IEM's AI Modeling: Short-term COVID-19 Projections
Date: 12/9/20

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 12/9/20 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
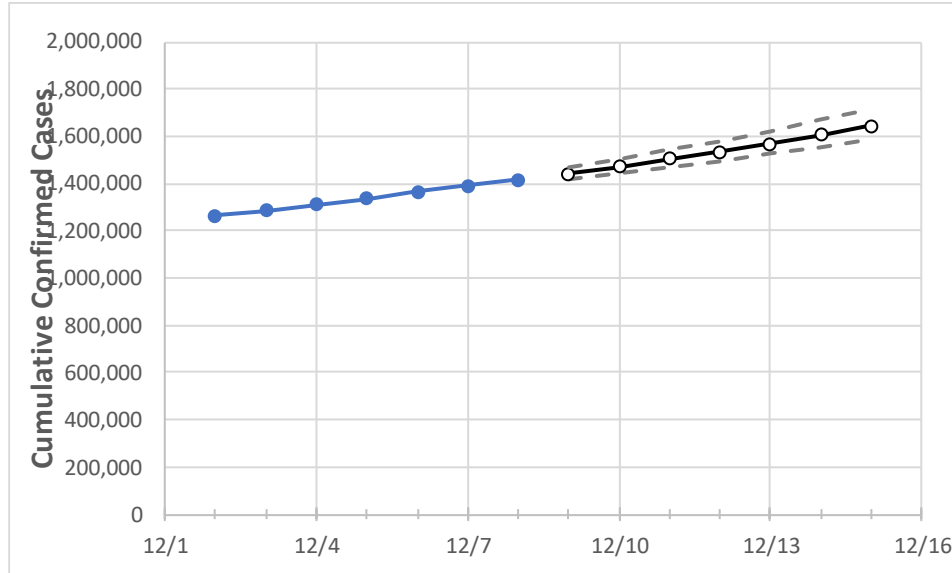
	Actual Confirmed Cases On:				Projected Cases For:						
	12/5	12/6	12/7	12/8	12/9	12/10	12/11	12/12	12/13	12/14	12/15
California	1,337,941	1,366,673	1,390,828	1,415,396	1,443,177	1,472,486	1,503,404	1,536,011	1,570,397	1,606,651	1,644,870

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:						
	12/5	12/6	12/7	12/8	12/9	12/10	12/11	12/12	12/13	12/14	12/15
Alameda	31,871	32,781	33,477	33,887	34,425	34,998	35,608	36,257	36,947	37,682	38,464
Contra Costa	25,768	26,355	26,703	27,455	27,875	28,316	28,779	29,263	29,772	30,305	30,864
Fresno	40,108	40,568	40,869	41,098	41,388	41,678	41,969	42,259	42,550	42,841	43,132
Kern	43,860	44,327	45,078	45,342	45,800	46,271	46,755	47,252	47,762	48,286	48,824
Lake	1,022	1,069	1,075	1,092	1,108	1,124	1,141	1,160	1,179	1,199	1,221
Los Angeles	439,408	449,851	457,880	466,321	476,801	488,022	500,031	512,878	526,618	541,308	557,010
Marin	7,962	8,016	8,064	8,102	8,147	8,194	8,244	8,295	8,350	8,407	8,466
Monterey	16,737	17,077	17,426	17,746	17,939	18,145	18,365	18,599	18,849	19,116	19,400
Orange	84,853	86,878	88,842	90,513	92,309	94,197	96,181	98,267	100,458	102,760	105,179
Placer	7,461	7,811	7,979	8,173	8,397	8,640	8,903	9,189	9,499	9,834	10,198
Riverside	95,255	98,612	100,088	103,221	105,290	107,503	109,868	112,394	115,093	117,975	121,051
Sacramento	41,096	41,878	42,808	43,426	44,166	44,934	45,729	46,554	47,409	48,295	49,213
San Bernardino	103,911	106,770	107,928	108,946	110,882	112,969	115,218	117,642	120,253	123,065	126,095
San Diego	90,468	92,171	94,169	95,445	97,460	99,665	102,078	104,714	107,594	110,739	114,172
San Francisco	16,499	16,786	17,107	17,220	17,422	17,632	17,850	18,075	18,308	18,550	18,801
San Joaquin	27,806	28,105	28,188	28,188	28,291	28,399	28,512	28,631	28,755	28,886	29,024
San Luis Obispo	6,540	6,623	6,723	6,873	6,918	6,963	7,009	7,055	7,102	7,149	7,197
San Mateo	15,468	15,512	16,101	16,371	16,487	16,608	16,735	16,866	17,003	17,146	17,295
Santa Barbara	11,947	12,107	12,252	12,379	12,439	12,499	12,560	12,621	12,684	12,747	12,810
Santa Clara	38,388	39,193	40,624	41,316	42,296	43,332	44,426	45,583	46,806	48,098	49,463
Santa Cruz	4,985	4,997	5,069	5,157	5,225	5,293	5,361	5,429	5,497	5,564	5,632
Solano	11,524	11,636	11,747	11,950	12,016	12,085	12,156	12,231	12,308	12,388	12,472
Sonoma	13,098	13,369	13,439	13,719	13,920	14,131	14,352	14,584	14,828	15,083	15,352
Ventura	22,024	22,710	23,035	23,354	23,846	24,368	24,922	25,510	26,134	26,796	27,498

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:		
	12/5	12/6	12/7	12/8	12/10	12/12	12/14
Alameda	31,871	32,781	33,477	33,887	34,998 (7,000) [1,680] {840}	36,257 (7,251) [1,740] {870}	37,682 (7,536) [1,809] {904}
Contra Costa	25,768	26,355	26,703	27,455	28,316 (5,663) [1,359] {680}	29,263 (5,853) [1,405] {702}	30,305 (6,061) [1,455] {727}
Fresno	40,108	40,568	40,869	41,098	41,678 (8,336) [2,001] {1,000}	42,259 (8,452) [2,028] {1,014}	42,841 (8,568) [2,056] {1,028}
Kern	43,860	44,327	45,078	45,342	46,271 (9,254) [2,221] {1,111}	47,252 (9,450) [2,268] {1,134}	48,286 (9,657) [2,318] {1,159}
Lake	1,022	1,069	1,075	1,092	1,124 (225) [54] {27}	1,160 (232) [56] {28}	1,199 (240) [58] {29}
Los Angeles	439,408	449,851	457,880	466,321	488,022 (97,604) [23,425] {11,713}	512,878 (102,576) [24,618] {12,309}	541,308 (108,262) [25,983] {12,991}
Marin	7,962	8,016	8,064	8,102	8,194 (1,639) [393] {197}	8,295 (1,659) [398] {199}	8,407 (1,681) [404] {202}
Monterey	16,737	17,077	17,426	17,746	18,145 (3,629) [871] {435}	18,599 (3,720) [893] {446}	19,116 (3,823) [918] {459}
Orange	84,853	86,878	88,842	90,513	94,197 (18,839) [4,521] {2,261}	98,267 (19,653) [4,717] {2,358}	102,760 (20,552) [4,932] {2,466}
Placer	7,461	7,811	7,979	8,173	8,640 (1,728) [415] {207}	9,189 (1,838) [441] {221}	9,834 (1,967) [472] {236}
Riverside	95,255	98,612	100,088	103,221	107,503 (21,501) [5,160] {2,580}	112,394 (22,479) [5,395] {2,697}	117,975 (23,595) [5,663] {2,831}
Sacramento	41,096	41,878	42,808	43,426	44,934 (8,987) [2,157] {1,078}	46,554 (9,311) [2,235] {1,117}	48,295 (9,659) [2,318] {1,159}
San Bernardino	103,911	106,770	107,928	108,946	112,969 (22,594) [5,423] {2,711}	117,642 (23,528) [5,647] {2,823}	123,065 (24,613) [5,907] {2,954}
San Diego	90,468	92,171	94,169	95,445	99,665 (19,933) [4,784] {2,392}	104,714 (20,943) [5,026] {2,513}	110,739 (22,148) [5,315] {2,658}
San Francisco	16,499	16,786	17,107	17,220	17,632 (3,526) [846] {423}	18,075 (3,615) [868] {434}	18,550 (3,710) [890] {445}
San Joaquin	27,806	28,105	28,188	28,188	28,399 (5,680) [1,363] {682}	28,631 (5,726) [1,374] {687}	28,886 (5,777) [1,387] {693}
San Luis Obispo	6,540	6,623	6,723	6,873	6,963 (1,393) [334] {167}	7,055 (1,411) [339] {169}	7,149 (1,430) [343] {172}
San Mateo	15,468	15,512	16,101	16,371	16,608 (3,322) [797] {399}	16,866 (3,373) [810] {405}	17,146 (3,429) [823] {411}
Santa Barbara	11,947	12,107	12,252	12,379	12,499 (2,500) [600] {300}	12,621 (2,524) [606] {303}	12,747 (2,549) [612] {306}
Santa Clara	38,388	39,193	40,624	41,316	43,332 (8,666) [2,080] {1,040}	45,583 (9,117) [2,188] {1,094}	48,098 (9,620) [2,309] {1,154}
Santa Cruz	4,985	4,997	5,069	5,157	5,293 (1,059) [254] {127}	5,429 (1,086) [261] {130}	5,564 (1,113) [267] {134}
Solano	11,524	11,636	11,747	11,950	12,085 (2,417) [580] {290}	12,231 (2,446) [587] {294}	12,388 (2,478) [595] {297}
Sonoma	13,098	13,369	13,439	13,719	14,131 (2,826) [678] {339}	14,584 (2,917) [700] {350}	15,083 (3,017) [724] {362}
Ventura	22,024	22,710	23,035	23,354	24,368 (4,874) [1,170] {585}	25,510 (5,102) [1,224] {612}	26,796 (5,359) [1,286] {643}

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.