IEM's AI Modeling: Short-term COVID-19 Projections
Date: 12/1/21

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 not 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 12/1/21 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
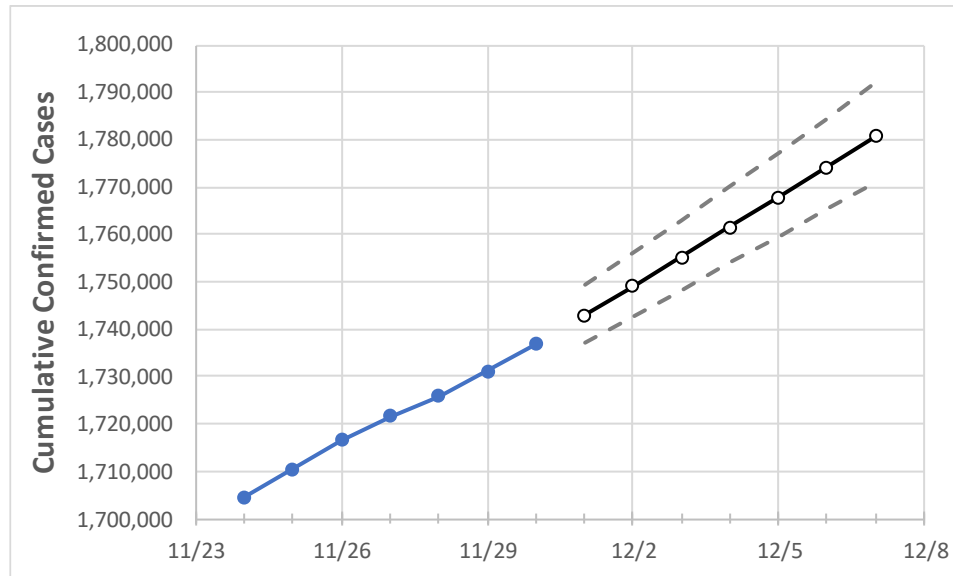
	Actual Confirmed Cases On:				Projected Cases For:						
	11/27	11/28	11/29	11/30	12/1	12/2	12/3	12/4	12/5	12/6	12/7
Pennsylvania	1,721,743	1,725,902	1,731,154	1,736,920	1,743,038	1,749,195	1,755,306	1,761,529	1,767,870	1,774,240	1,780,696

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:						
	11/27	11/28	11/29	11/30	12/1	12/2	12/3	12/4	12/5	12/6	12/7
Allegheny	148,492	148,898	149,645	150,179	150,874	151,564	152,244	152,987	153,710	154,425	155,166
Berks	64,039	64,227	64,357	64,559	64,756	64,960	65,160	65,364	65,572	65,780	65,991
Bucks	78,514	78,639	78,779	78,969	79,145	79,324	79,501	79,681	79,859	80,041	80,224
Butler	28,630	28,720	28,860	28,920	29,059	29,200	29,339	29,477	29,617	29,764	29,908
Chester	54,981	55,089	55,228	55,423	55,588	55,754	55,921	56,091	56,263	56,438	56,614
Delaware	65,854	65,944	66,035	66,167	66,307	66,442	66,580	66,720	66,860	67,005	67,151
Lackawanna	25,223	25,284	25,358	25,477	25,583	25,690	25,798	25,907	26,020	26,134	26,249
Lancaster	77,845	78,035	78,228	78,458	78,695	78,928	79,165	79,401	79,647	79,896	80,139
Lehigh	52,411	52,620	52,782	52,965	53,176	53,396	53,616	53,850	54,084	54,330	54,581
Luzerne	45,509	45,634	45,766	45,926	46,108	46,288	46,477	46,661	46,848	47,043	47,238
Monroe	21,586	21,660	21,735	21,810	21,898	21,986	22,077	22,171	22,262	22,359	22,456
Montgomery	91,936	92,082	92,358	92,586	92,842	93,095	93,344	93,604	93,863	94,130	94,401
Northampton	48,147	48,274	48,397	48,548	48,702	48,864	49,020	49,188	49,354	49,521	49,699
Philadelphia	190,694	191,061	191,231	191,401	191,698	191,998	192,296	192,600	192,908	193,222	193,532
Westmoreland	51,096	51,210	51,514	51,706	51,964	52,217	52,478	52,734	53,004	53,276	53,544
York	69,910	70,099	70,372	70,599	70,871	71,144	71,421	71,699	71,982	72,267	72,552

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: | | |
	11/27	11/28	11/29	11/30	12/2	12/4	12/6
Allegheny	148,492	148,898	149,645	150,179	151,564 (30,313) [7,275] {3,638}	152,987 (30,597) [7,343] {3,672}	154,425 (30,885) [7,412] {3,706}
Berks	64,039	64,227	64,357	64,559	64,960 (12,992) [3,118] {1,559}	65,364 (13,073) [3,137] {1,569}	65,780 (13,156) [3,157] {1,579}
Bucks	78,514	78,639	78,779	78,969	79,324 (15,865) [3,808] {1,904}	79,681 (15,936) [3,825] {1,912}	80,041 (16,008) [3,842] {1,921}
Butler	28,630	28,720	28,860	28,920	29,200 (5,840) [1,402] {701}	29,477 (5,895) [1,415] {707}	29,764 (5,953) [1,429] {714}
Chester	54,981	55,089	55,228	55,423	55,754 (11,151) [2,676] {1,338}	56,091 (11,218) [2,692] {1,346}	56,438 (11,288) [2,709] {1,355}
Delaware	65,854	65,944	66,035	66,167	66,442 (13,288) [3,189] {1,595}	66,720 (13,344) [3,203] {1,601}	67,005 (13,401) [3,216] {1,608}
Lackawanna	25,223	25,284	25,358	25,477	25,690 (5,138) [1,233] {617}	25,907 (5,181) [1,244] {622}	26,134 (5,227) [1,254] {627}
Lancaster	77,845	78,035	78,228	78,458	78,928 (15,786) [3,789] {1,894}	79,401 (15,880) [3,811] {1,906}	79,896 (15,979) [3,835] {1,917}
Lehigh	52,411	52,620	52,782	52,965	53,396 (10,679) [2,563] {1,282}	53,850 (10,770) [2,585] {1,292}	54,330 (10,866) [2,608] {1,304}
Luzerne	45,509	45,634	45,766	45,926	46,288 (9,258) [2,222] {1,111}	46,661 (9,332) [2,240] {1,120}	47,043 (9,409) [2,258] {1,129}
Monroe	21,586	21,660	21,735	21,810	21,986 (4,397) [1,055] {528}	22,171 (4,434) [1,064] {532}	22,359 (4,472) [1,073] {537}
Montgomery	91,936	92,082	92,358	92,586	93,095 (18,619) [4,469] {2,234}	93,604 (18,721) [4,493] {2,246}	94,130 (18,826) [4,518] {2,259}
Northampton	48,147	48,274	48,397	48,548	48,864 (9,773) [2,345] {1,173}	49,188 (9,838) [2,361] {1,181}	49,521 (9,904) [2,377] {1,189}
Philadelphia	190,694	191,061	191,231	191,401	191,998 (38,400) [9,216] {4,608}	192,600 (38,520) [9,245] {4,622}	193,222 (38,644) [9,275] {4,637}
Westmoreland	51,096	51,210	51,514	51,706	52,217 (10,443) [2,506] {1,253}	52,734 (10,547) [2,531] {1,266}	53,276 (10,655) [2,557] {1,279}
York	69,910	70,099	70,372	70,599	71,144 (14,229) [3,415] {1,707}	71,699 (14,340) [3,442] {1,721}	72,267 (14,453) [3,469] {1,734}

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.