IEM's AI Modeling: Short-term COVID-19 Projections
Date: 1/4/21

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 1/4/21 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
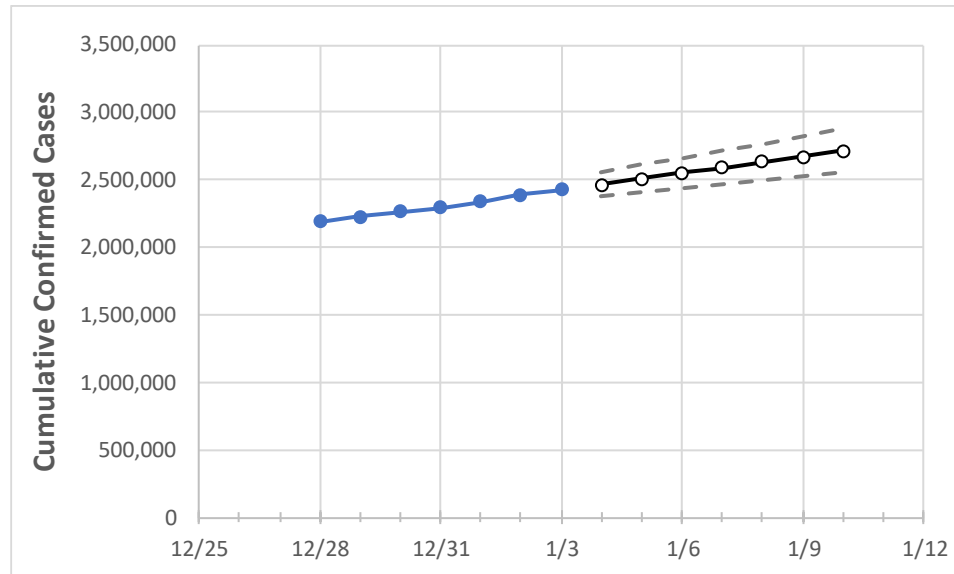
	Actual Confirmed Cases On:				Projected Cases For:						
	12/31	1/1	1/2	1/3	1/4	1/5	1/6	1/7	1/8	1/9	1/10
California	2,291,007	2,336,201	2,388,557	2,426,930	2,467,057	2,507,890	2,549,151	2,590,168	2,631,525	2,673,428	2,715,520

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:						
	12/31	1/1	1/2	1/3	1/4	1/5	1/6	1/7	1/8	1/9	1/10
Alameda	51,590	52,475	53,518	54,518	55,343	56,187	57,037	57,886	58,758	59,616	60,484
Contra Costa	39,736	40,697	41,599	41,993	42,578	43,173	43,778	44,376	45,001	45,638	46,288
Fresno	65,400	66,442	67,484	68,740	69,617	70,451	71,309	72,153	72,955	73,775	74,565
Kern	68,316	68,969	69,484	70,358	71,271	72,194	73,107	74,039	74,949	75,847	76,768
Lake	1,819	1,848	1,888	1,925	1,961	1,997	2,035	2,072	2,109	2,146	2,184
Los Angeles	770,602	790,582	806,210	818,639	832,251	845,986	859,549	873,218	887,667	901,903	916,188
Marin	9,728	9,798	9,900	10,012	10,092	10,174	10,256	10,339	10,422	10,505	10,588
Monterey	27,289	27,859	28,465	28,991	29,471	29,957	30,450	30,936	31,419	31,944	32,441
Orange	157,183	161,586	165,440	168,457	171,698	174,975	178,207	181,610	184,935	188,372	191,763
Placer	13,755	13,871	13,987	14,182	14,360	14,535	14,707	14,876	15,042	15,206	15,365
Riverside	180,553	184,193	188,674	192,069	195,335	198,598	201,768	205,016	208,287	211,596	214,824
Sacramento	65,541	65,817	66,956	67,810	68,685	69,549	70,438	71,310	72,186	73,019	73,867
San Bernardino	194,377	199,115	203,651	206,939	210,249	213,493	216,846	220,118	223,574	227,024	230,249
San Diego	155,595	160,048	164,500	168,020	171,517	175,075	178,771	182,529	186,384	190,279	194,262
San Francisco	23,224	23,740	24,145	24,414	24,710	25,015	25,319	25,623	25,929	26,238	26,563
San Joaquin	45,019	45,764	46,640	47,310	48,026	48,738	49,464	50,181	50,893	51,595	52,327
San Luis Obispo	10,490	10,846	11,160	11,467	11,708	11,957	12,218	12,483	12,755	13,044	13,340
San Mateo	24,589	24,815	25,041	25,483	25,815	26,144	26,476	26,814	27,148	27,493	27,829
Santa Barbara	17,025	17,434	17,759	18,135	18,456	18,789	19,131	19,490	19,864	20,243	20,648
Santa Clara	69,879	71,755	73,493	74,359	75,682	77,050	78,412	79,819	81,241	82,658	84,096
Santa Cruz	8,573	8,909	9,146	9,340	9,528	9,719	9,921	10,130	10,351	10,571	10,797
Solano	19,211	19,302	19,393	19,805	20,061	20,330	20,602	20,889	21,169	21,468	21,764
Sonoma	18,992	19,129	19,513	19,761	19,986	20,214	20,441	20,679	20,914	21,150	21,395
Ventura	39,259	40,854	42,026	43,397	44,552	45,774	47,020	48,386	49,753	51,169	52,629

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:		
	12/31	1/1	1/2	1/3	1/5	1/7	1/9
Alameda	51,590	52,475	53,518	54,518	56,187 (11,237) [2,697] {1,348}	57,886 (11,577) [2,779] {1,389}	59,616 (11,923) [2,862] {1,431}
Contra Costa	39,736	40,697	41,599	41,993	43,173 (8,635) [2,072] {1,036}	44,376 (8,875) [2,130] {1,065}	45,638 (9,128) [2,191] {1,095}
Fresno	65,400	66,442	67,484	68,740	70,451 (14,090) [3,382] {1,691}	72,153 (14,431) [3,463] {1,732}	73,775 (14,755) [3,541] {1,771}
Kern	68,316	68,969	69,484	70,358	72,194 (14,439) [3,465] {1,733}	74,039 (14,808) [3,554] {1,777}	75,847 (15,169) [3,641] {1,820}
Lake	1,819	1,848	1,888	1,925	1,997 (399) [96] {48}	2,072 (414) [99] {50}	2,146 (429) [103] {52}
Los Angeles	770,602	790,582	806,210	818,639	845,986 (169,197) [40,607] {20,304}	873,218 (174,644) [41,914] {20,957}	901,903 (180,381) [43,291] {21,646}
Marin	9,728	9,798	9,900	10,012	10,174 (2,035) [488] {244}	10,339 (2,068) [496] {248}	10,505 (2,101) [504] {252}
Monterey	27,289	27,859	28,465	28,991	29,957 (5,991) [1,438] {719}	30,936 (6,187) [1,485] {742}	31,944 (6,389) [1,533] {767}
Orange	157,183	161,586	165,440	168,457	174,975 (34,995) [8,399] {4,199}	181,610 (36,322) [8,717] {4,359}	188,372 (37,674) [9,042] {4,521}
Placer	13,755	13,871	13,987	14,182	14,535 (2,907) [698] {349}	14,876 (2,975) [714] {357}	15,206 (3,041) [730] {365}
Riverside	180,553	184,193	188,674	192,069	198,598 (39,720) [9,533] {4,766}	205,016 (41,003) [9,841] {4,920}	211,596 (42,319) [10,157] {5,078}
Sacramento	65,541	65,817	66,956	67,810	69,549 (13,910) [3,338] {1,669}	71,310 (14,262) [3,423] {1,711}	73,019 (14,604) [3,505] {1,752}
San Bernardino	194,377	199,115	203,651	206,939	213,493 (42,699) [10,248] {5,124}	220,118 (44,024) [10,566] {5,283}	227,024 (45,405) [10,897] {5,449}
San Diego	155,595	160,048	164,500	168,020	175,075 (35,015) [8,404] {4,202}	182,529 (36,506) [8,761] {4,381}	190,279 (38,056) [9,133] {4,567}
San Francisco	23,224	23,740	24,145	24,414	25,015 (5,003) [1,201] {600}	25,623 (5,125) [1,230] {615}	26,238 (5,248) [1,259] {630}
San Joaquin	45,019	45,764	46,640	47,310	48,738 (9,748) [2,339] {1,170}	50,181 (10,036) [2,409] {1,204}	51,595 (10,319) [2,477] {1,238}
San Luis Obispo	10,490	10,846	11,160	11,467	11,957 (2,391) [574] {287}	12,483 (2,497) [599] {300}	13,044 (2,609) [626] {313}
San Mateo	24,589	24,815	25,041	25,483	26,144 (5,229) [1,255] {627}	26,814 (5,363) [1,287] {644}	27,493 (5,499) [1,320] {660}
Santa Barbara	17,025	17,434	17,759	18,135	18,789 (3,758) [902] {451}	19,490 (3,898) [936] {468}	20,243 (4,049) [972] {486}
Santa Clara	69,879	71,755	73,493	74,359	77,050 (15,410) [3,698] {1,849}	79,819 (15,964) [3,831] {1,916}	82,658 (16,532) [3,968] {1,984}
Santa Cruz	8,573	8,909	9,146	9,340	9,719 (1,944) [467] {233}	10,130 (2,026) [486] {243}	10,571 (2,114) [507] {254}
Solano	19,211	19,302	19,393	19,805	20,330 (4,066) [976] {488}	20,889 (4,178) [1,003] {501}	21,468 (4,294) [1,030] {515}
Sonoma	18,992	19,129	19,513	19,761	20,214 (4,043) [970] {485}	20,679 (4,136) [993] {496}	21,150 (4,230) [1,015] {508}
Ventura	39,259	40,854	42,026	43,397	45,774 (9,155) [2,197] {1,099}	48,386 (9,677) [2,323] {1,161}	51,169 (10,234) [2,456] {1,228}

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.