IEM's AI Modeling: Short-term COVID-19 Projections
Date: 12/13/21

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 12/13/21 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
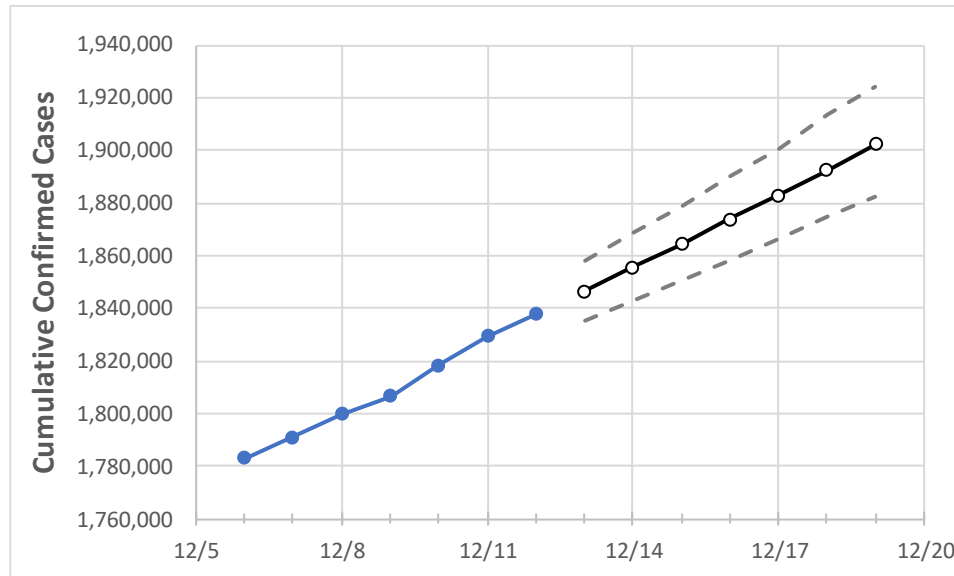
	Actual Confirmed Cases On:				Projected Cases For:						
	12/9	12/10	12/11	12/12	12/13	12/14	12/15	12/16	12/17	12/18	12/19
Pennsylvania	1,806,671	1,818,299	1,829,351	1,837,742	1,846,463	1,855,497	1,864,298	1,873,642	1,882,876	1,892,417	1,902,258

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:						
	12/9	12/10	12/11	12/12	12/13	12/14	12/15	12/16	12/17	12/18	12/19
Allegheny	156,669	157,410	158,347	159,011	159,737	160,508	161,257	162,004	162,768	163,553	164,318
Berks	67,533	68,000	68,576	69,031	69,436	69,851	70,258	70,698	71,149	71,613	72,086
Bucks	81,450	81,974	82,569	82,917	83,271	83,637	83,997	84,377	84,784	85,185	85,590
Butler	30,205	30,332	30,522	30,622	30,754	30,896	31,027	31,168	31,306	31,443	31,580
Chester	57,459	57,893	58,320	58,556	58,834	59,121	59,413	59,708	60,032	60,343	60,671
Delaware	68,028	68,413	68,673	68,979	69,232	69,489	69,746	70,014	70,290	70,579	70,872
Lackawanna	26,393	26,552	26,762	26,864	26,987	27,106	27,233	27,362	27,493	27,624	27,755
Lancaster	81,606	81,990	82,430	82,858	83,247	83,636	84,046	84,463	84,883	85,317	85,762
Lehigh	55,238	55,725	56,202	56,526	56,855	57,212	57,567	57,926	58,315	58,700	59,098
Luzerne	47,935	48,230	48,526	48,770	49,014	49,256	49,506	49,758	50,011	50,279	50,538
Monroe	22,719	22,888	23,091	23,219	23,344	23,473	23,600	23,732	23,869	24,006	24,147
Montgomery	95,838	96,653	97,164	97,641	98,099	98,587	99,057	99,574	100,079	100,629	101,169
Northampton	50,768	51,178	51,563	51,917	52,230	52,562	52,888	53,236	53,595	53,957	54,331
Philadelphia	195,644	197,431	197,981	198,751	199,432	200,155	200,851	201,585	202,361	203,177	204,030
Westmoreland	54,081	54,315	54,697	54,988	55,265	55,543	55,825	56,109	56,394	56,688	56,987
York	73,728	74,081	74,629	75,136	75,542	75,962	76,380	76,818	77,253	77,709	78,156

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:		
	12/9	12/10	12/11	12/12	12/14	12/16	12/18
Allegheny	156,669	157,410	158,347	159,011	160,508 (32,102) [7,704] {3,852}	162,004 (32,401) [7,776] {3,888}	163,553 (32,711) [7,851] {3,925}
Berks	67,533	68,000	68,576	69,031	69,851 (13,970) [3,353] {1,676}	70,698 (14,140) [3,394] {1,697}	71,613 (14,323) [3,437] {1,719}
Bucks	81,450	81,974	82,569	82,917	83,637 (16,727) [4,015] {2,007}	84,377 (16,875) [4,050] {2,025}	85,185 (17,037) [4,089] {2,044}
Butler	30,205	30,332	30,522	30,622	30,896 (6,179) [1,483] {741}	31,168 (6,234) [1,496] {748}	31,443 (6,289) [1,509] {755}
Chester	57,459	57,893	58,320	58,556	59,121 (11,824) [2,838] {1,419}	59,708 (11,942) [2,866] {1,433}	60,343 (12,069) [2,896] {1,448}
Delaware	68,028	68,413	68,673	68,979	69,489 (13,898) [3,335] {1,668}	70,014 (14,003) [3,361] {1,680}	70,579 (14,116) [3,388] {1,694}
Lackawanna	26,393	26,552	26,762	26,864	27,106 (5,421) [1,301] {651}	27,362 (5,472) [1,313] {657}	27,624 (5,525) [1,326] {663}
Lancaster	81,606	81,990	82,430	82,858	83,636 (16,727) [4,015] {2,007}	84,463 (16,893) [4,054] {2,027}	85,317 (17,063) [4,095] {2,048}
Lehigh	55,238	55,725	56,202	56,526	57,212 (11,442) [2,746] {1,373}	57,926 (11,585) [2,780] {1,390}	58,700 (11,740) [2,818] {1,409}
Luzerne	47,935	48,230	48,526	48,770	49,256 (9,851) [2,364] {1,182}	49,758 (9,952) [2,388] {1,194}	50,279 (10,056) [2,413] {1,207}
Monroe	22,719	22,888	23,091	23,219	23,473 (4,695) [1,127] {563}	23,732 (4,746) [1,139] {570}	24,006 (4,801) [1,152] {576}
Montgomery	95,838	96,653	97,164	97,641	98,587 (19,717) [4,732] {2,366}	99,574 (19,915) [4,780] {2,390}	100,629 (20,126) [4,830] {2,415}
Northampton	50,768	51,178	51,563	51,917	52,562 (10,512) [2,523] {1,261}	53,236 (10,647) [2,555] {1,278}	53,957 (10,791) [2,590] {1,295}
Philadelphia	195,644	197,431	197,981	198,751	200,155 (40,031) [9,607] {4,804}	201,585 (40,317) [9,676] {4,838}	203,177 (40,635) [9,752] {4,876}
Westmoreland	54,081	54,315	54,697	54,988	55,543 (11,109) [2,666] {1,333}	56,109 (11,222) [2,693] {1,347}	56,688 (11,338) [2,721] {1,361}
York	73,728	74,081	74,629	75,136	75,962 (15,192) [3,646] {1,823}	76,818 (15,364) [3,687] {1,844}	77,709 (15,542) [3,730] {1,865}

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.