IEM's AI Modeling: Short-term COVID-19 Projections
Date: 12/2/20

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 12/2/20 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.

Colorado State Projections
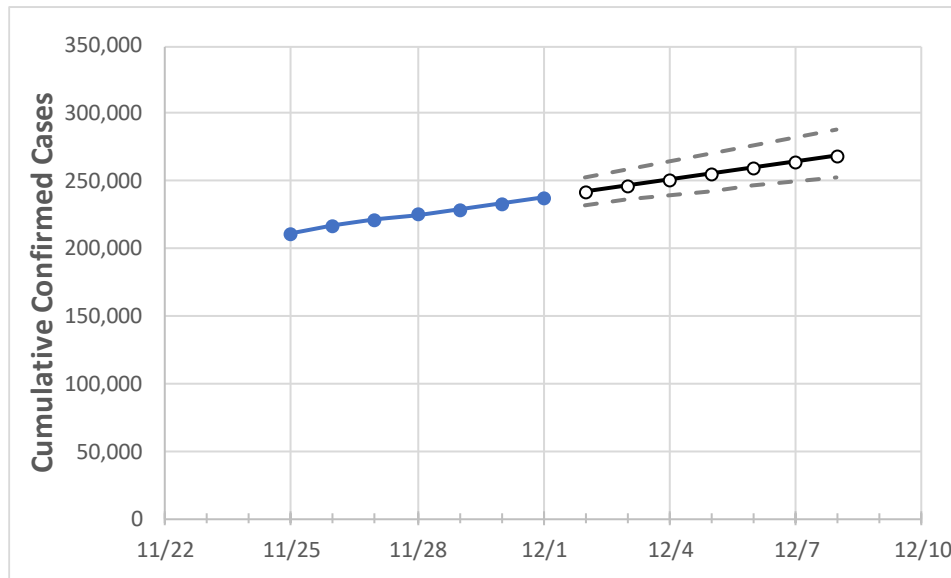
	Actual Confirmed Cases On:				Projected Cases For:						
	11/28	11/29	11/30	12/1	12/2	12/3	12/4	12/5	12/6	12/7	12/8
Colorado	225,283	228,772	232,905	237,310	241,754	246,191	250,622	255,047	259,465	263,878	268,284

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.

Colorado Counties

	Actual Confirmed Cases On:				Projected Cases For:						
	11/28	11/29	11/30	12/1	12/2	12/3	12/4	12/5	12/6	12/7	12/8
Adams	28,784	29,130	29,665	30,241	30,699	31,155	31,610	32,063	32,513	32,962	33,409
Arapahoe	26,391	26,753	27,228	27,727	28,166	28,602	29,035	29,465	29,892	30,316	30,737
Boulder	10,793	10,926	11,111	11,329	11,490	11,650	11,809	11,967	12,123	12,278	12,432
Denver	35,906	36,243	36,704	37,106	37,603	38,094	38,577	39,053	39,522	39,984	40,440
Douglas	10,404	10,560	10,782	11,037	11,274	11,511	11,748	11,986	12,224	12,463	12,701
Eagle	2,338	2,364	2,390	2,403	2,432	2,461	2,490	2,520	2,551	2,581	2,612
El Paso	26,026	26,639	27,197	27,829	28,462	29,101	29,745	30,395	31,051	31,711	32,377
Gunnison	466	471	473	476	479	482	485	488	491	494	498
Jefferson	20,106	20,358	20,710	21,156	21,545	21,932	22,318	22,704	23,087	23,470	23,851
Larimer	9,946	10,115	10,253	10,427	10,611	10,792	10,970	11,145	11,318	11,487	11,654
Pueblo	8,077	8,269	8,594	8,856	9,123	9,392	9,665	9,941	10,220	10,502	10,788
Weld	13,620	13,813	14,026	14,297	14,559	14,819	15,078	15,336	15,591	15,846	16,099

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.*

Colorado Medical Demands by County

	Actual Confirmed Cases On:				Projected Cases (Hospitalized) [ICU] {Ventilator} For:		
	11/28	11/29	11/30	12/1	12/3	12/5	12/7
Adams	28,784	29,130	29,665	30,241	31,155 (6,231) [1,495] {748}	32,063 (6,413) [1,539] {770}	32,962 (6,592) [1,582] {791}
Arapahoe	26,391	26,753	27,228	27,727	28,602 (5,720) [1,373] {686}	29,465 (5,893) [1,414] {707}	30,316 (6,063) [1,455] {728}
Boulder	10,793	10,926	11,111	11,329	11,650 (2,330) [559] {280}	11,967 (2,393) [574] {287}	12,278 (2,456) [589] {295}
Denver	35,906	36,243	36,704	37,106	38,094 (7,619) [1,828] {914}	39,053 (7,811) [1,875] {937}	39,984 (7,997) [1,919] {960}
Douglas	10,404	10,560	10,782	11,037	11,511 (2,302) [553] {276}	11,986 (2,397) [575] {288}	12,463 (2,493) [598] {299}
Eagle	2,338	2,364	2,390	2,403	2,461 (492) [118] {59}	2,520 (504) [121] {60}	2,581 (516) [124] {62}
El Paso	26,026	26,639	27,197	27,829	29,101 (5,820) [1,397] {698}	30,395 (6,079) [1,459] {729}	31,711 (6,342) [1,522] {761}
Gunnison	466	471	473	476	482 (96) [23] {12}	488 (98) [23] {12}	494 (99) [24] {12}
Jefferson	20,106	20,358	20,710	21,156	21,932 (4,386) [1,053] {526}	22,704 (4,541) [1,090] {545}	23,470 (4,694) [1,127] {563}
Larimer	9,946	10,115	10,253	10,427	10,792 (2,158) [518] {259}	11,145 (2,229) [535] {267}	11,487 (2,297) [551] {276}
Pueblo	8,077	8,269	8,594	8,856	9,392 (1,878) [451] {225}	9,941 (1,988) [477] {239}	10,502 (2,100) [504] {252}
Weld	13,620	13,813	14,026	14,297	14,819 (2,964) [711] {356}	15,336 (3,067) [736] {368}	15,846 (3,169) [761] {380}

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.