IEM's AI Modeling: Short-term COVID-19 Projections
Date: 4/6/21

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 4/6/21 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.

Pennsylvania State Projections
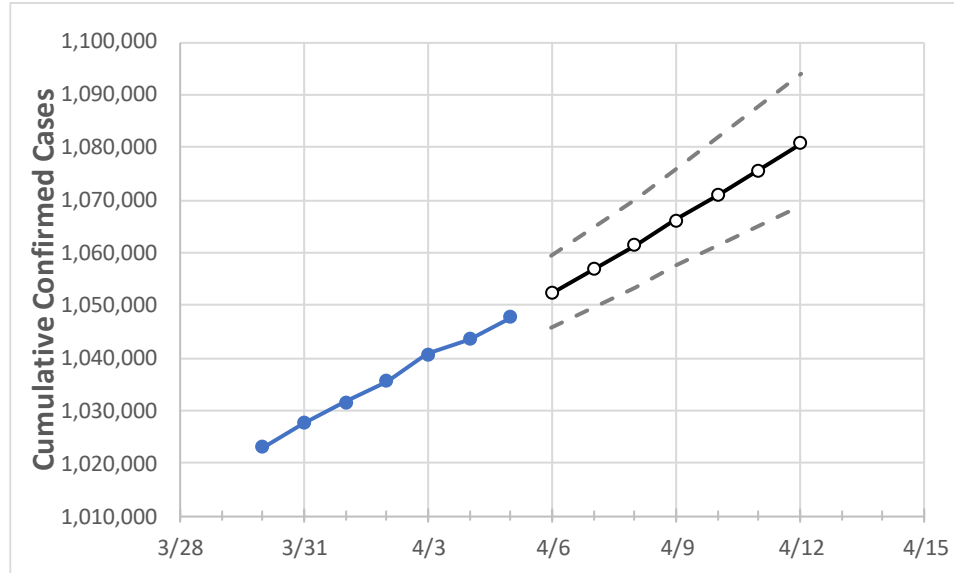
	Actual Confirmed Cases On:				Projected Cases For:						
	4/2	4/3	4/4	4/5	4/6	4/7	4/8	4/9	4/10	4/11	4/12
Pennsylvania	1,035,559	1,040,692	1,043,524	1,047,728	1,052,238	1,056,796	1,061,403	1,066,129	1,070,873	1,075,733	1,080,689

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.

Pennsylvania Counties

	Actual Confirmed Cases On:				Projected Cases For:						
	4/2	4/3	4/4	4/5	4/6	4/7	4/8	4/9	4/10	4/11	4/12
Allegheny	86,448	87,101	87,403	87,623	88,072	88,520	88,977	89,448	89,933	90,422	90,924
Berks	40,225	40,559	40,692	40,836	41,047	41,271	41,493	41,724	41,960	42,200	42,455
Bucks	51,556	51,920	52,149	52,418	52,742	53,076	53,410	53,752	54,105	54,459	54,834
Butler	15,371	15,451	15,482	15,513	15,584	15,655	15,729	15,804	15,881	15,959	16,039
Chester	31,759	31,900	32,040	32,181	32,351	32,525	32,703	32,885	33,071	33,265	33,460
Delaware	45,211	45,443	45,656	45,808	46,030	46,260	46,495	46,740	46,990	47,250	47,517
Lackawanna	15,738	15,827	15,896	15,931	16,010	16,092	16,176	16,259	16,343	16,431	16,519
Lancaster	48,232	48,481	48,681	48,771	48,971	49,173	49,378	49,592	49,813	50,038	50,264
Lehigh	34,368	34,584	34,706	34,821	34,998	35,181	35,369	35,562	35,756	35,960	36,164
Luzerne	27,276	27,434	27,532	27,593	27,706	27,825	27,945	28,069	28,194	28,324	28,457
Monroe	11,608	11,716	11,795	11,841	11,928	12,016	12,106	12,197	12,291	12,388	12,485
Montgomery	60,315	60,687	61,007	61,280	61,598	61,918	62,253	62,597	62,947	63,313	63,682
Northampton	30,768	31,002	31,125	31,225	31,418	31,616	31,820	32,028	32,240	32,457	32,677
Philadelphia	131,374	131,775	132,175	132,575	133,108	133,643	134,173	134,715	135,257	135,805	136,346
Westmoreland	29,395	29,609	29,665	29,722	29,870	30,026	30,184	30,349	30,515	30,691	30,868
York	39,820	39,993	40,118	40,198	40,416	40,638	40,861	41,089	41,320	41,562	41,811

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:		
	4/2	4/3	4/4	4/5	4/7	4/9	4/11
Allegheny	86,448	87,101	87,403	87,623	88,520 (17,704) [4,249] {2,124}	89,448 (17,890) [4,294] {2,147}	90,422 (18,084) [4,340] {2,170}
Berks	40,225	40,559	40,692	40,836	41,271 (8,254) [1,981] {990}	41,724 (8,345) [2,003] {1,001}	42,200 (8,440) [2,026] {1,013}
Bucks	51,556	51,920	52,149	52,418	53,076 (10,615) [2,548] {1,274}	53,752 (10,750) [2,580] {1,290}	54,459 (10,892) [2,614] {1,307}
Butler	15,371	15,451	15,482	15,513	15,655 (3,131) [751] {376}	15,804 (3,161) [759] {379}	15,959 (3,192) [766] {383}
Chester	31,759	31,900	32,040	32,181	32,525 (6,505) [1,561] {781}	32,885 (6,577) [1,578] {789}	33,265 (6,653) [1,597] {798}
Delaware	45,211	45,443	45,656	45,808	46,260 (9,252) [2,220] {1,110}	46,740 (9,348) [2,244] {1,122}	47,250 (9,450) [2,268] {1,134}
Lackawanna	15,738	15,827	15,896	15,931	16,092 (3,218) [772] {386}	16,259 (3,252) [780] {390}	16,431 (3,286) [789] {394}
Lancaster	48,232	48,481	48,681	48,771	49,173 (9,835) [2,360] {1,180}	49,592 (9,918) [2,380] {1,190}	50,038 (10,008) [2,402] {1,201}
Lehigh	34,368	34,584	34,706	34,821	35,181 (7,036) [1,689] {844}	35,562 (7,112) [1,707] {853}	35,960 (7,192) [1,726] {863}
Luzerne	27,276	27,434	27,532	27,593	27,825 (5,565) [1,336] {668}	28,069 (5,614) [1,347] {674}	28,324 (5,665) [1,360] {680}
Monroe	11,608	11,716	11,795	11,841	12,016 (2,403) [577] {288}	12,197 (2,439) [585] {293}	12,388 (2,478) [595] {297}
Montgomery	60,315	60,687	61,007	61,280	61,918 (12,384) [2,972] {1,486}	62,597 (12,519) [3,005] {1,502}	63,313 (12,663) [3,039] {1,520}
Northampton	30,768	31,002	31,125	31,225	31,616 (6,323) [1,518] {759}	32,028 (6,406) [1,537] {769}	32,457 (6,491) [1,558] {779}
Philadelphia	131,374	131,775	132,175	132,575	133,643 (26,729) [6,415] {3,207}	134,715 (26,943) [6,466] {3,233}	135,805 (27,161) [6,519] {3,259}
Westmoreland	29,395	29,609	29,665	29,722	30,026 (6,005) [1,441] {721}	30,349 (6,070) [1,457] {728}	30,691 (6,138) [1,473] {737}
York	39,820	39,993	40,118	40,198	40,638 (8,128) [1,951] {975}	41,089 (8,218) [1,972] {986}	41,562 (8,312) [1,995] {997}

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.