IEM's AI Modeling: Short-term COVID-19 Projections

Date: 12/22/20

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 not 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 12/22/20 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.

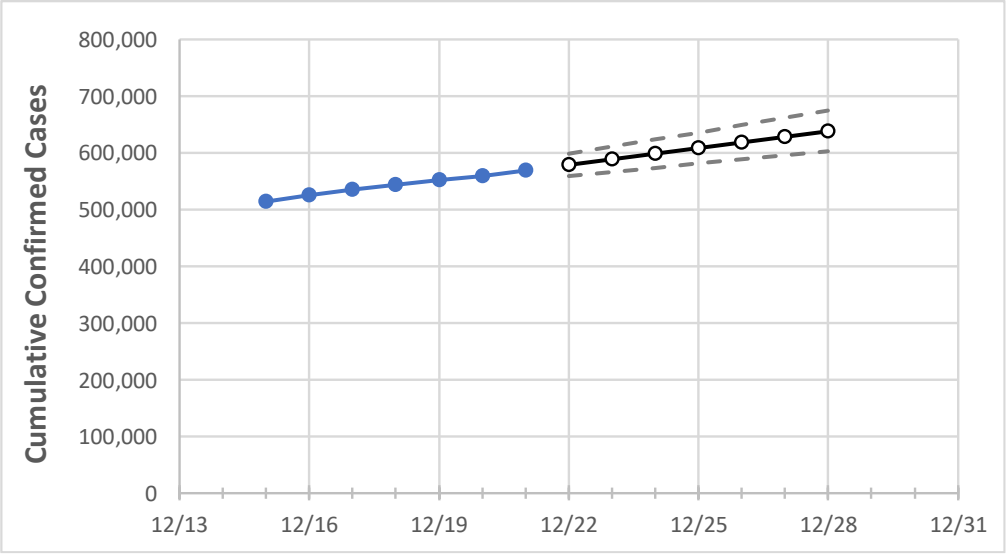
IEM's Modeling Lead

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:						
	12/18	12/19	12/20	12/21	12/22	12/23	12/24	12/25	12/26	12/27	12/28
Pennsylvania	544,116	552,895	559,256	569,099	578,966	588,856	598,768	608,701	618,655	628,626	638,615

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:						
	12/18	12/19	12/20	12/21	12/22	12/23	12/24	12/25	12/26	12/27	12/28
Allegheny	44,684	45,699	46,330	47,111	48,064	49,022	49,985	50,953	51,925	52,901	53,883
Berks	19,698	19,988	20,259	20,546	20,868	21,191	21,514	21,838	22,163	22,489	22,816
Bucks	26,036	26,387	26,706	27,009	27,389	27,764	28,135	28,501	28,863	29,220	29,573
Butler	7,352	7,577	7,709	7,853	8,044	8,239	8,438	8,640	8,845	9,055	9,268
Chester	17,052	17,263	17,474	17,685	17,953	18,223	18,493	18,765	19,037	19,310	19,584
Delaware	25,757	26,061	26,299	26,639	26,936	27,232	27,529	27,826	28,123	28,420	28,717
Lackawanna	7,125	7,286	7,386	7,499	7,634	7,771	7,912	8,055	8,202	8,351	8,504
Lancaster	23,951	24,293	24,613	24,899	25,270	25,639	26,007	26,373	26,737	27,099	27,460
Lehigh	16,758	17,000	17,286	17,668	17,984	18,302	18,623	18,946	19,271	19,599	19,928
Luzerne	14,716	14,983	15,135	15,340	15,639	15,942	16,250	16,563	16,881	17,204	17,532
Monroe	5,068	5,125	5,206	5,293	5,375	5,457	5,538	5,619	5,700	5,781	5,861
Montgomery	30,755	31,092	31,421	31,711	32,139	32,565	32,989	33,410	33,828	34,243	34,656
Northampton	13,642	13,855	14,123	14,443	14,718	14,995	15,275	15,557	15,842	16,129	16,418
Philadelphia	85,733	86,287	86,841	87,395	88,103	88,795	89,471	90,133	90,779	91,411	92,029
Westmoreland	15,793	16,203	16,416	16,777	17,195	17,619	18,051	18,489	18,934	19,386	19,844
York	19,039	19,439	19,760	20,128	20,574	21,026	21,483	21,945	22,412	22,884	23,361

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:		
	12/18	12/19	12/20	12/21	12/23	12/25	12/27
Allegheny	44,684	45,699	46,330	47,111	49,022 (9,804) [2,353] {1,177}	50,953 (10,191) [2,446] {1,223}	52,901 (10,580) [2,539] {1,270}
Berks	19,698	19,988	20,259	20,546	21,191 (4,238) [1,017] {509}	21,838 (4,368) [1,048] {524}	22,489 (4,498) [1,079] {540}
Bucks	26,036	26,387	26,706	27,009	27,764 (5,553) [1,333] {666}	28,501 (5,700) [1,368] {684}	29,220 (5,844) [1,403] {701}
Butler	7,352	7,577	7,709	7,853	8,239 (1,648) [395] {198}	8,640 (1,728) [415] {207}	9,055 (1,811) [435] {217}
Chester	17,052	17,263	17,474	17,685	18,223 (3,645) [875] {437}	18,765 (3,753) [901] {450}	19,310 (3,862) [927] {463}
Delaware	25,757	26,061	26,299	26,639	27,232 (5,446) [1,307] {654}	27,826 (5,565) [1,336] {668}	28,420 (5,684) [1,364] {682}
Lackawanna	7,125	7,286	7,386	7,499	7,771 (1,554) [373] {187}	8,055 (1,611) [387] {193}	8,351 (1,670) [401] {200}
Lancaster	23,951	24,293	24,613	24,899	25,639 (5,128) [1,231] {615}	26,373 (5,275) [1,266] {633}	27,099 (5,420) [1,301] {650}
Lehigh	16,758	17,000	17,286	17,668	18,302 (3,660) [879] {439}	18,946 (3,789) [909] {455}	19,599 (3,920) [941] {470}
Luzerne	14,716	14,983	15,135	15,340	15,942 (3,188) [765] {383}	16,563 (3,313) [795] {398}	17,204 (3,441) [826] {413}
Monroe	5,068	5,125	5,206	5,293	5,457 (1,091) [262] {131}	5,619 (1,124) [270] {135}	5,781 (1,156) [277] {139}
Montgomery	30,755	31,092	31,421	31,711	32,565 (6,513) [1,563] {782}	33,410 (6,682) [1,604] {802}	34,243 (6,849) [1,644] {822}
Northampton	13,642	13,855	14,123	14,443	14,995 (2,999) [720] {360}	15,557 (3,111) [747] {373}	16,129 (3,226) [774] {387}
Philadelphia	85,733	86,287	86,841	87,395	88,795 (17,759) [4,262] {2,131}	90,133 (18,027) [4,326] {2,163}	91,411 (18,282) [4,388] {2,194}
Westmoreland	15,793	16,203	16,416	16,777	17,619 (3,524) [846] {423}	18,489 (3,698) [887] {444}	19,386 (3,877) [931] {465}
York	19,039	19,439	19,760	20,128	21,026 (4,205) [1,009] {505}	21,945 (4,389) [1,053] {527}	22,884 (4,577) [1,098] {549}

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.