IEM's AI Modeling: Short-term COVID-19 Projections
Date: 3/1/21

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 3/1/21 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
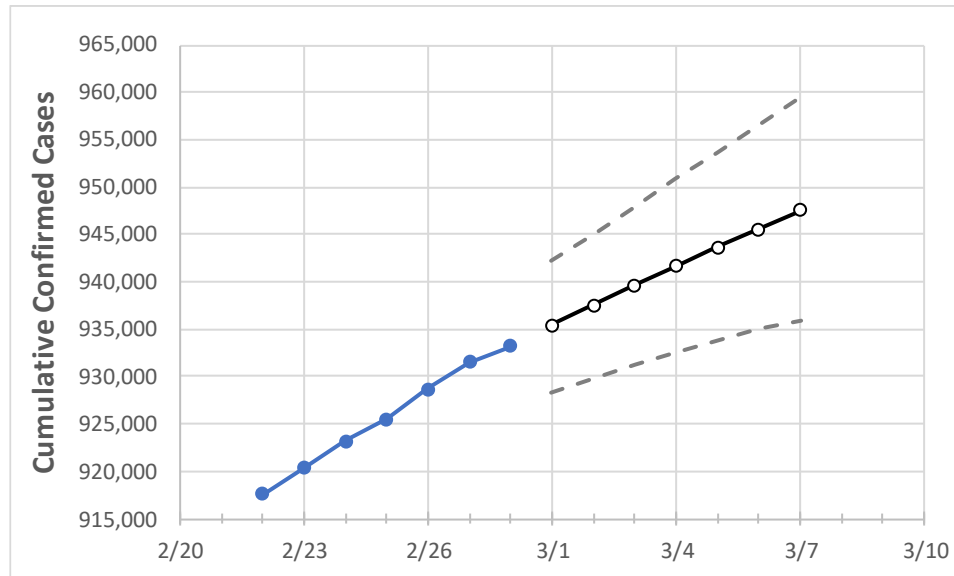
	Actual Confirmed Cases On:				Projected Cases For:						
	2/25	2/26	2/27	2/28	3/1	3/2	3/3	3/4	3/5	3/6	3/7
Pennsylvania	925,563	928,633	931,531	933,261	935,437	937,576	939,631	941,651	943,647	945,608	947,543

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:						
	2/25	2/26	2/27	2/28	3/1	3/2	3/3	3/4	3/5	3/6	3/7
Allegheny	75,724	76,136	76,449	76,669	76,894	77,131	77,365	77,598	77,829	78,063	78,292
Berks	35,370	35,476	35,577	35,658	35,738	35,815	35,891	35,965	36,039	36,112	36,182
Bucks	44,554	44,744	44,914	45,046	45,175	45,300	45,425	45,547	45,665	45,785	45,905
Butler	13,815	13,851	13,893	13,916	13,947	13,977	14,007	14,036	14,065	14,094	14,122
Chester	27,851	27,979	27,979	27,979	28,047	28,118	28,185	28,254	28,321	28,385	28,449
Delaware	40,512	40,700	40,849	40,957	41,067	41,176	41,284	41,391	41,496	41,605	41,711
Lackawanna	13,772	13,829	13,888	13,934	13,978	14,021	14,064	14,105	14,146	14,187	14,226
Lancaster	43,240	43,348	43,527	43,630	43,735	43,835	43,933	44,027	44,118	44,207	44,294
Lehigh	30,481	30,599	30,696	30,755	30,829	30,901	30,975	31,046	31,116	31,184	31,251
Luzerne	24,737	24,804	24,849	24,905	24,957	25,005	25,055	25,102	25,149	25,196	25,241
Monroe	9,543	9,589	9,631	9,656	9,687	9,718	9,748	9,777	9,807	9,836	9,864
Montgomery	53,371	53,604	53,760	53,921	54,073	54,223	54,368	54,516	54,658	54,804	54,949
Northampton	26,549	26,662	26,747	26,814	26,899	26,980	27,060	27,135	27,211	27,288	27,363
Philadelphia	117,642	117,642	117,642	117,642	117,866	118,089	118,309	118,519	118,733	118,940	119,147
Westmoreland	26,550	26,648	26,742	26,767	26,825	26,881	26,938	26,995	27,051	27,107	27,162
York	35,528	35,634	35,739	35,812	35,888	35,962	36,032	36,101	36,166	36,231	36,293

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:		
	2/25	2/26	2/27	2/28	3/2	3/4	3/6
Allegheny	75,724	76,136	76,449	76,669	77,131 (15,426) [3,702] {1,851}	77,598 (15,520) [3,725] {1,862}	78,063 (15,613) [3,747] {1,874}
Berks	35,370	35,476	35,577	35,658	35,815 (7,163) [1,719] {860}	35,965 (7,193) [1,726] {863}	36,112 (7,222) [1,733] {867}
Bucks	44,554	44,744	44,914	45,046	45,300 (9,060) [2,174] {1,087}	45,547 (9,109) [2,186] {1,093}	45,785 (9,157) [2,198] {1,099}
Butler	13,815	13,851	13,893	13,916	13,977 (2,795) [671] {335}	14,036 (2,807) [674] {337}	14,094 (2,819) [676] {338}
Chester	27,851	27,979	27,979	27,979	28,118 (5,624) [1,350] {675}	28,254 (5,651) [1,356] {678}	28,385 (5,677) [1,362] {681}
Delaware	40,512	40,700	40,849	40,957	41,176 (8,235) [1,976] {988}	41,391 (8,278) [1,987] {993}	41,605 (8,321) [1,997] {999}
Lackawanna	13,772	13,829	13,888	13,934	14,021 (2,804) [673] {337}	14,105 (2,821) [677] {339}	14,187 (2,837) [681] {340}
Lancaster	43,240	43,348	43,527	43,630	43,835 (8,767) [2,104] {1,052}	44,027 (8,805) [2,113] {1,057}	44,207 (8,841) [2,122] {1,061}
Lehigh	30,481	30,599	30,696	30,755	30,901 (6,180) [1,483] {742}	31,046 (6,209) [1,490] {745}	31,184 (6,237) [1,497] {748}
Luzerne	24,737	24,804	24,849	24,905	25,005 (5,001) [1,200] {600}	25,102 (5,020) [1,205] {602}	25,196 (5,039) [1,209] {605}
Monroe	9,543	9,589	9,631	9,656	9,718 (1,944) [466] {233}	9,777 (1,955) [469] {235}	9,836 (1,967) [472] {236}
Montgomery	53,371	53,604	53,760	53,921	54,223 (10,845) [2,603] {1,301}	54,516 (10,903) [2,617] {1,308}	54,804 (10,961) [2,631] {1,315}
Northampton	26,549	26,662	26,747	26,814	26,980 (5,396) [1,295] {648}	27,135 (5,427) [1,302] {651}	27,288 (5,458) [1,310] {655}
Philadelphia	117,642	117,642	117,642	117,642	118,089 (23,618) [5,668] {2,834}	118,519 (23,704) [5,689] {2,844}	118,940 (23,788) [5,709] {2,855}
Westmoreland	26,550	26,648	26,742	26,767	26,881 (5,376) [1,290] {645}	26,995 (5,399) [1,296] {648}	27,107 (5,421) [1,301] {651}
York	35,528	35,634	35,739	35,812	35,962 (7,192) [1,726] {863}	36,101 (7,220) [1,733] {866}	36,231 (7,246) [1,739] {870}

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.