IEM's AI Modeling: Short-term COVID-19 Projections
Date: 4/23/21

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 4/23/21 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
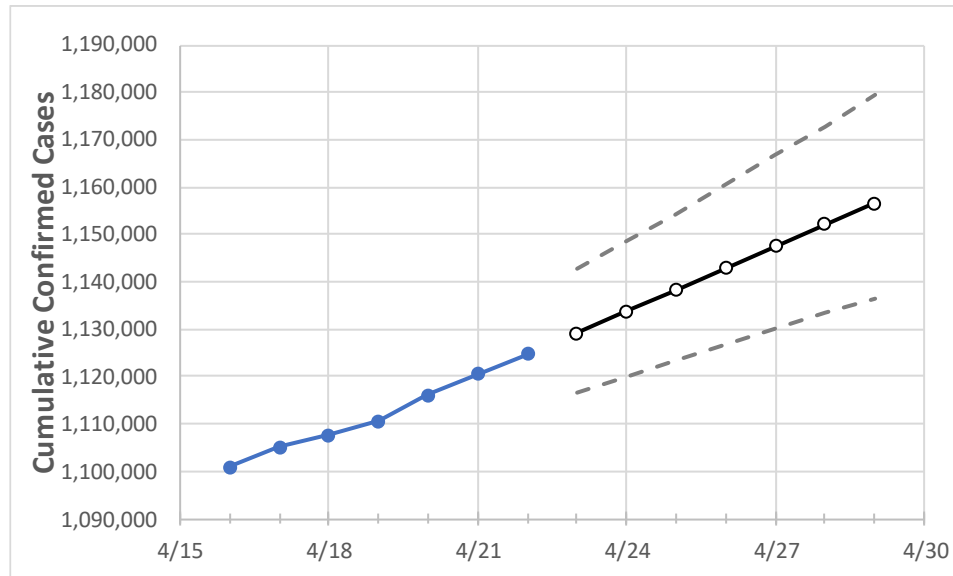
	Actual Confirmed Cases On:				Projected Cases For:						
	4/19	4/20	4/21	4/22	4/23	4/24	4/25	4/26	4/27	4/28	4/29
Pennsylvania	1,110,675	1,116,044	1,120,581	1,124,659	1,129,260	1,133,746	1,138,321	1,142,887	1,147,511	1,152,141	1,156,645

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:						
	4/19	4/20	4/21	4/22	4/23	4/24	4/25	4/26	4/27	4/28	4/29
Allegheny	94,112	94,501	94,841	95,140	95,548	95,965	96,365	96,773	97,169	97,564	97,966
Berks	43,516	43,771	43,923	44,134	44,325	44,518	44,714	44,901	45,096	45,295	45,498
Bucks	56,123	56,408	56,692	56,904	57,155	57,403	57,650	57,898	58,145	58,387	58,629
Butler	16,290	16,338	16,387	16,421	16,464	16,508	16,550	16,592	16,633	16,674	16,715
Chester	34,133	34,258	34,417	34,546	34,680	34,815	34,948	35,080	35,212	35,342	35,470
Delaware	48,757	48,964	49,196	49,343	49,564	49,791	50,017	50,245	50,470	50,698	50,928
Lackawanna	16,978	17,067	17,166	17,225	17,297	17,371	17,444	17,518	17,592	17,672	17,748
Lancaster	51,426	51,619	51,803	52,041	52,232	52,425	52,616	52,815	53,008	53,198	53,392
Lehigh	36,758	36,947	37,054	37,198	37,327	37,455	37,581	37,707	37,830	37,960	38,084
Luzerne	29,136	29,256	29,408	29,521	29,635	29,751	29,866	29,982	30,098	30,217	30,334
Monroe	13,064	13,158	13,225	13,306	13,389	13,467	13,548	13,627	13,709	13,789	13,868
Montgomery	65,352	65,675	65,915	66,088	66,374	66,665	66,946	67,222	67,502	67,788	68,073
Northampton	33,225	33,388	33,497	33,630	33,746	33,862	33,974	34,088	34,197	34,307	34,414
Philadelphia	141,551	142,297	142,980	143,574	144,201	144,838	145,484	146,148	146,798	147,438	148,094
Westmoreland	31,535	31,693	31,830	31,924	32,041	32,156	32,275	32,388	32,506	32,621	32,739
York	42,532	42,693	42,890	43,072	43,237	43,402	43,570	43,738	43,903	44,059	44,229

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:		
	4/19	4/20	4/21	4/22	4/24	4/26	4/28
Allegheny	94,112	94,501	94,841	95,140	95,965 (19,193) [4,606] {2,303}	96,773 (19,355) [4,645] {2,323}	97,564 (19,513) [4,683] {2,342}
Berks	43,516	43,771	43,923	44,134	44,518 (8,904) [2,137] {1,068}	44,901 (8,980) [2,155] {1,078}	45,295 (9,059) [2,174] {1,087}
Bucks	56,123	56,408	56,692	56,904	57,403 (11,481) [2,755] {1,378}	57,898 (11,580) [2,779] {1,390}	58,387 (11,677) [2,803] {1,401}
Butler	16,290	16,338	16,387	16,421	16,508 (3,302) [792] {396}	16,592 (3,318) [796] {398}	16,674 (3,335) [800] {400}
Chester	34,133	34,258	34,417	34,546	34,815 (6,963) [1,671] {836}	35,080 (7,016) [1,684] {842}	35,342 (7,068) [1,696] {848}
Delaware	48,757	48,964	49,196	49,343	49,791 (9,958) [2,390] {1,195}	50,245 (10,049) [2,412] {1,206}	50,698 (10,140) [2,434] {1,217}
Lackawanna	16,978	17,067	17,166	17,225	17,371 (3,474) [834] {417}	17,518 (3,504) [841] {420}	17,672 (3,534) [848] {424}
Lancaster	51,426	51,619	51,803	52,041	52,425 (10,485) [2,516] {1,258}	52,815 (10,563) [2,535] {1,268}	53,198 (10,640) [2,553] {1,277}
Lehigh	36,758	36,947	37,054	37,198	37,455 (7,491) [1,798] {899}	37,707 (7,541) [1,810] {905}	37,960 (7,592) [1,822] {911}
Luzerne	29,136	29,256	29,408	29,521	29,751 (5,950) [1,428] {714}	29,982 (5,996) [1,439] {720}	30,217 (6,043) [1,450] {725}
Monroe	13,064	13,158	13,225	13,306	13,467 (2,693) [646] {323}	13,627 (2,725) [654] {327}	13,789 (2,758) [662] {331}
Montgomery	65,352	65,675	65,915	66,088	66,665 (13,333) [3,200] {1,600}	67,222 (13,444) [3,227] {1,613}	67,788 (13,558) [3,254] {1,627}
Northampton	33,225	33,388	33,497	33,630	33,862 (6,772) [1,625] {813}	34,088 (6,818) [1,636] {818}	34,307 (6,861) [1,647] {823}
Philadelphia	141,551	142,297	142,980	143,574	144,838 (28,968) [6,952] {3,476}	146,148 (29,230) [7,015] {3,508}	147,438 (29,488) [7,077] {3,539}
Westmoreland	31,535	31,693	31,830	31,924	32,156 (6,431) [1,543] {772}	32,388 (6,478) [1,555] {777}	32,621 (6,524) [1,566] {783}
York	42,532	42,693	42,890	43,072	43,402 (8,680) [2,083] {1,042}	43,738 (8,748) [2,099] {1,050}	44,059 (8,812) [2,115] {1,057}

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.