IEM's AI Modeling: Short-term COVID-19 Projections
Date: 7/12/21

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 7/12/21 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
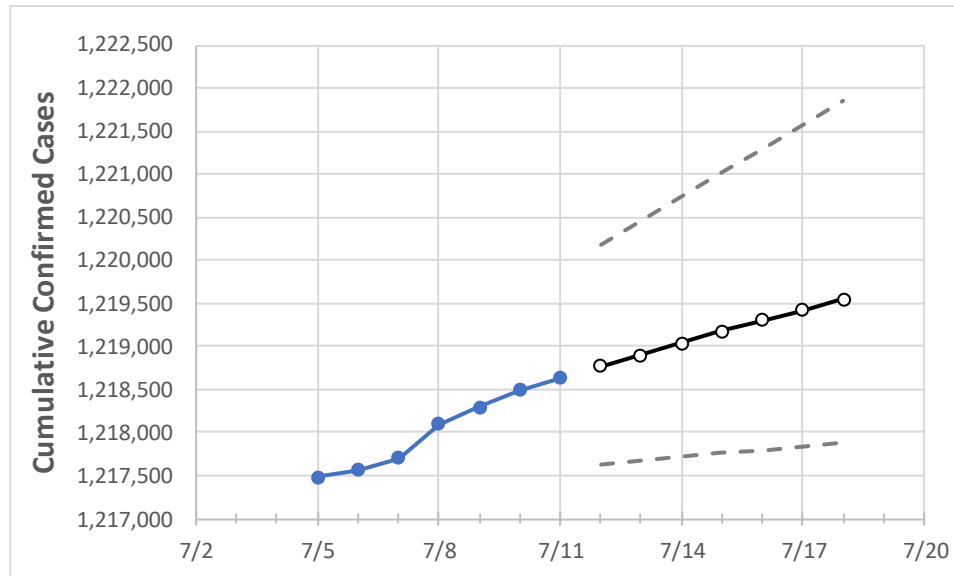
	Actual Confirmed Cases On:				Projected Cases For:						
	7/8	7/9	7/10	7/11	7/12	7/13	7/14	7/15	7/16	7/17	7/18
Pennsylvania	1,218,097	1,218,291	1,218,490	1,218,631	1,218,771	1,218,903	1,219,036	1,219,174	1,219,300	1,219,420	1,219,546

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:						
	7/8	7/9	7/10	7/11	7/12	7/13	7/14	7/15	7/16	7/17	7/18
Allegheny	101,997	102,018	102,036	102,050	102,063	102,076	102,090	102,103	102,116	102,130	102,143
Berks	48,498	48,499	48,510	48,513	48,516	48,519	48,522	48,524	48,527	48,529	48,532
Bucks	60,877	60,891	60,912	60,921	60,930	60,940	60,951	60,961	60,972	60,983	60,994
Butler	17,640	17,642	17,645	17,648	17,650	17,651	17,653	17,655	17,657	17,658	17,660
Chester	40,872	40,876	40,876	40,876	40,880	40,885	40,889	40,894	40,898	40,902	40,906
Delaware	52,451	52,460	52,474	52,483	52,491	52,499	52,507	52,516	52,524	52,532	52,541
Lackawanna	18,576	18,579	18,585	18,590	18,592	18,594	18,597	18,599	18,601	18,603	18,605
Lancaster	55,458	55,464	55,467	55,470	55,474	55,477	55,481	55,484	55,488	55,491	55,494
Lehigh	39,889	39,897	39,907	39,920	39,927	39,934	39,941	39,949	39,957	39,965	39,972
Luzerne	32,151	32,161	32,165	32,169	32,173	32,176	32,180	32,184	32,187	32,191	32,194
Monroe	14,848	14,852	14,855	14,865	14,868	14,871	14,874	14,877	14,879	14,882	14,885
Montgomery	70,482	70,495	70,513	70,525	70,534	70,544	70,553	70,563	70,572	70,581	70,591
Northampton	35,927	35,934	35,938	35,943	35,947	35,952	35,956	35,961	35,965	35,969	35,974
Philadelphia	154,993	154,993	154,993	154,993	155,027	155,061	155,093	155,127	155,160	155,191	155,224
Westmoreland	34,455	34,462	34,465	34,470	34,473	34,477	34,480	34,483	34,486	34,488	34,491
York	47,088	47,099	47,112	47,122	47,129	47,135	47,142	47,148	47,155	47,161	47,167

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:		
	7/8	7/9	7/10	7/11	7/13	7/15	7/17
Allegheny	101,997	102,018	102,036	102,050	102,076 (20,415) [4,900] {2,450}	102,103 (20,421) [4,901] {2,450}	102,130 (20,426) [4,902] {2,451}
Berks	48,498	48,499	48,510	48,513	48,519 (9,704) [2,329] {1,164}	48,524 (9,705) [2,329] {1,165}	48,529 (9,706) [2,329] {1,165}
Bucks	60,877	60,891	60,912	60,921	60,940 (12,188) [2,925] {1,463}	60,961 (12,192) [2,926] {1,463}	60,983 (12,197) [2,927] {1,464}
Butler	17,640	17,642	17,645	17,648	17,651 (3,530) [847] {424}	17,655 (3,531) [847] {424}	17,658 (3,532) [848] {424}
Chester	40,872	40,876	40,876	40,876	40,885 (8,177) [1,962] {981}	40,894 (8,179) [1,963] {981}	40,902 (8,180) [1,963] {982}
Delaware	52,451	52,460	52,474	52,483	52,499 (10,500) [2,520] {1,260}	52,516 (10,503) [2,521] {1,260}	52,532 (10,506) [2,522] {1,261}
Lackawanna	18,576	18,579	18,585	18,590	18,594 (3,719) [893] {446}	18,599 (3,720) [893] {446}	18,603 (3,721) [893] {446}
Lancaster	55,458	55,464	55,467	55,470	55,477 (11,095) [2,663] {1,331}	55,484 (11,097) [2,663] {1,332}	55,491 (11,098) [2,664] {1,332}
Lehigh	39,889	39,897	39,907	39,920	39,934 (7,987) [1,917] {958}	39,949 (7,990) [1,918] {959}	39,965 (7,993) [1,918] {959}
Luzerne	32,151	32,161	32,165	32,169	32,176 (6,435) [1,544] {772}	32,184 (6,437) [1,545] {772}	32,191 (6,438) [1,545] {773}
Monroe	14,848	14,852	14,855	14,865	14,871 (2,974) [714] {357}	14,877 (2,975) [714] {357}	14,882 (2,976) [714] {357}
Montgomery	70,482	70,495	70,513	70,525	70,544 (14,109) [3,386] {1,693}	70,563 (14,113) [3,387] {1,694}	70,581 (14,116) [3,388] {1,694}
Northampton	35,927	35,934	35,938	35,943	35,952 (7,190) [1,726] {863}	35,961 (7,192) [1,726] {863}	35,969 (7,194) [1,727] {863}
Philadelphia	154,993	154,993	154,993	154,993	155,061 (31,012) [7,443] {3,721}	155,127 (31,025) [7,446] {3,723}	155,191 (31,038) [7,449] {3,725}
Westmoreland	34,455	34,462	34,465	34,470	34,477 (6,895) [1,655] {827}	34,483 (6,897) [1,655] {828}	34,488 (6,898) [1,655] {828}
York	47,088	47,099	47,112	47,122	47,135 (9,427) [2,262] {1,131}	47,148 (9,430) [2,263] {1,132}	47,161 (9,432) [2,264] {1,132}

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.