IEM's AI Modeling: Short-term COVID-19 Projections
Date: 5/6/21

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 5/6/21 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
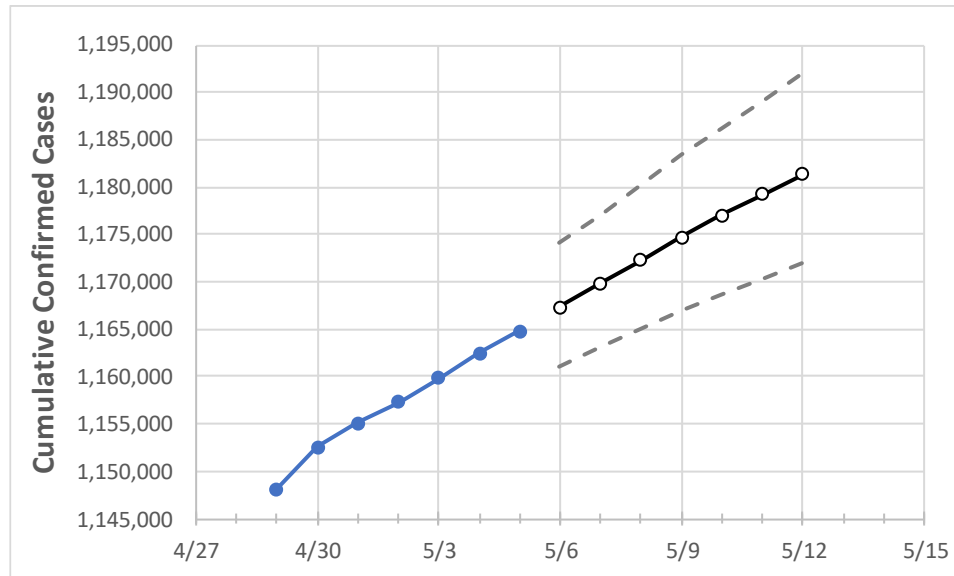
	Actual Confirmed Cases On:				Projected Cases For:						
	5/2	5/3	5/4	5/5	5/6	5/7	5/8	5/9	5/10	5/11	5/12
Pennsylvania	1,157,285	1,159,816	1,162,457	1,164,827	1,167,378	1,169,884	1,172,303	1,174,754	1,177,015	1,179,261	1,181,388

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:						
	5/2	5/3	5/4	5/5	5/6	5/7	5/8	5/9	5/10	5/11	5/12
Allegheny	97,760	97,975	98,197	98,355	98,538	98,714	98,885	99,055	99,221	99,372	99,525
Berks	45,835	45,865	46,102	46,236	46,378	46,519	46,654	46,793	46,931	47,057	47,187
Bucks	58,699	58,791	58,922	59,050	59,183	59,308	59,432	59,552	59,669	59,784	59,891
Butler	16,840	16,860	16,900	16,929	16,963	16,996	17,028	17,061	17,094	17,125	17,156
Chester	35,539	35,607	35,725	35,810	35,895	35,978	36,061	36,140	36,219	36,295	36,370
Delaware	50,680	50,743	50,814	50,908	50,999	51,088	51,171	51,253	51,331	51,404	51,481
Lackawanna	17,774	17,809	17,853	17,880	17,921	17,961	17,999	18,037	18,074	18,110	18,146
Lancaster	53,445	53,501	53,603	53,703	53,812	53,917	54,017	54,120	54,214	54,313	54,404
Lehigh	38,341	38,386	38,470	38,546	38,634	38,721	38,803	38,885	38,969	39,050	39,125
Luzerne	30,485	30,527	30,610	30,687	30,768	30,851	30,931	31,012	31,090	31,168	31,244
Monroe	14,009	14,038	14,094	14,136	14,190	14,242	14,294	14,345	14,397	14,446	14,493
Montgomery	68,153	68,241	68,399	68,508	68,651	68,795	68,935	69,069	69,202	69,329	69,452
Northampton	34,640	34,674	34,759	34,822	34,896	34,968	35,039	35,108	35,174	35,237	35,301
Philadelphia	147,729	148,031	148,031	148,031	148,366	148,692	149,009	149,323	149,634	149,938	150,236
Westmoreland	32,775	32,828	32,915	33,058	33,134	33,208	33,278	33,354	33,424	33,493	33,562
York	44,398	44,485	44,608	44,732	44,848	44,961	45,076	45,186	45,296	45,401	45,504

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:		
	5/2	5/3	5/4	5/5	5/7	5/9	5/11
Allegheny	97,760	97,975	98,197	98,355	98,714 (19,743) [4,738] {2,369}	99,055 (19,811) [4,755] {2,377}	99,372 (19,874) [4,770] {2,385}
Berks	45,835	45,865	46,102	46,236	46,519 (9,304) [2,233] {1,116}	46,793 (9,359) [2,246] {1,123}	47,057 (9,411) [2,259] {1,129}
Bucks	58,699	58,791	58,922	59,050	59,308 (11,862) [2,847] {1,423}	59,552 (11,910) [2,859] {1,429}	59,784 (11,957) [2,870] {1,435}
Butler	16,840	16,860	16,900	16,929	16,996 (3,399) [816] {408}	17,061 (3,412) [819] {409}	17,125 (3,425) [822] {411}
Chester	35,539	35,607	35,725	35,810	35,978 (7,196) [1,727] {863}	36,140 (7,228) [1,735] {867}	36,295 (7,259) [1,742] {871}
Delaware	50,680	50,743	50,814	50,908	51,088 (10,218) [2,452] {1,226}	51,253 (10,251) [2,460] {1,230}	51,404 (10,281) [2,467] {1,234}
Lackawanna	17,774	17,809	17,853	17,880	17,961 (3,592) [862] {431}	18,037 (3,607) [866] {433}	18,110 (3,622) [869] {435}
Lancaster	53,445	53,501	53,603	53,703	53,917 (10,783) [2,588] {1,294}	54,120 (10,824) [2,598] {1,299}	54,313 (10,863) [2,607] {1,304}
Lehigh	38,341	38,386	38,470	38,546	38,721 (7,744) [1,859] {929}	38,885 (7,777) [1,867] {933}	39,050 (7,810) [1,874] {937}
Luzerne	30,485	30,527	30,610	30,687	30,851 (6,170) [1,481] {740}	31,012 (6,202) [1,489] {744}	31,168 (6,234) [1,496] {748}
Monroe	14,009	14,038	14,094	14,136	14,242 (2,848) [684] {342}	14,345 (2,869) [689] {344}	14,446 (2,889) [693] {347}
Montgomery	68,153	68,241	68,399	68,508	68,795 (13,759) [3,302] {1,651}	69,069 (13,814) [3,315] {1,658}	69,329 (13,866) [3,328] {1,664}
Northampton	34,640	34,674	34,759	34,822	34,968 (6,994) [1,678] {839}	35,108 (7,022) [1,685] {843}	35,237 (7,047) [1,691] {846}
Philadelphia	147,729	148,031	148,031	148,031	148,692 (29,738) [7,137] {3,569}	149,323 (29,865) [7,168] {3,584}	149,938 (29,988) [7,197] {3,599}
Westmoreland	32,775	32,828	32,915	33,058	33,208 (6,642) [1,594] {797}	33,354 (6,671) [1,601] {801}	33,493 (6,699) [1,608] {804}
York	44,398	44,485	44,608	44,732	44,961 (8,992) [2,158] {1,079}	45,186 (9,037) [2,169] {1,084}	45,401 (9,080) [2,179] {1,090}

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.