IEM's AI Modeling: Short-term COVID-19 Projections
Date: 5/28/21

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 5/28/21 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
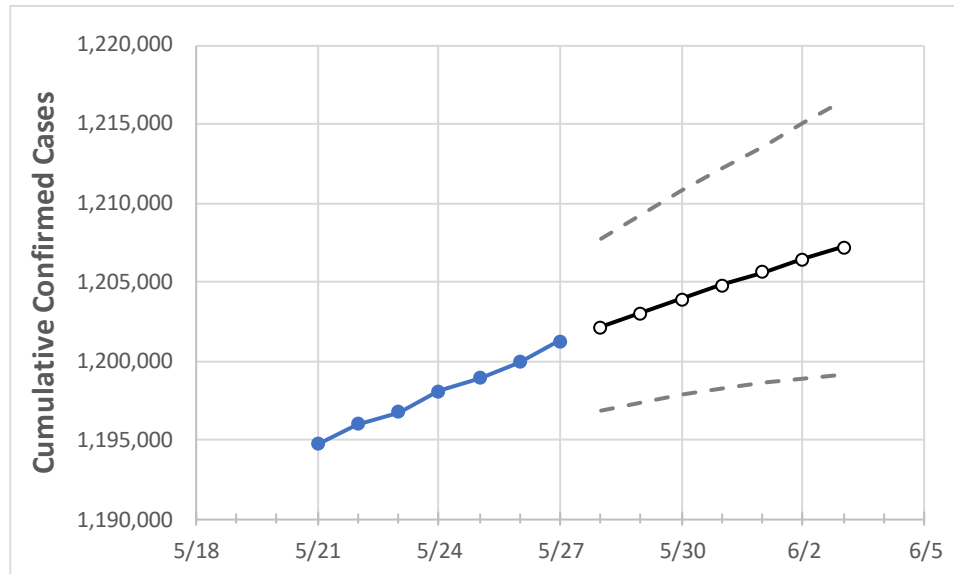
	Actual Confirmed Cases On:				Projected Cases For:						
	5/24	5/25	5/26	5/27	5/28	5/29	5/30	5/31	6/1	6/2	6/3
Pennsylvania	1,198,084	1,198,896	1,199,935	1,201,228	1,202,156	1,203,046	1,203,932	1,204,790	1,205,594	1,206,419	1,207,188

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:						
	5/24	5/25	5/26	5/27	5/28	5/29	5/30	5/31	6/1	6/2	6/3
Allegheny	100,922	100,984	101,056	101,103	101,165	101,226	101,283	101,339	101,391	101,440	101,487
Berks	47,725	47,778	47,826	47,853	47,890	47,925	47,957	47,987	48,017	48,044	48,069
Bucks	60,427	60,437	60,481	60,504	60,528	60,553	60,575	60,596	60,617	60,635	60,651
Butler	17,362	17,377	17,404	17,417	17,432	17,446	17,459	17,473	17,487	17,500	17,512
Chester	37,198	37,246	37,355	37,444	37,538	37,633	37,731	37,828	37,930	38,032	38,139
Delaware	51,978	51,995	52,020	52,053	52,079	52,104	52,128	52,150	52,173	52,193	52,212
Lackawanna	18,353	18,354	18,376	18,398	18,415	18,431	18,447	18,463	18,477	18,492	18,507
Lancaster	54,931	54,953	54,995	55,020	55,049	55,076	55,101	55,125	55,148	55,169	55,190
Lehigh	39,484	39,500	39,532	39,567	39,596	39,623	39,652	39,679	39,705	39,731	39,755
Luzerne	31,655	31,671	31,706	31,727	31,756	31,784	31,812	31,839	31,863	31,887	31,910
Monroe	14,634	14,649	14,659	14,672	14,681	14,689	14,697	14,705	14,712	14,718	14,724
Montgomery	69,882	69,867	69,911	69,950	69,980	70,008	70,036	70,061	70,085	70,106	70,127
Northampton	35,578	35,607	35,627	35,641	35,659	35,678	35,696	35,712	35,728	35,743	35,757
Philadelphia	152,530	152,672	152,814	152,956	153,092	153,222	153,351	153,479	153,602	153,725	153,844
Westmoreland	33,964	33,989	34,023	34,049	34,076	34,103	34,128	34,152	34,175	34,198	34,220
York	46,099	46,132	46,182	46,227	46,272	46,313	46,354	46,394	46,431	46,468	46,502

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:		
	5/24	5/25	5/26	5/27	5/29	5/31	6/2
Allegheny	100,922	100,984	101,056	101,103	101,226 (20,245) [4,859] {2,429}	101,339 (20,268) [4,864] {2,432}	101,440 (20,288) [4,869] {2,435}
Berks	47,725	47,778	47,826	47,853	47,925 (9,585) [2,300] {1,150}	47,987 (9,597) [2,303] {1,152}	48,044 (9,609) [2,306] {1,153}
Bucks	60,427	60,437	60,481	60,504	60,553 (12,111) [2,907] {1,453}	60,596 (12,119) [2,909] {1,454}	60,635 (12,127) [2,910] {1,455}
Butler	17,362	17,377	17,404	17,417	17,446 (3,489) [837] {419}	17,473 (3,495) [839] {419}	17,500 (3,500) [840] {420}
Chester	37,198	37,246	37,355	37,444	37,633 (7,527) [1,806] {903}	37,828 (7,566) [1,816] {908}	38,032 (7,606) [1,826] {913}
Delaware	51,978	51,995	52,020	52,053	52,104 (10,421) [2,501] {1,250}	52,150 (10,430) [2,503] {1,252}	52,193 (10,439) [2,505] {1,253}
Lackawanna	18,353	18,354	18,376	18,398	18,431 (3,686) [885] {442}	18,463 (3,693) [886] {443}	18,492 (3,698) [888] {444}
Lancaster	54,931	54,953	54,995	55,020	55,076 (11,015) [2,644] {1,322}	55,125 (11,025) [2,646] {1,323}	55,169 (11,034) [2,648] {1,324}
Lehigh	39,484	39,500	39,532	39,567	39,623 (7,925) [1,902] {951}	39,679 (7,936) [1,905] {952}	39,731 (7,946) [1,907] {954}
Luzerne	31,655	31,671	31,706	31,727	31,784 (6,357) [1,526] {763}	31,839 (6,368) [1,528] {764}	31,887 (6,377) [1,531] {765}
Monroe	14,634	14,649	14,659	14,672	14,689 (2,938) [705] {353}	14,705 (2,941) [706] {353}	14,718 (2,944) [706] {353}
Montgomery	69,882	69,867	69,911	69,950	70,008 (14,002) [3,360] {1,680}	70,061 (14,012) [3,363] {1,681}	70,106 (14,021) [3,365] {1,683}
Northampton	35,578	35,607	35,627	35,641	35,678 (7,136) [1,713] {856}	35,712 (7,142) [1,714] {857}	35,743 (7,149) [1,716] {858}
Philadelphia	152,530	152,672	152,814	152,956	153,222 (30,644) [7,355] {3,677}	153,479 (30,696) [7,367] {3,683}	153,725 (30,745) [7,379] {3,689}
Westmoreland	33,964	33,989	34,023	34,049	34,103 (6,821) [1,637] {818}	34,152 (6,830) [1,639] {820}	34,198 (6,840) [1,642] {821}
York	46,099	46,132	46,182	46,227	46,313 (9,263) [2,223] {1,112}	46,394 (9,279) [2,227] {1,113}	46,468 (9,294) [2,230] {1,115}

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.