IEM's AI Modeling: Short-term COVID-19 Projections
Date: 12/3/20

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 12/3/20 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.

Pennsylvania State Projections
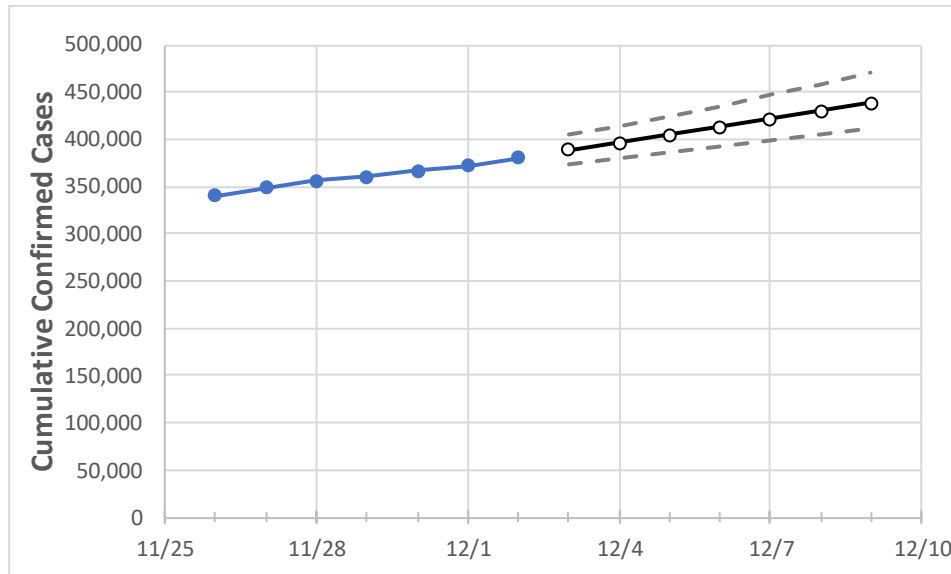
	Actual Confirmed Cases On:				Projected Cases For:						
	11/29	11/30	12/1	12/2	12/3	12/4	12/5	12/6	12/7	12/8	12/9
Pennsylvania	360,944	366,835	372,530	380,951	388,688	396,586	404,650	412,882	421,285	429,863	438,617

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.

Pennsylvania Counties

	Actual Confirmed Cases On:				Projected Cases For:						
	11/29	11/30	12/1	12/2	12/3	12/4	12/5	12/6	12/7	12/8	12/9
Allegheny	28,004	28,404	29,007	29,515	30,202	30,909	31,634	32,380	33,146	33,934	34,742
Berks	13,874	13,956	14,065	14,347	14,520	14,695	14,872	15,051	15,231	15,414	15,599
Bucks	17,410	17,733	17,936	18,296	18,671	19,054	19,446	19,848	20,258	20,679	21,108
Butler	4,484	4,532	4,665	4,750	4,859	4,969	5,081	5,195	5,310	5,427	5,546
Chester	11,977	12,110	12,263	12,263	12,444	12,628	12,815	13,006	13,200	13,397	13,598
Delaware	20,057	20,166	20,364	20,762	20,991	21,221	21,452	21,683	21,916	22,150	22,384
Lackawanna	5,173	5,214	5,269	5,365	5,443	5,524	5,607	5,694	5,783	5,876	5,971
Lancaster	16,470	16,702	17,012	17,380	17,769	18,172	18,587	19,016	19,458	19,915	20,387
Lehigh	11,412	11,512	11,579	11,868	12,070	12,276	12,484	12,696	12,910	13,128	13,348
Luzerne	9,656	9,760	9,886	10,098	10,292	10,490	10,691	10,896	11,105	11,318	11,534
Monroe	3,386	3,413	3,449	3,557	3,625	3,696	3,768	3,843	3,921	4,000	4,083
Montgomery	21,729	22,025	22,228	22,618	22,943	23,271	23,600	23,931	24,265	24,600	24,938
Northampton	9,000	9,104	9,199	9,444	9,629	9,819	10,013	10,214	10,419	10,630	10,847
Philadelphia	66,683	67,283	67,943	69,630	70,495	71,364	72,235	73,109	73,986	74,867	75,750
Westmoreland	9,132	9,261	9,460	9,643	9,885	10,130	10,381	10,636	10,896	11,160	11,430
York	11,001	11,202	11,338	11,711	11,963	12,225	12,497	12,779	13,071	13,374	13,688

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.*

Pennsylvania Medical Demands by County

	Actual Confirmed Cases On:				Projected Cases (Hospitalized) [ICU] {Ventilator} For:		
	11/29	11/30	12/1	12/2	12/4	12/6	12/8
Allegheny	28,004	28,404	29,007	29,515	30,909 (6,182) [1,484] {742}	32,380 (6,476) [1,554] {777}	33,934 (6,787) [1,629] {814}
Berks	13,874	13,956	14,065	14,347	14,695 (2,939) [705] {353}	15,051 (3,010) [722] {361}	15,414 (3,083) [740] {370}
Bucks	17,410	17,733	17,936	18,296	19,054 (3,811) [915] {457}	19,848 (3,970) [953] {476}	20,679 (4,136) [993] {496}
Butler	4,484	4,532	4,665	4,750	4,969 (994) [239] {119}	5,195 (1,039) [249] {125}	5,427 (1,085) [261] {130}
Chester	11,977	12,110	12,263	12,263	12,628 (2,526) [606] {303}	13,006 (2,601) [624] {312}	13,397 (2,679) [643] {322}
Delaware	20,057	20,166	20,364	20,762	21,221 (4,244) [1,019] {509}	21,683 (4,337) [1,041] {520}	22,150 (4,430) [1,063] {532}
Lackawanna	5,173	5,214	5,269	5,365	5,524 (1,105) [265] {133}	5,694 (1,139) [273] {137}	5,876 (1,175) [282] {141}
Lancaster	16,470	16,702	17,012	17,380	18,172 (3,634) [872] {436}	19,016 (3,803) [913] {456}	19,915 (3,983) [956] {478}
Lehigh	11,412	11,512	11,579	11,868	12,276 (2,455) [589] {295}	12,696 (2,539) [609] {305}	13,128 (2,626) [630] {315}
Luzerne	9,656	9,760	9,886	10,098	10,490 (2,098) [504] {252}	10,896 (2,179) [523] {262}	11,318 (2,264) [543] {272}
Monroe	3,386	3,413	3,449	3,557	3,696 (739) [177] {89}	3,843 (769) [184] {92}	4,000 (800) [192] {96}
Montgomery	21,729	22,025	22,228	22,618	23,271 (4,654) [1,117] {558}	23,931 (4,786) [1,149] {574}	24,600 (4,920) [1,181] {590}
Northampton	9,000	9,104	9,199	9,444	9,819 (1,964) [471] {236}	10,214 (2,043) [490] {245}	10,630 (2,126) [510] {255}
Philadelphia	66,683	67,283	67,943	69,630	71,364 (14,273) [3,425] {1,713}	73,109 (14,622) [3,509] {1,755}	74,867 (14,973) [3,594] {1,797}
Westmoreland	9,132	9,261	9,460	9,643	10,130 (2,026) [486] {243}	10,636 (2,127) [511] {255}	11,160 (2,232) [536] {268}
York	11,001	11,202	11,338	11,711	12,225 (2,445) [587] {293}	12,779 (2,556) [613] {307}	13,374 (2,675) [642] {321}

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.