IEM's AI Modeling: Short-term COVID-19 Projections
Date: 4/5/21

Leveraging over 15 years of support to HHS for medical consequence modeling and our proprietary artificial intelligence (AI) models, IEM believes that our Coronavirus model outputs can be used to assist localities and their medical facilities to better prepare for an increase in hospitalizations, to better plan for and locate drive-through testing facilities, and to determine where increased levels of transmission may be occurring.

We have been refining our AI model over the past month and are confident in its ability to provide accurate 7-day projections that can be used for operational and logistical planning.

AI-based Model Background

IEM is currently using an AI model to fit data from various sources and project new cases of COVID-19. We do <u>not</u> assume the average number of secondary infections (R-value) stays the same over time. IEM's AI model finds the best R-value over time to evaluate how it changes over the course of the outbreak. The IEM modeling team is running ~11 million simulations to fit each state's data and using the best fit for the R-value to project new cases over the next 7 days. The AI models are executed on a daily basis to evaluate the changing dynamics of the COVID-19 pandemic. Our projections have typically been within 10%, and are often within 5%, of actual confirmed cases.

The projections shown in this document are based on data pulled in as of 4/5/21 9 a.m.

Please provide any feedback or send any questions that you might have to us. We are continually updating and improving the model, so your feedback is critical.

Also, if you have more current or refined data for your State, Commonwealth or Territory that you would like IEM to factor in, please let us know.

IEM's Modeling Lead

Dr. Prasith "Sid" Baccam is a **Computational Epidemiologist expert** at IEM with more than **20 years of experience in medical consequence modeling and simulation of disease outbreaks** and medical consequences following hypothetical attacks with biological agents or emerging infectious diseases. He develops key simulation models and decision support tools at IEM, specializing in public health, disaster response, and medical countermeasures (MCM) to enhance data-driven decision making and improve modeling assumptions.

Upon receiving his **Ph.D. in Applied Mathematics and Immunobiology** at Iowa State University, Dr. Baccam worked as a Postdoctoral Research Associate at Los Alamos National Laboratory where he focused on researching viral and immunological modeling. After his stint at Los Alamos, Dr. Baccam has served as Task Lead in multiple public health projects have allowed him to develop expertise as a mathematical biologist and a leader on high-performance modeling and simulation teams.

He has worked with state and local public health officials as well as Federal agencies, including **HHS**, the Centers for Disease Control and Prevention (**CDC**), and the Department of Homeland Security (**DHS**). Dr. Baccam has published numerous papers on public health response models and implications on policy and has been invited to participate in workshops and symposiums held by the Institute of Medicine (now the National Academy of Health). His modeling results have been briefed to the **Executive Office of the President** and informed two presidential policy actions.

California State Projections
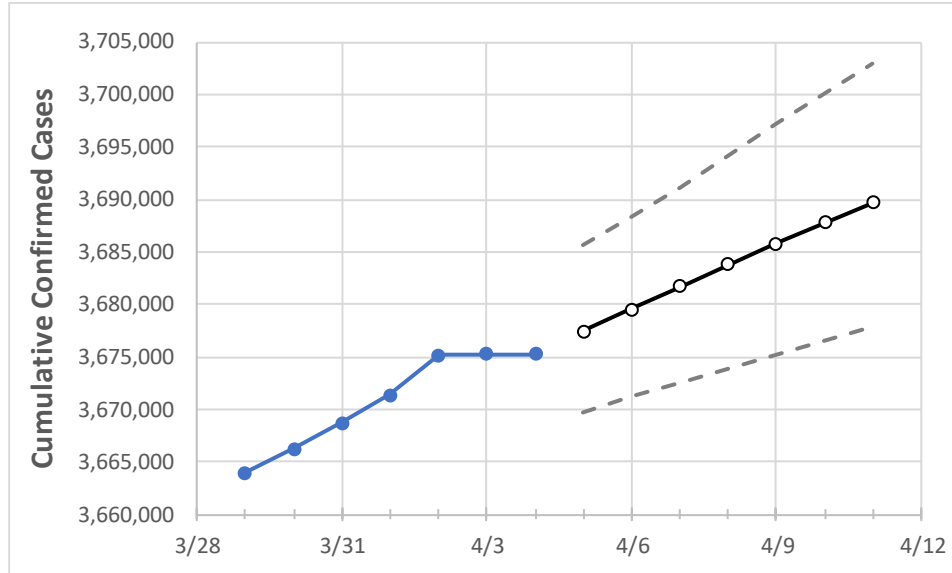
	Actual Confirmed Cases On:				Projected Cases For:						
	4/1	4/2	4/3	4/4	4/5	4/6	4/7	4/8	4/9	4/10	4/11
California	3,671,349	3,675,191	3,675,272	3,675,272	3,677,453	3,679,563	3,681,702	3,683,759	3,685,834	3,687,786	3,689,665

Note: The State's projection shows a "best estimate" curve (the solid line with circles) and the dotted lines are the upper and lower estimates around that best estimate. Our projections have typically been within 10%, and are often within 5%, of actual confirmed cases.

California Counties

	Actual Confirmed Cases On:				Projected Cases For:						
	4/1	4/2	4/3	4/4	4/5	4/6	4/7	4/8	4/9	4/10	4/11
Alameda	83,475	83,574	83,574	83,574	83,652	83,730	83,809	83,885	83,965	84,045	84,121
Contra Costa	65,435	65,559	65,559	65,559	65,636	65,714	65,793	65,872	65,950	66,029	66,107
Fresno	99,240	99,317	99,317	99,317	99,409	99,499	99,586	99,673	99,762	99,845	99,929
Kern	106,288	106,329	106,329	106,329	106,384	106,437	106,490	106,540	106,592	106,641	106,689
Lake	3,332	3,337	3,337	3,337	3,342	3,348	3,353	3,358	3,364	3,369	3,374
Los Angeles	1,220,256	1,220,893	1,220,893	1,220,893	1,221,307	1,221,731	1,222,139	1,222,531	1,222,913	1,223,294	1,223,666
Marin	13,694	13,713	13,713	13,713	13,726	13,739	13,753	13,766	13,780	13,793	13,806
Monterey	42,961	42,979	42,979	42,979	42,995	43,012	43,027	43,042	43,058	43,073	43,088
Orange	266,353	266,464	266,464	266,464	266,594	266,723	266,852	266,978	267,107	267,235	267,358
Placer	20,972	21,095	21,095	21,095	21,158	21,225	21,295	21,367	21,444	21,524	21,608
Riverside	294,617	294,736	294,736	294,736	294,865	294,990	295,121	295,247	295,370	295,497	295,623
Sacramento	97,883	98,488	98,488	98,488	98,735	98,990	99,256	99,531	99,815	100,118	100,431
San Bernardino	291,022	291,199	291,199	291,199	291,318	291,433	291,549	291,664	291,778	291,893	292,008
San Diego	270,539	271,035	271,035	271,035	271,316	271,592	271,874	272,141	272,429	272,706	272,989
San Francisco	35,347	35,386	35,386	35,386	35,414	35,443	35,471	35,499	35,527	35,556	35,584
San Joaquin	69,978	70,117	70,117	70,117	70,232	70,352	70,477	70,601	70,724	70,851	70,975
San Luis Obispo	20,522	20,547	20,547	20,547	20,571	20,595	20,619	20,642	20,666	20,691	20,716
San Mateo	40,424	40,462	40,542	40,542	40,588	40,632	40,679	40,725	40,772	40,819	40,868
Santa Barbara	33,217	33,270	33,270	33,270	33,306	33,343	33,379	33,415	33,452	33,490	33,528
Santa Clara	114,683	114,852	114,852	114,852	114,954	115,053	115,154	115,250	115,346	115,444	115,540
Santa Cruz	15,363	15,363	15,363	15,363	15,376	15,389	15,402	15,415	15,427	15,439	15,451
Solano	31,240	31,301	31,301	31,301	31,349	31,399	31,450	31,500	31,553	31,607	31,661
Sonoma	29,257	29,310	29,310	29,310	29,333	29,355	29,377	29,399	29,420	29,440	29,461
Ventura	79,716	79,774	79,774	79,774	79,818	79,861	79,903	79,946	79,987	80,030	80,073

Some recipients of our daily COVID-19 short-term (7 day) projections have requested projections of demand for: hospital bed, intensive care unit (ICU) beds, and mechanical ventilation. We realize that different states and localities will have different characteristics for hospital demand of COVID-19 cases, and we are presenting the best assumptions we could find for those medical demands based on scientific literature and health data reporting. Specifically:

- *Beds: For hospitalization, we use a range of 10% and 20% of cases require hospitalization based on CDC's report (MMWR, March 18, 2020) and state reports of COVID-19 cases.*
- *ICU: The CDC report found that 24% of hospitalized cases require ICU care.*
- *Ventilators: Based on clinical data from China and state reports, we assume that 50% of ICU cases require a ventilator.*

If you have other estimates for these assumptions, please share them with us as we work to refine our modeling, assumptions, and data on a daily basis.

*The medical demands shown in the table assume 20% of **cumulative** confirmed cases require hospitalization. To get the medical demand for the assumption that 10% of confirmed cases require hospitalization, simply divide the demand by 2.*

California Medical Demand by County

	Actual Confirmed Cases On:				Projected Cases (Hospitalized) [ICU] {Ventilator} For:		
	4/1	4/2	4/3	4/4	4/6	4/8	4/10
Alameda	83,475	83,574	83,574	83,574	83,730 (16,746) [4,019] {2,010}	83,885 (16,777) [4,026] {2,013}	84,045 (16,809) [4,034] {2,017}
Contra Costa	65,435	65,559	65,559	65,559	65,714 (13,143) [3,154] {1,577}	65,872 (13,174) [3,162] {1,581}	66,029 (13,206) [3,169] {1,585}
Fresno	99,240	99,317	99,317	99,317	99,499 (19,900) [4,776] {2,388}	99,673 (19,935) [4,784] {2,392}	99,845 (19,969) [4,793] {2,396}
Kern	106,288	106,329	106,329	106,329	106,437 (21,287) [5,109] {2,554}	106,540 (21,308) [5,114] {2,557}	106,641 (21,328) [5,119] {2,559}
Lake	3,332	3,337	3,337	3,337	3,348 (670) [161] {80}	3,358 (672) [161] {81}	3,369 (674) [162] {81}
Los Angeles	1,220,256	1,220,893	1,220,893	1,220,893	1,221,731 (244,346) [58,643] {29,322}	1,222,531 (244,506) [58,682] {29,341}	1,223,294 (244,659) [58,718] {29,359}
Marin	13,694	13,713	13,713	13,713	13,739 (2,748) [659] {330}	13,766 (2,753) [661] {330}	13,793 (2,759) [662] {331}
Monterey	42,961	42,979	42,979	42,979	43,012 (8,602) [2,065] {1,032}	43,042 (8,608) [2,066] {1,033}	43,073 (8,615) [2,067] {1,034}
Orange	266,353	266,464	266,464	266,464	266,723 (53,345) [12,803] {6,401}	266,978 (53,396) [12,815] {6,407}	267,235 (53,447) [12,827] {6,414}
Placer	20,972	21,095	21,095	21,095	21,225 (4,245) [1,019] {509}	21,367 (4,273) [1,026] {513}	21,524 (4,305) [1,033] {517}
Riverside	294,617	294,736	294,736	294,736	294,990 (58,998) [14,160] {7,080}	295,247 (59,049) [14,172] {7,086}	295,497 (59,099) [14,184] {7,092}
Sacramento	97,883	98,488	98,488	98,488	98,990 (19,798) [4,752] {2,376}	99,531 (19,906) [4,777] {2,389}	100,118 (20,024) [4,806] {2,403}
San Bernardino	291,022	291,199	291,199	291,199	291,433 (58,287) [13,989] {6,994}	291,664 (58,333) [14,000] {7,000}	291,893 (58,379) [14,011] {7,005}
San Diego	270,539	271,035	271,035	271,035	271,592 (54,318) [13,036] {6,518}	272,141 (54,428) [13,063] {6,531}	272,706 (54,541) [13,090] {6,545}
San Francisco	35,347	35,386	35,386	35,386	35,443 (7,089) [1,701] {851}	35,499 (7,100) [1,704] {852}	35,556 (7,111) [1,707] {853}
San Joaquin	69,978	70,117	70,117	70,117	70,352 (14,070) [3,377] {1,688}	70,601 (14,120) [3,389] {1,694}	70,851 (14,170) [3,401] {1,700}
San Luis Obispo	20,522	20,547	20,547	20,547	20,595 (4,119) [989] {494}	20,642 (4,128) [991] {495}	20,691 (4,138) [993] {497}
San Mateo	40,424	40,462	40,542	40,542	40,632 (8,126) [1,950] {975}	40,725 (8,145) [1,955] {977}	40,819 (8,164) [1,959] {980}
Santa Barbara	33,217	33,270	33,270	33,270	33,343 (6,669) [1,600] {800}	33,415 (6,683) [1,604] {802}	33,490 (6,698) [1,607] {804}
Santa Clara	114,683	114,852	114,852	114,852	115,053 (23,011) [5,523] {2,761}	115,250 (23,050) [5,532] {2,766}	115,444 (23,089) [5,541] {2,771}
Santa Cruz	15,363	15,363	15,363	15,363	15,389 (3,078) [739] {369}	15,415 (3,083) [740] {370}	15,439 (3,088) [741] {371}
Solano	31,240	31,301	31,301	31,301	31,399 (6,280) [1,507] {754}	31,500 (6,300) [1,512] {756}	31,607 (6,321) [1,517] {759}
Sonoma	29,257	29,310	29,310	29,310	29,355 (5,871) [1,409] {705}	29,399 (5,880) [1,411] {706}	29,440 (5,888) [1,413] {707}
Ventura	79,716	79,774	79,774	79,774	79,861 (15,972) [3,833] {1,917}	79,946 (15,989) [3,837] {1,919}	80,030 (16,006) [3,841] {1,921}

For additional information from IEM, please contact Bryan Koon, Vice President of Emergency Management and Homeland Security at bryan.koon@iem.com or 850-519-7966 or Stephanie Tennyson at stephanie.tennyson@iem.com or 202-309-4257.