IEM's AI Modeling: Short-term COVID-19 Projections
Date: 11/22/21

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 11/22/21 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
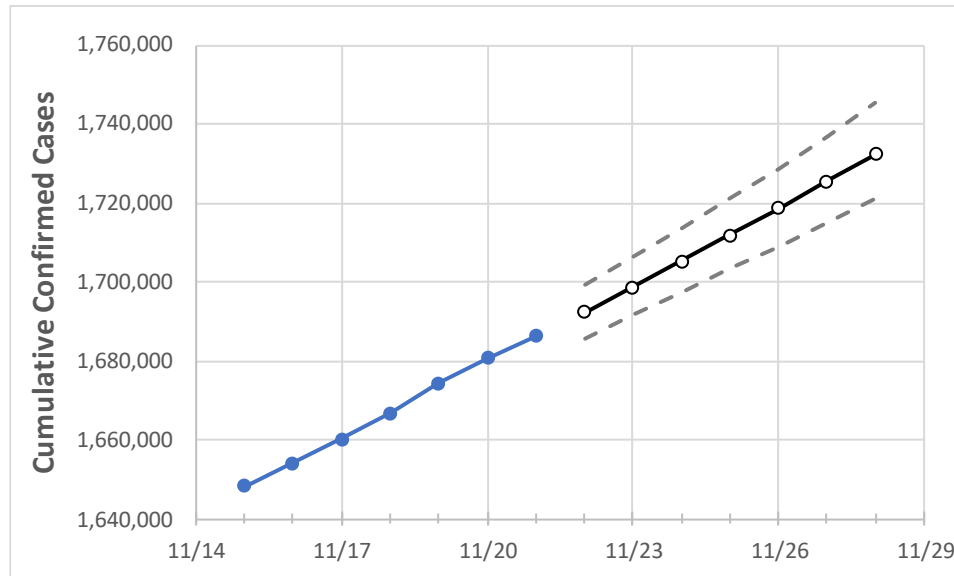
	Actual Confirmed Cases On:				Projected Cases For:						
	11/18	11/19	11/20	11/21	11/22	11/23	11/24	11/25	11/26	11/27	11/28
Pennsylvania	1,666,724	1,674,328	1,680,752	1,686,169	1,692,434	1,698,775	1,705,255	1,711,793	1,718,556	1,725,373	1,732,219

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:						
	11/18	11/19	11/20	11/21	11/22	11/23	11/24	11/25	11/26	11/27	11/28
Allegheny	142,527	143,372	144,076	144,615	145,253	145,911	146,560	147,241	147,946	148,656	149,360
Berks	62,287	62,496	62,652	62,848	63,033	63,222	63,412	63,606	63,806	64,007	64,209
Bucks	76,934	77,104	77,278	77,424	77,606	77,792	77,976	78,166	78,359	78,553	78,744
Butler	27,374	27,553	27,731	27,882	28,035	28,188	28,346	28,509	28,675	28,846	29,015
Chester	53,655	53,807	53,944	54,083	54,240	54,403	54,568	54,737	54,909	55,083	55,259
Delaware	64,640	64,791	64,919	65,041	65,163	65,284	65,407	65,532	65,664	65,795	65,924
Lackawanna	24,359	24,458	24,544	24,629	24,733	24,839	24,947	25,057	25,173	25,292	25,412
Lancaster	75,754	76,092	76,288	76,495	76,715	76,939	77,164	77,399	77,629	77,864	78,103
Lehigh	50,839	51,023	51,176	51,318	51,473	51,635	51,804	51,970	52,148	52,327	52,516
Luzerne	43,905	44,096	44,283	44,478	44,657	44,839	45,027	45,213	45,410	45,608	45,811
Monroe	20,889	20,968	21,052	21,106	21,183	21,261	21,342	21,420	21,506	21,592	21,678
Montgomery	89,848	90,075	90,260	90,520	90,762	91,003	91,252	91,507	91,765	92,029	92,295
Northampton	46,886	47,038	47,162	47,261	47,391	47,527	47,661	47,796	47,942	48,080	48,233
Philadelphia	188,101	188,416	188,736	188,996	189,271	189,551	189,828	190,119	190,412	190,704	191,009
Westmoreland	48,945	49,221	49,576	49,730	49,959	50,186	50,418	50,660	50,899	51,152	51,404
York	67,519	67,776	67,957	68,294	68,540	68,788	69,038	69,296	69,553	69,815	70,078

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:		
	11/18	11/19	11/20	11/21	11/23	11/25	11/27
Allegheny	142,527	143,372	144,076	144,615	145,911 (29,182) [7,004] {3,502}	147,241 (29,448) [7,068] {3,534}	148,656 (29,731) [7,136] {3,568}
Berks	62,287	62,496	62,652	62,848	63,222 (12,644) [3,035] {1,517}	63,606 (12,721) [3,053] {1,527}	64,007 (12,801) [3,072] {1,536}
Bucks	76,934	77,104	77,278	77,424	77,792 (15,558) [3,734] {1,867}	78,166 (15,633) [3,752] {1,876}	78,553 (15,711) [3,771] {1,885}
Butler	27,374	27,553	27,731	27,882	28,188 (5,638) [1,353] {677}	28,509 (5,702) [1,368] {684}	28,846 (5,769) [1,385] {692}
Chester	53,655	53,807	53,944	54,083	54,403 (10,881) [2,611] {1,306}	54,737 (10,947) [2,627] {1,314}	55,083 (11,017) [2,644] {1,322}
Delaware	64,640	64,791	64,919	65,041	65,284 (13,057) [3,134] {1,567}	65,532 (13,106) [3,146] {1,573}	65,795 (13,159) [3,158] {1,579}
Lackawanna	24,359	24,458	24,544	24,629	24,839 (4,968) [1,192] {596}	25,057 (5,011) [1,203] {601}	25,292 (5,058) [1,214] {607}
Lancaster	75,754	76,092	76,288	76,495	76,939 (15,388) [3,693] {1,847}	77,399 (15,480) [3,715] {1,858}	77,864 (15,573) [3,737] {1,869}
Lehigh	50,839	51,023	51,176	51,318	51,635 (10,327) [2,478] {1,239}	51,970 (10,394) [2,495] {1,247}	52,327 (10,465) [2,512] {1,256}
Luzerne	43,905	44,096	44,283	44,478	44,839 (8,968) [2,152] {1,076}	45,213 (9,043) [2,170] {1,085}	45,608 (9,122) [2,189] {1,095}
Monroe	20,889	20,968	21,052	21,106	21,261 (4,252) [1,021] {510}	21,420 (4,284) [1,028] {514}	21,592 (4,318) [1,036] {518}
Montgomery	89,848	90,075	90,260	90,520	91,003 (18,201) [4,368] {2,184}	91,507 (18,301) [4,392] {2,196}	92,029 (18,406) [4,417] {2,209}
Northampton	46,886	47,038	47,162	47,261	47,527 (9,505) [2,281] {1,141}	47,796 (9,559) [2,294] {1,147}	48,080 (9,616) [2,308] {1,154}
Philadelphia	188,101	188,416	188,736	188,996	189,551 (37,910) [9,098] {4,549}	190,119 (38,024) [9,126] {4,563}	190,704 (38,141) [9,154] {4,577}
Westmoreland	48,945	49,221	49,576	49,730	50,186 (10,037) [2,409] {1,204}	50,660 (10,132) [2,432] {1,216}	51,152 (10,230) [2,455] {1,228}
York	67,519	67,776	67,957	68,294	68,788 (13,758) [3,302] {1,651}	69,296 (13,859) [3,326] {1,663}	69,815 (13,963) [3,351] {1,676}

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.