IEM's AI Modeling: Short-term COVID-19 Projections
Date: 2/23/21

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 2/23/21 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
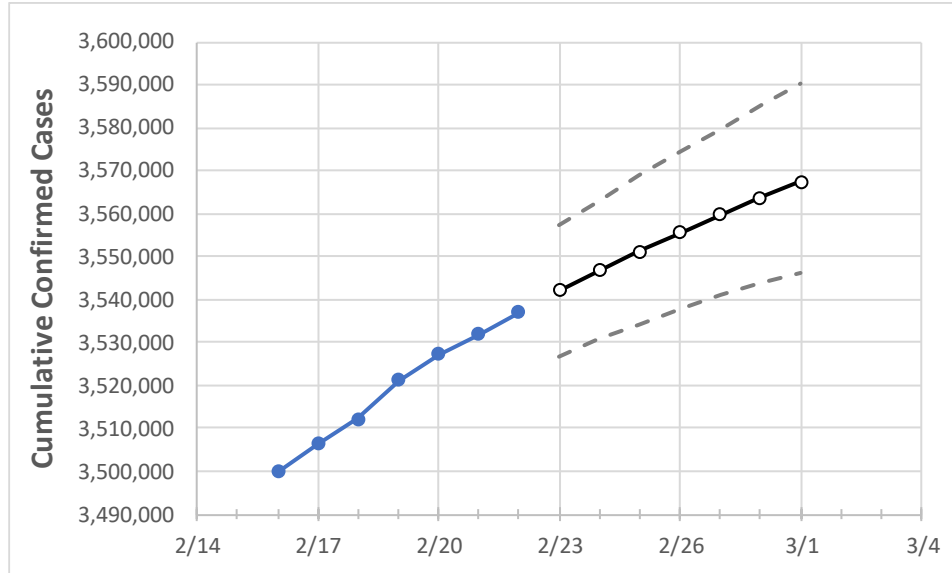
	Actual Confirmed Cases On:				Projected Cases For:						
	2/19	2/20	2/21	2/22	2/23	2/24	2/25	2/26	2/27	2/28	3/1
California	3,521,225	3,527,338	3,531,846	3,536,946	3,542,040	3,546,848	3,551,239	3,555,674	3,559,841	3,563,702	3,567,439

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:						
	2/19	2/20	2/21	2/22	2/23	2/24	2/25	2/26	2/27	2/28	3/1
Alameda	79,297	79,471	79,539	79,649	79,791	79,916	80,036	80,148	80,249	80,344	80,435
Contra Costa	61,284	61,469	61,628	61,744	61,877	62,006	62,130	62,250	62,371	62,484	62,592
Fresno	93,734	93,973	94,234	94,374	94,552	94,719	94,884	95,045	95,196	95,341	95,483
Kern	101,370	101,613	101,738	101,849	102,062	102,276	102,476	102,658	102,839	103,013	103,180
Lake	3,066	3,078	3,089	3,100	3,109	3,118	3,127	3,137	3,145	3,153	3,162
Los Angeles	1,176,843	1,179,149	1,180,505	1,181,469	1,182,932	1,184,335	1,185,634	1,186,866	1,188,030	1,189,158	1,190,204
Marin	12,990	13,011	13,031	13,052	13,073	13,094	13,114	13,134	13,153	13,171	13,190
Monterey	41,787	41,884	41,884	41,884	41,943	42,002	42,056	42,108	42,158	42,203	42,249
Orange	258,567	258,991	259,305	259,581	259,877	260,161	260,405	260,647	260,879	261,101	261,311
Placer	19,520	19,562	19,604	19,646	19,682	19,717	19,751	19,784	19,817	19,849	19,880
Riverside	287,534	287,630	287,726	287,822	287,989	288,148	288,293	288,422	288,544	288,653	288,755
Sacramento	91,797	91,815	92,057	92,428	92,636	92,833	93,035	93,227	93,414	93,594	93,768
San Bernardino	283,873	284,280	284,639	284,866	285,152	285,429	285,686	285,946	286,185	286,410	286,629
San Diego	255,802	256,513	257,030	257,351	257,845	258,333	258,800	259,238	259,667	260,085	260,479
San Francisco	33,650	33,746	33,820	33,891	33,960	34,029	34,098	34,163	34,225	34,285	34,346
San Joaquin	65,891	65,943	65,994	66,046	66,138	66,225	66,308	66,392	66,468	66,539	66,605
San Luis Obispo	19,340	19,379	19,419	19,458	19,497	19,533	19,568	19,602	19,631	19,662	19,691
San Mateo	38,229	38,256	38,371	38,448	38,518	38,585	38,650	38,711	38,769	38,825	38,878
Santa Barbara	31,334	31,432	31,518	31,567	31,643	31,715	31,781	31,846	31,910	31,970	32,025
Santa Clara	108,462	108,800	109,054	109,276	109,486	109,690	109,887	110,072	110,249	110,424	110,584
Santa Cruz	14,438	14,457	14,476	14,495	14,518	14,541	14,561	14,581	14,600	14,619	14,635
Solano	29,766	29,797	29,828	29,859	29,903	29,942	29,980	30,017	30,052	30,086	30,118
Sonoma	27,542	27,606	27,703	27,793	27,842	27,889	27,934	27,977	28,020	28,062	28,104
Ventura	76,442	76,582	76,757	76,862	76,999	77,125	77,247	77,358	77,462	77,557	77,653

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:		
	2/19	2/20	2/21	2/22	2/24	2/26	2/28
Alameda	79,297	79,471	79,539	79,649	79,916 (15,983) [3,836] {1,918}	80,148 (16,030) [3,847] {1,924}	80,344 (16,069) [3,857] {1,928}
Contra Costa	61,284	61,469	61,628	61,744	62,006 (12,401) [2,976] {1,488}	62,250 (12,450) [2,988] {1,494}	62,484 (12,497) [2,999] {1,500}
Fresno	93,734	93,973	94,234	94,374	94,719 (18,944) [4,547] {2,273}	95,045 (19,009) [4,562] {2,281}	95,341 (19,068) [4,576] {2,288}
Kern	101,370	101,613	101,738	101,849	102,276 (20,455) [4,909] {2,455}	102,658 (20,532) [4,928] {2,464}	103,013 (20,603) [4,945] {2,472}
Lake	3,066	3,078	3,089	3,100	3,118 (624) [150] {75}	3,137 (627) [151] {75}	3,153 (631) [151] {76}
Los Angeles	1,176,843	1,179,149	1,180,505	1,181,469	1,184,335 (236,867) [56,848] {28,424}	1,186,866 (237,373) [56,970] {28,485}	1,189,158 (237,832) [57,080] {28,540}
Marin	12,990	13,011	13,031	13,052	13,094 (2,619) [629] {314}	13,134 (2,627) [630] {315}	13,171 (2,634) [632] {316}
Monterey	41,787	41,884	41,884	41,884	42,002 (8,400) [2,016] {1,008}	42,108 (8,422) [2,021] {1,011}	42,203 (8,441) [2,026] {1,013}
Orange	258,567	258,991	259,305	259,581	260,161 (52,032) [12,488] {6,244}	260,647 (52,129) [12,511] {6,256}	261,101 (52,220) [12,533] {6,266}
Placer	19,520	19,562	19,604	19,646	19,717 (3,943) [946] {473}	19,784 (3,957) [950] {475}	19,849 (3,970) [953] {476}
Riverside	287,534	287,630	287,726	287,822	288,148 (57,630) [13,831] {6,916}	288,422 (57,684) [13,844] {6,922}	288,653 (57,731) [13,855] {6,928}
Sacramento	91,797	91,815	92,057	92,428	92,833 (18,567) [4,456] {2,228}	93,227 (18,645) [4,475] {2,237}	93,594 (18,719) [4,493] {2,246}
San Bernardino	283,873	284,280	284,639	284,866	285,429 (57,086) [13,701] {6,850}	285,946 (57,189) [13,725] {6,863}	286,410 (57,282) [13,748] {6,874}
San Diego	255,802	256,513	257,030	257,351	258,333 (51,667) [12,400] {6,200}	259,238 (51,848) [12,443] {6,222}	260,085 (52,017) [12,484] {6,242}
San Francisco	33,650	33,746	33,820	33,891	34,029 (6,806) [1,633] {817}	34,163 (6,833) [1,640] {820}	34,285 (6,857) [1,646] {823}
San Joaquin	65,891	65,943	65,994	66,046	66,225 (13,245) [3,179] {1,589}	66,392 (13,278) [3,187] {1,593}	66,539 (13,308) [3,194] {1,597}
San Luis Obispo	19,340	19,379	19,419	19,458	19,533 (3,907) [938] {469}	19,602 (3,920) [941] {470}	19,662 (3,932) [944] {472}
San Mateo	38,229	38,256	38,371	38,448	38,585 (7,717) [1,852] {926}	38,711 (7,742) [1,858] {929}	38,825 (7,765) [1,864] {932}
Santa Barbara	31,334	31,432	31,518	31,567	31,715 (6,343) [1,522] {761}	31,846 (6,369) [1,529] {764}	31,970 (6,394) [1,535] {767}
Santa Clara	108,462	108,800	109,054	109,276	109,690 (21,938) [5,265] {2,633}	110,072 (22,014) [5,283] {2,642}	110,424 (22,085) [5,300] {2,650}
Santa Cruz	14,438	14,457	14,476	14,495	14,541 (2,908) [698] {349}	14,581 (2,916) [700] {350}	14,619 (2,924) [702] {351}
Solano	29,766	29,797	29,828	29,859	29,942 (5,988) [1,437] {719}	30,017 (6,003) [1,441] {720}	30,086 (6,017) [1,444] {722}
Sonoma	27,542	27,606	27,703	27,793	27,889 (5,578) [1,339] {669}	27,977 (5,595) [1,343] {671}	28,062 (5,612) [1,347] {673}
Ventura	76,442	76,582	76,757	76,862	77,125 (15,425) [3,702] {1,851}	77,358 (15,472) [3,713] {1,857}	77,557 (15,511) [3,723] {1,861}

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.