IEM's AI Modeling: Short-term COVID-19 Projections
Date: 2/12/21

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 2/12/21 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
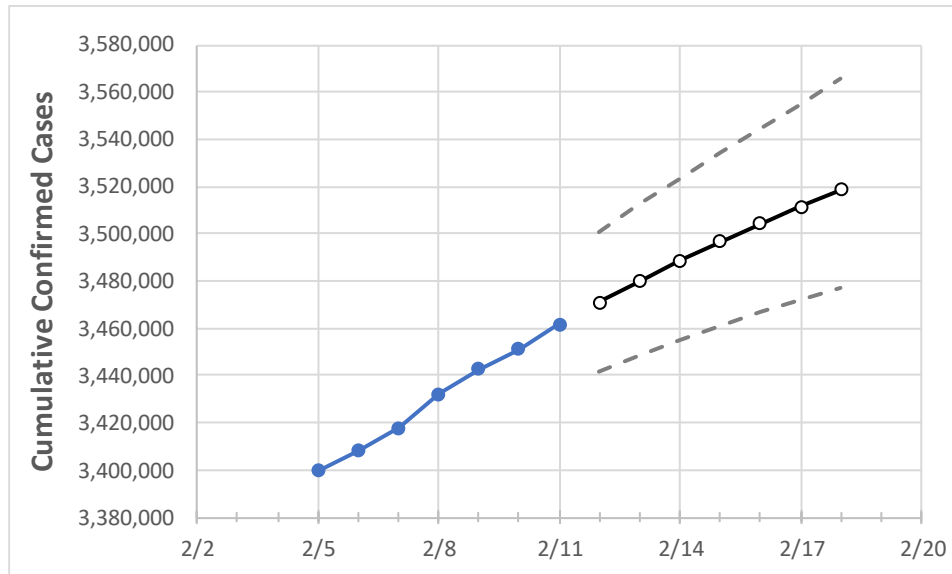
	Actual Confirmed Cases On:				Projected Cases For:							
	2/8	2/9	2/10	2/11	2/12	2/13	2/14	2/15	2/16	2/17	2/18
California	3,432,088	3,442,672	3,451,176	3,461,753	3,470,966	3,480,040	3,488,713	3,496,717	3,504,451	3,511,627	3,518,616

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:						
	2/8	2/9	2/10	2/11	2/12	2/13	2/14	2/15	2/16	2/17	2/18
Alameda	76,648	77,109	77,216	77,632	78,204	78,762	79,315	79,844	80,405	80,951	81,521
Contra Costa	59,313	59,585	59,751	59,895	60,085	60,269	60,448	60,620	60,792	60,953	61,105
Fresno	91,184	91,430	91,730	91,876	92,115	92,347	92,569	92,790	93,002	93,203	93,395
Kern	97,522	98,187	98,636	99,087	99,477	99,860	100,228	100,584	100,936	101,281	101,613
Lake	2,940	2,949	2,955	2,975	2,987	2,999	3,010	3,021	3,032	3,042	3,052
Los Angeles	1,149,346	1,152,430	1,155,491	1,158,794	1,161,563	1,164,231	1,166,671	1,169,047	1,171,245	1,173,361	1,175,393
Marin	12,657	12,678	12,715	12,754	12,785	12,815	12,845	12,874	12,902	12,930	12,955
Monterey	40,783	40,908	40,971	41,076	41,181	41,273	41,370	41,456	41,538	41,616	41,690
Orange	253,289	253,900	254,417	255,254	256,005	256,756	257,466	258,178	258,852	259,536	260,189
Placer	18,973	19,036	19,121	19,175	19,222	19,270	19,312	19,355	19,396	19,435	19,472
Riverside	282,736	283,525	284,168	284,814	285,490	286,131	286,753	287,336	287,850	288,363	288,850
Sacramento	88,919	89,267	89,378	89,653	89,851	90,046	90,233	90,414	90,585	90,744	90,897
San Bernardino	278,802	279,412	279,673	280,068	280,404	280,731	281,037	281,313	281,540	281,776	281,984
San Diego	247,462	248,051	248,861	249,974	250,848	251,696	252,504	253,289	254,023	254,744	255,420
San Francisco	32,609	32,679	32,782	32,955	33,058	33,159	33,258	33,354	33,448	33,538	33,624
San Joaquin	64,138	64,396	64,457	64,709	64,896	65,078	65,256	65,429	65,596	65,767	65,927
San Luis Obispo	18,684	18,788	18,838	18,889	18,960	19,028	19,094	19,157	19,219	19,279	19,336
San Mateo	37,058	37,139	37,277	37,437	37,555	37,670	37,780	37,889	37,990	38,088	38,181
Santa Barbara	30,087	30,206	30,352	30,502	30,638	30,771	30,898	31,020	31,134	31,243	31,352
Santa Clara	105,386	105,740	106,023	106,372	106,681	106,977	107,267	107,538	107,808	108,063	108,307
Santa Cruz	14,011	14,055	14,092	14,163	14,214	14,265	14,311	14,357	14,400	14,443	14,482
Solano	28,994	29,040	29,172	29,251	29,343	29,432	29,511	29,589	29,665	29,740	29,812
Sonoma	26,909	26,939	26,971	27,056	27,124	27,187	27,251	27,310	27,364	27,418	27,470
Ventura	73,759	74,068	74,333	74,651	74,974	75,277	75,562	75,835	76,093	76,342	76,594

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:		
	2/8	2/9	2/10	2/11	2/13	2/15	2/17
Alameda	76,648	77,109	77,216	77,632	78,762 (15,752) [3,781] {1,890}	79,844 (15,969) [3,833] {1,916}	80,951 (16,190) [3,886] {1,943}
Contra Costa	59,313	59,585	59,751	59,895	60,269 (12,054) [2,893] {1,446}	60,620 (12,124) [2,910] {1,455}	60,953 (12,191) [2,926] {1,463}
Fresno	91,184	91,430	91,730	91,876	92,347 (18,469) [4,433] {2,216}	92,790 (18,558) [4,454] {2,227}	93,203 (18,641) [4,474] {2,237}
Kern	97,522	98,187	98,636	99,087	99,860 (19,972) [4,793] {2,397}	100,584 (20,117) [4,828] {2,414}	101,281 (20,256) [4,861] {2,431}
Lake	2,940	2,949	2,955	2,975	2,999 (600) [144] {72}	3,021 (604) [145] {72}	3,042 (608) [146] {73}
Los Angeles	1,149,346	1,152,430	1,155,491	1,158,794	1,164,231 (232,846) [55,883] {27,942}	1,169,047 (233,809) [56,114] {28,057}	1,173,361 (234,672) [56,321] {28,161}
Marin	12,657	12,678	12,715	12,754	12,815 (2,563) [615] {308}	12,874 (2,575) [618] {309}	12,930 (2,586) [621] {310}
Monterey	40,783	40,908	40,971	41,076	41,273 (8,255) [1,981] {991}	41,456 (8,291) [1,990] {995}	41,616 (8,323) [1,998] {999}
Orange	253,289	253,900	254,417	255,254	256,756 (51,351) [12,324] {6,162}	258,178 (51,636) [12,393] {6,196}	259,536 (51,907) [12,458] {6,229}
Placer	18,973	19,036	19,121	19,175	19,270 (3,854) [925] {462}	19,355 (3,871) [929] {465}	19,435 (3,887) [933] {466}
Riverside	282,736	283,525	284,168	284,814	286,131 (57,226) [13,734] {6,867}	287,336 (57,467) [13,792] {6,896}	288,363 (57,673) [13,841] {6,921}
Sacramento	88,919	89,267	89,378	89,653	90,046 (18,009) [4,322] {2,161}	90,414 (18,083) [4,340] {2,170}	90,744 (18,149) [4,356] {2,178}
San Bernardino	278,802	279,412	279,673	280,068	280,731 (56,146) [13,475] {6,738}	281,313 (56,263) [13,503] {6,752}	281,776 (56,355) [13,525] {6,763}
San Diego	247,462	248,051	248,861	249,974	251,696 (50,339) [12,081] {6,041}	253,289 (50,658) [12,158] {6,079}	254,744 (50,949) [12,228] {6,114}
San Francisco	32,609	32,679	32,782	32,955	33,159 (6,632) [1,592] {796}	33,354 (6,671) [1,601] {801}	33,538 (6,708) [1,610] {805}
San Joaquin	64,138	64,396	64,457	64,709	65,078 (13,016) [3,124] {1,562}	65,429 (13,086) [3,141] {1,570}	65,767 (13,153) [3,157] {1,578}
San Luis Obispo	18,684	18,788	18,838	18,889	19,028 (3,806) [913] {457}	19,157 (3,831) [920] {460}	19,279 (3,856) [925] {463}
San Mateo	37,058	37,139	37,277	37,437	37,670 (7,534) [1,808] {904}	37,889 (7,578) [1,819] {909}	38,088 (7,618) [1,828] {914}
Santa Barbara	30,087	30,206	30,352	30,502	30,771 (6,154) [1,477] {739}	31,020 (6,204) [1,489] {744}	31,243 (6,249) [1,500] {750}
Santa Clara	105,386	105,740	106,023	106,372	106,977 (21,395) [5,135] {2,567}	107,538 (21,508) [5,162] {2,581}	108,063 (21,613) [5,187] {2,594}
Santa Cruz	14,011	14,055	14,092	14,163	14,265 (2,853) [685] {342}	14,357 (2,871) [689] {345}	14,443 (2,889) [693] {347}
Solano	28,994	29,040	29,172	29,251	29,432 (5,886) [1,413] {706}	29,589 (5,918) [1,420] {710}	29,740 (5,948) [1,428] {714}
Sonoma	26,909	26,939	26,971	27,056	27,187 (5,437) [1,305] {652}	27,310 (5,462) [1,311] {655}	27,418 (5,484) [1,316] {658}
Ventura	73,759	74,068	74,333	74,651	75,277 (15,055) [3,613] {1,807}	75,835 (15,167) [3,640] {1,820}	76,342 (15,268) [3,664] {1,832}

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.