IEM's AI Modeling: Short-term COVID-19 Projections
Date: 10/13/21

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 10/13/21 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
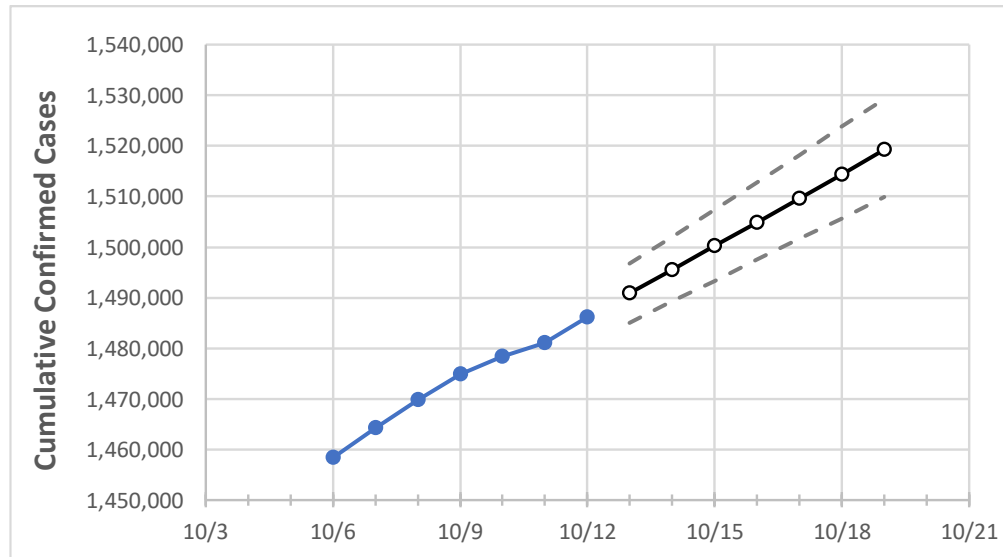
	Actual Confirmed Cases On:				Projected Cases For:						
	10/9	10/10	10/11	10/12	10/13	10/14	10/15	10/16	10/17	10/18	10/19
Pennsylvania	1,474,822	1,478,421	1,481,015	1,486,134	1,490,811	1,495,421	1,500,187	1,504,798	1,509,616	1,514,346	1,519,233

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:						
	10/9	10/10	10/11	10/12	10/13	10/14	10/15	10/16	10/17	10/18	10/19
Allegheny	124,654	124,987	125,240	125,590	125,976	126,364	126,757	127,151	127,544	127,940	128,337
Berks	55,997	56,121	56,235	56,366	56,513	56,661	56,807	56,952	57,099	57,249	57,399
Bucks	70,612	70,783	70,895	71,061	71,230	71,407	71,578	71,753	71,930	72,110	72,290
Butler	23,519	23,628	23,681	23,762	23,880	23,997	24,113	24,232	24,350	24,469	24,585
Chester	48,683	48,792	48,901	49,010	49,128	49,243	49,358	49,475	49,590	49,707	49,824
Delaware	60,224	60,327	60,385	60,476	60,587	60,699	60,810	60,920	61,035	61,150	61,257
Lackawanna	21,767	21,835	21,860	21,903	21,965	22,027	22,091	22,155	22,217	22,282	22,342
Lancaster	67,825	68,057	68,161	68,317	68,540	68,759	68,984	69,199	69,422	69,649	69,870
Lehigh	46,980	47,044	47,104	47,199	47,293	47,384	47,477	47,566	47,658	47,749	47,840
Luzerne	38,610	38,739	38,805	38,912	39,068	39,220	39,373	39,529	39,689	39,844	40,006
Monroe	18,727	18,790	18,818	18,891	18,950	19,008	19,066	19,122	19,182	19,238	19,298
Montgomery	82,342	82,527	82,667	82,840	83,014	83,191	83,370	83,546	83,724	83,906	84,089
Northampton	43,050	43,098	43,156	43,262	43,354	43,448	43,540	43,632	43,725	43,818	43,907
Philadelphia	176,978	177,202	177,427	177,651	177,914	178,163	178,420	178,676	178,928	179,186	179,435
Westmoreland	42,260	42,361	42,431	42,552	42,700	42,844	42,994	43,139	43,284	43,434	43,574
York	58,300	58,479	58,715	58,929	59,153	59,384	59,614	59,846	60,079	60,314	60,545

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:		
	10/9	10/10	10/11	10/12	10/14	10/16	10/18
Allegheny	124,654	124,987	125,240	125,590	126,364 (25,273) [6,065] {3,033}	127,151 (25,430) [6,103] {3,052}	127,940 (25,588) [6,141] {3,071}
Berks	55,997	56,121	56,235	56,366	56,661 (11,332) [2,720] {1,360}	56,952 (11,390) [2,734] {1,367}	57,249 (11,450) [2,748] {1,374}
Bucks	70,612	70,783	70,895	71,061	71,407 (14,281) [3,428] {1,714}	71,753 (14,351) [3,444] {1,722}	72,110 (14,422) [3,461] {1,731}
Butler	23,519	23,628	23,681	23,762	23,997 (4,799) [1,152] {576}	24,232 (4,846) [1,163] {582}	24,469 (4,894) [1,174] {587}
Chester	48,683	48,792	48,901	49,010	49,243 (9,849) [2,364] {1,182}	49,475 (9,895) [2,375] {1,187}	49,707 (9,941) [2,386] {1,193}
Delaware	60,224	60,327	60,385	60,476	60,699 (12,140) [2,914] {1,457}	60,920 (12,184) [2,924] {1,462}	61,150 (12,230) [2,935] {1,468}
Lackawanna	21,767	21,835	21,860	21,903	22,027 (4,405) [1,057] {529}	22,155 (4,431) [1,063] {532}	22,282 (4,456) [1,070] {535}
Lancaster	67,825	68,057	68,161	68,317	68,759 (13,752) [3,300] {1,650}	69,199 (13,840) [3,322] {1,661}	69,649 (13,930) [3,343] {1,672}
Lehigh	46,980	47,044	47,104	47,199	47,384 (9,477) [2,274] {1,137}	47,566 (9,513) [2,283] {1,142}	47,749 (9,550) [2,292] {1,146}
Luzerne	38,610	38,739	38,805	38,912	39,220 (7,844) [1,883] {941}	39,529 (7,906) [1,897] {949}	39,844 (7,969) [1,913] {956}
Monroe	18,727	18,790	18,818	18,891	19,008 (3,802) [912] {456}	19,122 (3,824) [918] {459}	19,238 (3,848) [923] {462}
Montgomery	82,342	82,527	82,667	82,840	83,191 (16,638) [3,993] {1,997}	83,546 (16,709) [4,010] {2,005}	83,906 (16,781) [4,028] {2,014}
Northampton	43,050	43,098	43,156	43,262	43,448 (8,690) [2,086] {1,043}	43,632 (8,726) [2,094] {1,047}	43,818 (8,764) [2,103] {1,052}
Philadelphia	176,978	177,202	177,427	177,651	178,163 (35,633) [8,552] {4,276}	178,676 (35,735) [8,576] {4,288}	179,186 (35,837) [8,601] {4,300}
Westmoreland	42,260	42,361	42,431	42,552	42,844 (8,569) [2,057] {1,028}	43,139 (8,628) [2,071] {1,035}	43,434 (8,687) [2,085] {1,042}
York	58,300	58,479	58,715	58,929	59,384 (11,877) [2,850] {1,425}	59,846 (11,969) [2,873] {1,436}	60,314 (12,063) [2,895] {1,448}

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.