IEM's AI Modeling: Short-term COVID-19 Projections
Date: 9/17/21

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 9/17/21 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
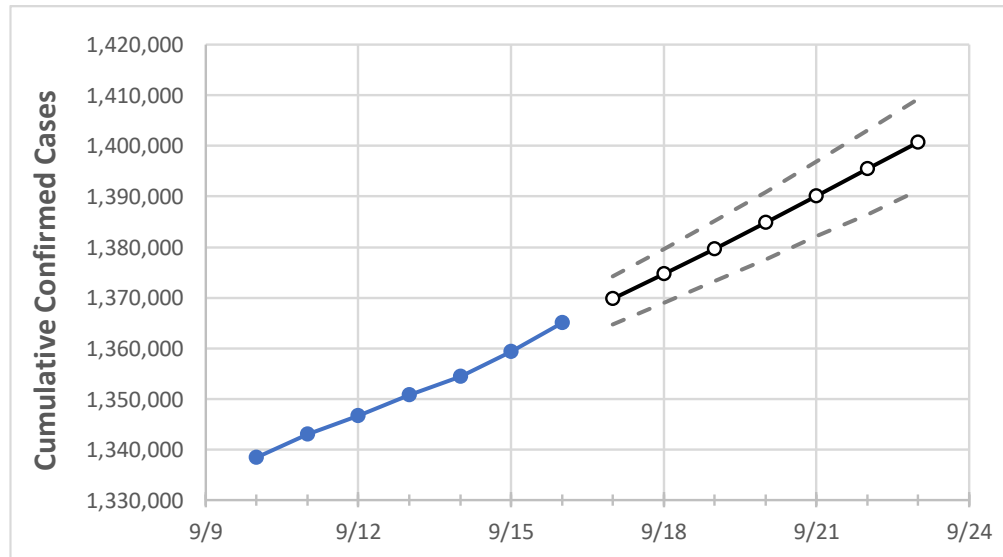
	Actual Confirmed Cases On:				Projected Cases For:						
	9/13	9/14	9/15	9/16	9/17	9/18	9/19	9/20	9/21	9/22	9/23
Pennsylvania	1,350,719	1,354,451	1,359,263	1,365,049	1,369,811	1,374,744	1,379,663	1,384,820	1,390,033	1,395,387	1,400,765

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:						
	9/13	9/14	9/15	9/16	9/17	9/18	9/19	9/20	9/21	9/22	9/23
Allegheny	114,110	114,358	114,775	115,349	115,749	116,167	116,575	116,998	117,426	117,878	118,306
Berks	52,464	52,578	52,687	52,829	52,954	53,079	53,206	53,333	53,462	53,593	53,727
Bucks	66,642	66,759	66,903	67,082	67,222	67,361	67,502	67,643	67,785	67,930	68,072
Butler	20,402	20,467	20,579	20,738	20,867	21,005	21,142	21,288	21,432	21,581	21,738
Chester	45,384	45,499	45,659	45,804	45,946	46,091	46,236	46,387	46,537	46,690	46,848
Delaware	57,349	57,430	57,551	57,698	57,814	57,932	58,045	58,165	58,275	58,391	58,509
Lackawanna	20,094	20,145	20,208	20,264	20,321	20,377	20,436	20,495	20,556	20,618	20,682
Lancaster	61,919	62,128	62,306	62,566	62,786	63,008	63,231	63,461	63,689	63,927	64,167
Lehigh	44,154	44,257	44,383	44,512	44,634	44,754	44,874	45,001	45,121	45,251	45,372
Luzerne	35,162	35,263	35,402	35,514	35,627	35,742	35,861	35,983	36,105	36,233	36,364
Monroe	16,999	17,062	17,129	17,224	17,307	17,394	17,480	17,571	17,660	17,759	17,853
Montgomery	77,812	77,947	78,184	78,351	78,523	78,697	78,873	79,050	79,230	79,410	79,583
Northampton	40,223	40,326	40,452	40,580	40,707	40,840	40,974	41,105	41,240	41,382	41,520
Philadelphia	169,382	169,565	169,984	170,332	170,593	170,857	171,127	171,386	171,658	171,923	172,173
Westmoreland	38,211	38,280	38,466	38,683	38,829	38,980	39,134	39,290	39,457	39,620	39,788
York	52,753	52,906	53,062	53,323	53,531	53,742	53,957	54,174	54,400	54,629	54,860

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:		
	9/13	9/14	9/15	9/16	9/18	9/20	9/22
Allegheny	114,110	114,358	114,775	115,349	116,167 (23,233) [5,576] {2,788}	116,998 (23,400) [5,616] {2,808}	117,878 (23,576) [5,658] {2,829}
Berks	52,464	52,578	52,687	52,829	53,079 (10,616) [2,548] {1,274}	53,333 (10,667) [2,560] {1,280}	53,593 (10,719) [2,572] {1,286}
Bucks	66,642	66,759	66,903	67,082	67,361 (13,472) [3,233] {1,617}	67,643 (13,529) [3,247] {1,623}	67,930 (13,586) [3,261] {1,630}
Butler	20,402	20,467	20,579	20,738	21,005 (4,201) [1,008] {504}	21,288 (4,258) [1,022] {511}	21,581 (4,316) [1,036] {518}
Chester	45,384	45,499	45,659	45,804	46,091 (9,218) [2,212] {1,106}	46,387 (9,277) [2,227] {1,113}	46,690 (9,338) [2,241] {1,121}
Delaware	57,349	57,430	57,551	57,698	57,932 (11,586) [2,781] {1,390}	58,165 (11,633) [2,792] {1,396}	58,391 (11,678) [2,803] {1,401}
Lackawanna	20,094	20,145	20,208	20,264	20,377 (4,075) [978] {489}	20,495 (4,099) [984] {492}	20,618 (4,124) [990] {495}
Lancaster	61,919	62,128	62,306	62,566	63,008 (12,602) [3,024] {1,512}	63,461 (12,692) [3,046] {1,523}	63,927 (12,785) [3,068] {1,534}
Lehigh	44,154	44,257	44,383	44,512	44,754 (8,951) [2,148] {1,074}	45,001 (9,000) [2,160] {1,080}	45,251 (9,050) [2,172] {1,086}
Luzerne	35,162	35,263	35,402	35,514	35,742 (7,148) [1,716] {858}	35,983 (7,197) [1,727] {864}	36,233 (7,247) [1,739] {870}
Monroe	16,999	17,062	17,129	17,224	17,394 (3,479) [835] {417}	17,571 (3,514) [843] {422}	17,759 (3,552) [852] {426}
Montgomery	77,812	77,947	78,184	78,351	78,697 (15,739) [3,777] {1,889}	79,050 (15,810) [3,794] {1,897}	79,410 (15,882) [3,812] {1,906}
Northampton	40,223	40,326	40,452	40,580	40,840 (8,168) [1,960] {980}	41,105 (8,221) [1,973] {987}	41,382 (8,276) [1,986] {993}
Philadelphia	169,382	169,565	169,984	170,332	170,857 (34,171) [8,201] {4,101}	171,386 (34,277) [8,227] {4,113}	171,923 (34,385) [8,252] {4,126}
Westmoreland	38,211	38,280	38,466	38,683	38,980 (7,796) [1,871] {936}	39,290 (7,858) [1,886] {943}	39,620 (7,924) [1,902] {951}
York	52,753	52,906	53,062	53,323	53,742 (10,748) [2,580] {1,290}	54,174 (10,835) [2,600] {1,300}	54,629 (10,926) [2,622] {1,311}

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.