IEM's AI Modeling: Short-term COVID-19 Projections
Date: 12/31/20

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 12/31/20 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
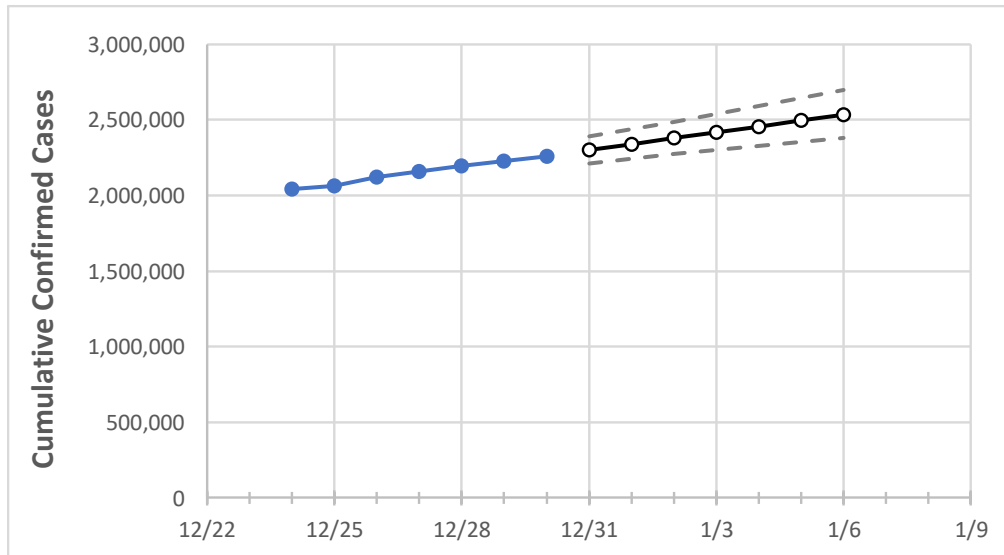
	Actual Confirmed Cases On:				Projected Cases For:						
	12/27	12/28	12/29	12/30	12/31	1/1	1/2	1/3	1/4	1/5	1/6
California	2,156,389	2,192,684	2,228,332	2,261,035	2,299,833	2,338,524	2,377,742	2,417,267	2,456,542	2,496,225	2,535,876

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 20%, and are often within 10%, of actual confirmed cases.

California Counties

	Actual Confirmed Cases On:				Projected Cases For:						
	12/27	12/28	12/29	12/30	12/31	1/1	1/2	1/3	1/4	1/5	1/6
Alameda	49,084	49,796	50,405	50,946	51,685	52,419	53,151	53,879	54,599	55,323	56,042
Contra Costa	38,138	38,558	39,029	39,391	39,894	40,393	40,897	41,386	41,881	42,352	42,846
Fresno	63,080	63,811	64,274	65,149	66,242	67,376	68,574	69,762	70,915	72,126	73,394
Kern	63,557	64,810	66,526	67,292	68,365	69,443	70,511	71,644	72,796	73,925	75,068
Lake	1,710	1,769	1,791	1,805	1,843	1,881	1,920	1,959	1,999	2,040	2,081
Los Angeles	719,833	733,325	746,089	756,116	769,122	781,926	794,834	807,876	820,627	833,438	846,777
Marin	9,505	9,569	9,616	9,661	9,734	9,810	9,888	9,964	10,042	10,124	10,203
Monterey	26,010	26,322	26,723	26,894	27,319	27,739	28,158	28,570	28,979	29,387	29,790
Orange	147,463	149,607	152,089	156,573	159,847	163,281	166,667	170,135	173,677	177,313	180,985
Placer	12,816	13,055	13,272	13,550	13,763	13,986	14,211	14,436	14,664	14,879	15,122
Riverside	169,360	174,477	176,688	180,537	184,219	187,907	191,604	195,455	199,373	203,143	206,988
Sacramento	62,435	63,416	64,322	65,078	66,051	67,024	68,005	68,971	69,935	70,896	71,841
San Bernardino	185,111	186,776	191,087	193,214	196,626	199,975	203,261	206,527	209,759	213,030	216,096
San Diego	145,779	147,530	150,064	152,512	155,301	158,070	160,841	163,651	166,441	169,203	171,986
San Francisco	22,319	22,514	22,726	22,996	23,243	23,483	23,731	23,972	24,210	24,447	24,685
San Joaquin	42,887	43,529	44,172	44,699	45,437	46,179	46,914	47,655	48,421	49,165	49,930
San Luis Obispo	9,945	10,154	10,260	10,387	10,567	10,748	10,927	11,113	11,302	11,489	11,678
San Mateo	22,908	23,681	23,916	24,246	24,610	24,966	25,319	25,674	26,042	26,403	26,763
Santa Barbara	16,159	16,364	16,579	16,797	17,043	17,297	17,555	17,809	18,067	18,337	18,614
Santa Clara	64,974	66,270	67,423	67,581	68,675	69,787	70,890	71,999	73,086	74,194	75,302
Santa Cruz	8,113	8,234	8,310	8,492	8,646	8,803	8,959	9,114	9,276	9,437	9,599
Solano	17,528	18,518	18,726	19,008	19,330	19,651	19,998	20,334	20,705	21,077	21,448
Sonoma	18,539	18,603	18,667	18,872	19,091	19,322	19,540	19,764	20,000	20,236	20,474
Ventura	36,064	36,661	37,151	38,669	39,588	40,551	41,560	42,582	43,641	44,721	45,864

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:		
	12/27	12/28	12/29	12/30	1/1	1/3	1/5
Alameda	49,084	49,796	50,405	50,946	52,419 (10,484) [2,516] {1,258}	53,879 (10,776) [2,586] {1,293}	55,323 (11,065) [2,656] {1,328}
Contra Costa	38,138	38,558	39,029	39,391	40,393 (8,079) [1,939] {969}	41,386 (8,277) [1,987] {993}	42,352 (8,470) [2,033] {1,016}
Fresno	63,080	63,811	64,274	65,149	67,376 (13,475) [3,234] {1,617}	69,762 (13,952) [3,349] {1,674}	72,126 (14,425) [3,462] {1,731}
Kern	63,557	64,810	66,526	67,292	69,443 (13,889) [3,333] {1,667}	71,644 (14,329) [3,439] {1,719}	73,925 (14,785) [3,548] {1,774}
Lake	1,710	1,769	1,791	1,805	1,881 (376) [90] {45}	1,959 (392) [94] {47}	2,040 (408) [98] {49}
Los Angeles	719,833	733,325	746,089	756,116	781,926 (156,385) [37,532] {18,766}	807,876 (161,575) [38,778] {19,389}	833,438 (166,688) [40,005] {20,003}
Marin	9,505	9,569	9,616	9,661	9,810 (1,962) [471] {235}	9,964 (1,993) [478] {239}	10,124 (2,025) [486] {243}
Monterey	26,010	26,322	26,723	26,894	27,739 (5,548) [1,331] {666}	28,570 (5,714) [1,371] {686}	29,387 (5,877) [1,411] {705}
Orange	147,463	149,607	152,089	156,573	163,281 (32,656) [7,837] {3,919}	170,135 (34,027) [8,166] {4,083}	177,313 (35,463) [8,511] {4,256}
Placer	12,816	13,055	13,272	13,550	13,986 (2,797) [671] {336}	14,436 (2,887) [693] {346}	14,879 (2,976) [714] {357}
Riverside	169,360	174,477	176,688	180,537	187,907 (37,581) [9,020] {4,510}	195,455 (39,091) [9,382] {4,691}	203,143 (40,629) [9,751] {4,875}
Sacramento	62,435	63,416	64,322	65,078	67,024 (13,405) [3,217] {1,609}	68,971 (13,794) [3,311] {1,655}	70,896 (14,179) [3,403] {1,702}
San Bernardino	185,111	186,776	191,087	193,214	199,975 (39,995) [9,599] {4,799}	206,527 (41,305) [9,913] {4,957}	213,030 (42,606) [10,225] {5,113}
San Diego	145,779	147,530	150,064	152,512	158,070 (31,614) [7,587] {3,794}	163,651 (32,730) [7,855] {3,928}	169,203 (33,841) [8,122] {4,061}
San Francisco	22,319	22,514	22,726	22,996	23,483 (4,697) [1,127] {564}	23,972 (4,794) [1,151] {575}	24,447 (4,889) [1,173] {587}
San Joaquin	42,887	43,529	44,172	44,699	46,179 (9,236) [2,217] {1,108}	47,655 (9,531) [2,287] {1,144}	49,165 (9,833) [2,360] {1,180}
San Luis Obispo	9,945	10,154	10,260	10,387	10,748 (2,150) [516] {258}	11,113 (2,223) [533] {267}	11,489 (2,298) [551] {276}
San Mateo	22,908	23,681	23,916	24,246	24,966 (4,993) [1,198] {599}	25,674 (5,135) [1,232] {616}	26,403 (5,281) [1,267] {634}
Santa Barbara	16,159	16,364	16,579	16,797	17,297 (3,459) [830] {415}	17,809 (3,562) [855] {427}	18,337 (3,667) [880] {440}
Santa Clara	64,974	66,270	67,423	67,581	69,787 (13,957) [3,350] {1,675}	71,999 (14,400) [3,456] {1,728}	74,194 (14,839) [3,561] {1,781}
Santa Cruz	8,113	8,234	8,310	8,492	8,803 (1,761) [423] {211}	9,114 (1,823) [437] {219}	9,437 (1,887) [453] {226}
Solano	17,528	18,518	18,726	19,008	19,651 (3,930) [943] {472}	20,334 (4,067) [976] {488}	21,077 (4,215) [1,012] {506}
Sonoma	18,539	18,603	18,667	18,872	19,322 (3,864) [927] {464}	19,764 (3,953) [949] {474}	20,236 (4,047) [971] {486}
Ventura	36,064	36,661	37,151	38,669	40,551 (8,110) [1,946] {973}	42,582 (8,516) [2,044] {1,022}	44,721 (8,944) [2,147] {1,073}

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.