IEM's AI Modeling: Short-term COVID-19 Projections
Date: 4/13/21

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 4/13/21 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
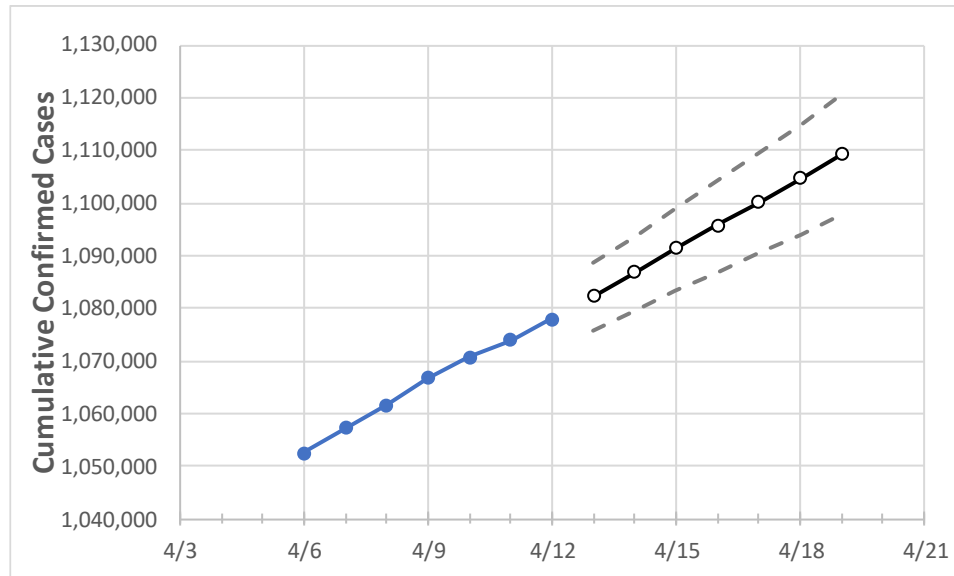
	Actual Confirmed Cases On:				Projected Cases For:						
	4/9	4/10	4/11	4/12	4/13	4/14	4/15	4/16	4/17	4/18	4/19
Pennsylvania	1,066,707	1,070,730	1,073,924	1,077,936	1,082,350	1,086,779	1,091,304	1,095,706	1,100,201	1,104,640	1,109,169

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:						
	4/9	4/10	4/11	4/12	4/13	4/14	4/15	4/16	4/17	4/18	4/19
Allegheny	89,545	89,917	90,386	90,634	91,065	91,514	91,967	92,427	92,889	93,344	93,813
Berks	41,590	41,773	41,900	41,991	42,168	42,348	42,531	42,711	42,887	43,068	43,252
Bucks	53,486	53,806	54,003	54,186	54,464	54,746	55,018	55,302	55,593	55,876	56,158
Butler	15,797	15,849	15,899	15,921	15,979	16,035	16,090	16,148	16,205	16,262	16,320
Chester	32,726	32,862	32,999	33,135	33,291	33,447	33,606	33,764	33,919	34,081	34,244
Delaware	46,548	46,778	46,933	47,049	47,256	47,462	47,671	47,883	48,091	48,305	48,518
Lackawanna	16,245	16,329	16,375	16,406	16,479	16,552	16,627	16,701	16,776	16,849	16,924
Lancaster	49,469	49,665	49,812	49,979	50,169	50,364	50,558	50,753	50,945	51,140	51,334
Lehigh	35,433	35,608	35,699	35,781	35,929	36,076	36,222	36,370	36,519	36,670	36,822
Luzerne	28,033	28,186	28,289	28,341	28,452	28,565	28,679	28,795	28,915	29,035	29,157
Monroe	12,254	12,353	12,425	12,468	12,560	12,652	12,748	12,847	12,947	13,047	13,150
Montgomery	62,399	62,711	62,945	63,131	63,438	63,744	64,052	64,364	64,680	65,000	65,324
Northampton	31,882	32,051	32,118	32,197	32,340	32,475	32,612	32,750	32,884	33,018	33,150
Philadelphia	135,632	136,155	136,678	137,201	137,854	138,509	139,178	139,854	140,529	141,225	141,943
Westmoreland	30,300	30,418	30,605	30,666	30,794	30,924	31,056	31,190	31,329	31,473	31,612
York	40,851	41,076	41,220	41,306	41,455	41,604	41,752	41,901	42,046	42,192	42,336

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:		
	4/9	4/10	4/11	4/12	4/14	4/16	4/18
Allegheny	89,545	89,917	90,386	90,634	91,514 (18,303) [4,393] {2,196}	92,427 (18,485) [4,436] {2,218}	93,344 (18,669) [4,480] {2,240}
Berks	41,590	41,773	41,900	41,991	42,348 (8,470) [2,033] {1,016}	42,711 (8,542) [2,050] {1,025}	43,068 (8,614) [2,067] {1,034}
Bucks	53,486	53,806	54,003	54,186	54,746 (10,949) [2,628] {1,314}	55,302 (11,060) [2,655] {1,327}	55,876 (11,175) [2,682] {1,341}
Butler	15,797	15,849	15,899	15,921	16,035 (3,207) [770] {385}	16,148 (3,230) [775] {388}	16,262 (3,252) [781] {390}
Chester	32,726	32,862	32,999	33,135	33,447 (6,689) [1,605] {803}	33,764 (6,753) [1,621] {810}	34,081 (6,816) [1,636] {818}
Delaware	46,548	46,778	46,933	47,049	47,462 (9,492) [2,278] {1,139}	47,883 (9,577) [2,298] {1,149}	48,305 (9,661) [2,319] {1,159}
Lackawanna	16,245	16,329	16,375	16,406	16,552 (3,310) [794] {397}	16,701 (3,340) [802] {401}	16,849 (3,370) [809] {404}
Lancaster	49,469	49,665	49,812	49,979	50,364 (10,073) [2,417] {1,209}	50,753 (10,151) [2,436] {1,218}	51,140 (10,228) [2,455] {1,227}
Lehigh	35,433	35,608	35,699	35,781	36,076 (7,215) [1,732] {866}	36,370 (7,274) [1,746] {873}	36,670 (7,334) [1,760] {880}
Luzerne	28,033	28,186	28,289	28,341	28,565 (5,713) [1,371] {686}	28,795 (5,759) [1,382] {691}	29,035 (5,807) [1,394] {697}
Monroe	12,254	12,353	12,425	12,468	12,652 (2,530) [607] {304}	12,847 (2,569) [617] {308}	13,047 (2,609) [626] {313}
Montgomery	62,399	62,711	62,945	63,131	63,744 (12,749) [3,060] {1,530}	64,364 (12,873) [3,089] {1,545}	65,000 (13,000) [3,120] {1,560}
Northampton	31,882	32,051	32,118	32,197	32,475 (6,495) [1,559] {779}	32,750 (6,550) [1,572] {786}	33,018 (6,604) [1,585] {792}
Philadelphia	135,632	136,155	136,678	137,201	138,509 (27,702) [6,648] {3,324}	139,854 (27,971) [6,713] {3,356}	141,225 (28,245) [6,779] {3,389}
Westmoreland	30,300	30,418	30,605	30,666	30,924 (6,185) [1,484] {742}	31,190 (6,238) [1,497] {749}	31,473 (6,295) [1,511] {755}
York	40,851	41,076	41,220	41,306	41,604 (8,321) [1,997] {998}	41,901 (8,380) [2,011] {1,006}	42,192 (8,438) [2,025] {1,013}

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.