IEM's AI Modeling: Short-term COVID-19 Projections
Date: 12/4/20

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 12/4/20 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
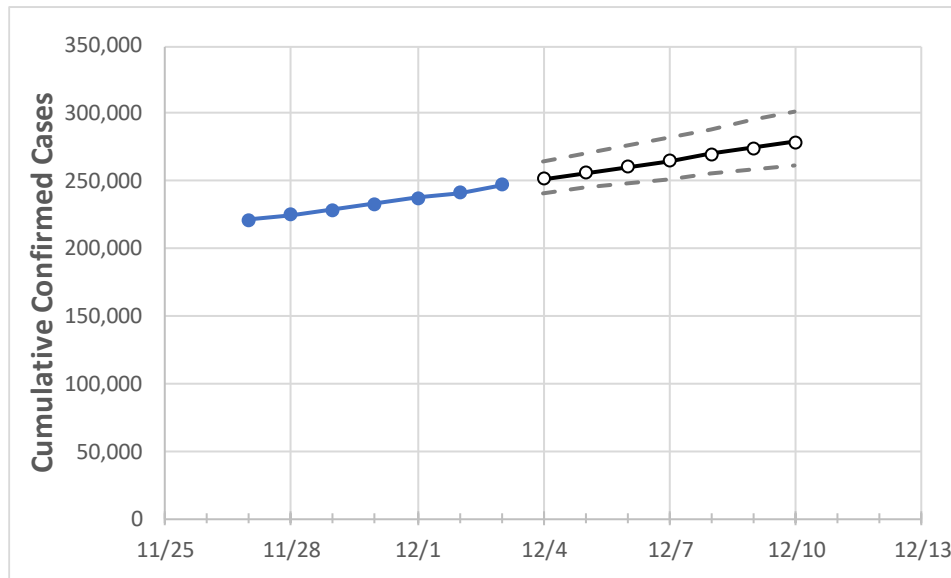
	Actual Confirmed Cases On:				Projected Cases For:						
	11/30	12/1	12/2	12/3	12/4	12/5	12/6	12/7	12/8	12/9	12/10
Colorado	232,905	237,310	241,172	247,209	251,706	256,206	260,709	265,215	269,723	274,235	278,749

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:						
	11/30	12/1	12/2	12/3	12/4	12/5	12/6	12/7	12/8	12/9	12/10
Adams	29,665	30,241	30,538	31,038	31,461	31,879	32,295	32,707	33,115	33,519	33,920
Arapahoe	27,228	27,727	28,064	28,683	29,119	29,554	29,987	30,418	30,848	31,275	31,701
Boulder	11,111	11,329	11,454	11,626	11,779	11,931	12,081	12,230	12,379	12,526	12,671
Denver	36,704	37,106	37,510	38,219	38,689	39,152	39,609	40,058	40,501	40,937	41,366
Douglas	10,782	11,037	11,188	11,456	11,676	11,895	12,114	12,332	12,549	12,765	12,981
Eagle	2,390	2,403	2,438	2,477	2,509	2,541	2,573	2,606	2,640	2,674	2,708
El Paso	27,197	27,829	28,394	29,420	30,107	30,805	31,513	32,231	32,960	33,699	34,449
Gunnison	473	476	477	491	494	497	500	503	507	510	514
Jefferson	20,710	21,156	21,476	21,922	22,300	22,677	23,052	23,426	23,799	24,170	24,539
Larimer	10,253	10,427	10,627	10,932	11,139	11,346	11,553	11,760	11,967	12,174	12,381
Pueblo	8,594	8,856	9,048	9,335	9,594	9,854	10,117	10,381	10,647	10,915	11,185
Weld	14,026	14,297	14,509	14,850	15,110	15,370	15,628	15,885	16,142	16,397	16,651

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:		
	11/30	12/1	12/2	12/3	12/5	12/7	12/9
Adams	29,665	30,241	30,538	31,038	31,879 (6,376) [1,530] {765}	32,707 (6,541) [1,570] {785}	33,519 (6,704) [1,609] {804}
Arapahoe	27,228	27,727	28,064	28,683	29,554 (5,911) [1,419] {709}	30,418 (6,084) [1,460] {730}	31,275 (6,255) [1,501] {751}
Boulder	11,111	11,329	11,454	11,626	11,931 (2,386) [573] {286}	12,230 (2,446) [587] {294}	12,526 (2,505) [601] {301}
Denver	36,704	37,106	37,510	38,219	39,152 (7,830) [1,879] {940}	40,058 (8,012) [1,923] {961}	40,937 (8,187) [1,965] {982}
Douglas	10,782	11,037	11,188	11,456	11,895 (2,379) [571] {285}	12,332 (2,466) [592] {296}	12,765 (2,553) [613] {306}
Eagle	2,390	2,403	2,438	2,477	2,541 (508) [122] {61}	2,606 (521) [125] {63}	2,674 (535) [128] {64}
El Paso	27,197	27,829	28,394	29,420	30,805 (6,161) [1,479] {739}	32,231 (6,446) [1,547] {774}	33,699 (6,740) [1,618] {809}
Gunnison	473	476	477	491	497 (99) [24] {12}	503 (101) [24] {12}	510 (102) [24] {12}
Jefferson	20,710	21,156	21,476	21,922	22,677 (4,535) [1,088] {544}	23,426 (4,685) [1,124] {562}	24,170 (4,834) [1,160] {580}
Larimer	10,253	10,427	10,627	10,932	11,346 (2,269) [545] {272}	11,760 (2,352) [564] {282}	12,174 (2,435) [584] {292}
Pueblo	8,594	8,856	9,048	9,335	9,854 (1,971) [473] {237}	10,381 (2,076) [498] {249}	10,915 (2,183) [524] {262}
Weld	14,026	14,297	14,509	14,850	15,370 (3,074) [738] {369}	15,885 (3,177) [763] {381}	16,397 (3,279) [787] {394}

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.