IEM's AI Modeling: Short-term COVID-19 Projections
Date: 12/17/21

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 12/17/21 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
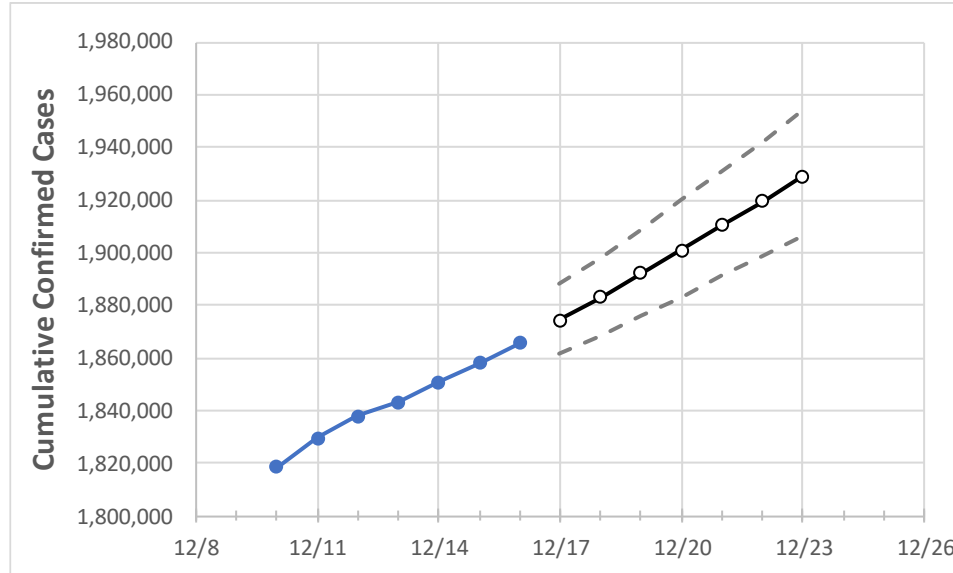
	Actual Confirmed Cases On:				Projected Cases For:						
	12/13	12/14	12/15	12/16	12/17	12/18	12/19	12/20	12/21	12/22	12/23
Pennsylvania	1,843,137	1,850,578	1,857,879	1,865,568	1,874,126	1,883,177	1,892,074	1,901,051	1,910,279	1,919,566	1,929,045

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:						
	12/13	12/14	12/15	12/16	12/17	12/18	12/19	12/20	12/21	12/22	12/23
Allegheny	159,390	160,084	160,659	161,085	161,762	162,468	163,129	163,788	164,461	165,163	165,850
Berks	69,282	69,550	69,849	70,182	70,588	71,009	71,421	71,847	72,283	72,734	73,188
Bucks	83,124	83,414	83,735	84,083	84,482	84,896	85,326	85,764	86,218	86,696	87,174
Butler	30,685	30,799	30,902	30,969	31,090	31,210	31,328	31,440	31,564	31,686	31,801
Chester	58,779	59,056	59,384	59,688	60,024	60,362	60,704	61,058	61,420	61,789	62,177
Delaware	69,145	69,378	69,551	69,868	70,146	70,438	70,737	71,038	71,361	71,682	72,018
Lackawanna	26,962	27,095	27,268	27,395	27,533	27,671	27,812	27,955	28,098	28,248	28,402
Lancaster	83,158	83,431	83,789	84,155	84,554	84,947	85,360	85,764	86,183	86,604	87,041
Lehigh	56,795	57,085	57,358	57,650	57,995	58,346	58,702	59,064	59,441	59,828	60,217
Luzerne	48,920	49,135	49,372	49,602	49,842	50,084	50,326	50,570	50,818	51,074	51,328
Monroe	23,312	23,447	23,511	23,658	23,794	23,926	24,065	24,205	24,349	24,496	24,642
Montgomery	97,996	98,316	98,650	99,151	99,650	100,171	100,702	101,245	101,795	102,365	102,969
Northampton	52,131	52,376	52,581	52,929	53,264	53,609	53,960	54,318	54,680	55,065	55,460
Philadelphia	199,077	199,369	200,129	200,668	201,405	202,191	202,971	203,806	204,679	205,580	206,481
Westmoreland	55,104	55,435	55,666	55,847	56,116	56,384	56,659	56,932	57,205	57,476	57,752
York	75,451	75,757	76,049	76,480	76,893	77,304	77,726	78,155	78,600	79,040	79,478

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:		
	12/13	12/14	12/15	12/16	12/18	12/20	12/22
Allegheny	159,390	160,084	160,659	161,085	162,468 (32,494) [7,798] {3,899}	163,788 (32,758) [7,862] {3,931}	165,163 (33,033) [7,928] {3,964}
Berks	69,282	69,550	69,849	70,182	71,009 (14,202) [3,408] {1,704}	71,847 (14,369) [3,449] {1,724}	72,734 (14,547) [3,491] {1,746}
Bucks	83,124	83,414	83,735	84,083	84,896 (16,979) [4,075] {2,037}	85,764 (17,153) [4,117] {2,058}	86,696 (17,339) [4,161] {2,081}
Butler	30,685	30,799	30,902	30,969	31,210 (6,242) [1,498] {749}	31,440 (6,288) [1,509] {755}	31,686 (6,337) [1,521] {760}
Chester	58,779	59,056	59,384	59,688	60,362 (12,072) [2,897] {1,449}	61,058 (12,212) [2,931] {1,465}	61,789 (12,358) [2,966] {1,483}
Delaware	69,145	69,378	69,551	69,868	70,438 (14,088) [3,381] {1,691}	71,038 (14,208) [3,410] {1,705}	71,682 (14,336) [3,441] {1,720}
Lackawanna	26,962	27,095	27,268	27,395	27,671 (5,534) [1,328] {664}	27,955 (5,591) [1,342] {671}	28,248 (5,650) [1,356] {678}
Lancaster	83,158	83,431	83,789	84,155	84,947 (16,989) [4,077] {2,039}	85,764 (17,153) [4,117] {2,058}	86,604 (17,321) [4,157] {2,078}
Lehigh	56,795	57,085	57,358	57,650	58,346 (11,669) [2,801] {1,400}	59,064 (11,813) [2,835] {1,418}	59,828 (11,966) [2,872] {1,436}
Luzerne	48,920	49,135	49,372	49,602	50,084 (10,017) [2,404] {1,202}	50,570 (10,114) [2,427] {1,214}	51,074 (10,215) [2,452] {1,226}
Monroe	23,312	23,447	23,511	23,658	23,926 (4,785) [1,148] {574}	24,205 (4,841) [1,162] {581}	24,496 (4,899) [1,176] {588}
Montgomery	97,996	98,316	98,650	99,151	100,171 (20,034) [4,808] {2,404}	101,245 (20,249) [4,860] {2,430}	102,365 (20,473) [4,914] {2,457}
Northampton	52,131	52,376	52,581	52,929	53,609 (10,722) [2,573] {1,287}	54,318 (10,864) [2,607] {1,304}	55,065 (11,013) [2,643] {1,322}
Philadelphia	199,077	199,369	200,129	200,668	202,191 (40,438) [9,705] {4,853}	203,806 (40,761) [9,783] {4,891}	205,580 (41,116) [9,868] {4,934}
Westmoreland	55,104	55,435	55,666	55,847	56,384 (11,277) [2,706] {1,353}	56,932 (11,386) [2,733] {1,366}	57,476 (11,495) [2,759] {1,379}
York	75,451	75,757	76,049	76,480	77,304 (15,461) [3,711] {1,855}	78,155 (15,631) [3,751] {1,876}	79,040 (15,808) [3,794] {1,897}

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.