IEM's AI Modeling: Short-term COVID-19 Projections
Date: 11/15/21

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 11/15/21 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
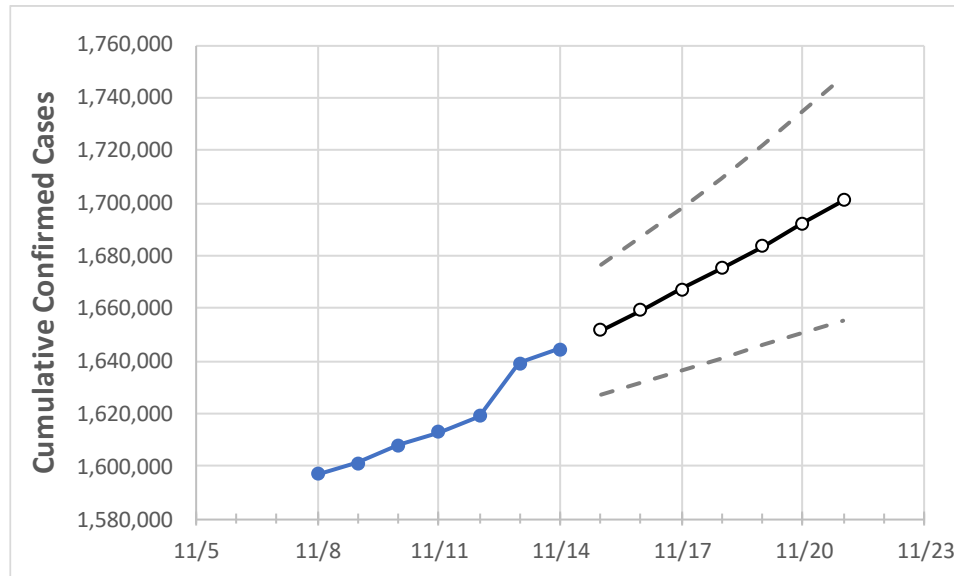
	Actual Confirmed Cases On:				Projected Cases For:						
	11/11	11/12	11/13	11/14	11/15	11/16	11/17	11/18	11/19	11/20	11/21
Pennsylvania	1,612,997	1,618,870	1,639,190	1,644,501	1,651,554	1,659,257	1,667,147	1,675,242	1,683,398	1,692,346	1,700,920

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:						
	11/11	11/12	11/13	11/14	11/15	11/16	11/17	11/18	11/19	11/20	11/21
Allegheny	137,203	137,807	139,730	140,263	140,920	141,634	142,329	143,067	143,822	144,628	145,385
Berks	60,401	60,530	61,433	61,592	61,856	62,118	62,387	62,662	62,972	63,263	63,575
Bucks	75,231	75,366	76,115	76,251	76,491	76,751	76,997	77,271	77,558	77,835	78,117
Butler	26,250	26,366	26,813	26,894	27,060	27,223	27,389	27,575	27,769	27,957	28,158
Chester	52,208	52,331	52,609	52,886	53,052	53,233	53,417	53,606	53,799	54,008	54,217
Delaware	63,351	63,441	64,082	64,214	64,370	64,542	64,690	64,875	65,061	65,226	65,417
Lackawanna	23,506	23,604	23,930	23,996	24,122	24,248	24,382	24,529	24,673	24,843	25,005
Lancaster	73,645	73,806	74,799	74,966	75,223	75,499	75,772	76,053	76,346	76,673	76,959
Lehigh	49,519	49,611	50,148	50,254	50,408	50,578	50,754	50,929	51,112	51,314	51,518
Luzerne	42,464	42,603	43,122	43,262	43,442	43,629	43,823	44,012	44,214	44,406	44,623
Monroe	20,256	20,317	20,537	20,594	20,678	20,762	20,851	20,941	21,038	21,137	21,234
Montgomery	87,770	87,962	88,743	88,947	89,212	89,488	89,778	90,070	90,370	90,700	91,007
Northampton	45,639	45,756	46,286	46,375	46,532	46,704	46,872	47,061	47,239	47,436	47,643
Philadelphia	186,235	186,491	186,667	186,842	187,252	187,688	188,109	188,565	189,067	189,584	190,073
Westmoreland	46,833	47,051	47,984	48,132	48,400	48,661	48,957	49,253	49,555	49,875	50,186
York	65,028	65,235	66,404	66,586	66,894	67,233	67,555	67,877	68,217	68,590	68,953

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:		
	11/11	11/12	11/13	11/14	11/16	11/18	11/20
Allegheny	137,203	137,807	139,730	140,263	141,634 (28,327) [6,798] {3,399}	143,067 (28,613) [6,867] {3,434}	144,628 (28,926) [6,942] {3,471}
Berks	60,401	60,530	61,433	61,592	62,118 (12,424) [2,982] {1,491}	62,662 (12,532) [3,008] {1,504}	63,263 (12,653) [3,037] {1,518}
Bucks	75,231	75,366	76,115	76,251	76,751 (15,350) [3,684] {1,842}	77,271 (15,454) [3,709] {1,855}	77,835 (15,567) [3,736] {1,868}
Butler	26,250	26,366	26,813	26,894	27,223 (5,445) [1,307] {653}	27,575 (5,515) [1,324] {662}	27,957 (5,591) [1,342] {671}
Chester	52,208	52,331	52,609	52,886	53,233 (10,647) [2,555] {1,278}	53,606 (10,721) [2,573] {1,287}	54,008 (10,802) [2,592] {1,296}
Delaware	63,351	63,441	64,082	64,214	64,542 (12,908) [3,098] {1,549}	64,875 (12,975) [3,114] {1,557}	65,226 (13,045) [3,131] {1,565}
Lackawanna	23,506	23,604	23,930	23,996	24,248 (4,850) [1,164] {582}	24,529 (4,906) [1,177] {589}	24,843 (4,969) [1,192] {596}
Lancaster	73,645	73,806	74,799	74,966	75,499 (15,100) [3,624] {1,812}	76,053 (15,211) [3,651] {1,825}	76,673 (15,335) [3,680] {1,840}
Lehigh	49,519	49,611	50,148	50,254	50,578 (10,116) [2,428] {1,214}	50,929 (10,186) [2,445] {1,222}	51,314 (10,263) [2,463] {1,232}
Luzerne	42,464	42,603	43,122	43,262	43,629 (8,726) [2,094] {1,047}	44,012 (8,802) [2,113] {1,056}	44,406 (8,881) [2,131] {1,066}
Monroe	20,256	20,317	20,537	20,594	20,762 (4,152) [997] {498}	20,941 (4,188) [1,005] {503}	21,137 (4,227) [1,015] {507}
Montgomery	87,770	87,962	88,743	88,947	89,488 (17,898) [4,295] {2,148}	90,070 (18,014) [4,323] {2,162}	90,700 (18,140) [4,354] {2,177}
Northampton	45,639	45,756	46,286	46,375	46,704 (9,341) [2,242] {1,121}	47,061 (9,412) [2,259] {1,129}	47,436 (9,487) [2,277] {1,138}
Philadelphia	186,235	186,491	186,667	186,842	187,688 (37,538) [9,009] {4,505}	188,565 (37,713) [9,051] {4,526}	189,584 (37,917) [9,100] {4,550}
Westmoreland	46,833	47,051	47,984	48,132	48,661 (9,732) [2,336] {1,168}	49,253 (9,851) [2,364] {1,182}	49,875 (9,975) [2,394] {1,197}
York	65,028	65,235	66,404	66,586	67,233 (13,447) [3,227] {1,614}	67,877 (13,575) [3,258] {1,629}	68,590 (13,718) [3,292] {1,646}

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.