IEM's AI Modeling: Short-term COVID-19 Projections
Date: 8/4/21

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 8/4/21 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
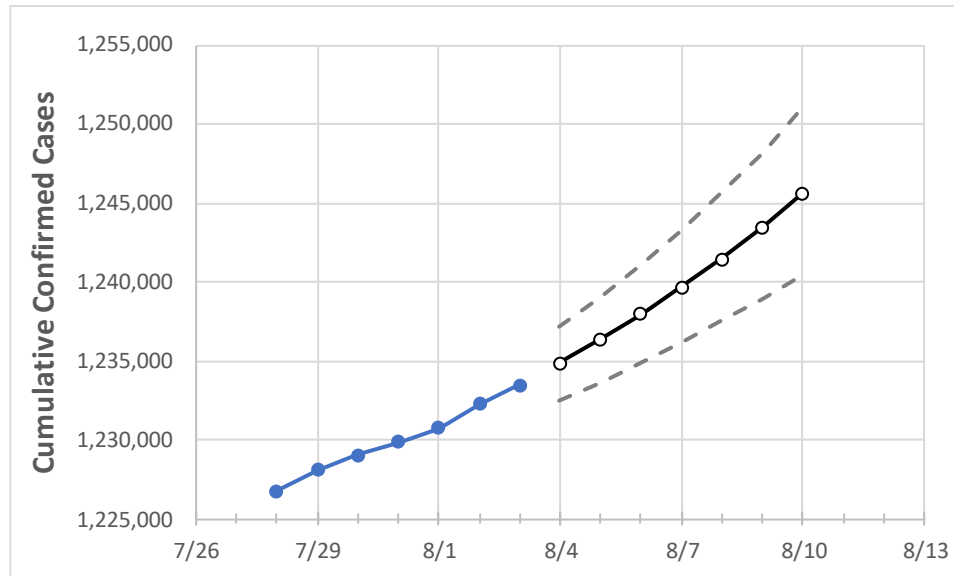
	Actual Confirmed Cases On:				Projected Cases For:						
	7/31	8/1	8/2	8/3	8/4	8/5	8/6	8/7	8/8	8/9	8/10
Pennsylvania	1,229,872	1,230,742	1,232,238	1,233,461	1,234,848	1,236,345	1,237,942	1,239,633	1,241,463	1,243,451	1,245,626

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:						
	7/31	8/1	8/2	8/3	8/4	8/5	8/6	8/7	8/8	8/9	8/10
Allegheny	103,173	103,287	103,378	103,529	103,677	103,837	104,013	104,208	104,416	104,645	104,894
Berks	48,841	48,867	48,894	48,927	48,961	48,998	49,037	49,078	49,121	49,168	49,217
Bucks	61,577	61,637	61,687	61,757	61,829	61,904	61,986	62,073	62,165	62,264	62,368
Butler	17,803	17,818	17,834	17,845	17,863	17,881	17,902	17,923	17,947	17,972	17,999
Chester	41,295	41,337	41,380	41,423	41,475	41,531	41,592	41,656	41,727	41,803	41,883
Delaware	52,998	53,038	53,092	53,162	53,231	53,306	53,388	53,476	53,571	53,673	53,783
Lackawanna	18,727	18,739	18,748	18,768	18,781	18,794	18,808	18,823	18,838	18,855	18,872
Lancaster	55,976	56,031	56,081	56,138	56,206	56,281	56,363	56,451	56,548	56,655	56,770
Lehigh	40,277	40,301	40,332	40,379	40,417	40,458	40,501	40,548	40,596	40,649	40,705
Luzerne	32,446	32,476	32,502	32,536	32,574	32,614	32,658	32,705	32,756	32,810	32,869
Monroe	15,085	15,101	15,120	15,161	15,188	15,218	15,250	15,284	15,321	15,361	15,405
Montgomery	71,416	71,506	71,588	71,657	71,761	71,871	71,987	72,113	72,248	72,393	72,547
Northampton	36,371	36,413	36,459	36,535	36,599	36,670	36,748	36,835	36,929	37,033	37,146
Philadelphia	156,981	157,128	157,274	157,274	157,463	157,660	157,871	158,097	158,334	158,584	158,849
Westmoreland	34,739	34,765	34,794	34,825	34,857	34,892	34,929	34,970	35,013	35,059	35,110
York	47,506	47,537	47,571	47,615	47,656	47,700	47,747	47,796	47,848	47,906	47,965

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:		
	7/31	8/1	8/2	8/3	8/5	8/7	8/9
Allegheny	103,173	103,287	103,378	103,529	103,837 (20,767) [4,984] {2,492}	104,208 (20,842) [5,002] {2,501}	104,645 (20,929) [5,023] {2,511}
Berks	48,841	48,867	48,894	48,927	48,998 (9,800) [2,352] {1,176}	49,078 (9,816) [2,356] {1,178}	49,168 (9,834) [2,360] {1,180}
Bucks	61,577	61,637	61,687	61,757	61,904 (12,381) [2,971] {1,486}	62,073 (12,415) [2,979] {1,490}	62,264 (12,453) [2,989] {1,494}
Butler	17,803	17,818	17,834	17,845	17,881 (3,576) [858] {429}	17,923 (3,585) [860] {430}	17,972 (3,594) [863] {431}
Chester	41,295	41,337	41,380	41,423	41,531 (8,306) [1,993] {997}	41,656 (8,331) [1,999] {1,000}	41,803 (8,361) [2,007] {1,003}
Delaware	52,998	53,038	53,092	53,162	53,306 (10,661) [2,559] {1,279}	53,476 (10,695) [2,567] {1,283}	53,673 (10,735) [2,576] {1,288}
Lackawanna	18,727	18,739	18,748	18,768	18,794 (3,759) [902] {451}	18,823 (3,765) [903] {452}	18,855 (3,771) [905] {453}
Lancaster	55,976	56,031	56,081	56,138	56,281 (11,256) [2,701] {1,351}	56,451 (11,290) [2,710] {1,355}	56,655 (11,331) [2,719] {1,360}
Lehigh	40,277	40,301	40,332	40,379	40,458 (8,092) [1,942] {971}	40,548 (8,110) [1,946] {973}	40,649 (8,130) [1,951] {976}
Luzerne	32,446	32,476	32,502	32,536	32,614 (6,523) [1,565] {783}	32,705 (6,541) [1,570] {785}	32,810 (6,562) [1,575] {787}
Monroe	15,085	15,101	15,120	15,161	15,218 (3,044) [730] {365}	15,284 (3,057) [734] {367}	15,361 (3,072) [737] {369}
Montgomery	71,416	71,506	71,588	71,657	71,871 (14,374) [3,450] {1,725}	72,113 (14,423) [3,461] {1,731}	72,393 (14,479) [3,475] {1,737}
Northampton	36,371	36,413	36,459	36,535	36,670 (7,334) [1,760] {880}	36,835 (7,367) [1,768] {884}	37,033 (7,407) [1,778] {889}
Philadelphia	156,981	157,128	157,274	157,274	157,660 (31,532) [7,568] {3,784}	158,097 (31,619) [7,589] {3,794}	158,584 (31,717) [7,612] {3,806}
Westmoreland	34,739	34,765	34,794	34,825	34,892 (6,978) [1,675] {837}	34,970 (6,994) [1,679] {839}	35,059 (7,012) [1,683] {841}
York	47,506	47,537	47,571	47,615	47,700 (9,540) [2,290] {1,145}	47,796 (9,559) [2,294] {1,147}	47,906 (9,581) [2,299] {1,150}

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.