

Figure7. Pediatric Medical/Surgical Occupancy Rates

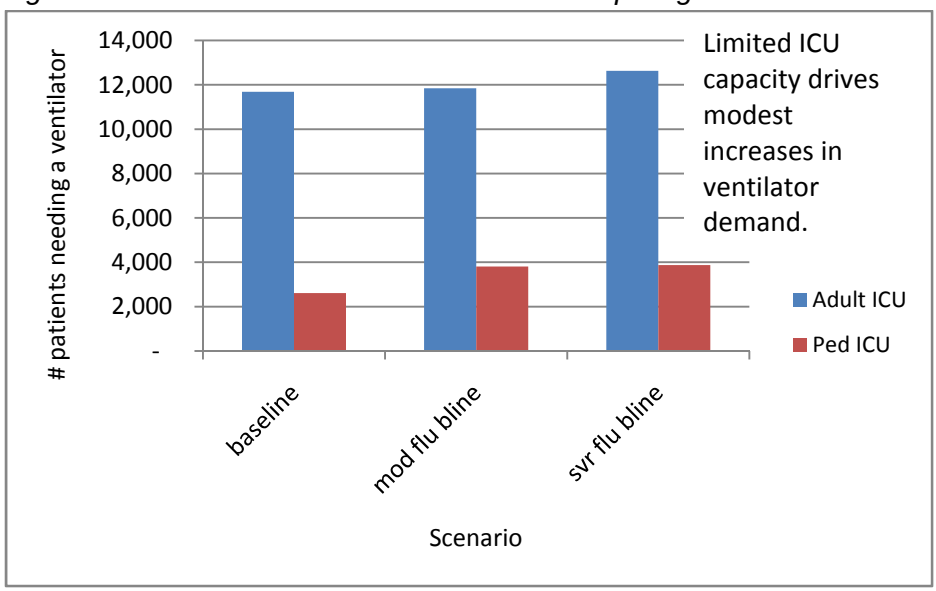


Source: National Health Foundation

Numbers of Patients Requiring Ventilation

During a 25 week baseline non-flu scenario, 14,300 patients in the ICU require ventilation (Figure 8). Limited baseline ICU capacity and increased demand for these beds due to a flu surge results in many patients who need an ICU bed but are unable to find one. Furthermore, the interventions modeled do little to increase ICU capacity (Figures 4 & 5). As such, 1,400 (10%) additional patients who are admitted into an ICU bed will need a ventilator in a moderate flu scenario and 2,200 (15%) in a severe flu scenario.

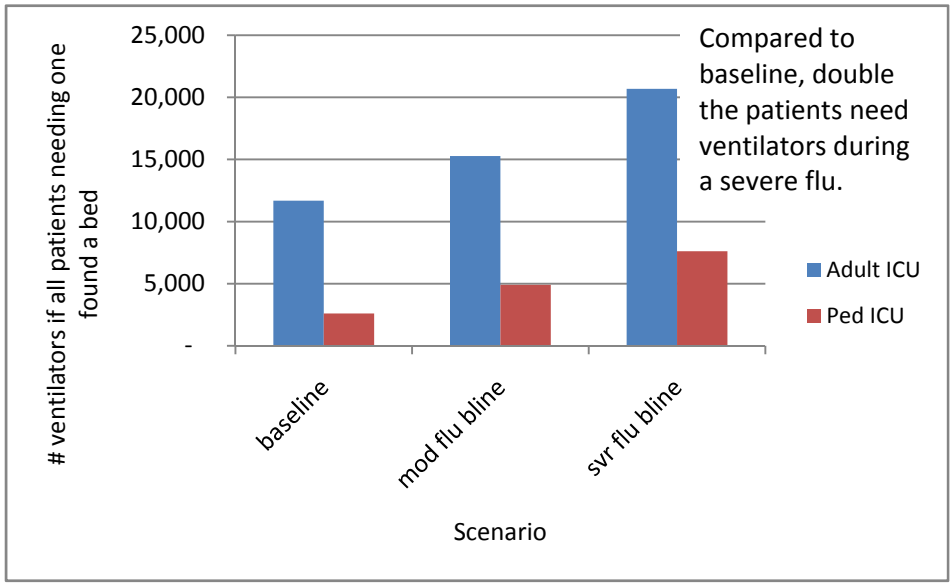
Figure 8. Number of Admitted ICU Patients Requiring a Ventilator



Source: National Health Foundation

If all patients who required an ICU bed were admitted (e.g. capacity to serve all ICU patients existed), an additional 5,900 (49%) ICU patients would need a ventilator during a moderate flu scenario. An additional 14,000 ICU patients would require a ventilator during a severe flu scenario; roughly double the 25 week baseline ventilator demand (see figure 9).

Figure 9. Number of Patients Needing ICU Care and Requiring a Ventilator



Source: National Health Foundation

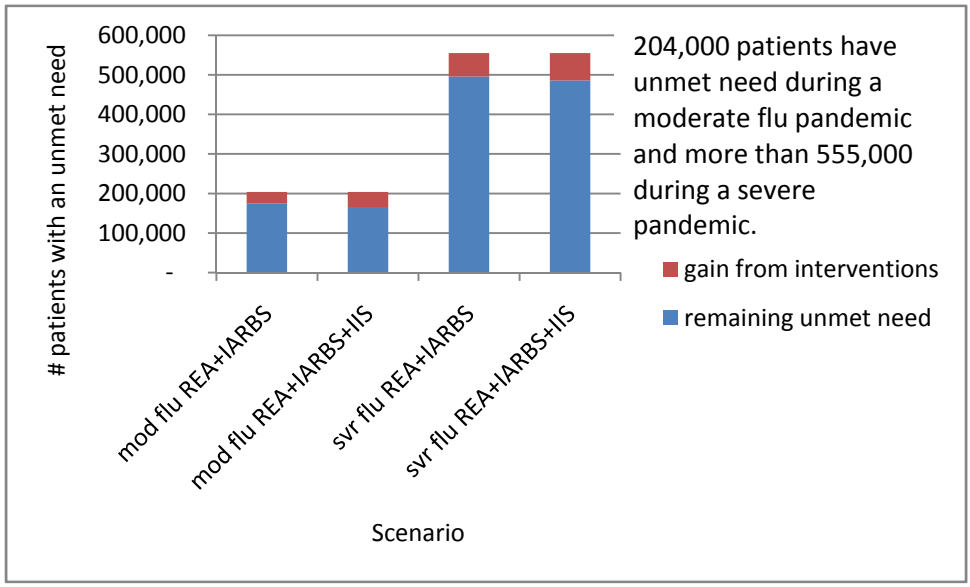
Unmet Need

From a public health standpoint, quantifying the numbers of patients that are unable to be served by the hospital system during a surge event is paramount to preparedness as alternative forms of care will be needed to address the gaps in service coverage. Furthermore, to understand the value of the interventions, it is necessary to understand the extent to which the interventions proposed reduce unmet need.

For the purposes of this report, unmet need is defined as follows: 1) ED patients who require inpatient admission but for whom no beds are available, 2) unscheduled patients for whom no beds are available, and 3) ED patients who leave the ED without being treated. The following section quantifies "total unmet need" combining all measures (i.e., the sum of all three unmet need measures), and each individual unmet need measure.

Hundreds of thousands of LA County residents will have an unmet need during a flu pandemic (Figure 10). Nearly 200,000 patients during a moderate flu pandemic and more than 555,000 patients during a severe flu pandemic are estimated to have unmet needs when no interventions are enacted.

Figure 10. Impact of Interventions on Unmet Need



Source: National Health Foundation

The two intervention (REA + IARBS) option resulted in 14% (28,700) and 11% (59,200) reductions in unmet need during moderate and severe flu pandemics respectively (Table 3). When the IIS option is added, this gain increases by approximately 10,000 patients in both scenarios yielding a 19% (38,300) and 12% (69,100) reduction in unmet need during a moderate and severe flu pandemic respectively. The model estimates for a moderate flu pandemic are concordant with LA County Emergency Medical Services estimates that LA County hospitals have 15-20% surge capacity.[10]

Table 3. Reductions in Unmet Needs by Intervention

Scenario	REA+IARBS	REA+IARBS+IIS
Moderate	14%	19%
Severe	11%	12%

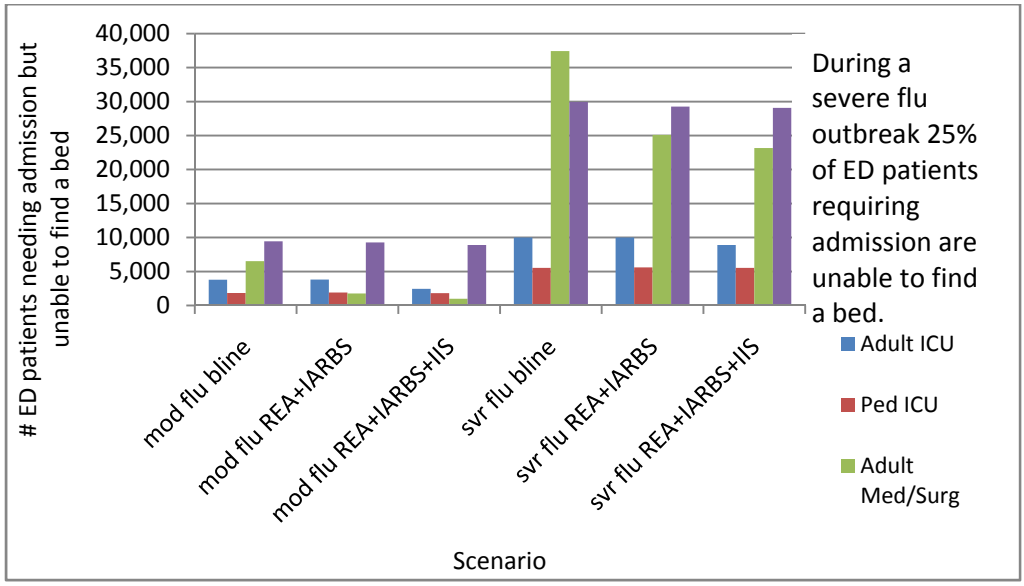
ED Patients Requiring Admission but Unable to Find a Bed

As with the global estimate of unmet need described above, none of the proposed interventions are sufficient to meet the needs of all ED patients requiring admission. Figure 11 shows the bed type distribution of these patients. Over the course of a pandemic, nearly 31,600 ED patients requiring admission (8 % of all patients requiring admission) will be unable to find a bed in a moderate flu scenario. About one in five (4,800) of these patients will be served if only the REA and IARBS interventions are enacted compared to 34% (7,400) if the IIS intervention is added. During a severe flu pandemic, about 82,900, or 25%, ED patients requiring admission will be

[10] Conversation with LA County Department of Health Services Emergency Medical Services on July 2nd, 2009.

unable to find a bed. Of these, 16% (12,900) will be served in the two intervention option compared to 20% (16,300) in the three intervention option.

Figure 11. ED Patients Requiring Admission but Unable to Find a Bed

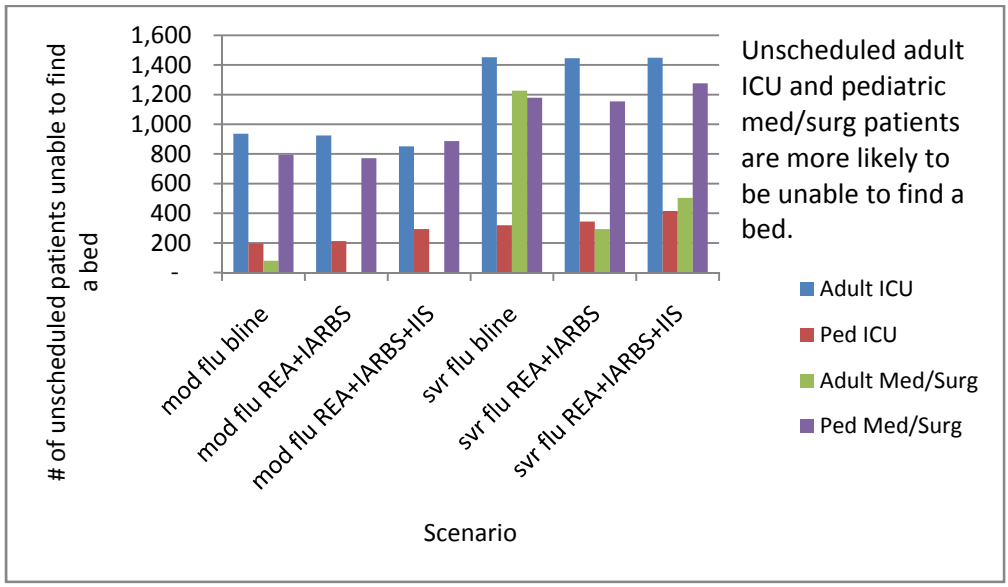


Source: National Health Foundation

Unscheduled Patients Requiring Admission but Unable to Find a Bed

Unscheduled patients (e.g. patients who would be directly admitted into the inpatient ward without first going through the ED) are also impacted by constrained inpatient capacity. The majority of unscheduled patients unable to find a bed during both moderate and severe flu scenarios are adult ICU and pediatric med/surg patients. During a moderate flu scenario, 2,000 unscheduled patients requiring admission will be unable to find a bed (Figure 12). Of these, about 5% (100) will be served if either set of interventions are enacted. For a severe flu scenario, 4,200 unscheduled patients requiring admission will be unable to find a bed. Among these patients, 22% (900) will be treated if the REA and IARBS interventions are enacted compared to 13% (500) if the IIS intervention is added. This last difference results from the IIS intervention allowing more admits from the emergency department into ICU beds which in turn crowds out a small number of unscheduled patients.

Figure 12. Unscheduled Patients Requiring Admission but Unable to Find a Bed

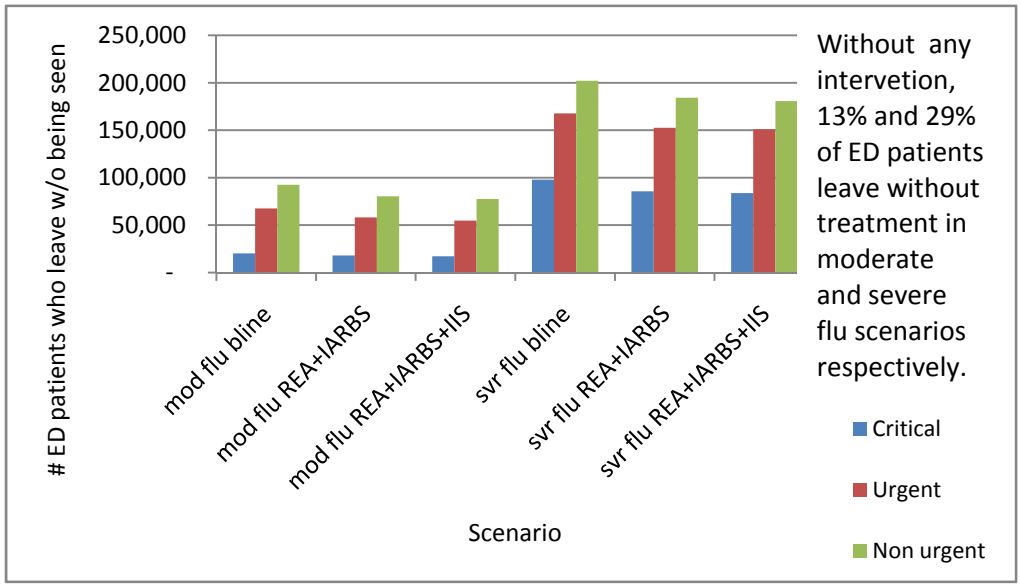


Source: National Health Foundation

ED Patients Who Leave Without Being Treated

As wait times in the ED become protracted due to the congestion caused by a flu pandemic, many patients who need medical care will leave the ED without receiving any treatment. These patients will go home, go to another ED, or go to their primary care doctor to receive treatment or referral to the inpatient wards, and others may die while waiting. In total, 180,400 ED patients (13%) will leave without being seen at least once during a moderate flu scenario when no interventions are enacted (Figure 13). In a severe flu scenario, 467,900 ED patients (29%) will leave without any treatment. The two intervention option results in a 13% (23,800) decrease in unmet need in a moderate flu scenario and a 10% (45,300) reduction in a severe flu scenario. The three intervention option decreases the number of ED patients who would otherwise leave without being seen by 17% (30,800) in a moderate scenario and 11% (53,400) in a severe scenario.

Figure 13. ED Patients Who Leave Without Being Treated



Source: National Health Foundation

Conclusions

This report addresses the paucity of information regarding the intersection of demand for and supply of hospital care during a flu pandemic, the potential consequences of supply-demand imbalance for LA County residents, and the effectiveness of proposed policy interventions aimed at reducing unmet need for hospital services.

Results from the model indicate a close correlation between anticipated surge on hospital resources and the anticipated epidemic curve of the disease. The corresponding flatness of the epidemic curve in the first 6 weeks gives hospitals time to enact the proposed interventions. Absent any intervention, more than 200,000 residents will require hospital care when no hospital supply is available during a moderate flu scenario and more than 555,000 in a severe flu pandemic. The interventions modeled result in 12-19% reductions in this excess demand depending on the severity of the flu and whether or not all three intervention policies (reduce elective admissions, increase acute respiratory bed supply, and ignore insurance status) are implemented. The ignore insurance status policy offers some added benefit, serving about 10,000 additional patients during a pandemic, when added to the two intervention option.

The interventions modeled assume coordination among and participation by all hospitals, emergency services and public health agencies at week one of the pandemic.[11] The difficulty in implementing such a coordinated effort by hospitals should not be understated.

[11] Policy interventions were also modeled beginning 3 weeks after the flu pandemic began to examine the effect of delayed intervention due to poor coordination. Results from this delayed scenario indicated there were no meaningful differences in intervening three weeks after the pandemic begins compared to intervening at week zero due to the flatness of the epidemic curve in the early weeks of the pandemic.

The magnitudes of numbers of Los Angeles County residents who cannot be served by the hospital system even after supply side interventions are implemented demonstrate that alternatives to hospital interventions are essential. Public health officials should pursue interventions targeted at preventing and treating pandemic flu cases in communities in order to reduce hospital demand. Such interventions may include early identification of cases, aggressive pharmaceutical treatment and prophylaxis for the infected and exposed, social distancing policies, screening and treating mild or moderate flu cases in non-hospital based settings and transferring non-critical patients out of hospitals and into non-hospital based settings.

Appendix A. Data Tables

A 1. Total ED visits by flu week

	Baseline			Moderate flu baseline			Moderate flu REA+IARBS			Moderate flu REA+IARBS+IIS		
Flu week	Mean	90% CI		Mean	90% CI		Mean	90% CI		Mean	90% CI	
1	54,107	54,039	54,176	54,090	54,019	54,161	54,039	53,943	54,135	53,845	53,764	53,925
2	54,190	54,105	54,275	54,024	53,948	54,100	54,037	53,957	54,117	53,839	53,771	53,907
3	54,054	53,972	54,137	54,137	54,056	54,218	54,033	53,952	54,115	53,940	53,857	54,024
4	54,060	53,992	54,128	54,222	54,140	54,304	54,186	54,096	54,275	53,972	53,905	54,039
5	54,137	54,048	54,225	54,268	54,171	54,365	54,288	54,213	54,363	54,162	54,093	54,232
6	54,183	54,120	54,245	54,700	54,625	54,776	54,430	54,344	54,516	54,462	54,370	54,554
7	54,029	53,964	54,094	55,133	55,035	55,231	54,939	54,858	55,021	54,981	54,890	55,071
8	54,084	54,004	54,164	56,121	56,033	56,209	55,881	55,768	55,994	55,728	55,637	55,820
9	54,166	54,090	54,243	57,324	57,232	57,415	57,180	57,089	57,271	56,934	56,830	57,038
10	54,108	54,030	54,186	59,392	59,313	59,470	59,103	58,995	59,211	59,050	58,944	59,157
11	54,060	53,967	54,153	62,033	61,941	62,124	61,722	61,640	61,804	61,667	61,560	61,775
12	54,061	53,968	54,153	65,021	64,938	65,105	64,508	64,407	64,608	64,484	64,377	64,590
13	54,136	54,059	54,212	69,254	69,146	69,361	68,891	68,764	69,018	68,865	68,745	68,985
14	54,109	54,016	54,203	76,490	76,398	76,582	75,951	75,802	76,099	75,983	75,840	76,125
15	54,160	54,080	54,240	84,491	84,398	84,585	83,810	83,695	83,925	83,686	83,533	83,840
16	54,180	54,086	54,275	88,256	88,084	88,428	87,170	87,051	87,288	87,129	87,008	87,251
17	54,215	54,104	54,326	83,729	83,605	83,853	82,617	82,472	82,762	82,576	82,457	82,695
18	54,118	54,003	54,234	73,947	73,815	74,079	72,959	72,845	73,072	72,865	72,756	72,974
19	54,070	53,966	54,173	64,813	64,682	64,944	64,172	64,082	64,263	64,000	63,888	64,112
20	54,146	54,065	54,226	58,965	58,861	59,068	58,623	58,543	58,702	58,645	58,535	58,754
21	54,102	54,025	54,178	56,207	56,111	56,303	55,929	55,843	56,014	55,818	55,736	55,899
22	54,172	54,101	54,244	54,983	54,887	55,079	54,834	54,742	54,926	54,789	54,725	54,853
23	54,108	54,015	54,201	54,497	54,417	54,577	54,450	54,374	54,527	54,201	54,108	54,294
24	53,993	53,910	54,077	54,370	54,281	54,459	54,162	54,053	54,271	54,143	54,042	54,244
25	53,189	53,122	53,257	53,313	53,251	53,375	53,284	53,211	53,357	53,342	53,261	53,422

	Baseline			Severe flu baseline			Severe flu REA+IARBS			Severe flu REA+IARBS+IIS		
Flu week	Mean	90% CI		Mean	90% CI		Mean	90% CI		Mean	90% CI	
1	54,107	54,039	54,176	54,172	54,101	54,244	54,017	53,925	54,109	53,927	53,855	53,999
2	54,190	54,105	54,275	54,109	54,034	54,185	54,137	54,039	54,235	53,851	53,764	53,938
3	54,054	53,972	54,137	54,199	54,114	54,283	54,161	54,088	54,234	54,062	53,974	54,150
4	54,060	53,992	54,128	54,526	54,425	54,627	54,451	54,357	54,546	54,398	54,309	54,486
5	54,137	54,048	54,225	55,402	55,328	55,477	55,274	55,205	55,342	55,147	55,078	55,216
6	54,183	54,120	54,245	57,403	57,315	57,491	57,303	57,192	57,415	57,117	57,022	57,212
7	54,029	53,964	54,094	62,015	61,909	62,121	61,645	61,546	61,744	61,548	61,459	61,636
8	54,084	54,004	54,164	70,265	70,137	70,392	69,552	69,413	69,691	69,547	69,439	69,654
9	54,166	54,090	54,243	83,438	83,325	83,551	82,599	82,512	82,687	82,671	82,529	82,812
10	54,108	54,030	54,186	108,199	108,066	108,332	106,609	106,492	106,726	106,822	106,698	106,947
11	54,060	53,967	54,153	147,302	147,179	147,424	145,000	144,872	145,128	144,628	144,474	144,782
12	54,061	53,968	54,153	171,273	171,127	171,420	168,893	168,694	169,091	168,721	168,548	168,895
13	54,136	54,059	54,212	147,595	147,445	147,744	145,478	145,325	145,632	145,924	145,758	146,090
14	54,109	54,016	54,203	103,852	103,718	103,985	101,340	101,213	101,467	101,318	101,181	101,454
15	54,160	54,080	54,240	73,364	73,235	73,493	71,275	71,155	71,394	71,036	70,937	71,135
16	54,180	54,086	54,275	60,064	59,984	60,145	59,202	59,112	59,293	59,112	59,023	59,201
17	54,215	54,104	54,326	56,011	55,908	56,113	55,657	55,583	55,731	55,486	55,411	55,560
18	54,118	54,003	54,234	54,706	54,630	54,782	54,368	54,283	54,452	54,467	54,371	54,564
19	54,070	53,966	54,173	54,380	54,292	54,468	54,294	54,215	54,372	54,103	53,995	54,212
20	54,146	54,065	54,226	54,332	54,259	54,406	54,165	54,087	54,243	53,971	53,912	54,030
21	54,102	54,025	54,178	54,201	54,115	54,288	54,034	53,933	54,136	53,976	53,887	54,065
22	54,172	54,101	54,244	54,216	54,096	54,335	54,012	53,922	54,101	53,947	53,838	54,057
23	54,108	54,015	54,201	54,208	54,124	54,291	54,046	53,971	54,120	53,909	53,807	54,010
24	53,993	53,910	54,077	54,118	54,043	54,192	53,986	53,888	54,085	53,928	53,849	54,008
25	53,189	53,122	53,257	53,251	53,160	53,343	53,179	53,106	53,252	53,232	53,154	53,310

A 2. Patient days by bed type

	Baseline			Moderate flu baseline			Moderate flu REA+IARBS			Moderate flu REA+IARBS+IIS		
Bed type	Mean	90% CI		Mean	90% CI		Mean	90% CI		Mean	90% CI	
Adult ICU	391,315	390,516	392,114	411,433	410,442	412,424	383,948	383,328	384,568	407,002	406,097	407,907
Pediatric ICU	118,991	118,228	119,755	170,629	173,800	174,687	170,629	170,034	171,224	172,250	171,587	172,913
Adult med/surg	1,192,532	1,191,543	1,193,521	1,198,199	1,331,069	1,333,306	1,147,168	1,146,094	1,148,242	1,151,575	1,150,496	1,152,654
Pediatric med/surg	91,217	90,875	91,559	151,650	151,296	152,003	150,081	149,754	150,409	152,170	151,804	152,535

	Baseline			Severe flu baseline			Severe flu REA+IARBS			Severe flu REA+IARBS+IIS		
Bed type	Mean	90% CI		Mean	90% CI		Mean	90% CI		Mean	90% CI	
Adult ICU	391,315	390,516	392,114	413,468	412,713	414,224	385,038	384,394	385,681	406,828	406,297	407,360
Pediatric ICU	118,991	118,228	119,755	174,756	174,184	175,328	170,551	169,832	171,271	170,658	169,950	171,366
Adult med/surg	1,192,532	1,191,543	1,193,521	1,383,276	1,382,356	1,384,197	1,251,248	1,250,420	1,252,076	1,262,256	1,261,238	1,263,274
Pediatric med/surg	91,217	90,875	91,559	154,836	154,470	155,202	156,046	155,762	156,331	156,935	156,606	157,263

A 3. Adult ICU occupancy rates

	Baseline			Moderate flu baseline			Moderate flu REA+IARBS			Moderate flu REA+IARBS+IIS		
Flu week	Mean	90% CI		Mean	90% CI		Mean	90% CI		Mean	90% CI	
1	90.1%	89.8%	90.3%	90.2%	90.0%	90.4%	90.0%	89.7%	90.3%	90.0%	89.7%	90.2%
2	90.7%	90.5%	90.9%	90.8%	90.6%	91.0%	90.5%	90.2%	90.8%	91.2%	91.0%	91.5%
3	91.0%	90.8%	91.2%	91.2%	91.0%	91.4%	90.8%	90.5%	91.1%	92.2%	92.0%	92.5%
4	91.3%	91.1%	91.5%	91.4%	91.2%	91.6%	91.0%	90.8%	91.3%	93.0%	92.8%	93.3%
5	91.5%	91.3%	91.7%	91.6%	91.4%	91.8%	91.2%	90.9%	91.4%	93.6%	93.4%	93.8%
6	91.7%	91.5%	91.8%	91.8%	91.6%	92.0%	91.3%	91.1%	91.5%	94.1%	93.9%	94.3%
7	91.8%	91.7%	92.0%	91.9%	91.8%	92.1%	91.4%	91.2%	91.6%	94.5%	94.3%	94.7%
8	92.0%	91.8%	92.1%	92.1%	91.9%	92.2%	91.5%	91.3%	91.7%	94.9%	94.7%	95.1%
9	92.1%	91.9%	92.2%	92.2%	92.1%	92.4%	91.6%	91.4%	91.8%	95.2%	95.0%	95.4%
10	92.1%	92.0%	92.3%	92.3%	92.2%	92.5%	91.8%	91.6%	91.9%	95.5%	95.4%	95.7%
11	92.2%	92.1%	92.3%	92.5%	92.4%	92.6%	91.9%	91.8%	92.1%	95.8%	95.7%	96.0%
12	92.2%	92.1%	92.4%	92.7%	92.5%	92.8%	92.1%	92.0%	92.3%	96.1%	96.0%	96.3%
13	92.3%	92.2%	92.4%	92.8%	92.7%	93.0%	92.3%	92.2%	92.4%	96.4%	96.3%	96.5%
14	92.3%	92.2%	92.4%	93.0%	92.9%	93.1%	92.5%	92.4%	92.6%	96.6%	96.5%	96.7%
15	92.4%	92.3%	92.5%	93.2%	93.1%	93.3%	92.7%	92.6%	92.8%	96.8%	96.7%	96.9%
16	92.4%	92.3%	92.5%	93.4%	93.3%	93.5%	92.9%	92.8%	93.0%	97.0%	96.9%	97.1%
17	92.5%	92.3%	92.6%	93.6%	93.5%	93.7%	93.1%	93.0%	93.2%	97.2%	97.0%	97.3%
18	92.5%	92.4%	92.6%	93.7%	93.6%	93.8%	93.3%	93.2%	93.4%	97.3%	97.2%	97.4%
19	92.5%	92.4%	92.6%	93.9%	93.8%	94.0%	93.5%	93.4%	93.6%	97.4%	97.3%	97.5%

	Baseline			Moderate flu baseline			Moderate flu REA+IARBS			Moderate flu REA+IARBS+IIS		
Flu week	Mean	90% CI		Mean	90% CI		Mean	90% CI		Mean	90% CI	
20	92.5%	92.4%	92.6%	94.0%	94.0%	94.1%	93.6%	93.5%	93.7%	97.5%	97.5%	97.6%
21	92.6%	92.4%	92.7%	94.2%	94.1%	94.2%	93.7%	93.7%	93.8%	97.7%	97.6%	97.7%
22	92.6%	92.5%	92.7%	94.2%	94.2%	94.3%	93.8%	93.8%	93.9%	97.7%	97.7%	97.8%
23	92.6%	92.5%	92.7%	94.3%	94.2%	94.4%	93.9%	93.8%	94.0%	97.8%	97.8%	97.9%
24	92.6%	92.5%	92.7%	94.3%	94.2%	94.4%	93.9%	93.9%	94.0%	97.9%	97.8%	98.0%
25	92.6%	92.5%	92.7%	94.3%	94.3%	94.4%	94.0%	93.9%	94.0%	98.0%	97.9%	98.1%

	Baseline			Severe flu baseline			Severe flu REA+IARBS			Severe flu REA+IARBS+IIS		
Flu week	Mean	90% CI		Mean	90% CI		Mean	90% CI		Mean	90% CI	
1	90.1%	89.8%	90.3%	90.1%	89.9%	90.4%	90.0%	89.8%	90.2%	89.8%	89.5%	90.1%
2	90.7%	90.5%	90.9%	90.7%	90.5%	90.9%	90.5%	90.3%	90.8%	91.2%	90.9%	91.5%
3	91.0%	90.8%	91.2%	91.0%	90.9%	91.2%	90.8%	90.6%	91.1%	92.3%	92.0%	92.6%
4	91.3%	91.1%	91.5%	91.3%	91.2%	91.5%	91.0%	90.8%	91.2%	93.0%	92.7%	93.3%
5	91.5%	91.3%	91.7%	91.6%	91.4%	91.7%	91.2%	91.0%	91.4%	93.6%	93.4%	93.9%
6	91.7%	91.5%	91.8%	91.8%	91.6%	91.9%	91.3%	91.1%	91.5%	94.1%	93.9%	94.4%
7	91.8%	91.7%	92.0%	92.0%	91.8%	92.2%	91.5%	91.3%	91.6%	94.6%	94.4%	94.8%
8	92.0%	91.8%	92.1%	92.2%	92.1%	92.4%	91.7%	91.6%	91.9%	95.1%	94.9%	95.3%
9	92.1%	91.9%	92.2%	92.5%	92.4%	92.7%	92.0%	91.9%	92.2%	95.5%	95.4%	95.7%
10	92.1%	92.0%	92.3%	92.8%	92.7%	92.9%	92.3%	92.2%	92.5%	95.9%	95.7%	96.1%
11	92.2%	92.1%	92.3%	93.1%	93.0%	93.2%	92.7%	92.6%	92.8%	96.2%	96.1%	96.4%

	Baseline			Severe flu baseline			Severe flu REA+IARBS			Severe flu REA+IARBS+IIS		
Flu week	Mean	90% CI		Mean	90% CI		Mean	90% CI		Mean	90% CI	
12	92.2%	92.1%	92.4%	93.5%	93.4%	93.6%	93.1%	93.0%	93.2%	96.5%	96.4%	96.6%
13	92.3%	92.2%	92.4%	93.9%	93.8%	94.0%	93.5%	93.4%	93.6%	96.7%	96.6%	96.9%
14	92.3%	92.2%	92.4%	94.2%	94.1%	94.3%	93.9%	93.8%	94.0%	96.9%	96.8%	97.1%
15	92.4%	92.3%	92.5%	94.6%	94.5%	94.6%	94.3%	94.2%	94.4%	97.1%	97.0%	97.2%
16	92.4%	92.3%	92.5%	94.8%	94.7%	94.9%	94.6%	94.5%	94.6%	97.3%	97.2%	97.4%
17	92.5%	92.3%	92.6%	95.0%	94.9%	95.1%	94.8%	94.7%	94.8%	97.4%	97.3%	97.5%
18	92.5%	92.4%	92.6%	95.1%	95.0%	95.2%	94.9%	94.8%	94.9%	97.6%	97.5%	97.7%
19	92.5%	92.4%	92.6%	95.2%	95.1%	95.2%	94.9%	94.8%	95.0%	97.7%	97.6%	97.8%
20	92.5%	92.4%	92.6%	95.2%	95.1%	95.2%	94.9%	94.9%	95.0%	97.8%	97.7%	97.9%
21	92.6%	92.4%	92.7%	95.2%	95.1%	95.3%	94.9%	94.9%	95.0%	97.9%	97.8%	98.0%
22	92.6%	92.5%	92.7%	95.2%	95.1%	95.2%	94.9%	94.9%	95.0%	98.0%	97.9%	98.0%
23	92.6%	92.5%	92.7%	95.2%	95.1%	95.2%	94.9%	94.8%	95.0%	98.0%	97.9%	98.1%
24	92.6%	92.5%	92.7%	95.1%	95.1%	95.2%	94.9%	94.8%	94.9%	98.1%	98.0%	98.2%
25	92.6%	92.5%	92.7%	95.1%	95.0%	95.2%	94.8%	94.8%	94.9%	98.1%	98.1%	98.2%

A 4. Pediatric ICU occupancy rates

	Baseline			Moderate flu baseline			Moderate flu REA+IARBS			Moderate flu REA+IARBS+IIS		
Flu week	Mean	90% CI		Mean	90% CI		Mean	90% CI		Mean	90% CI	
1	56.4%	55.9%	57.0%	55.4%	54.9%	56.0%	55.6%	55.0%	56.1%	55.7%	55.3%	56.1%
2	57.5%	57.0%	58.1%	56.4%	55.9%	57.0%	56.5%	55.9%	57.1%	56.8%	56.4%	57.3%
3	58.2%	57.7%	58.7%	57.1%	56.6%	57.6%	57.3%	56.7%	57.8%	57.7%	57.3%	58.1%
4	58.8%	58.3%	59.3%	57.6%	57.2%	58.1%	58.0%	57.4%	58.5%	58.4%	58.0%	58.9%
5	59.2%	58.7%	59.7%	58.1%	57.6%	58.5%	58.5%	58.0%	59.1%	59.1%	58.7%	59.6%
6	59.5%	59.0%	60.0%	58.4%	58.0%	58.9%	59.1%	58.5%	59.6%	59.8%	59.3%	60.2%
7	59.8%	59.3%	60.2%	58.8%	58.4%	59.3%	59.6%	59.1%	60.2%	60.5%	60.0%	60.9%
8	60.0%	59.5%	60.4%	59.3%	58.9%	59.7%	60.2%	59.6%	60.7%	61.1%	60.7%	61.6%
9	60.2%	59.7%	60.6%	59.8%	59.4%	60.2%	60.8%	60.3%	61.4%	61.9%	61.5%	62.3%
10	60.3%	59.9%	60.8%	60.5%	60.1%	60.9%	61.6%	61.1%	62.1%	62.8%	62.4%	63.1%
11	60.5%	60.0%	60.9%	61.4%	61.1%	61.8%	62.6%	62.1%	63.1%	63.9%	63.5%	64.2%
12	60.6%	60.2%	61.0%	62.7%	62.3%	63.1%	63.9%	63.4%	64.3%	65.4%	65.0%	65.7%
13	60.7%	60.3%	61.1%	64.3%	63.9%	64.7%	65.6%	65.2%	66.1%	67.1%	66.8%	67.5%
14	60.8%	60.4%	61.2%	66.3%	65.9%	66.6%	67.5%	67.1%	67.9%	69.0%	68.7%	69.4%
15	60.9%	60.5%	61.2%	68.2%	67.9%	68.6%	69.4%	69.0%	69.8%	70.8%	70.5%	71.1%
16	60.9%	60.6%	61.3%	70.0%	69.6%	70.3%	71.0%	70.6%	71.4%	72.4%	72.1%	72.7%
17	61.0%	60.7%	61.4%	71.6%	71.2%	71.9%	72.5%	72.2%	72.9%	73.8%	73.6%	74.1%
18	61.1%	60.7%	61.5%	73.0%	72.7%	73.3%	73.9%	73.5%	74.2%	75.1%	74.8%	75.4%
19	61.1%	60.8%	61.5%	74.3%	74.0%	74.5%	75.1%	74.7%	75.4%	76.3%	76.0%	76.5%

	Baseline			Moderate flu baseline			Moderate flu REA+IARBS			Moderate flu REA+IARBS+IIS		
Flu week	Mean	90% CI		Mean	90% CI		Mean	90% CI		Mean	90% CI	
20	61.2%	60.9%	61.6%	75.4%	75.2%	75.7%	76.2%	75.9%	76.5%	77.3%	77.1%	77.6%
21	61.3%	60.9%	61.6%	76.5%	76.2%	76.8%	77.2%	76.9%	77.5%	78.3%	78.1%	78.5%
22	61.3%	61.0%	61.7%	77.4%	77.2%	77.7%	78.1%	77.8%	78.4%	79.2%	79.0%	79.4%
23	61.4%	61.1%	61.7%	78.2%	78.0%	78.5%	78.9%	78.6%	79.1%	79.9%	79.7%	80.2%
24	61.4%	61.1%	61.7%	78.9%	78.7%	79.1%	79.5%	79.2%	79.8%	80.6%	80.4%	80.8%
25	61.4%	61.1%	61.8%	79.4%	79.1%	79.6%	80.0%	79.7%	80.3%	81.2%	81.0%	81.4%

	Baseline			Severe flu baseline			Severe flu REA+IARBS			Severe flu REA+IARBS+IIS		
Flu week	Mean	90% CI		Mean	90% CI		Mean	90% CI		Mean	90% CI	
1	56.4%	55.9%	57.0%	55.9%	55.4%	56.5%	56.0%	55.5%	56.5%	56.1%	55.4%	56.8%
2	57.5%	57.0%	58.1%	56.9%	56.4%	57.4%	57.0%	56.6%	57.4%	57.2%	56.5%	57.8%
3	58.2%	57.7%	58.7%	57.6%	57.1%	58.1%	57.8%	57.4%	58.2%	57.9%	57.2%	58.5%
4	58.8%	58.3%	59.3%	58.1%	57.6%	58.6%	58.4%	58.0%	58.8%	58.6%	57.9%	59.2%
5	59.2%	58.7%	59.7%	58.6%	58.1%	59.1%	59.1%	58.6%	59.5%	59.3%	58.7%	59.9%
6	59.5%	59.0%	60.0%	59.2%	58.7%	59.7%	59.8%	59.4%	60.2%	60.2%	59.6%	60.8%
7	59.8%	59.3%	60.2%	60.0%	59.6%	60.5%	60.8%	60.4%	61.2%	61.2%	60.7%	61.8%
8	60.0%	59.5%	60.4%	61.2%	60.8%	61.6%	62.2%	61.7%	62.6%	62.7%	62.2%	63.2%
9	60.2%	59.7%	60.6%	63.1%	62.7%	63.5%	64.2%	63.8%	64.6%	64.9%	64.4%	65.4%
10	60.3%	59.9%	60.8%	65.7%	65.3%	66.1%	66.8%	66.4%	67.2%	67.6%	67.1%	68.0%
11	60.5%	60.0%	60.9%	68.3%	68.0%	68.7%	69.3%	68.9%	69.6%	70.0%	69.6%	70.4%

	Baseline			Severe flu baseline			Severe flu REA+IARBS			Severe flu REA+IARBS+IIS		
Flu week	Mean	90% CI		Mean	90% CI		Mean	90% CI		Mean	90% CI	
12	60.6%	60.2%	61.0%	70.6%	70.3%	70.9%	71.4%	71.1%	71.8%	72.1%	71.7%	72.5%
13	60.7%	60.3%	61.1%	72.6%	72.3%	72.9%	73.3%	73.0%	73.6%	74.0%	73.6%	74.3%
14	60.8%	60.4%	61.2%	74.3%	74.0%	74.6%	74.9%	74.6%	75.2%	75.5%	75.2%	75.9%
15	60.9%	60.5%	61.2%	75.8%	75.5%	76.1%	76.4%	76.1%	76.6%	77.0%	76.6%	77.3%
16	60.9%	60.6%	61.3%	77.1%	76.9%	77.4%	77.7%	77.4%	77.9%	78.2%	77.9%	78.5%
17	61.0%	60.7%	61.4%	78.4%	78.1%	78.6%	78.8%	78.5%	79.0%	79.3%	79.0%	79.6%
18	61.1%	60.7%	61.5%	79.4%	79.2%	79.6%	79.8%	79.6%	80.0%	80.4%	80.1%	80.6%
19	61.1%	60.8%	61.5%	80.3%	80.1%	80.5%	80.7%	80.4%	80.9%	81.2%	81.0%	81.5%
20	61.2%	60.9%	61.6%	81.0%	80.8%	81.2%	81.3%	81.1%	81.6%	82.0%	81.7%	82.2%
21	61.3%	60.9%	61.6%	81.5%	81.3%	81.7%	81.8%	81.6%	82.1%	82.6%	82.3%	82.8%
22	61.3%	61.0%	61.7%	81.8%	81.6%	82.0%	82.2%	82.0%	82.4%	83.0%	82.7%	83.2%
23	61.4%	61.1%	61.7%	81.9%	81.7%	82.1%	82.3%	82.1%	82.5%	83.2%	82.9%	83.5%
24	61.4%	61.1%	61.7%	81.9%	81.7%	82.1%	82.4%	82.1%	82.6%	83.3%	83.1%	83.6%
25	61.4%	61.1%	61.8%	81.7%	81.5%	81.9%	82.3%	82.1%	82.5%	83.3%	83.1%	83.6%

A 5. Adult medical/surgical occupancy rates

	Baseline			Moderate flu baseline			Moderate flu REA+IARBS			Moderate flu REA+IARBS+IIS		
Flu week	Mean	90% CI		Mean	90% CI		Mean	90% CI		Mean	90% CI	
1	68.3%	68.2%	68.5%	68.2%	68.0%	68.4%	70.3%	70.2%	70.5%	70.1%	70.0%	70.3%
2	68.4%	68.2%	68.5%	68.3%	68.1%	68.5%	65.7%	65.6%	65.9%	65.6%	65.4%	65.7%
3	68.4%	68.2%	68.5%	68.4%	68.2%	68.5%	62.4%	62.3%	62.6%	62.4%	62.3%	62.5%
4	68.4%	68.3%	68.5%	68.4%	68.2%	68.5%	60.2%	60.0%	60.3%	60.1%	60.0%	60.2%
5	68.4%	68.2%	68.5%	68.4%	68.3%	68.5%	58.5%	58.4%	58.6%	58.4%	58.3%	58.5%
6	68.4%	68.3%	68.5%	68.5%	68.3%	68.6%	57.3%	57.2%	57.4%	57.2%	57.1%	57.3%
7	68.4%	68.3%	68.5%	68.5%	68.4%	68.6%	56.4%	56.3%	56.5%	56.3%	56.2%	56.4%
8	68.4%	68.3%	68.5%	68.6%	68.5%	68.7%	55.8%	55.7%	55.9%	55.7%	55.6%	55.8%
9	68.4%	68.3%	68.5%	68.8%	68.7%	68.9%	55.3%	55.2%	55.4%	55.2%	55.1%	55.3%
10	68.4%	68.3%	68.5%	69.1%	69.0%	69.2%	55.0%	54.9%	55.1%	54.9%	54.9%	55.0%
11	68.4%	68.3%	68.5%	69.5%	69.4%	69.6%	55.0%	54.9%	55.0%	54.9%	54.8%	55.0%
12	68.5%	68.4%	68.5%	70.0%	69.9%	70.1%	55.1%	55.0%	55.2%	55.0%	55.0%	55.1%
13	68.5%	68.4%	68.5%	70.7%	70.6%	70.8%	55.4%	55.3%	55.5%	55.4%	55.3%	55.4%
14	68.5%	68.4%	68.6%	71.4%	71.3%	71.5%	55.8%	55.7%	55.9%	55.8%	55.7%	55.9%
15	68.5%	68.4%	68.6%	72.2%	72.2%	72.3%	56.4%	56.3%	56.5%	56.4%	56.3%	56.5%
16	68.5%	68.4%	68.6%	73.2%	73.1%	73.3%	57.2%	57.1%	57.2%	57.2%	57.1%	57.3%
17	68.5%	68.4%	68.6%	74.3%	74.2%	74.3%	58.1%	58.0%	58.2%	58.2%	58.1%	58.2%
18	68.5%	68.4%	68.6%	75.3%	75.3%	75.4%	59.1%	59.0%	59.1%	59.2%	59.1%	59.3%
19	68.5%	68.4%	68.6%	76.2%	76.2%	76.3%	59.9%	59.8%	59.9%	60.0%	60.0%	60.1%

	Baseline			Moderate flu baseline			Moderate flu REA+IARBS			Moderate flu REA+IARBS+IIS		
Flu week	Mean	90% CI		Mean	90% CI		Mean	90% CI		Mean	90% CI	
20	68.5%	68.4%	68.6%	76.9%	76.8%	76.9%	60.3%	60.3%	60.4%	60.5%	60.5%	60.6%
21	68.5%	68.5%	68.6%	77.2%	77.1%	77.2%	60.5%	60.4%	60.5%	60.7%	60.6%	60.7%
22	68.5%	68.5%	68.6%	77.2%	77.2%	77.3%	60.3%	60.3%	60.4%	60.5%	60.5%	60.6%
23	68.5%	68.5%	68.6%	77.1%	77.0%	77.1%	60.0%	60.0%	60.1%	60.3%	60.2%	60.3%
24	68.5%	68.5%	68.6%	76.9%	76.9%	77.0%	59.7%	59.7%	59.8%	59.9%	59.9%	60.0%
25	68.5%	68.5%	68.6%	76.7%	76.6%	76.7%	59.4%	59.3%	59.4%	59.5%	59.5%	59.6%

	Baseline			Severe flu baseline			Severe flu REA+IARBS			Severe flu REA+IARBS+IIS		
Flu week	Mean	90% CI		Mean	90% CI		Mean	90% CI		Mean	90% CI	
1	68.3%	68.2%	68.5%	68.2%	68.1%	68.3%	70.2%	70.0%	70.3%	70.2%	70.1%	70.3%
2	68.4%	68.2%	68.5%	68.3%	68.2%	68.4%	65.5%	65.4%	65.6%	65.6%	65.5%	65.7%
3	68.4%	68.2%	68.5%	68.4%	68.3%	68.5%	62.2%	62.1%	62.4%	62.3%	62.2%	62.4%
4	68.4%	68.3%	68.5%	68.4%	68.3%	68.5%	60.0%	59.9%	60.1%	60.1%	60.0%	60.2%
5	68.4%	68.2%	68.5%	68.5%	68.4%	68.6%	58.4%	58.3%	58.5%	58.5%	58.4%	58.6%
6	68.4%	68.3%	68.5%	68.6%	68.5%	68.7%	57.3%	57.2%	57.4%	57.4%	57.3%	57.4%
7	68.4%	68.3%	68.5%	68.9%	68.8%	69.0%	56.6%	56.5%	56.7%	56.7%	56.6%	56.8%
8	68.4%	68.3%	68.5%	69.5%	69.4%	69.6%	56.5%	56.4%	56.6%	56.5%	56.5%	56.6%
9	68.4%	68.3%	68.5%	70.6%	70.5%	70.7%	57.0%	56.9%	57.0%	57.0%	57.0%	57.1%
10	68.4%	68.3%	68.5%	72.2%	72.1%	72.2%	58.0%	57.9%	58.1%	58.1%	58.0%	58.2%
11	68.4%	68.3%	68.5%	73.9%	73.9%	74.0%	59.5%	59.5%	59.6%	59.7%	59.7%	59.8%

	Baseline			Severe flu baseline			Severe flu REA+IARBS			Severe flu REA+IARBS+IIS		
Flu week	Mean	90% CI		Mean	90% CI		Mean	90% CI		Mean	90% CI	
12	68.5%	68.4%	68.5%	75.8%	75.7%	75.8%	61.6%	61.5%	61.6%	61.9%	61.8%	62.0%
13	68.5%	68.4%	68.5%	77.4%	77.3%	77.5%	63.9%	63.9%	64.0%	64.5%	64.4%	64.5%
14	68.5%	68.4%	68.6%	78.8%	78.8%	78.9%	66.2%	66.2%	66.3%	66.8%	66.7%	66.8%
15	68.5%	68.4%	68.6%	80.1%	80.0%	80.1%	68.3%	68.2%	68.3%	68.8%	68.7%	68.8%
16	68.5%	68.4%	68.6%	81.2%	81.1%	81.2%	69.7%	69.6%	69.8%	70.3%	70.2%	70.4%
17	68.5%	68.4%	68.6%	81.9%	81.9%	82.0%	70.1%	70.0%	70.1%	70.7%	70.7%	70.8%
18	68.5%	68.4%	68.6%	82.2%	82.1%	82.2%	69.7%	69.6%	69.7%	70.4%	70.3%	70.4%
19	68.5%	68.4%	68.6%	82.0%	82.0%	82.1%	69.0%	68.9%	69.0%	69.6%	69.6%	69.7%
20	68.5%	68.4%	68.6%	81.7%	81.7%	81.8%	68.2%	68.1%	68.2%	68.8%	68.8%	68.9%
21	68.5%	68.5%	68.6%	81.3%	81.2%	81.4%	67.4%	67.3%	67.5%	68.0%	67.9%	68.0%
22	68.5%	68.5%	68.6%	80.9%	80.8%	80.9%	66.6%	66.6%	66.7%	67.2%	67.1%	67.3%
23	68.5%	68.5%	68.6%	80.4%	80.4%	80.5%	65.9%	65.9%	66.0%	66.5%	66.4%	66.5%
24	68.5%	68.5%	68.6%	80.0%	80.0%	80.1%	65.3%	65.2%	65.3%	65.8%	65.7%	65.8%
25	68.5%	68.5%	68.6%	79.6%	79.6%	79.7%	64.7%	64.6%	64.7%	65.2%	65.1%	65.2%

A 6. Pediatric medical/surgical occupancy rates

	Baseline			Moderate flu baseline			Moderate flu REA+IARBS			Moderate flu REA+IARBS+IIS		
Flu week	Mean	90% CI		Mean	90% CI		Mean	90% CI		Mean	90% CI	
1	53.0%	52.6%	53.5%	52.6%	52.2%	53.0%	52.7%	52.4%	53.1%	52.7%	52.3%	53.1%
2	53.2%	52.8%	53.6%	52.6%	52.3%	53.0%	52.7%	52.4%	53.0%	52.6%	52.2%	53.1%
3	53.1%	52.8%	53.4%	52.8%	52.4%	53.1%	52.6%	52.3%	52.9%	52.4%	52.0%	52.8%
4	53.1%	52.9%	53.4%	52.9%	52.6%	53.2%	52.5%	52.2%	52.9%	52.3%	51.9%	52.7%
5	53.1%	52.9%	53.4%	53.1%	52.8%	53.4%	52.5%	52.2%	52.8%	52.2%	51.8%	52.6%
6	53.1%	52.9%	53.4%	53.3%	53.1%	53.6%	52.6%	52.3%	52.9%	52.3%	52.0%	52.7%
7	53.1%	52.9%	53.3%	53.6%	53.4%	53.9%	52.8%	52.5%	53.1%	52.6%	52.2%	52.9%
8	53.2%	53.0%	53.4%	54.1%	53.8%	54.3%	53.2%	52.9%	53.5%	53.0%	52.7%	53.4%
9	53.2%	53.0%	53.4%	54.8%	54.6%	55.0%	53.9%	53.6%	54.2%	53.8%	53.5%	54.1%
10	53.2%	53.0%	53.4%	56.0%	55.8%	56.2%	55.1%	54.8%	55.3%	55.0%	54.8%	55.3%
11	53.3%	53.1%	53.5%	57.8%	57.6%	58.0%	56.8%	56.6%	57.1%	56.9%	56.6%	57.1%
12	53.3%	53.1%	53.5%	60.2%	60.1%	60.4%	59.2%	59.0%	59.5%	59.4%	59.2%	59.7%
13	53.3%	53.1%	53.5%	62.7%	62.5%	62.9%	61.8%	61.5%	62.0%	62.1%	61.9%	62.3%
14	53.3%	53.1%	53.5%	65.0%	64.8%	65.1%	64.1%	63.8%	64.3%	64.4%	64.2%	64.6%
15	53.2%	53.1%	53.4%	67.0%	66.8%	67.1%	66.2%	65.9%	66.4%	66.5%	66.3%	66.7%
16	53.2%	53.0%	53.4%	68.8%	68.7%	68.9%	68.0%	67.8%	68.2%	68.4%	68.2%	68.6%
17	53.3%	53.1%	53.4%	70.4%	70.3%	70.6%	69.7%	69.5%	69.9%	70.0%	69.9%	70.2%
18	53.3%	53.1%	53.4%	71.9%	71.8%	72.0%	71.2%	71.0%	71.4%	71.5%	71.4%	71.7%
19	53.3%	53.1%	53.5%	73.2%	73.1%	73.4%	72.6%	72.4%	72.7%	72.9%	72.7%	73.1%

	Baseline			Moderate flu baseline			Moderate flu REA+IARBS			Moderate flu REA+IARBS+IIS		
Flu week	Mean	90% CI		Mean	90% CI		Mean	90% CI		Mean	90% CI	
20	53.3%	53.1%	53.4%	74.4%	74.3%	74.5%	73.8%	73.6%	73.9%	74.1%	74.0%	74.3%
21	53.3%	53.1%	53.4%	75.4%	75.3%	75.5%	74.7%	74.6%	74.9%	75.2%	75.0%	75.3%
22	53.3%	53.1%	53.4%	75.9%	75.8%	76.0%	75.2%	75.0%	75.3%	75.8%	75.6%	75.9%
23	53.2%	53.1%	53.4%	75.9%	75.8%	76.1%	75.1%	75.0%	75.3%	75.8%	75.7%	76.0%
24	53.2%	53.0%	53.4%	75.6%	75.5%	75.8%	74.8%	74.6%	74.9%	75.4%	75.3%	75.6%
25	53.2%	53.0%	53.4%	75.2%	75.0%	75.3%	74.2%	74.0%	74.3%	74.8%	74.7%	75.0%

	Baseline			Severe flu baseline			Severe flu REA+IARBS			Severe flu REA+IARBS+IIS		
Flu week	Mean	90% CI		Mean	90% CI		Mean	90% CI		Mean	90% CI	
1	53.0%	52.6%	53.5%	52.8%	52.4%	53.3%	52.6%	52.2%	53.0%	52.4%	51.9%	52.8%
2	53.2%	52.8%	53.6%	52.9%	52.5%	53.3%	52.6%	52.2%	53.0%	52.5%	52.0%	53.0%
3	53.1%	52.8%	53.4%	53.0%	52.6%	53.3%	52.5%	52.1%	52.8%	52.4%	52.0%	52.8%
4	53.1%	52.9%	53.4%	53.2%	52.8%	53.5%	52.4%	52.1%	52.8%	52.5%	52.1%	52.9%
5	53.1%	52.9%	53.4%	53.6%	53.3%	53.9%	52.7%	52.3%	53.0%	52.8%	52.4%	53.1%
6	53.1%	52.9%	53.4%	54.4%	54.1%	54.7%	53.3%	53.1%	53.6%	53.5%	53.2%	53.8%
7	53.1%	52.9%	53.3%	56.0%	55.7%	56.2%	54.8%	54.5%	55.1%	54.9%	54.7%	55.2%
8	53.2%	53.0%	53.4%	58.7%	58.4%	59.0%	57.5%	57.2%	57.7%	57.7%	57.4%	57.9%
9	53.2%	53.0%	53.4%	62.1%	61.9%	62.4%	61.0%	60.7%	61.2%	61.3%	61.1%	61.6%
10	53.2%	53.0%	53.4%	65.2%	65.0%	65.5%	64.2%	64.0%	64.4%	64.6%	64.3%	64.8%
11	53.3%	53.1%	53.5%	67.9%	67.7%	68.1%	66.9%	66.7%	67.1%	67.3%	67.1%	67.5%

	Baseline			Severe flu baseline			Severe flu REA+IARBS			Severe flu REA+IARBS+IIS		
Flu week	Mean	90% CI		Mean	90% CI		Mean	90% CI		Mean	90% CI	
12	53.3%	53.1%	53.5%	70.2%	70.0%	70.4%	69.3%	69.1%	69.5%	69.6%	69.4%	69.8%
13	53.3%	53.1%	53.5%	72.2%	72.0%	72.4%	71.3%	71.2%	71.5%	71.6%	71.4%	71.8%
14	53.3%	53.1%	53.5%	73.9%	73.7%	74.1%	73.1%	73.0%	73.3%	73.4%	73.2%	73.6%
15	53.2%	53.1%	53.4%	75.4%	75.2%	75.6%	74.7%	74.6%	74.9%	75.0%	74.8%	75.2%
16	53.2%	53.0%	53.4%	76.8%	76.6%	76.9%	76.1%	75.9%	76.2%	76.4%	76.2%	76.5%
17	53.3%	53.1%	53.4%	77.8%	77.7%	78.0%	77.1%	77.0%	77.3%	77.5%	77.4%	77.7%
18	53.3%	53.1%	53.4%	78.3%	78.2%	78.5%	77.5%	77.4%	77.6%	78.0%	77.8%	78.2%
19	53.3%	53.1%	53.5%	78.1%	78.0%	78.3%	77.2%	77.0%	77.3%	77.7%	77.5%	77.9%
20	53.3%	53.1%	53.4%	77.6%	77.4%	77.7%	76.5%	76.3%	76.6%	77.0%	76.8%	77.2%
21	53.3%	53.1%	53.4%	76.8%	76.6%	77.0%	75.7%	75.5%	75.8%	76.1%	75.9%	76.3%
22	53.3%	53.1%	53.4%	76.0%	75.8%	76.2%	74.8%	74.7%	75.0%	75.2%	75.0%	75.4%
23	53.2%	53.1%	53.4%	75.2%	75.0%	75.4%	74.0%	73.9%	74.1%	74.3%	74.2%	74.5%
24	53.2%	53.0%	53.4%	74.4%	74.2%	74.6%	73.2%	73.1%	73.3%	73.5%	73.3%	73.7%
25	53.2%	53.0%	53.4%	73.7%	73.5%	73.8%	72.4%	72.3%	72.5%	72.7%	72.5%	72.9%

A 7. Number of admitted ICU patients requiring a ventilator

	Baseline			Moderate flu baseline			Severe flu baseline		
Bed type	Mean	90% CI		Mean	90% CI		Mean	90% CI	
Adult ICU	11,682	11,649	11,715	11,843	12,391	12,460	12,628	12,591	12,666
Pediatric ICU	2,608	2,587	2,628	3,805	3,790	3,821	3,872	3,853	3,890

A 8. Number of patients needing ICU care and requiring a ventilator

	Baseline	Moderate flu baseline	Severe flu baseline
Bed type	Mean	Mean	Mean
Adult ICU	11,682	15,282	20,682
Pediatric ICU	2,608	4,908	7,608

A9. Impact of interventions on unmet need

	Moderate flu REA+IARBS	Moderate flu REA+IARBS+IIS	Severe flu REA+IARBS	Severe flu REA+IARBS+IIS
Reduction in unmet need	28,748	38,275	59,199	69,145
Remaining unmet need	175,234	165,706	495,788	485,842

A10. ED patients requiring admission unable to find a bed

	Moderate flu baseline			Moderate flu REA+IARBS			Moderate flu REA+IARBS+IIS		
Bed type	Mean	90% CI		Mean	90% CI		Mean	90% CI	
Adult ICU	3,795	3,780	3,810	3,809	3,796	3,823	2,443	2,427	2,460
Pediatric ICU	1,826	1,814	1,838	1,918	1,903	1,933	1,806	1,796	1,817
Adult med/surg	6,524	6,507	6,541	1,755	1,751	1,760	985	977	993
Pediatric med/surg	9,432	9,402	9,463	9,277	9,246	9,309	8,900	8,847	8,953

	Severe flu baseline			Severe flu REA+IARBS			Severe flu REA+IARBS+IIS		
Bed type	Mean	90% CI		Mean	90% CI		Mean	90% CI	
Adult ICU	10,010	9,995	10,025	10,007	9,989	10,026	8,901	8,873	8,930
Pediatric ICU	5,540	5,517	5,563	5,600	5,568	5,632	5,529	5,504	5,554
Adult med/surg	37,424	37,348	37,500	25,107	25,046	25,169	23,174	23,099	23,249
Pediatric med/surg	29,959	29,909	30,008	29,269	29,230	29,309	29,072	29,016	29,128

A11. Unscheduled patients requiring admission but unable to find a bed

	Moderate flu baseline			Moderate flu REA+IARBS			Moderate flu REA+IARBS+IIS		
Bed type	Mean	90% CI		Mean	90% CI		Mean	90% CI	
Adult ICU	937	927	947	924	916	933	851	838	863
Pediatric ICU	196	192	200	212	207	218	293	286	299
Adult med/surg	80	78	83	0	0	0	0	0	0
Pediatric med/surg	795	784	805	771	763	779	887	875	899

	Severe flu baseline			Severe flu REA+IARBS			Severe flu REA+IARBS+IIS		
Bed type	Mean	90% CI		Mean	90% CI		Mean	90% CI	
Adult ICU	1,452	1,444	1,460	1,446	1,439	1,452	1,449	1,444	1,454
Pediatric ICU	319	313	324	344	336	352	415	408	422
Adult med/surg	1,227	1,218	1,236	294	288	301	505	492	517
Pediatric med/surg	1,179	1,168	1,190	1,155	1,143	1,167	1,276	1,264	1,288

A12. ED patients who leave without being treated

	Moderate flu baseline			Moderate flu REA+IARBS			Moderate flu REA+IARBS+IIS		
Bed type	Mean	90% CI		Mean	90% CI		Mean	90% CI	
Adult ICU	20,260	20,160	20,360	17,984	17,888	18,080	17,258	17,150	17,366
Pediatric ICU	67,547	67,692	67,402	58,105	58,124	58,086	54,822	54,894	54,751
Adult med/surg	92,590	92,460	92,720	80,478	80,369	80,588	77,564	77,471	77,658
Pediatric med/surg	20,260	20,160	20,360	17,984	17,888	18,080	17,258	17,150	17,366

	Severe flu baseline			Severe flu REA+IARBS			Severe flu REA+IARBS+IIS		
Bed type	Mean	90% CI		Mean	90% CI		Mean	90% CI	
Adult ICU	97,954	97,820	98,089	85,654	85,521	85,788	83,825	83,625	84,026
Pediatric ICU	167,748	167,831	167,665	152,636	152,661	152,612	151,060	151,190	150,931
Adult med/surg	202,175	202,015	202,335	184,274	184,119	184,429	180,635	180,513	180,758
Pediatric med/surg	97,954	97,820	98,089	85,654	85,521	85,788	83,825	83,625	84,026