Synopsis of Projections for the COVID-19 Pandemic

Models as of 4/8/2020

COVID-19 Projections Workgroup
Arizona State University
The University of Arizona

Facilitated by the Arizona Department of Health Services

Arizona-Specific COVID-19 Epidemic Projection Model

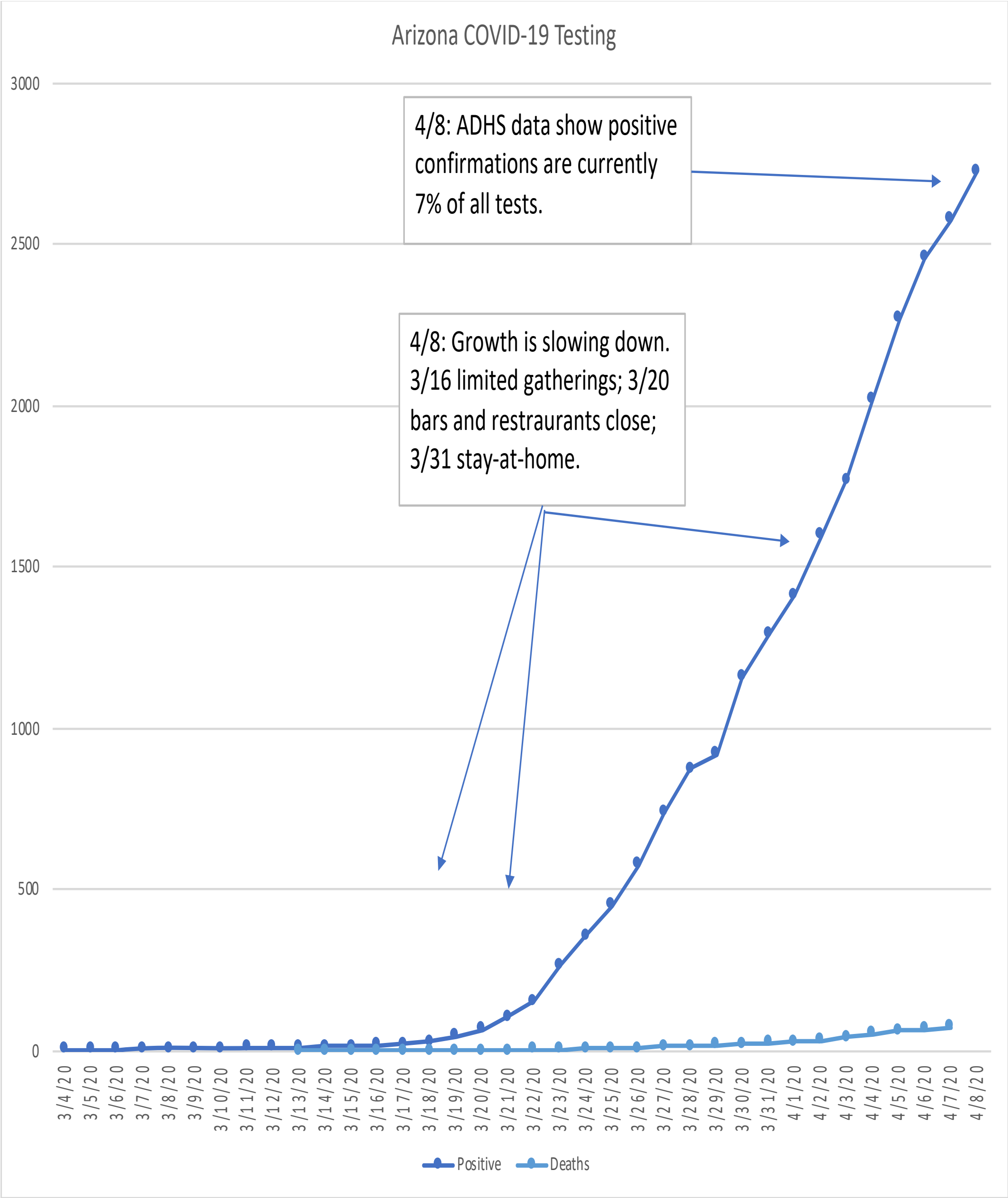
- Arizona-specific projections were deemed necessary because the Institute for Health Metrics and Evaluation (IHME) University of Washington model in common use was found to be often too optimistic in its projections and does not consider a variety of scenarios.
- Modeling and projections are highly complex, and require focused attention and effort by a team of experts over several weeks and potentially months.
- ADHS called upon partners at ASU and U of A with special previous experience doing projections and modeling, and who are working with CDC and the National Institutes of Health on COVID-19 response.

Key findings:

- Based on the latest data and considering multiple possible scenarios, this Arizona-specific model predicts infections will peak around the middle of May.
- This model is highly-sensitive to physical distancing and increased temperature.
- A wide range in outcomes is still feasible because of uncertainties in the number of undetected cases and the effectiveness of physical distancing.

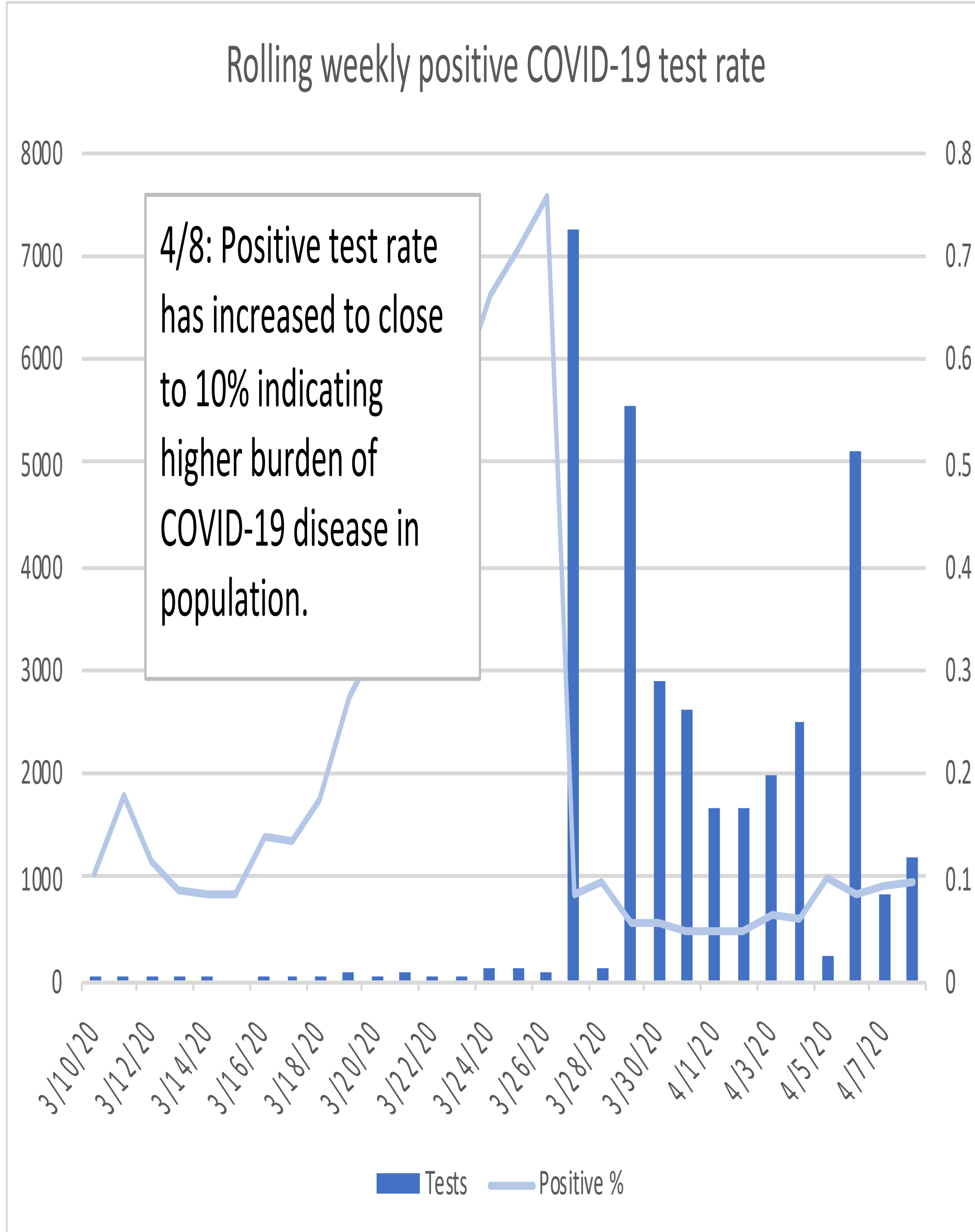
Epidemiology:

- Growth is rapid, but has slowed
- Doubling times
  - March 17-24: 1.7 days
  - March 25-April 8: 5.3 days
- Does not include undetected cases



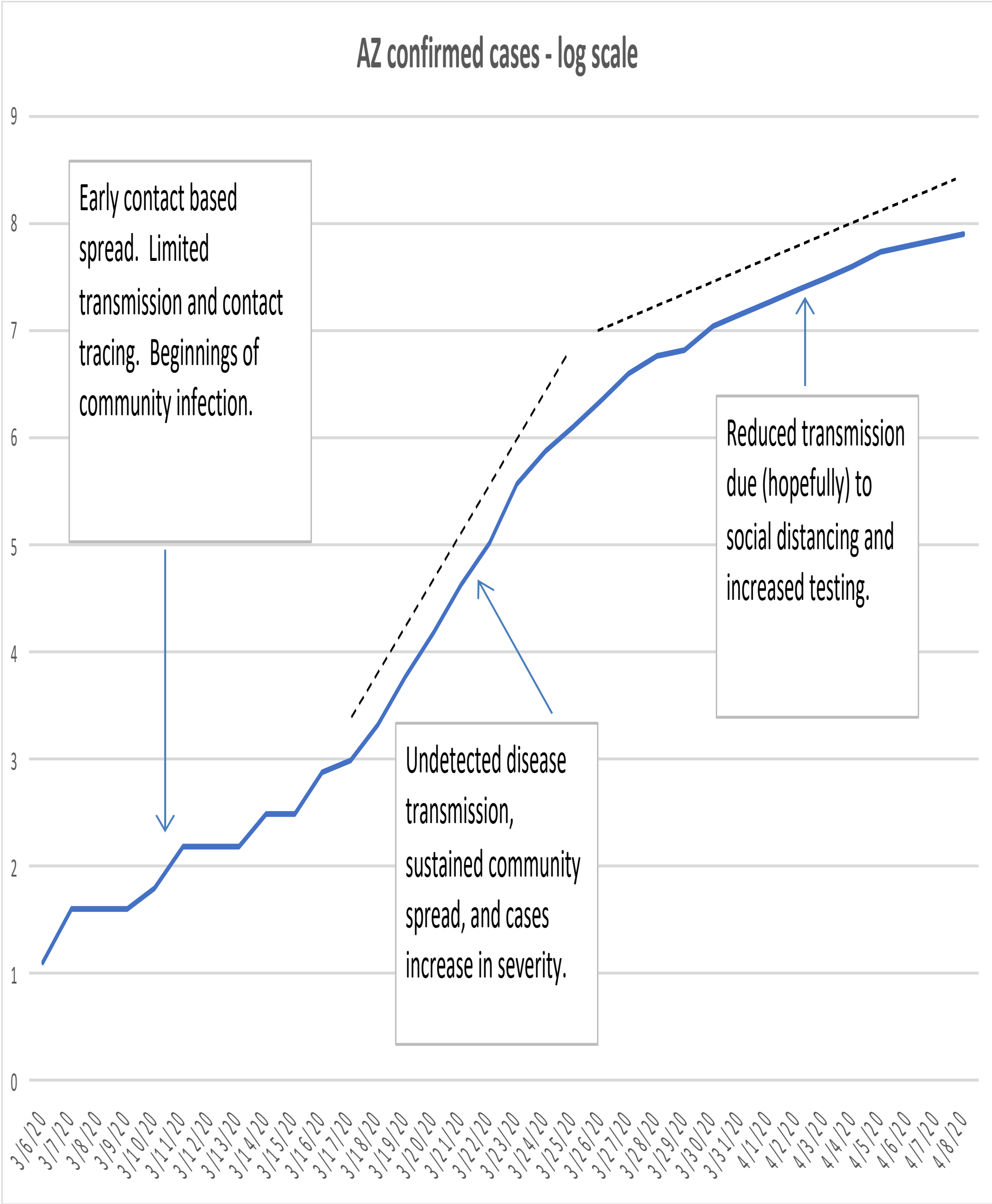
Testing:

- Information about negative tests results released March 27.
  - Positive test result drops to <10%.
- Range of 8%-10% is consistent with other US cities with community spread



Transmission

- Early stochastic effects
- Fast exponential growth
- Slowing growth



Assumptions & Parameters

Table 1: Estimated parameters for COVID-19 clinical progression, and literature sources

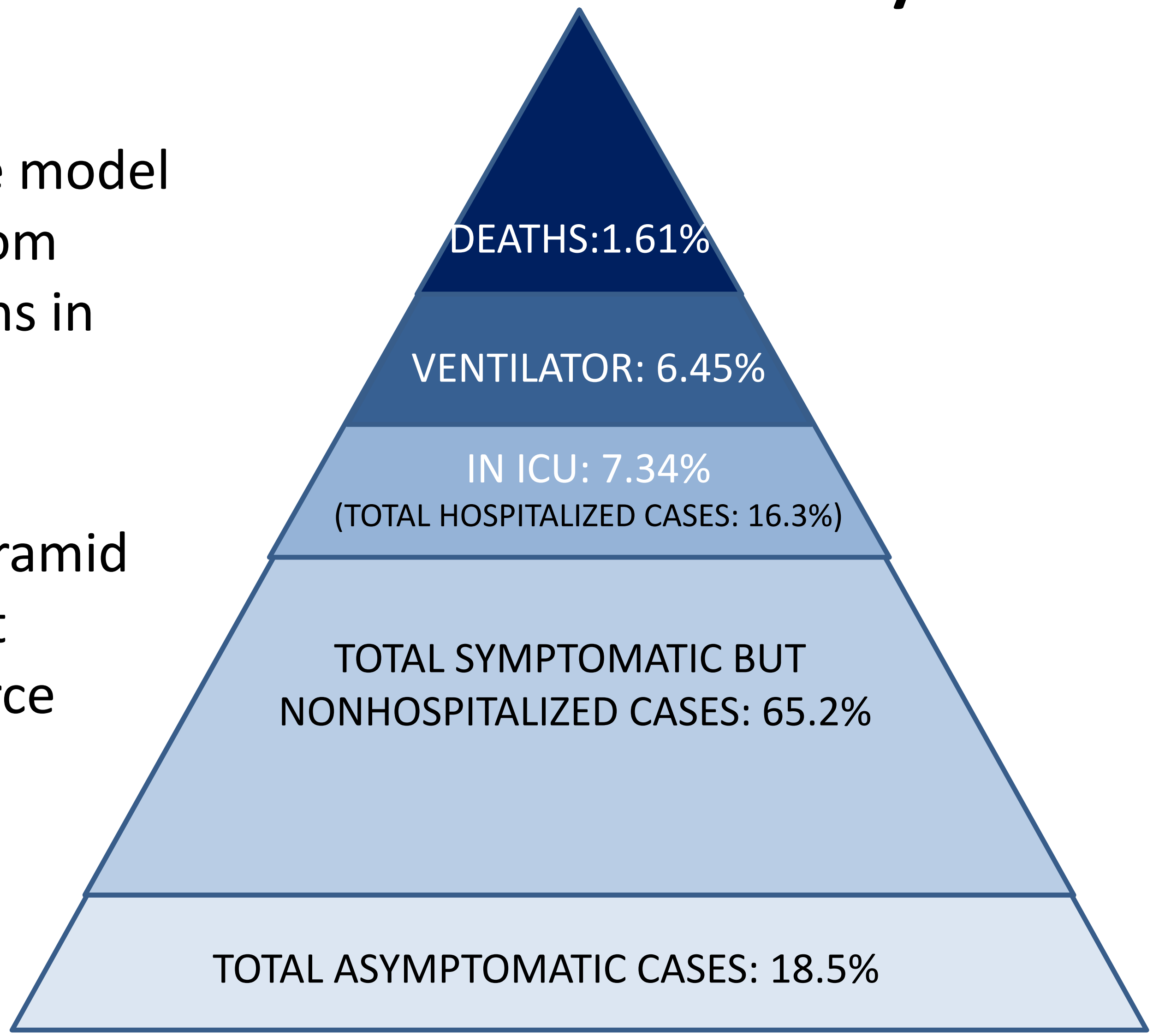
Quantity	Parameter	Value	Source
Incubation Period	$E+I_P$	4 days	Cai et al., 2020; Laio et al., 2020; Lauer et al., 2020;
Proportion of Asymptomatic Infections	*A*	18.5%	Mizumoto et al., 2020
Asymptomatic viral shedding		0.55	Li et al., 2020
Duration of mild/presymptomatic phase of infection	I_P	2 days	Wei et al., 2020
Infection rate for I_S and I_H cases		0.30	Pei & Shaman, 2020
Duration of LR symptoms before hospital admission	I_S	3 days	Zhou et al., 2020

Assumptions & Parameters

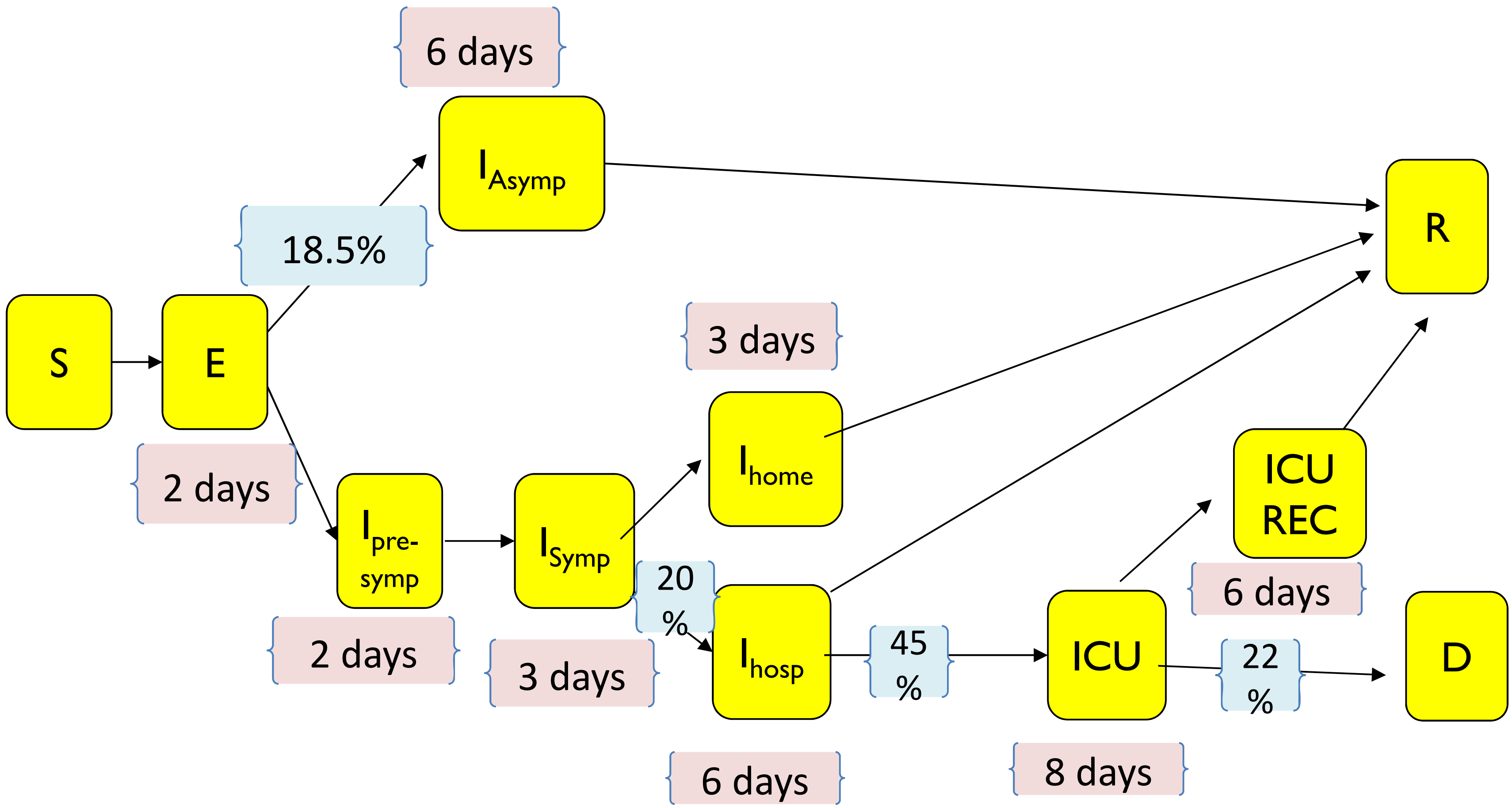
Quantity	Parameter	Value	Source
Duration of infection (Time from symptoms to hospitalization)	I_P+I_S	5 days	Tindale et al., 2020; Ferguson et al., 2020; Chen et al., 2020; Wang et al., 2020; Zhou et al., 2020
Hospitalization rate of Is cases	p_H	20%	Wu et al., 2020
Proportions of hospitalizations that go to the ICU	p_{ICU}	45%	Guan et al., 2020; Wu & McGoogan, 2020
Proportion of mild infections	$1-p_H$	80%	Wu et al., 2020; Yang et al., 2020
Duration of illness from symptom onset		23 days	Verity et al., 2020
Time from symptom onset to death		17 days	Verity et al., 2020; Wu et al. 2020
Case Fatality Rate		2%	Wu et al., 2020
Overall ICU Mortality	p_D	22%	Grasselli et al., 2020

Pyramid of Disease Severity

- The assumed parameters in the model are all sourced from recent publications in the literature
- The top of the pyramid implies significant healthcare resource requirements



Arizona COVID-19 Model

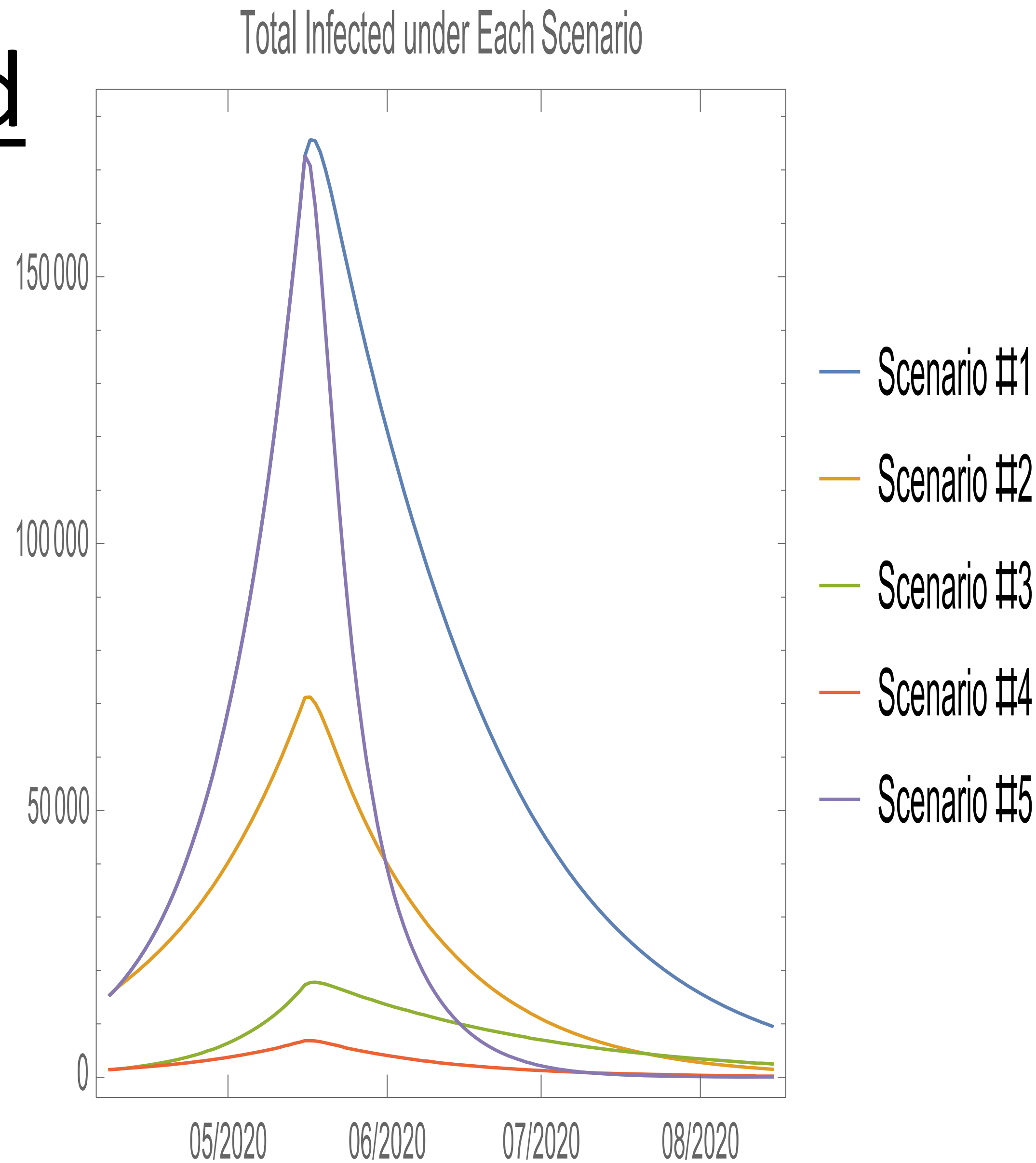


Scenarios:

Scenario	Description
Scenario 1.	Assumes all infections are known based on a reporting rate of 9% and ``moderate" influence of physical distancing. The estimate of unreported cases obtained by an estimate provided by Shaman et. al. 2020. Assumes no additional mitigation. Summer effect is modeled by reducing transmission efficiency by half from May 15.
Scenario 2.	Assumes a reporting rate of **9**% and ``maximal" influence of physical distancing. Assumes ongoing mitigation. Summer effect is modeled by reducing transmission efficiency by half from May 15.
Scenario 3.	Assumes that the current reported cases reflect the actual number of infected individuals as of 4/8/20 and moderate influence of physical distancing. Assumes no additional mitigation. Summer effect is modeled by reducing transmission efficiency by half from May 15.
Scenario 4.	Assumes that the current reported cases reflect the actual number of infected individuals as of 4/8/20 and maximal influence of physical distancing. Assumes no ongoing mitigation. Summer effect is modeled by reducing transmission efficiency by half on May 15.
Scenario 5.	Same as Scenario 1 with extreme summer-time reduction in transmission efficiency (heat or distancing); Assumes no additional mitigation for physical distancing.

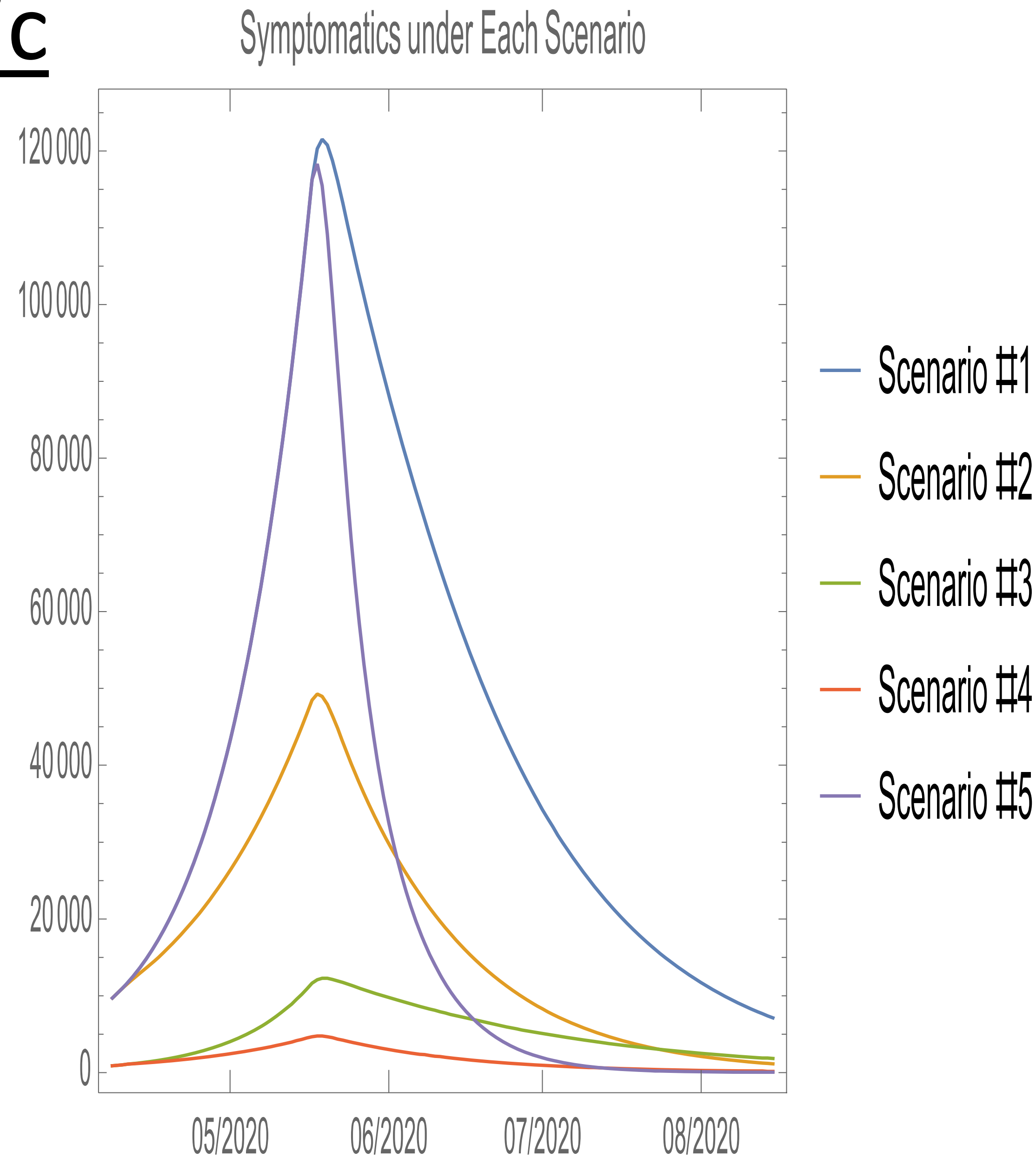
Total Infected

- Total infected includes asymptomatic and pre-symptomatic individuals, who may be transmitting the disease
- The sharp decline in Scenario #5 due to the reduction in transmission rate due to summer effect
  - Assumes May 15 for reduction in transmission
  - Summer effects not yet known



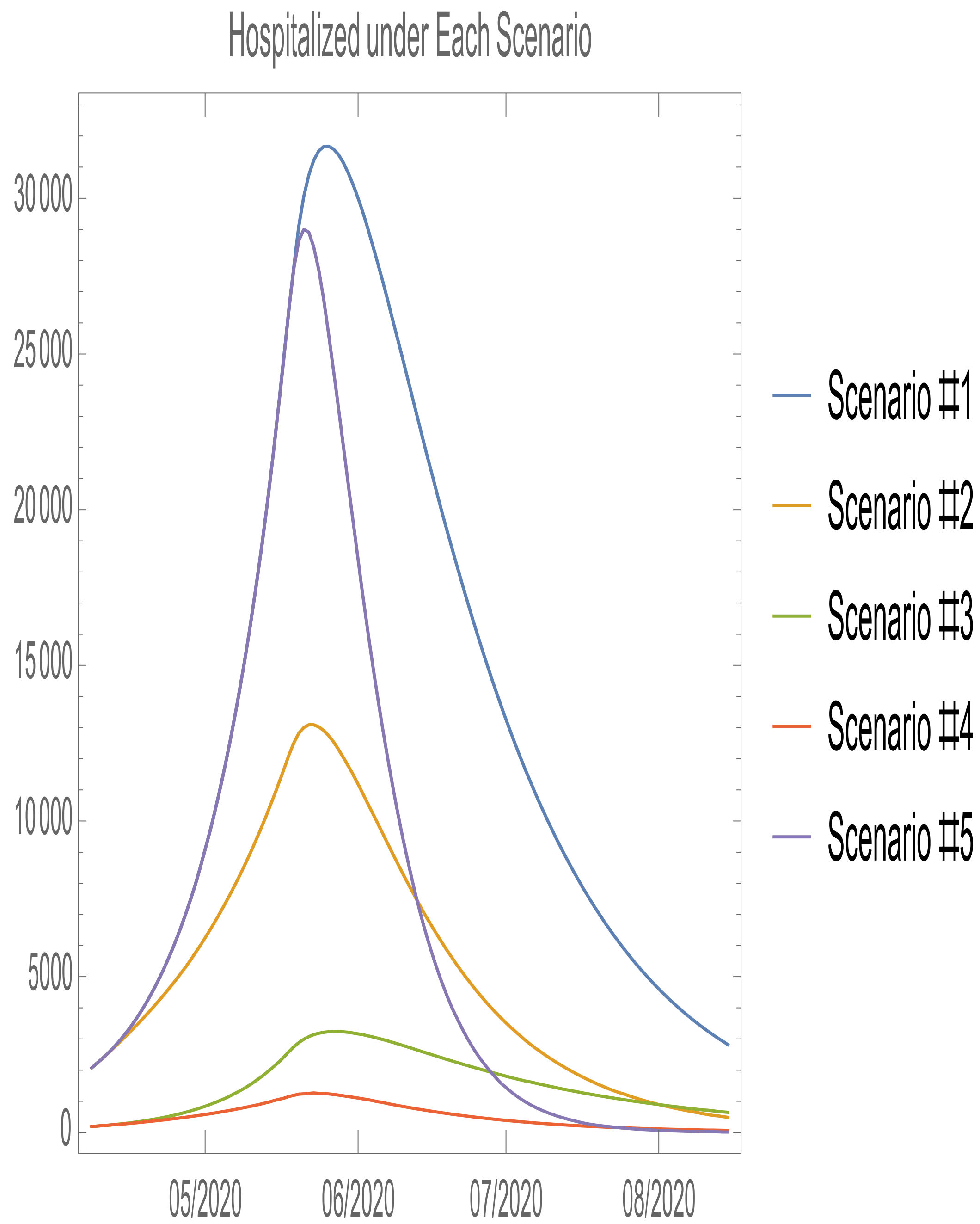
Symptomatic Infections

- A large number of the symptomatic infections will recover at home
  - Due to physical distancing measures, we assumed that these individuals will transmit the disease at a lower rate



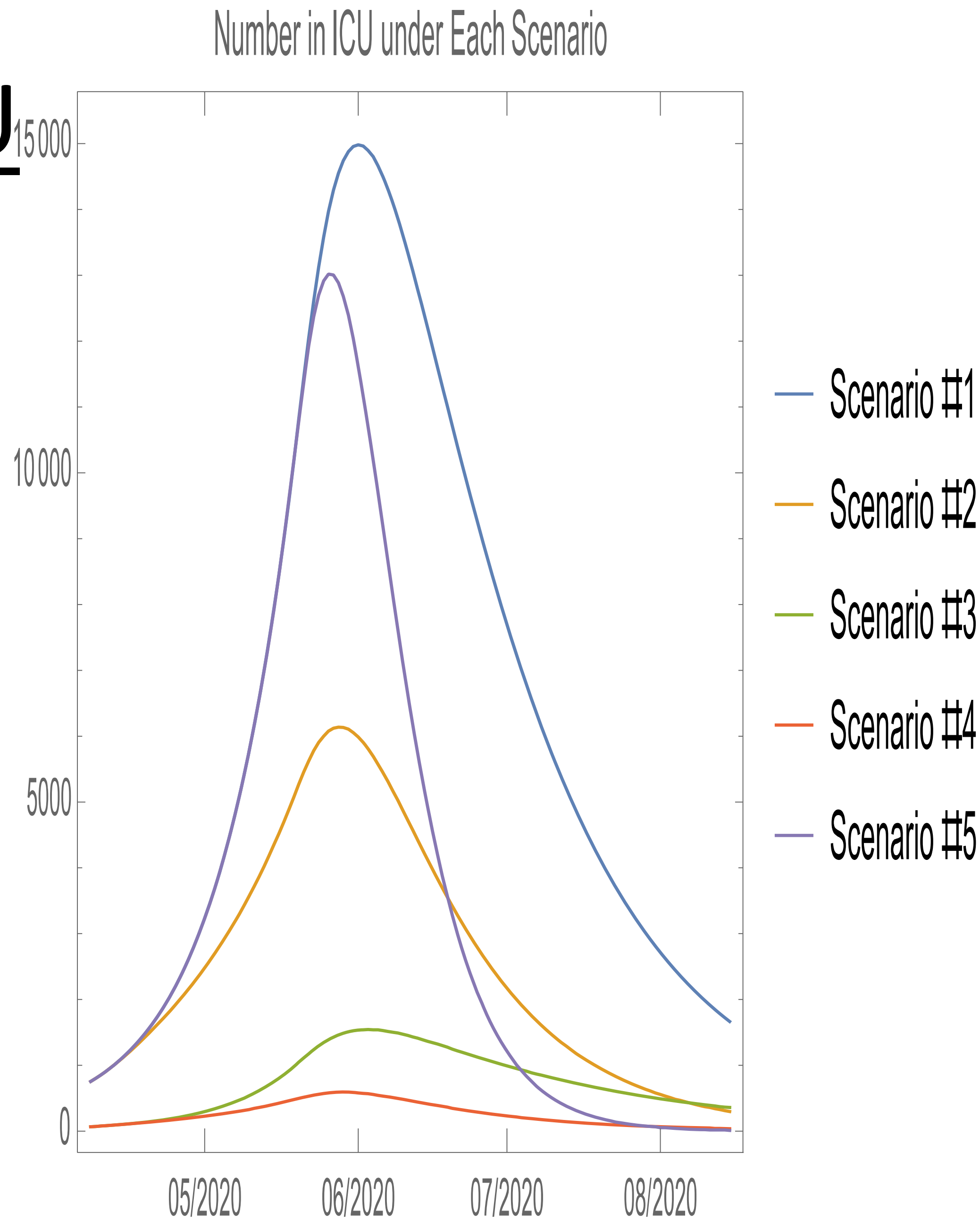
Hospitalized Infections

- A portion of the hospitalized infections are in ICU, which we track separately due to the significant resources required to care for ICU patients
- Under our mid-range scenario (Scenario #2), the number of hospitalized patients hit 13,091 on May 23
- Scenario #4 estimates a max of 1,258 patients on May 23, similar to IHME estimates of 1,203 on April 22



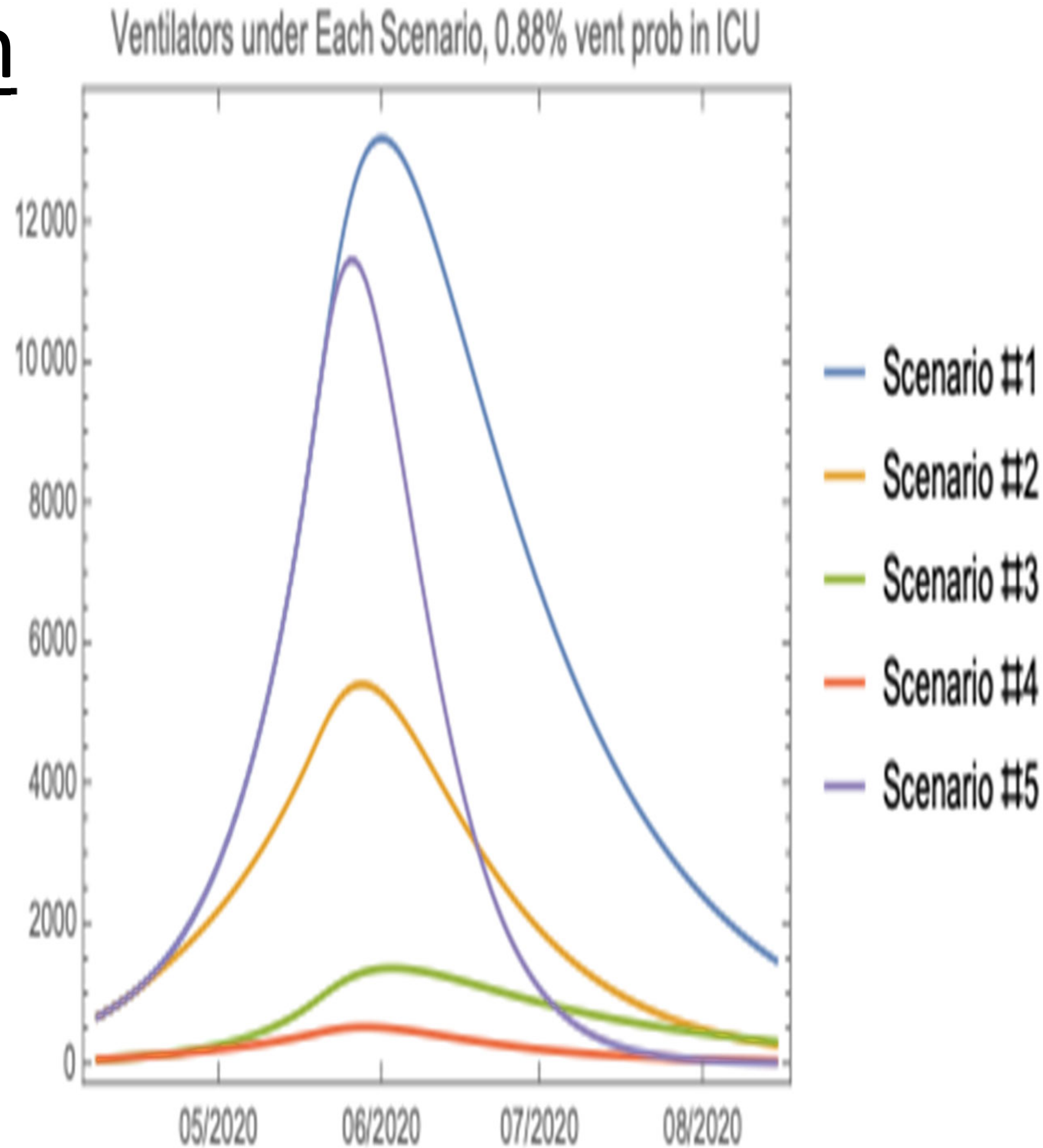
Patients in ICU

- ICU resources can be critical to save lives
- In particular, several sources have pointed to longer ICU stays by patients that eventually recover
- ICU stays can be as long as 14+ days for these patients



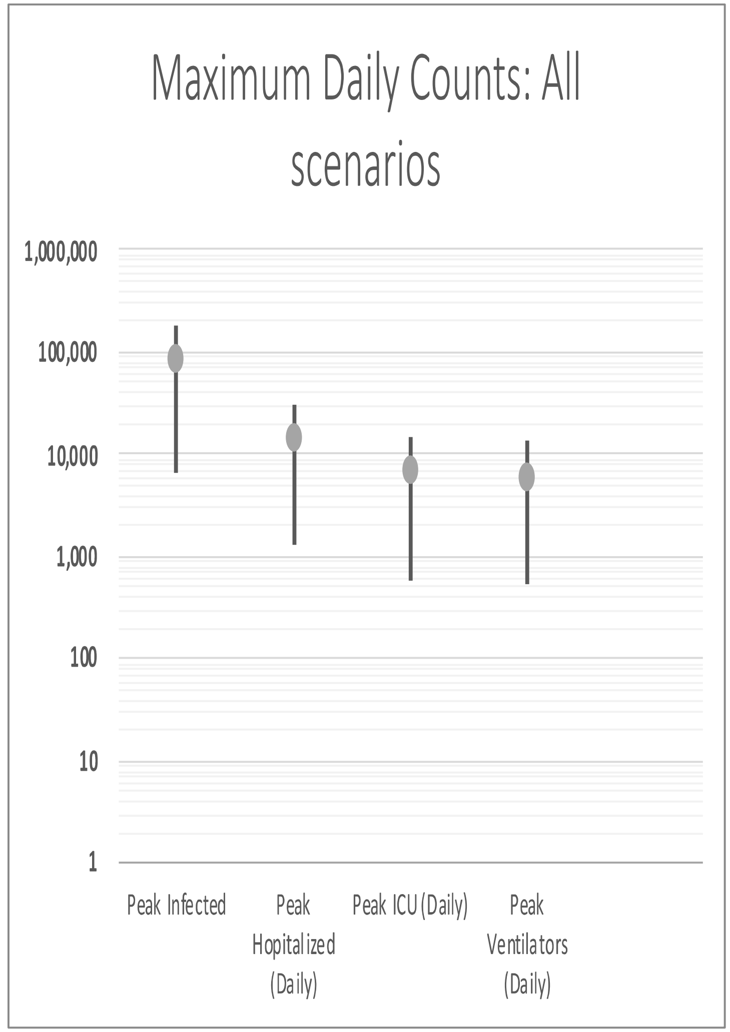
Patients on Ventilator

- A significant fraction of patients (~88%) need mechanical ventilators in ICU
- Rate of mortality among patients on mechanical ventilator is higher than other causes of Acute Respiratory Distress Syndrome (ARDS) (~67%)

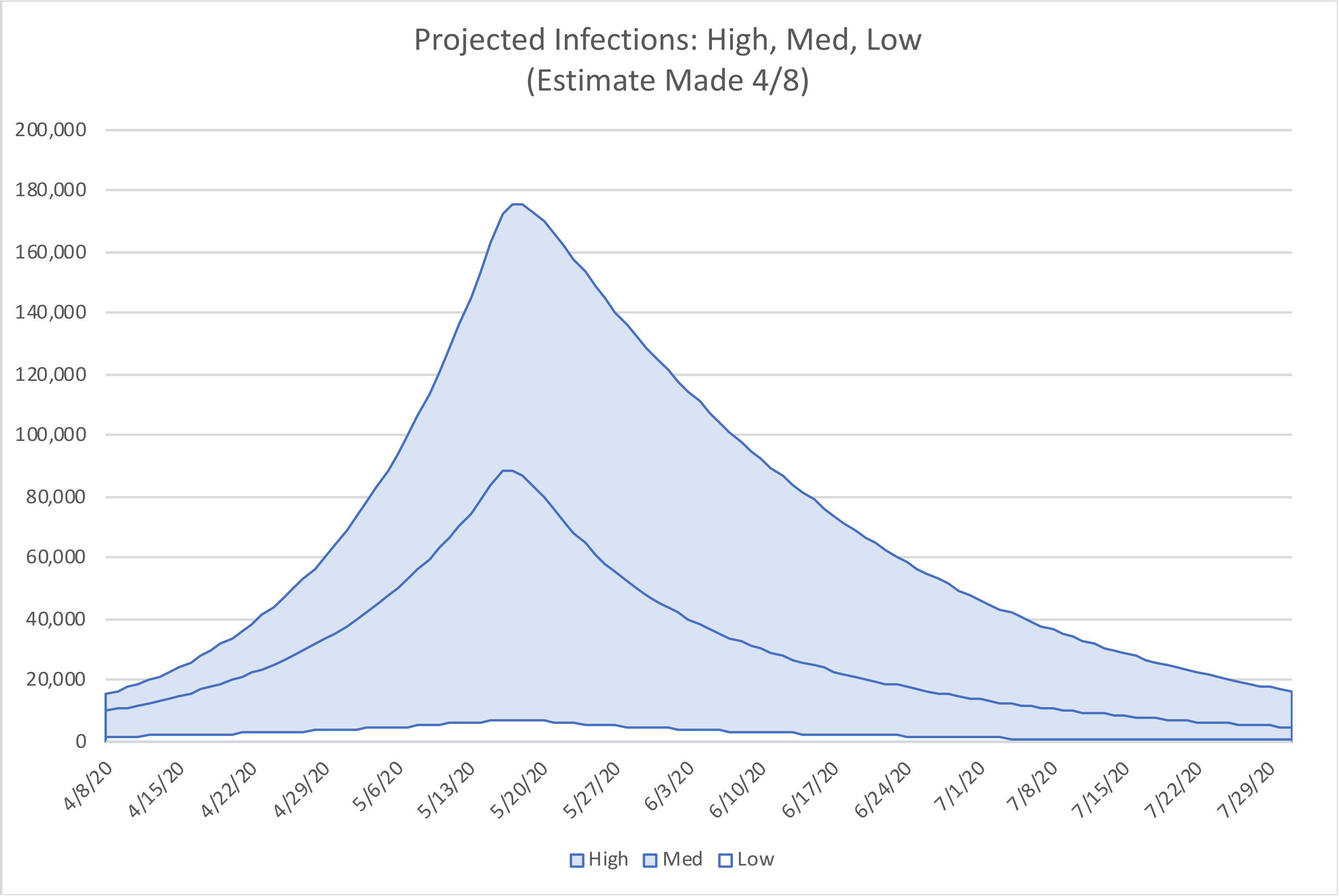


Maximum Daily Counts: All scenarios

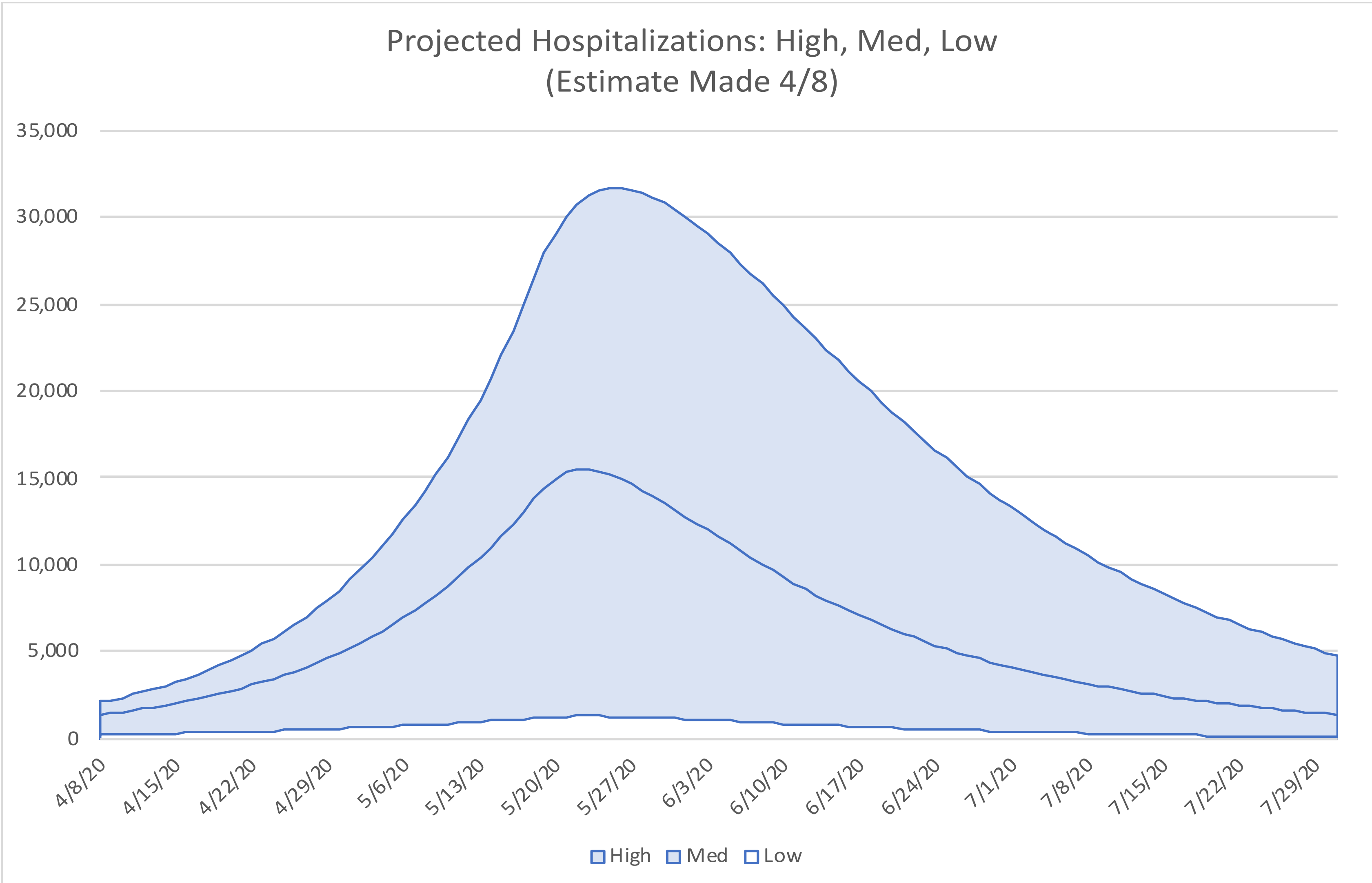
	Low	High	Mid
Peak Infected	6,875	175,695	88,466
Peak Hopitalized (Daily)	1,259	31,670	15,428
Peak ICU (Daily)	591	14,981	7,126
Peak Ventilators (Daily)	520	13,183	6,270



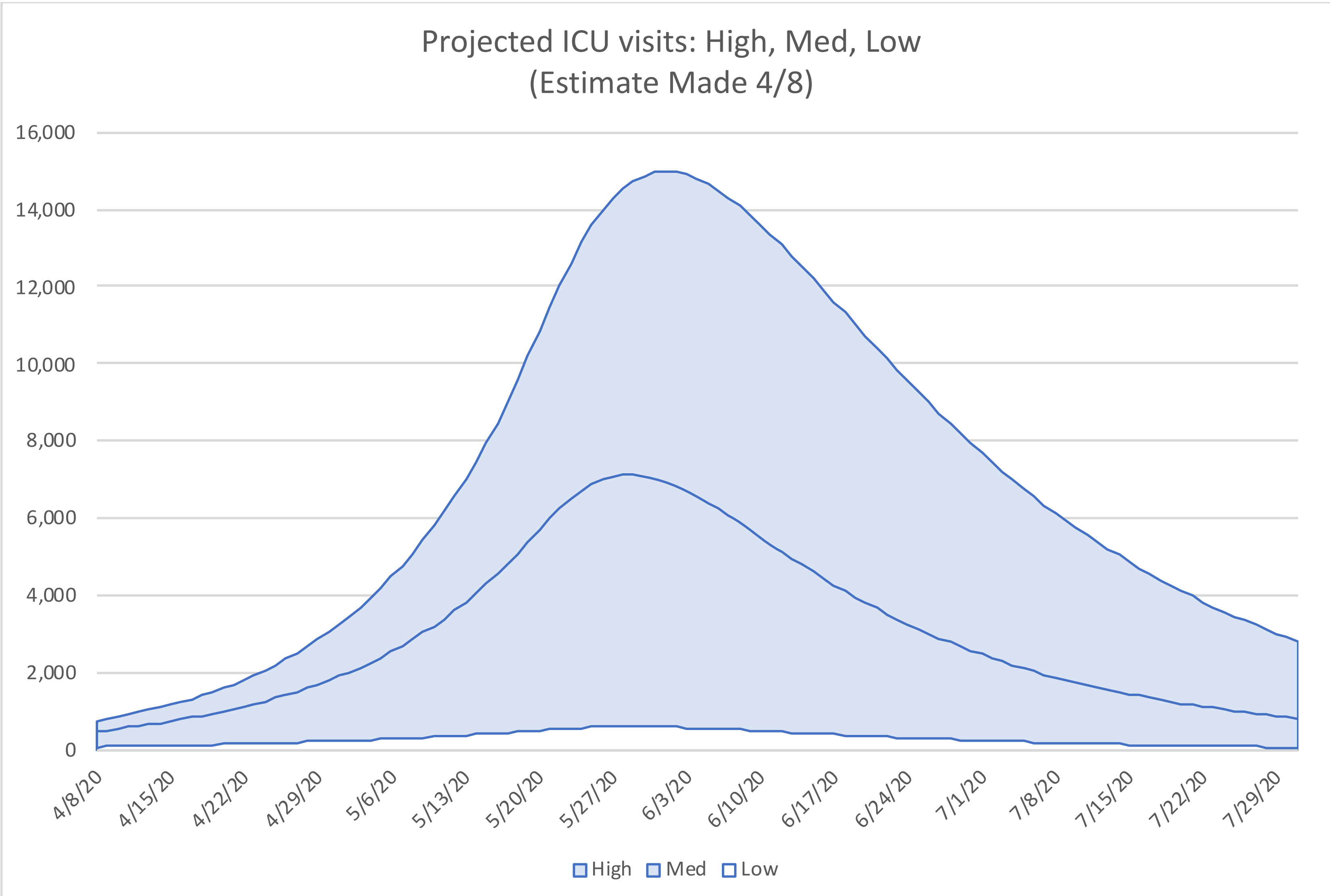
Projected Infections: Low, medium, high



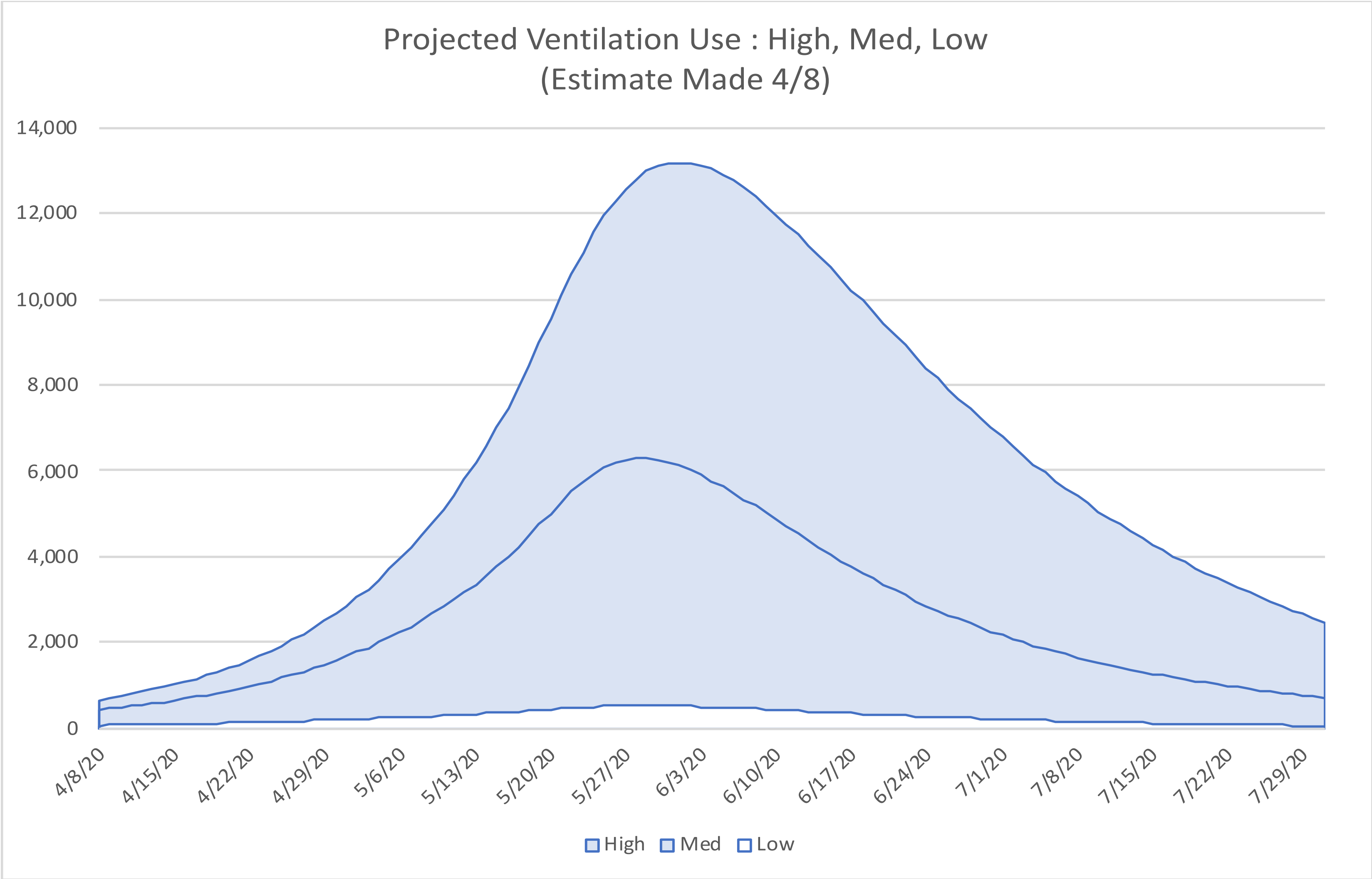
Projected Hospitalizations: Low, medium, high



Projected ICU visits: Low, medium, high

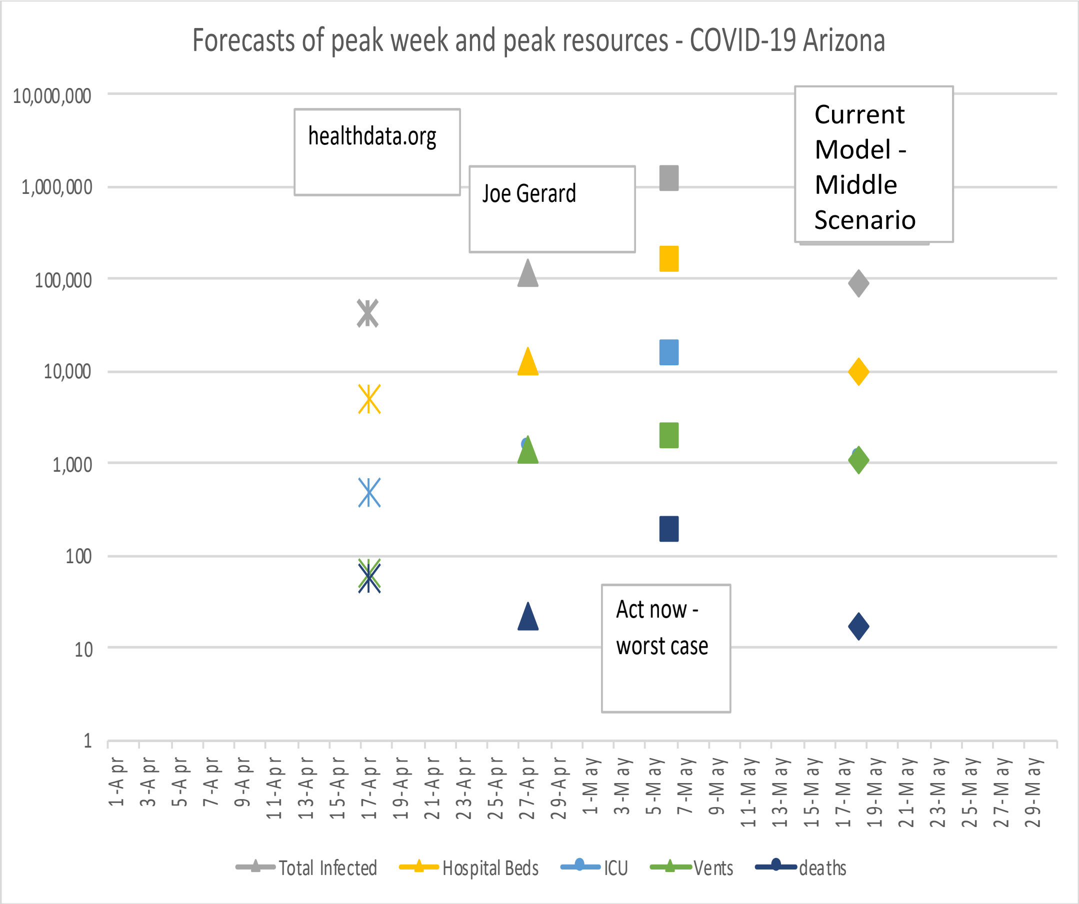


Projected Ventilator Use: Low, medium, high



Assumes 88% ventilator utilization for ICU patients

Model Comparison: External models



Authors and Contributors:

<u>Team 1:</u> The Biodesign Institute, Knowledge Enterprise

Arizona State University

Tim Lant, PhD, MAS;

Megan Jehn, PhD;

Esma Gel, PhD;

Anna Muldoon, MPH;

Heather Ross PhD, DNP, ANP-BC;

Neal W. Woodbury, PhD;

<u>Team 2:</u> The Center for Population Health Sciences

Arizona Health Sciences, the Zuckerman College of Public Health, and the Center for Biomedical Informatics and Biostatistics

University of Arizona

Joe K. Gerald, MD, PhD;

Patrick Wightman, PhD, MPP;

Kathy Hiller, MD, MPH, FACEP;

Vern Pilling;

Authors and Contributors:

<u>Team 3:</u> The Center for Health Information and Research (CHIR)
Arizona State University
George Runger, PhD;
Anita Murcko, MD, FACP;
Dieter Armbruster, PhD;
Gevork Harootunian;
Klim Drobnyh;
Seho Kee;
Maziar Roodsari;
Basam Alasaly;
Nassim Idouraine;
Logan Cameron;

<u>Team 4:</u> Seidman Research Institute, WP Carey School of Business,
Arizona State University
Tim James, PhD
Timothy J. Richards, PhD
Mark Manfredo, PhD