IEM's AI Modeling: Short-term COVID-19 Projections
Date: 214/22

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 2/14/22 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
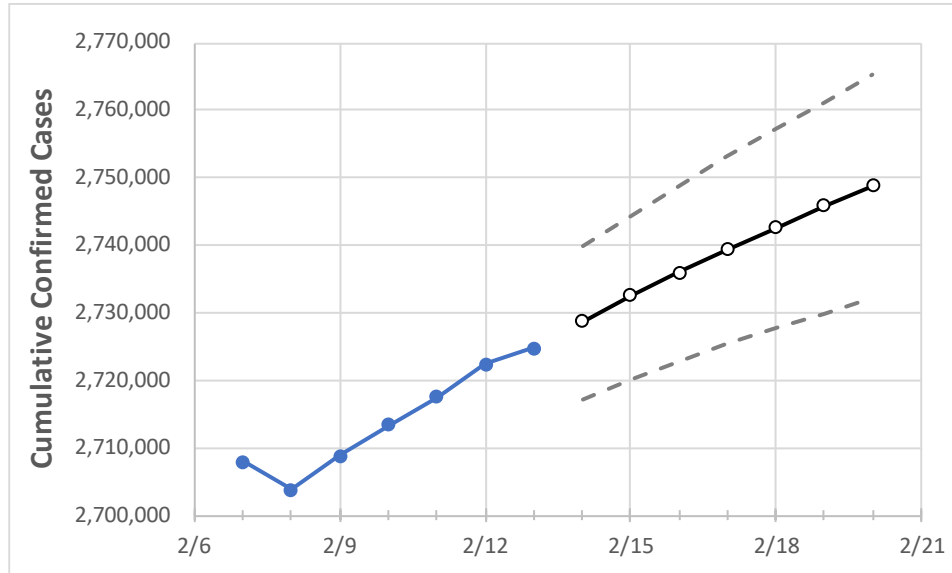
	Actual Confirmed Cases On:				Projected Cases For:						
	2/10	2/11	2/12	2/13	2/14	2/15	2/16	2/17	2/18	2/19	2/20
Pennsylvania	2,713,459	2,717,577	2,722,395	2,724,802	2,728,745	2,732,547	2,735,971	2,739,387	2,742,634	2,745,922	2,748,825

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:						
	2/10	2/11	2/12	2/13	2/14	2/15	2/16	2/17	2/18	2/19	2/20
Allegheny	256,178	256,562	257,052	257,293	257,648	257,999	258,327	258,626	258,931	259,228	259,491
Berks	100,419	100,531	100,671	100,765	100,865	100,956	101,047	101,134	101,219	101,302	101,374
Bucks	120,296	120,436	120,600	120,659	120,836	121,000	121,167	121,318	121,481	121,633	121,755
Butler	43,387	43,440	43,526	43,551	43,610	43,665	43,714	43,766	43,814	43,860	43,903
Chester	88,909	89,022	89,152	89,213	89,337	89,457	89,573	89,689	89,786	89,895	89,988
Delaware	107,637	107,763	107,890	107,946	108,089	108,205	108,319	108,436	108,546	108,666	108,758
Lackawanna	41,787	41,874	42,018	42,064	42,155	42,245	42,327	42,414	42,496	42,578	42,655
Lancaster	118,545	118,722	118,889	118,976	119,153	119,319	119,495	119,649	119,827	119,967	120,125
Lehigh	88,000	88,101	88,195	88,227	88,307	88,384	88,463	88,531	88,606	88,663	88,731
Luzerne	71,504	71,605	71,739	71,803	71,904	71,999	72,090	72,176	72,260	72,341	72,419
Monroe	36,195	36,262	36,315	36,348	36,394	36,438	36,480	36,522	36,560	36,599	36,638
Montgomery	147,550	147,715	147,932	148,017	148,237	148,447	148,634	148,811	149,007	149,185	149,359
Northampton	77,993	78,062	78,160	78,193	78,274	78,354	78,427	78,493	78,565	78,634	78,696
Philadelphia	299,963	300,509	300,817	301,219	301,495	301,755	302,000	302,243	302,462	302,688	302,915
Westmoreland	77,462	77,589	77,791	77,875	77,987	78,104	78,206	78,308	78,400	78,497	78,582
York	116,070	116,225	116,425	116,532	116,672	116,814	116,940	117,067	117,188	117,303	117,410

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:		
	2/10	2/11	2/12	2/13	2/15	2/17	2/19
Allegheny	256,178	256,562	257,052	257,293	257,999 (51,600) [12,384] {6,192}	258,626 (51,725) [12,414] {6,207}	259,228 (51,846) [12,443] {6,221}
Berks	100,419	100,531	100,671	100,765	100,956 (20,191) [4,846] {2,423}	101,134 (20,227) [4,854] {2,427}	101,302 (20,260) [4,862] {2,431}
Bucks	120,296	120,436	120,600	120,659	121,000 (24,200) [5,808] {2,904}	121,318 (24,264) [5,823] {2,912}	121,633 (24,327) [5,838] {2,919}
Butler	43,387	43,440	43,526	43,551	43,665 (8,733) [2,096] {1,048}	43,766 (8,753) [2,101] {1,050}	43,860 (8,772) [2,105] {1,053}
Chester	88,909	89,022	89,152	89,213	89,457 (17,891) [4,294] {2,147}	89,689 (17,938) [4,305] {2,153}	89,895 (17,979) [4,315] {2,157}
Delaware	107,637	107,763	107,890	107,946	108,205 (21,641) [5,194] {2,597}	108,436 (21,687) [5,205] {2,602}	108,666 (21,733) [5,216] {2,608}
Lackawanna	41,787	41,874	42,018	42,064	42,245 (8,449) [2,028] {1,014}	42,414 (8,483) [2,036] {1,018}	42,578 (8,516) [2,044] {1,022}
Lancaster	118,545	118,722	118,889	118,976	119,319 (23,864) [5,727] {2,864}	119,649 (23,930) [5,743] {2,872}	119,967 (23,993) [5,758] {2,879}
Lehigh	88,000	88,101	88,195	88,227	88,384 (17,677) [4,242] {2,121}	88,531 (17,706) [4,249] {2,125}	88,663 (17,733) [4,256] {2,128}
Luzerne	71,504	71,605	71,739	71,803	71,999 (14,400) [3,456] {1,728}	72,176 (14,435) [3,464] {1,732}	72,341 (14,468) [3,472] {1,736}
Monroe	36,195	36,262	36,315	36,348	36,438 (7,288) [1,749] {875}	36,522 (7,304) [1,753] {877}	36,599 (7,320) [1,757] {878}
Montgomery	147,550	147,715	147,932	148,017	148,447 (29,689) [7,125] {3,563}	148,811 (29,762) [7,143] {3,571}	149,185 (29,837) [7,161] {3,580}
Northampton	77,993	78,062	78,160	78,193	78,354 (15,671) [3,761] {1,880}	78,493 (15,699) [3,768] {1,884}	78,634 (15,727) [3,774] {1,887}
Philadelphia	299,963	300,509	300,817	301,219	301,755 (60,351) [14,484] {7,242}	302,243 (60,449) [14,508] {7,254}	302,688 (60,538) [14,529] {7,265}
Westmoreland	77,462	77,589	77,791	77,875	78,104 (15,621) [3,749] {1,875}	78,308 (15,662) [3,759] {1,879}	78,497 (15,699) [3,768] {1,884}
York	116,070	116,225	116,425	116,532	116,814 (23,363) [5,607] {2,804}	117,067 (23,413) [5,619] {2,810}	117,303 (23,461) [5,631] {2,815}

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.