IEM's AI Modeling: Short-term COVID-19 Projections
Date: 12/10/20

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 12/10/20 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
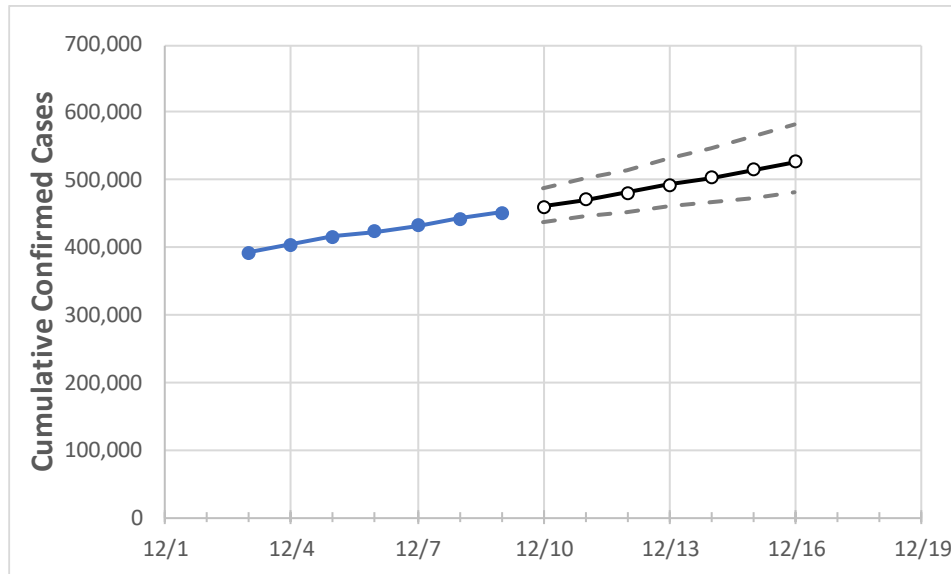
	Actual Confirmed Cases On:				Projected Cases For:						
	12/6	12/7	12/8	12/9	12/10	12/11	12/12	12/13	12/14	12/15	12/16
Pennsylvania	423,100	432,207	442,311	450,924	460,861	471,075	481,571	492,355	503,433	514,812	526,498

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 20%, and are often within 10%, of actual confirmed cases.

Pennsylvania Counties

	Actual Confirmed Cases On:				Projected Cases For:						
	12/6	12/7	12/8	12/9	12/10	12/11	12/12	12/13	12/14	12/15	12/16
Allegheny	33,505	34,121	34,814	35,541	36,391	37,263	38,158	39,075	40,016	40,982	41,971
Berks	15,791	16,049	16,468	16,748	17,054	17,374	17,708	18,055	18,418	18,797	19,192
Bucks	20,619	21,146	21,586	21,923	22,434	22,961	23,505	24,067	24,647	25,245	25,862
Butler	5,368	5,462	5,530	5,702	5,827	5,953	6,082	6,212	6,345	6,480	6,616
Chester	13,733	13,975	14,253	14,461	14,738	15,025	15,322	15,630	15,949	16,279	16,620
Delaware	22,258	22,470	22,761	23,010	23,306	23,607	23,912	24,223	24,539	24,859	25,185
Lackawanna	5,789	5,856	5,947	6,034	6,134	6,238	6,345	6,456	6,572	6,691	6,815
Lancaster	19,182	19,426	19,805	20,233	20,636	21,047	21,465	21,892	22,326	22,769	23,219
Lehigh	13,200	13,455	13,760	14,013	14,288	14,570	14,860	15,159	15,466	15,782	16,106
Luzerne	11,292	11,476	11,747	11,931	12,185	12,445	12,712	12,986	13,267	13,554	13,849
Monroe	4,010	4,072	4,203	4,264	4,359	4,458	4,560	4,667	4,778	4,893	5,013
Montgomery	25,008	25,277	25,825	26,123	26,596	27,083	27,583	28,097	28,626	29,169	29,727
Northampton	10,539	10,767	11,000	11,226	11,466	11,715	11,971	12,235	12,508	12,789	13,079
Philadelphia	74,153	75,073	76,589	77,601	78,534	79,473	80,420	81,374	82,334	83,302	84,276
Westmoreland	11,177	11,414	11,667	11,864	12,141	12,424	12,711	13,003	13,300	13,603	13,910
York	13,845	13,967	14,436	14,950	15,370	15,814	16,281	16,774	17,293	17,841	18,417

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:		
	12/6	12/7	12/8	12/9	12/11	12/13	12/15
Allegheny	33,505	34,121	34,814	35,541	37,263 (7,453) [1,789] {894}	39,075 (7,815) [1,876] {938}	40,982 (8,196) [1,967] {984}
Berks	15,791	16,049	16,468	16,748	17,374 (3,475) [834] {417}	18,055 (3,611) [867] {433}	18,797 (3,759) [902] {451}
Bucks	20,619	21,146	21,586	21,923	22,961 (4,592) [1,102] {551}	24,067 (4,813) [1,155] {578}	25,245 (5,049) [1,212] {606}
Butler	5,368	5,462	5,530	5,702	5,953 (1,191) [286] {143}	6,212 (1,242) [298] {149}	6,480 (1,296) [311] {156}
Chester	13,733	13,975	14,253	14,461	15,025 (3,005) [721] {361}	15,630 (3,126) [750] {375}	16,279 (3,256) [781] {391}
Delaware	22,258	22,470	22,761	23,010	23,607 (4,721) [1,133] {567}	24,223 (4,845) [1,163] {581}	24,859 (4,972) [1,193] {597}
Lackawanna	5,789	5,856	5,947	6,034	6,238 (1,248) [299] {150}	6,456 (1,291) [310] {155}	6,691 (1,338) [321] {161}
Lancaster	19,182	19,426	19,805	20,233	21,047 (4,209) [1,010] {505}	21,892 (4,378) [1,051] {525}	22,769 (4,554) [1,093] {546}
Lehigh	13,200	13,455	13,760	14,013	14,570 (2,914) [699] {350}	15,159 (3,032) [728] {364}	15,782 (3,156) [758] {379}
Luzerne	11,292	11,476	11,747	11,931	12,445 (2,489) [597] {299}	12,986 (2,597) [623] {312}	13,554 (2,711) [651] {325}
Monroe	4,010	4,072	4,203	4,264	4,458 (892) [214] {107}	4,667 (933) [224] {112}	4,893 (979) [235] {117}
Montgomery	25,008	25,277	25,825	26,123	27,083 (5,417) [1,300] {650}	28,097 (5,619) [1,349] {674}	29,169 (5,834) [1,400] {700}
Northampton	10,539	10,767	11,000	11,226	11,715 (2,343) [562] {281}	12,235 (2,447) [587] {294}	12,789 (2,558) [614] {307}
Philadelphia	74,153	75,073	76,589	77,601	79,473 (15,895) [3,815] {1,907}	81,374 (16,275) [3,906] {1,953}	83,302 (16,660) [3,998] {1,999}
Westmoreland	11,177	11,414	11,667	11,864	12,424 (2,485) [596] {298}	13,003 (2,601) [624] {312}	13,603 (2,721) [653] {326}
York	13,845	13,967	14,436	14,950	15,814 (3,163) [759] {380}	16,774 (3,355) [805] {403}	17,841 (3,568) [856] {428}

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.