IEM's AI Modeling: Short-term COVID-19 Projections
Date: 12/22/21

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 12/22/21 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
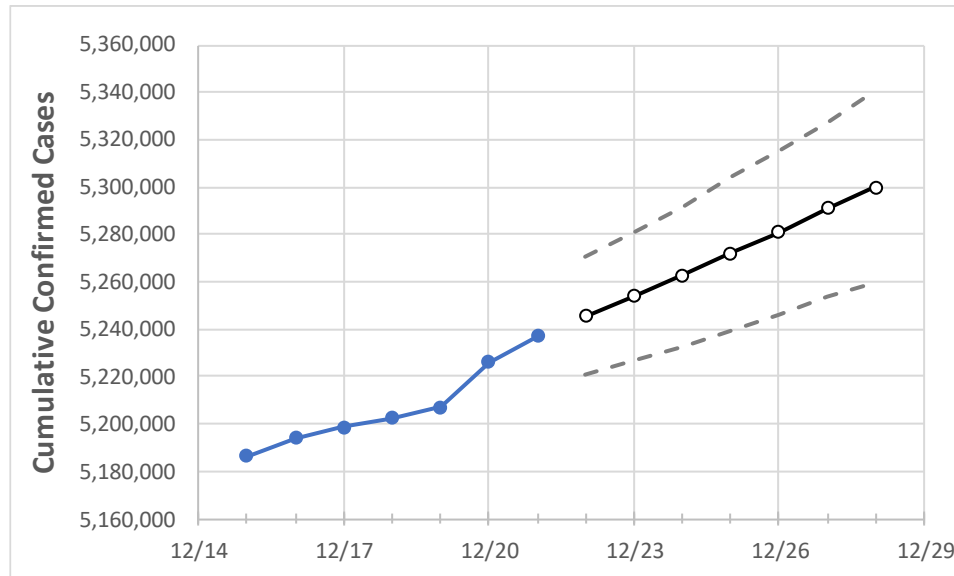
	Actual Confirmed Cases On:				Projected Cases For:						
	12/18	12/19	12/20	12/21	12/22	12/23	12/24	12/25	12/26	12/27	12/28
California	5,202,380	5,206,956	5,226,183	5,237,078	5,245,581	5,254,072	5,262,754	5,272,010	5,280,872	5,290,901	5,299,922

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:						
	12/18	12/19	12/20	12/21	12/22	12/23	12/24	12/25	12/26	12/27	12/28
Alameda	127,799	127,799	128,680	128,978	129,171	129,397	129,610	129,852	130,102	130,371	130,601
Contra Costa	106,139	106,271	106,402	106,547	106,681	106,812	106,953	107,088	107,227	107,375	107,513
Fresno	159,924	159,925	160,392	160,492	160,613	160,757	160,889	161,021	161,151	161,304	161,432
Kern	161,235	161,388	161,540	161,760	161,948	162,140	162,332	162,521	162,715	162,907	163,101
Lake	7,156	7,161	7,167	7,167	7,173	7,179	7,185	7,191	7,197	7,203	7,209
Los Angeles	1,560,377	1,563,879	1,567,133	1,570,230	1,573,264	1,576,446	1,579,702	1,583,141	1,586,691	1,590,470	1,594,191
Marin	19,201	19,244	19,286	19,326	19,365	19,404	19,448	19,486	19,528	19,574	19,614
Monterey	53,830	53,830	54,003	54,043	54,101	54,156	54,213	54,276	54,338	54,405	54,459
Orange	340,836	341,287	341,739	342,391	342,874	343,377	343,880	344,395	344,935	345,488	346,047
Placer	43,498	43,545	43,592	43,646	43,699	43,751	43,803	43,852	43,906	43,958	44,012
Riverside	397,008	397,009	398,960	399,496	400,131	400,650	401,216	401,738	402,331	402,929	403,531
Sacramento	172,461	172,461	173,348	173,568	173,800	174,026	174,262	174,506	174,735	174,984	175,240
San Bernardino	384,015	384,019	385,841	386,242	386,741	387,279	387,807	388,374	388,879	389,408	389,996
San Diego	420,493	420,848	421,204	424,490	425,525	426,595	427,674	428,713	429,856	431,074	432,236
San Francisco	58,893	59,092	59,291	59,594	59,797	60,011	60,236	60,473	60,735	60,987	61,264
San Joaquin	109,810	109,916	110,023	110,086	110,189	110,291	110,396	110,498	110,597	110,707	110,812
San Luis Obispo	32,348	32,389	32,429	32,469	32,518	32,566	32,609	32,654	32,704	32,754	32,803
San Mateo	57,904	58,005	58,105	58,220	58,311	58,405	58,501	58,602	58,703	58,807	58,912
Santa Barbara	48,714	48,788	48,861	48,922	48,996	49,068	49,144	49,222	49,295	49,378	49,453
Santa Clara	156,030	156,031	156,837	157,215	157,448	157,683	157,913	158,149	158,393	158,663	158,894
Santa Cruz	23,018	23,056	23,095	23,124	23,161	23,199	23,238	23,274	23,315	23,354	23,391
Solano	48,491	48,499	48,666	48,719	48,769	48,816	48,864	48,913	48,963	49,020	49,072
Sonoma	44,402	44,474	44,545	44,583	44,651	44,715	44,784	44,855	44,927	44,995	45,069
Ventura	106,252	106,252	106,810	107,092	107,272	107,441	107,607	107,807	107,992	108,198	108,404

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:		
	12/18	12/19	12/20	12/21	12/23	12/25	12/27
Alameda	127,799	127,799	128,680	128,978	129,397 (25,879) [6,211] {3,106}	129,852 (25,970) [6,233] {3,116}	130,371 (26,074) [6,258] {3,129}
Contra Costa	106,139	106,271	106,402	106,547	106,812 (21,362) [5,127] {2,563}	107,088 (21,418) [5,140] {2,570}	107,375 (21,475) [5,154] {2,577}
Fresno	159,924	159,925	160,392	160,492	160,757 (32,151) [7,716] {3,858}	161,021 (32,204) [7,729] {3,864}	161,304 (32,261) [7,743] {3,871}
Kern	161,235	161,388	161,540	161,760	162,140 (32,428) [7,783] {3,891}	162,521 (32,504) [7,801] {3,901}	162,907 (32,581) [7,820] {3,910}
Lake	7,156	7,161	7,167	7,167	7,179 (1,436) [345] {172}	7,191 (1,438) [345] {173}	7,203 (1,441) [346] {173}
Los Angeles	1,560,377	1,563,879	1,567,133	1,570,230	1,576,446 (315,289) [75,669] {37,835}	1,583,141 (316,628) [75,991] {37,995}	1,590,470 (318,094) [76,343] {38,171}
Marin	19,201	19,244	19,286	19,326	19,404 (3,881) [931] {466}	19,486 (3,897) [935] {468}	19,574 (3,915) [940] {470}
Monterey	53,830	53,830	54,003	54,043	54,156 (10,831) [2,599] {1,300}	54,276 (10,855) [2,605] {1,303}	54,405 (10,881) [2,611] {1,306}
Orange	340,836	341,287	341,739	342,391	343,377 (68,675) [16,482] {8,241}	344,395 (68,879) [16,531] {8,265}	345,488 (69,098) [16,583] {8,292}
Placer	43,498	43,545	43,592	43,646	43,751 (8,750) [2,100] {1,050}	43,852 (8,770) [2,105] {1,052}	43,958 (8,792) [2,110] {1,055}
Riverside	397,008	397,009	398,960	399,496	400,650 (80,130) [19,231] {9,616}	401,738 (80,348) [19,283] {9,642}	402,929 (80,586) [19,341] {9,670}
Sacramento	172,461	172,461	173,348	173,568	174,026 (34,805) [8,353] {4,177}	174,506 (34,901) [8,376] {4,188}	174,984 (34,997) [8,399] {4,200}
San Bernardino	384,015	384,019	385,841	386,242	387,279 (77,456) [18,589] {9,295}	388,374 (77,675) [18,642] {9,321}	389,408 (77,882) [18,692] {9,346}
San Diego	420,493	420,848	421,204	424,490	426,595 (85,319) [20,477] {10,238}	428,713 (85,743) [20,578] {10,289}	431,074 (86,215) [20,692] {10,346}
San Francisco	58,893	59,092	59,291	59,594	60,011 (12,002) [2,881] {1,440}	60,473 (12,095) [2,903] {1,451}	60,987 (12,197) [2,927] {1,464}
San Joaquin	109,810	109,916	110,023	110,086	110,291 (22,058) [5,294] {2,647}	110,498 (22,100) [5,304] {2,652}	110,707 (22,141) [5,314] {2,657}
San Luis Obispo	32,348	32,389	32,429	32,469	32,566 (6,513) [1,563] {782}	32,654 (6,531) [1,567] {784}	32,754 (6,551) [1,572] {786}
San Mateo	57,904	58,005	58,105	58,220	58,405 (11,681) [2,803] {1,402}	58,602 (11,720) [2,813] {1,406}	58,807 (11,761) [2,823] {1,411}
Santa Barbara	48,714	48,788	48,861	48,922	49,068 (9,814) [2,355] {1,178}	49,222 (9,844) [2,363] {1,181}	49,378 (9,876) [2,370] {1,185}
Santa Clara	156,030	156,031	156,837	157,215	157,683 (31,537) [7,569] {3,784}	158,149 (31,630) [7,591] {3,796}	158,663 (31,733) [7,616] {3,808}
Santa Cruz	23,018	23,056	23,095	23,124	23,199 (4,640) [1,114] {557}	23,274 (4,655) [1,117] {559}	23,354 (4,671) [1,121] {561}
Solano	48,491	48,499	48,666	48,719	48,816 (9,763) [2,343] {1,172}	48,913 (9,783) [2,348] {1,174}	49,020 (9,804) [2,353] {1,176}
Sonoma	44,402	44,474	44,545	44,583	44,715 (8,943) [2,146] {1,073}	44,855 (8,971) [2,153] {1,077}	44,995 (8,999) [2,160] {1,080}
Ventura	106,252	106,252	106,810	107,092	107,441 (21,488) [5,157] {2,579}	107,807 (21,561) [5,175] {2,587}	108,198 (21,640) [5,193] {2,597}

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.