IEM's AI Modeling: Short-term COVID-19 Projections
Date: 11/13/20

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 11/13/20 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
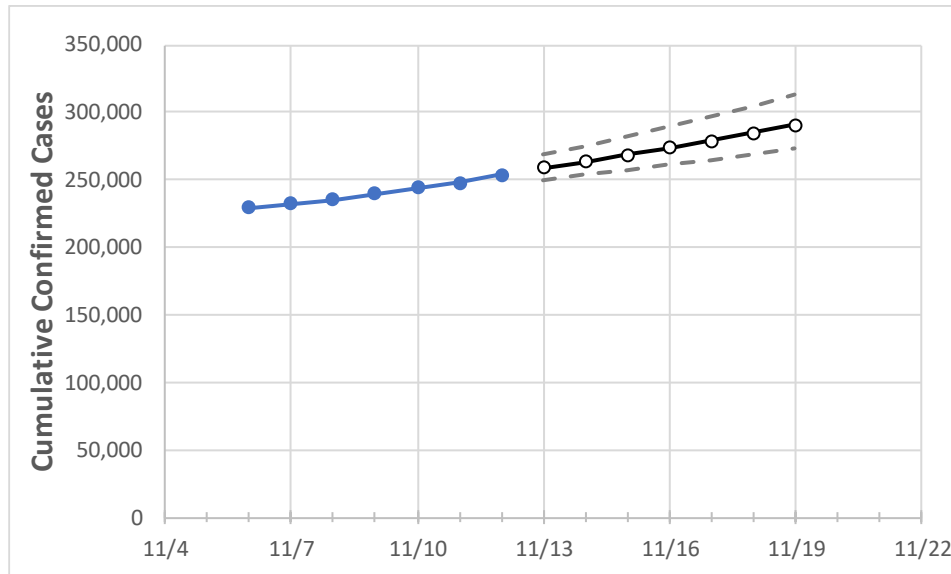
	Actual Confirmed Cases On:				Projected Cases For:						
	11/9	11/10	11/11	11/12	11/13	11/14	11/15	11/16	11/17	11/18	11/19
Pennsylvania	239,724	244,046	248,015	254,155	258,613	263,295	268,209	273,368	278,782	284,464	290,427

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:						
	11/9	11/10	11/11	11/12	11/13	11/14	11/15	11/16	11/17	11/18	11/19
Allegheny	17,656	17,973	18,339	18,751	19,104	19,480	19,880	20,306	20,759	21,242	21,756
Berks	10,447	10,595	10,767	10,899	11,015	11,132	11,251	11,372	11,495	11,620	11,746
Bucks	11,519	11,676	11,921	12,229	12,446	12,681	12,932	13,203	13,495	13,809	14,146
Butler	2,375	2,476	2,566	2,659	2,741	2,827	2,919	3,016	3,119	3,229	3,344
Chester	8,928	9,040	9,160	9,279	9,385	9,496	9,613	9,735	9,863	9,998	10,139
Delaware	15,232	15,402	15,592	15,832	16,054	16,288	16,534	16,792	17,064	17,351	17,652
Lackawanna	4,106	4,147	4,185	4,234	4,263	4,292	4,321	4,350	4,379	4,407	4,436
Lancaster	10,951	11,069	11,271	11,465	11,642	11,828	12,024	12,230	12,446	12,674	12,914
Lehigh	7,657	7,775	7,965	8,167	8,343	8,533	8,737	8,958	9,196	9,453	9,729
Luzerne	6,206	6,339	6,450	6,642	6,753	6,869	6,990	7,116	7,246	7,383	7,525
Monroe	2,287	2,318	2,367	2,413	2,455	2,501	2,550	2,603	2,661	2,724	2,792
Montgomery	15,660	15,857	16,115	16,455	16,723	17,009	17,314	17,640	17,988	18,359	18,755
Northampton	6,131	6,207	6,324	6,457	6,560	6,669	6,784	6,906	7,036	7,172	7,317
Philadelphia	49,456	50,354	50,934	51,513	52,203	52,924	53,677	54,463	55,284	56,141	57,035
Westmoreland	5,174	5,293	5,431	5,638	5,761	5,890	6,026	6,167	6,316	6,472	6,635
York	7,388	7,477	7,608	7,734	7,826	7,920	8,017	8,116	8,218	8,322	8,429

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:		
	11/9	11/10	11/11	11/12	11/14	11/16	11/18
Allegheny	17,656	17,973	18,339	18,751	19,480 (3,896) [935] {468}	20,306 (4,061) [975] {487}	21,242 (4,248) [1,020] {510}
Berks	10,447	10,595	10,767	10,899	11,132 (2,226) [534] {267}	11,372 (2,274) [546] {273}	11,620 (2,324) [558] {279}
Bucks	11,519	11,676	11,921	12,229	12,681 (2,536) [609] {304}	13,203 (2,641) [634] {317}	13,809 (2,762) [663] {331}
Butler	2,375	2,476	2,566	2,659	2,827 (565) [136] {68}	3,016 (603) [145] {72}	3,229 (646) [155] {77}
Chester	8,928	9,040	9,160	9,279	9,496 (1,899) [456] {228}	9,735 (1,947) [467] {234}	9,998 (2,000) [480] {240}
Delaware	15,232	15,402	15,592	15,832	16,288 (3,258) [782] {391}	16,792 (3,358) [806] {403}	17,351 (3,470) [833] {416}
Lackawanna	4,106	4,147	4,185	4,234	4,292 (858) [206] {103}	4,350 (870) [209] {104}	4,407 (881) [212] {106}
Lancaster	10,951	11,069	11,271	11,465	11,828 (2,366) [568] {284}	12,230 (2,446) [587] {294}	12,674 (2,535) [608] {304}
Lehigh	7,657	7,775	7,965	8,167	8,533 (1,707) [410] {205}	8,958 (1,792) [430] {215}	9,453 (1,891) [454] {227}
Luzerne	6,206	6,339	6,450	6,642	6,869 (1,374) [330] {165}	7,116 (1,423) [342] {171}	7,383 (1,477) [354] {177}
Monroe	2,287	2,318	2,367	2,413	2,501 (500) [120] {60}	2,603 (521) [125] {62}	2,724 (545) [131] {65}
Montgomery	15,660	15,857	16,115	16,455	17,009 (3,402) [816] {408}	17,640 (3,528) [847] {423}	18,359 (3,672) [881] {441}
Northampton	6,131	6,207	6,324	6,457	6,669 (1,334) [320] {160}	6,906 (1,381) [331] {166}	7,172 (1,434) [344] {172}
Philadelphia	49,456	50,354	50,934	51,513	52,924 (10,585) [2,540] {1,270}	54,463 (10,893) [2,614] {1,307}	56,141 (11,228) [2,695] {1,347}
Westmoreland	5,174	5,293	5,431	5,638	5,890 (1,178) [283] {141}	6,167 (1,233) [296] {148}	6,472 (1,294) [311] {155}
York	7,388	7,477	7,608	7,734	7,920 (1,584) [380] {190}	8,116 (1,623) [390] {195}	8,322 (1,664) [399] {200}

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.