IEM's AI Modeling: Short-term COVID-19 Projections
Date: 4/23/21

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 4/23/21 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
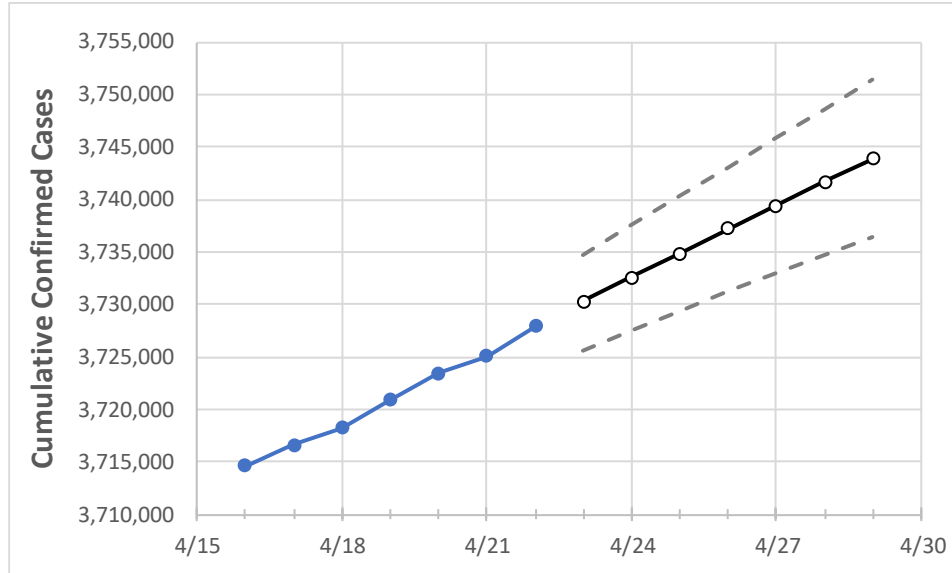
	Actual Confirmed Cases On:				Projected Cases For:						
	4/19	4/20	4/21	4/22	4/23	4/24	4/25	4/26	4/27	4/28	4/29
California	3,720,901	3,723,446	3,725,088	3,727,913	3,730,275	3,732,600	3,734,890	3,737,180	3,739,438	3,741,667	3,743,846

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:						
	4/19	4/20	4/21	4/22	4/23	4/24	4/25	4/26	4/27	4/28	4/29
Alameda	85,481	85,583	85,652	85,762	85,877	85,988	86,103	86,214	86,329	86,444	86,564
Contra Costa	67,101	67,157	67,229	67,300	67,390	67,481	67,571	67,659	67,750	67,844	67,933
Fresno	100,621	100,702	100,768	100,838	100,892	100,944	100,994	101,044	101,092	101,140	101,187
Kern	107,879	108,013	108,061	108,131	108,219	108,305	108,390	108,474	108,564	108,648	108,736
Lake	3,413	3,416	3,418	3,421	3,425	3,429	3,433	3,437	3,441	3,445	3,449
Los Angeles	1,229,328	1,229,641	1,229,998	1,230,398	1,230,793	1,231,178	1,231,551	1,231,917	1,232,270	1,232,620	1,232,965
Marin	13,865	13,868	13,876	13,883	13,889	13,895	13,900	13,906	13,911	13,916	13,922
Monterey	43,290	43,301	43,324	43,346	43,363	43,380	43,396	43,411	43,427	43,444	43,460
Orange	269,036	269,176	269,258	269,352	269,475	269,596	269,716	269,832	269,946	270,057	270,164
Placer	21,878	21,908	21,957	21,979	22,026	22,072	22,117	22,164	22,211	22,256	22,304
Riverside	297,319	297,620	297,631	297,770	297,876	297,983	298,088	298,191	298,288	298,386	298,484
Sacramento	101,511	101,665	101,787	101,906	102,064	102,224	102,379	102,544	102,702	102,852	103,013
San Bernardino	294,883	294,973	295,131	295,315	295,469	295,633	295,792	295,952	296,107	296,266	296,425
San Diego	275,112	275,368	275,631	275,912	276,151	276,391	276,630	276,883	277,121	277,373	277,625
San Francisco	36,073	36,094	36,117	36,194	36,237	36,280	36,324	36,367	36,411	36,455	36,499
San Joaquin	71,527	71,735	71,817	71,899	71,984	72,066	72,155	72,239	72,328	72,409	72,496
San Luis Obispo	20,972	20,991	21,015	21,038	21,062	21,087	21,112	21,137	21,161	21,186	21,211
San Mateo	41,201	41,226	41,251	41,318	41,361	41,405	41,449	41,492	41,538	41,582	41,627
Santa Barbara	33,913	33,926	33,926	33,926	33,959	33,991	34,023	34,055	34,088	34,117	34,149
Santa Clara	117,186	117,317	117,379	117,538	117,667	117,797	117,927	118,057	118,182	118,310	118,439
Santa Cruz	15,615	15,666	15,719	15,759	15,798	15,840	15,883	15,928	15,974	16,021	16,067
Solano	32,027	32,047	32,086	32,126	32,172	32,219	32,265	32,312	32,360	32,407	32,456
Sonoma	29,715	29,720	29,734	29,747	29,766	29,783	29,800	29,817	29,834	29,851	29,868
Ventura	80,309	80,332	80,360	80,398	80,429	80,459	80,488	80,517	80,546	80,572	80,600

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:		
	4/19	4/20	4/21	4/22	4/24	4/26	4/28
Alameda	85,481	85,583	85,652	85,762	85,988 (17,198) [4,127] {2,064}	86,214 (17,243) [4,138] {2,069}	86,444 (17,289) [4,149] {2,075}
Contra Costa	67,101	67,157	67,229	67,300	67,481 (13,496) [3,239] {1,620}	67,659 (13,532) [3,248] {1,624}	67,844 (13,569) [3,257] {1,628}
Fresno	100,621	100,702	100,768	100,838	100,944 (20,189) [4,845] {2,423}	101,044 (20,209) [4,850] {2,425}	101,140 (20,228) [4,855] {2,427}
Kern	107,879	108,013	108,061	108,131	108,305 (21,661) [5,199] {2,599}	108,474 (21,695) [5,207] {2,603}	108,648 (21,730) [5,215] {2,608}
Lake	3,413	3,416	3,418	3,421	3,429 (686) [165] {82}	3,437 (687) [165] {82}	3,445 (689) [165] {83}
Los Angeles	1,229,328	1,229,641	1,229,998	1,230,398	1,231,178 (246,236) [59,097] {29,548}	1,231,917 (246,383) [59,132] {29,566}	1,232,620 (246,524) [59,166] {29,583}
Marin	13,865	13,868	13,876	13,883	13,895 (2,779) [667] {333}	13,906 (2,781) [667] {334}	13,916 (2,783) [668] {334}
Monterey	43,290	43,301	43,324	43,346	43,380 (8,676) [2,082] {1,041}	43,411 (8,682) [2,084] {1,042}	43,444 (8,689) [2,085] {1,043}
Orange	269,036	269,176	269,258	269,352	269,596 (53,919) [12,941] {6,470}	269,832 (53,966) [12,952] {6,476}	270,057 (54,011) [12,963] {6,481}
Placer	21,878	21,908	21,957	21,979	22,072 (4,414) [1,059] {530}	22,164 (4,433) [1,064] {532}	22,256 (4,451) [1,068] {534}
Riverside	297,319	297,620	297,631	297,770	297,983 (59,597) [14,303] {7,152}	298,191 (59,638) [14,313] {7,157}	298,386 (59,677) [14,323] {7,161}
Sacramento	101,511	101,665	101,787	101,906	102,224 (20,445) [4,907] {2,453}	102,544 (20,509) [4,922] {2,461}	102,852 (20,570) [4,937] {2,468}
San Bernardino	294,883	294,973	295,131	295,315	295,633 (59,127) [14,190] {7,095}	295,952 (59,190) [14,206] {7,103}	296,266 (59,253) [14,221] {7,110}
San Diego	275,112	275,368	275,631	275,912	276,391 (55,278) [13,267] {6,633}	276,883 (55,377) [13,290] {6,645}	277,373 (55,475) [13,314] {6,657}
San Francisco	36,073	36,094	36,117	36,194	36,280 (7,256) [1,741] {871}	36,367 (7,273) [1,746] {873}	36,455 (7,291) [1,750] {875}
San Joaquin	71,527	71,735	71,817	71,899	72,066 (14,413) [3,459] {1,730}	72,239 (14,448) [3,467] {1,734}	72,409 (14,482) [3,476] {1,738}
San Luis Obispo	20,972	20,991	21,015	21,038	21,087 (4,217) [1,012] {506}	21,137 (4,227) [1,015] {507}	21,186 (4,237) [1,017] {508}
San Mateo	41,201	41,226	41,251	41,318	41,405 (8,281) [1,987] {994}	41,492 (8,298) [1,992] {996}	41,582 (8,316) [1,996] {998}
Santa Barbara	33,913	33,926	33,926	33,926	33,991 (6,798) [1,632] {816}	34,055 (6,811) [1,635] {817}	34,117 (6,823) [1,638] {819}
Santa Clara	117,186	117,317	117,379	117,538	117,797 (23,559) [5,654] {2,827}	118,057 (23,611) [5,667] {2,833}	118,310 (23,662) [5,679] {2,839}
Santa Cruz	15,615	15,666	15,719	15,759	15,840 (3,168) [760] {380}	15,928 (3,186) [765] {382}	16,021 (3,204) [769] {384}
Solano	32,027	32,047	32,086	32,126	32,219 (6,444) [1,546] {773}	32,312 (6,462) [1,551] {775}	32,407 (6,481) [1,556] {778}
Sonoma	29,715	29,720	29,734	29,747	29,783 (5,957) [1,430] {715}	29,817 (5,963) [1,431] {716}	29,851 (5,970) [1,433] {716}
Ventura	80,309	80,332	80,360	80,398	80,459 (16,092) [3,862] {1,931}	80,517 (16,103) [3,865] {1,932}	80,572 (16,114) [3,867] {1,934}

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.