IEM's AI Modeling: Short-term COVID-19 Projections
Date: 6/9/21

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 6/9/21 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
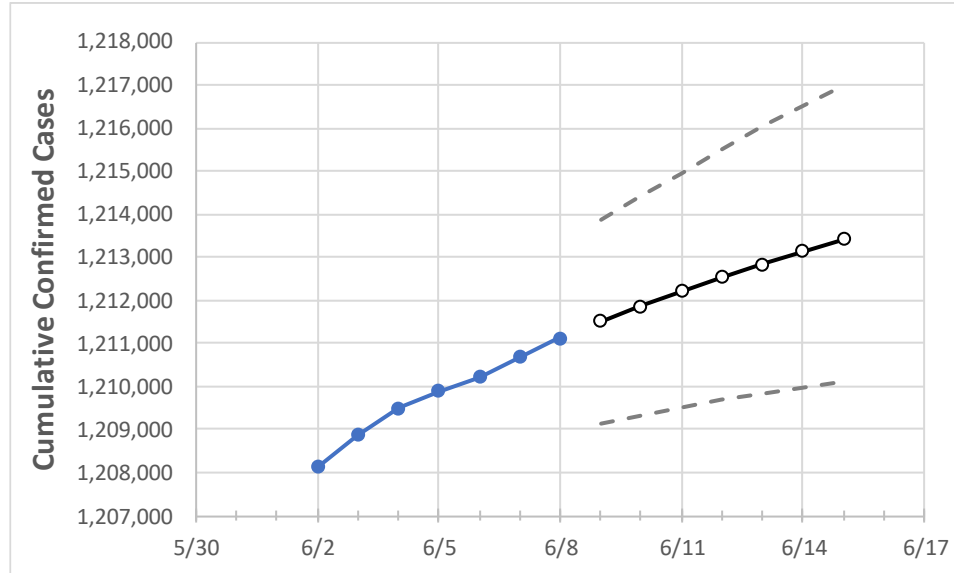
	Actual Confirmed Cases On:				Projected Cases For:						
	6/5	6/6	6/7	6/8	6/9	6/10	6/11	6/12	6/13	6/14	6/15
Pennsylvania	1,209,894	1,210,224	1,210,691	1,211,114	1,211,508	1,211,877	1,212,218	1,212,538	1,212,851	1,213,152	1,213,419

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:						
	6/5	6/6	6/7	6/8	6/9	6/10	6/11	6/12	6/13	6/14	6/15
Allegheny	101,471	101,492	101,522	101,546	101,569	101,589	101,608	101,627	101,644	101,660	101,675
Berks	48,118	48,135	48,147	48,188	48,206	48,224	48,240	48,254	48,269	48,282	48,296
Bucks	60,652	60,667	60,682	60,687	60,696	60,704	60,712	60,718	60,724	60,731	60,737
Butler	17,518	17,523	17,529	17,535	17,543	17,550	17,557	17,564	17,570	17,576	17,582
Chester	40,699	40,699	40,700	40,697	40,702	40,707	40,712	40,716	40,719	40,723	40,726
Delaware	52,247	52,255	52,269	52,283	52,295	52,307	52,318	52,328	52,338	52,347	52,356
Lackawanna	18,465	18,472	18,475	18,477	18,482	18,488	18,492	18,497	18,501	18,505	18,509
Lancaster	55,216	55,236	55,249	55,262	55,274	55,286	55,298	55,308	55,318	55,327	55,336
Lehigh	39,689	39,699	39,710	39,726	39,736	39,745	39,754	39,763	39,771	39,778	39,785
Luzerne	31,900	31,908	31,918	31,933	31,944	31,954	31,964	31,973	31,982	31,990	31,998
Monroe	14,723	14,729	14,731	14,743	14,747	14,750	14,754	14,757	14,760	14,762	14,765
Montgomery	70,189	70,201	70,219	70,232	70,249	70,265	70,280	70,294	70,308	70,322	70,334
Northampton	35,728	35,734	35,742	35,763	35,769	35,775	35,780	35,785	35,789	35,794	35,798
Philadelphia	153,623	153,673	153,724	153,724	153,774	153,820	153,864	153,904	153,942	153,977	154,010
Westmoreland	34,204	34,221	34,228	34,236	34,246	34,256	34,265	34,274	34,282	34,289	34,297
York	46,537	46,554	46,573	46,626	46,651	46,676	46,699	46,723	46,745	46,767	46,787

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:		
	6/5	6/6	6/7	6/8	6/10	6/12	6/14
Allegheny	101,471	101,492	101,522	101,546	101,589 (20,318) [4,876] {2,438}	101,627 (20,325) [4,878] {2,439}	101,660 (20,332) [4,880] {2,440}
Berks	48,118	48,135	48,147	48,188	48,224 (9,645) [2,315] {1,157}	48,254 (9,651) [2,316] {1,158}	48,282 (9,656) [2,318] {1,159}
Bucks	60,652	60,667	60,682	60,687	60,704 (12,141) [2,914] {1,457}	60,718 (12,144) [2,914] {1,457}	60,731 (12,146) [2,915] {1,458}
Butler	17,518	17,523	17,529	17,535	17,550 (3,510) [842] {421}	17,564 (3,513) [843] {422}	17,576 (3,515) [844] {422}
Chester	40,699	40,699	40,700	40,697	40,707 (8,141) [1,954] {977}	40,716 (8,143) [1,954] {977}	40,723 (8,145) [1,955] {977}
Delaware	52,247	52,255	52,269	52,283	52,307 (10,461) [2,511] {1,255}	52,328 (10,466) [2,512] {1,256}	52,347 (10,469) [2,513] {1,256}
Lackawanna	18,465	18,472	18,475	18,477	18,488 (3,698) [887] {444}	18,497 (3,699) [888] {444}	18,505 (3,701) [888] {444}
Lancaster	55,216	55,236	55,249	55,262	55,286 (11,057) [2,654] {1,327}	55,308 (11,062) [2,655] {1,327}	55,327 (11,065) [2,656] {1,328}
Lehigh	39,689	39,699	39,710	39,726	39,745 (7,949) [1,908] {954}	39,763 (7,953) [1,909] {954}	39,778 (7,956) [1,909] {955}
Luzerne	31,900	31,908	31,918	31,933	31,954 (6,391) [1,534] {767}	31,973 (6,395) [1,535] {767}	31,990 (6,398) [1,536] {768}
Monroe	14,723	14,729	14,731	14,743	14,750 (2,950) [708] {354}	14,757 (2,951) [708] {354}	14,762 (2,952) [709] {354}
Montgomery	70,189	70,201	70,219	70,232	70,265 (14,053) [3,373] {1,686}	70,294 (14,059) [3,374] {1,687}	70,322 (14,064) [3,375] {1,688}
Northampton	35,728	35,734	35,742	35,763	35,775 (7,155) [1,717] {859}	35,785 (7,157) [1,718] {859}	35,794 (7,159) [1,718] {859}
Philadelphia	153,623	153,673	153,724	153,724	153,820 (30,764) [7,383] {3,692}	153,904 (30,781) [7,387] {3,694}	153,977 (30,795) [7,391] {3,695}
Westmoreland	34,204	34,221	34,228	34,236	34,256 (6,851) [1,644] {822}	34,274 (6,855) [1,645] {823}	34,289 (6,858) [1,646] {823}
York	46,537	46,554	46,573	46,626	46,676 (9,335) [2,240] {1,120}	46,723 (9,345) [2,243] {1,121}	46,767 (9,353) [2,245] {1,122}

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.