IEM's AI Modeling: Short-term COVID-19 Projections
Date: 2/24/21

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 2/24/21 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
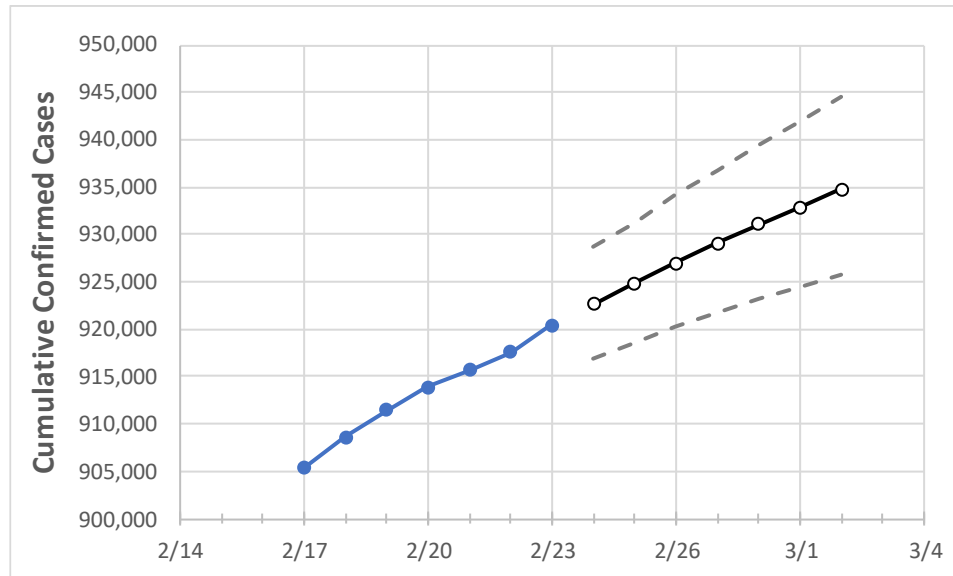
	Actual Confirmed Cases On:				Projected Cases For:						
	2/20	2/21	2/22	2/23	2/24	2/25	2/26	2/27	2/28	3/1	3/2
Pennsylvania	913,912	915,639	917,565	920,385	922,638	924,827	927,007	929,065	931,075	932,918	934,803

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:						
	2/20	2/21	2/22	2/23	2/24	2/25	2/26	2/27	2/28	3/1	3/2
Allegheny	74,602	74,866	74,976	75,250	75,460	75,670	75,875	76,072	76,272	76,469	76,665
Berks	34,960	35,025	35,105	35,180	35,244	35,304	35,363	35,419	35,473	35,525	35,570
Bucks	43,904	43,996	44,105	44,251	44,380	44,504	44,623	44,741	44,857	44,969	45,079
Butler	13,656	13,693	13,705	13,741	13,770	13,798	13,825	13,852	13,878	13,902	13,926
Chester	27,433	27,488	27,544	27,636	27,707	27,777	27,846	27,914	27,978	28,042	28,105
Delaware	39,983	40,052	40,132	40,241	40,334	40,423	40,510	40,595	40,680	40,761	40,842
Lackawanna	13,563	13,595	13,629	13,670	13,719	13,766	13,813	13,860	13,906	13,952	13,997
Lancaster	42,660	42,740	42,843	42,945	43,074	43,198	43,319	43,429	43,539	43,646	43,745
Lehigh	30,121	30,179	30,230	30,315	30,382	30,445	30,508	30,568	30,626	30,680	30,733
Luzerne	24,461	24,505	24,543	24,593	24,643	24,691	24,738	24,784	24,826	24,867	24,907
Monroe	9,390	9,417	9,435	9,488	9,519	9,550	9,582	9,613	9,643	9,672	9,701
Montgomery	52,637	52,748	52,898	53,049	53,182	53,312	53,434	53,558	53,679	53,798	53,909
Northampton	26,058	26,143	26,208	26,356	26,461	26,565	26,665	26,763	26,858	26,956	27,052
Philadelphia	116,403	116,565	116,726	117,022	117,244	117,459	117,671	117,879	118,081	118,276	118,466
Westmoreland	26,275	26,325	26,351	26,429	26,490	26,550	26,609	26,666	26,723	26,777	26,832
York	35,108	35,185	35,231	35,332	35,425	35,514	35,601	35,685	35,766	35,842	35,920

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:		
	2/20	2/21	2/22	2/23	2/25	2/27	3/1
Allegheny	74,602	74,866	74,976	75,250	75,670 (15,134) [3,632] {1,816}	76,072 (15,214) [3,651] {1,826}	76,469 (15,294) [3,671] {1,835}
Berks	34,960	35,025	35,105	35,180	35,304 (7,061) [1,695] {847}	35,419 (7,084) [1,700] {850}	35,525 (7,105) [1,705] {853}
Bucks	43,904	43,996	44,105	44,251	44,504 (8,901) [2,136] {1,068}	44,741 (8,948) [2,148] {1,074}	44,969 (8,994) [2,159] {1,079}
Butler	13,656	13,693	13,705	13,741	13,798 (2,760) [662] {331}	13,852 (2,770) [665] {332}	13,902 (2,780) [667] {334}
Chester	27,433	27,488	27,544	27,636	27,777 (5,555) [1,333] {667}	27,914 (5,583) [1,340] {670}	28,042 (5,608) [1,346] {673}
Delaware	39,983	40,052	40,132	40,241	40,423 (8,085) [1,940] {970}	40,595 (8,119) [1,949] {974}	40,761 (8,152) [1,957] {978}
Lackawanna	13,563	13,595	13,629	13,670	13,766 (2,753) [661] {330}	13,860 (2,772) [665] {333}	13,952 (2,790) [670] {335}
Lancaster	42,660	42,740	42,843	42,945	43,198 (8,640) [2,074] {1,037}	43,429 (8,686) [2,085] {1,042}	43,646 (8,729) [2,095] {1,047}
Lehigh	30,121	30,179	30,230	30,315	30,445 (6,089) [1,461] {731}	30,568 (6,114) [1,467] {734}	30,680 (6,136) [1,473] {736}
Luzerne	24,461	24,505	24,543	24,593	24,691 (4,938) [1,185] {593}	24,784 (4,957) [1,190] {595}	24,867 (4,973) [1,194] {597}
Monroe	9,390	9,417	9,435	9,488	9,550 (1,910) [458] {229}	9,613 (1,923) [461] {231}	9,672 (1,934) [464] {232}
Montgomery	52,637	52,748	52,898	53,049	53,312 (10,662) [2,559] {1,279}	53,558 (10,712) [2,571] {1,285}	53,798 (10,760) [2,582] {1,291}
Northampton	26,058	26,143	26,208	26,356	26,565 (5,313) [1,275] {638}	26,763 (5,353) [1,285] {642}	26,956 (5,391) [1,294] {647}
Philadelphia	116,403	116,565	116,726	117,022	117,459 (23,492) [5,638] {2,819}	117,879 (23,576) [5,658] {2,829}	118,276 (23,655) [5,677] {2,839}
Westmoreland	26,275	26,325	26,351	26,429	26,550 (5,310) [1,274] {637}	26,666 (5,333) [1,280] {640}	26,777 (5,355) [1,285] {643}
York	35,108	35,185	35,231	35,332	35,514 (7,103) [1,705] {852}	35,685 (7,137) [1,713] {856}	35,842 (7,168) [1,720] {860}

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.