IEM's AI Modeling: Short-term COVID-19 Projections
Date: 12/21/20

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 12/21/20 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
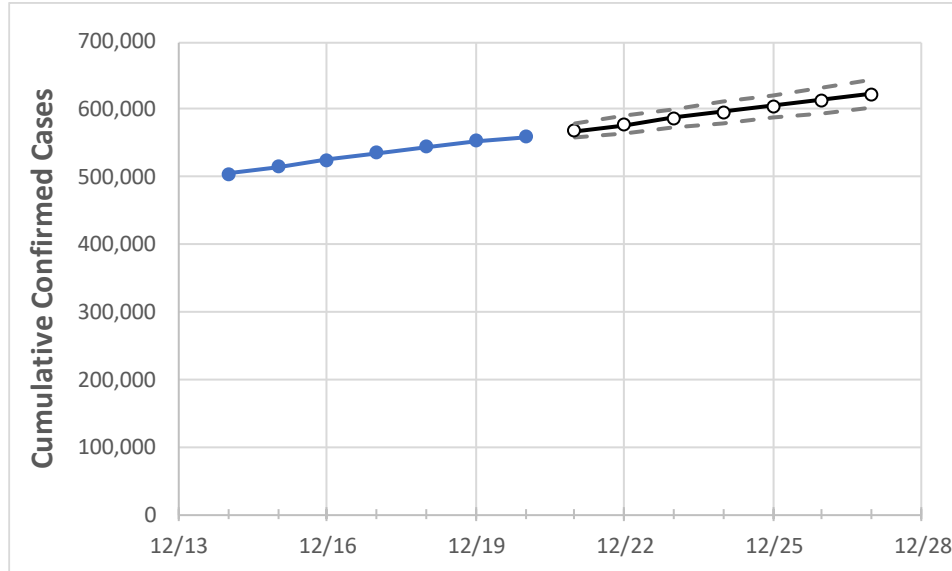
	Actual Confirmed Cases On:				Projected Cases For:						
	12/17	12/18	12/19	12/20	12/21	12/22	12/23	12/24	12/25	12/26	12/27
Pennsylvania	534,948	544,116	552,895	559,256	568,478	577,631	586,717	595,738	604,695	613,587	622,418

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:						
	12/17	12/18	12/19	12/20	12/21	12/22	12/23	12/24	12/25	12/26	12/27
Allegheny	43,857	44,684	45,699	46,330	47,296	48,268	49,248	50,233	51,226	52,225	53,230
Berks	19,401	19,698	19,988	20,259	20,590	20,924	21,259	21,596	21,935	22,276	22,618
Bucks	25,496	26,036	26,387	26,706	27,102	27,495	27,884	28,269	28,651	29,028	29,402
Butler	7,172	7,352	7,577	7,709	7,907	8,109	8,317	8,529	8,746	8,968	9,196
Chester	16,646	17,052	17,052	17,052	17,375	17,703	18,038	18,380	18,727	19,082	19,442
Delaware	25,450	25,757	26,061	26,299	26,586	26,872	27,157	27,442	27,727	28,010	28,294
Lackawanna	7,021	7,125	7,286	7,386	7,522	7,662	7,805	7,952	8,103	8,258	8,417
Lancaster	23,464	23,951	24,293	24,613	25,003	25,394	25,785	26,176	26,568	26,961	27,353
Lehigh	16,525	16,758	17,000	17,286	17,583	17,882	18,182	18,483	18,785	19,088	19,393
Luzerne	14,417	14,716	14,983	15,135	15,431	15,733	16,040	16,352	16,669	16,992	17,320
Monroe	4,983	5,068	5,125	5,206	5,287	5,367	5,447	5,526	5,606	5,684	5,763
Montgomery	30,172	30,755	31,092	31,421	31,879	32,337	32,795	33,254	33,713	34,173	34,633
Northampton	13,459	13,642	13,855	14,123	14,389	14,657	14,927	15,199	15,473	15,748	16,026
Philadelphia	85,033	85,733	85,733	85,733	86,573	87,404	88,225	89,036	89,838	90,630	91,412
Westmoreland	15,545	15,793	16,203	16,416	16,837	17,266	17,701	18,144	18,594	19,051	19,516
York	18,556	19,039	19,439	19,760	20,212	20,671	21,138	21,612	22,093	22,581	23,076

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:		
	12/17	12/18	12/19	12/20	12/22	12/24	12/26
Allegheny	43,857	44,684	45,699	46,330	48,268 (9,654) [2,317] {1,158}	50,233 (10,047) [2,411] {1,206}	52,225 (10,445) [2,507] {1,253}
Berks	19,401	19,698	19,988	20,259	20,924 (4,185) [1,004] {502}	21,596 (4,319) [1,037] {518}	22,276 (4,455) [1,069] {535}
Bucks	25,496	26,036	26,387	26,706	27,495 (5,499) [1,320] {660}	28,269 (5,654) [1,357] {678}	29,028 (5,806) [1,393] {697}
Butler	7,172	7,352	7,577	7,709	8,109 (1,622) [389] {195}	8,529 (1,706) [409] {205}	8,968 (1,794) [430] {215}
Chester	16,646	17,052	17,052	17,052	17,703 (3,541) [850] {425}	18,380 (3,676) [882] {441}	19,082 (3,816) [916] {458}
Delaware	25,450	25,757	26,061	26,299	26,872 (5,374) [1,290] {645}	27,442 (5,488) [1,317] {659}	28,010 (5,602) [1,345] {672}
Lackawanna	7,021	7,125	7,286	7,386	7,662 (1,532) [368] {184}	7,952 (1,590) [382] {191}	8,258 (1,652) [396] {198}
Lancaster	23,464	23,951	24,293	24,613	25,394 (5,079) [1,219] {609}	26,176 (5,235) [1,256] {628}	26,961 (5,392) [1,294] {647}
Lehigh	16,525	16,758	17,000	17,286	17,882 (3,576) [858] {429}	18,483 (3,697) [887] {444}	19,088 (3,818) [916] {458}
Luzerne	14,417	14,716	14,983	15,135	15,733 (3,147) [755] {378}	16,352 (3,270) [785] {392}	16,992 (3,398) [816] {408}
Monroe	4,983	5,068	5,125	5,206	5,367 (1,073) [258] {129}	5,526 (1,105) [265] {133}	5,684 (1,137) [273] {136}
Montgomery	30,172	30,755	31,092	31,421	32,337 (6,467) [1,552] {776}	33,254 (6,651) [1,596] {798}	34,173 (6,835) [1,640] {820}
Northampton	13,459	13,642	13,855	14,123	14,657 (2,931) [704] {352}	15,199 (3,040) [730] {365}	15,748 (3,150) [756] {378}
Philadelphia	85,033	85,733	85,733	85,733	87,404 (17,481) [4,195] {2,098}	89,036 (17,807) [4,274] {2,137}	90,630 (18,126) [4,350] {2,175}
Westmoreland	15,545	15,793	16,203	16,416	17,266 (3,453) [829] {414}	18,144 (3,629) [871] {435}	19,051 (3,810) [914] {457}
York	18,556	19,039	19,439	19,760	20,671 (4,134) [992] {496}	21,612 (4,322) [1,037] {519}	22,581 (4,516) [1,084] {542}

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.