Impact of Mask Mandate Timing on Community Transmission of SARS-CoV-2 in the St. Louis Metropolitan Area

Washington University in St. Louis School of Medicine

Karthik W. Rohatgi, MD, Branson Fox, BA, Khai Hoan Tram, MD, Elvin Geng, MD, MPH, Aaloke Mody, MD

Division of Infectious Diseases, Department of Medicine, Washington University School of Medicine

BACKGROUND

- Mask mandates have been a widely used public health tool during the COVID-19 pandemic.
- Rising case counts lead public officials to implement mitigation measures (e.g., mask mandates), but also lead to spontaneous, concurrent behavior change in individuals.
- Understanding how to optimize mask mandates is challenging because it is difficult to know the contribution of the mandates versus spontaneous behavior changes.
- This study aimed to examine how earlier or later mask mandate implementation in the context of different levels of spontaneous behavior change would have affected transmission of SARS-CoV-2 and severe COVID-19 outcomes in the St. Louis, Missouri area (where a mask mandate was implemented on July 3, 2020).

METHODS

- We sought to model counterfactual scenarios for COVID-19 hospitalizations and compare these to the real-life scenario (mandate on July 3, 2020). We compared counterfactual scenarios in which:
  1) The mandate was implemented 3 or 7 days earlier, or 7 or 14 days later, and
  2) 10%, 25%, and 50% of the changes seen in the baseline scenario were attributed to the mandate (as opposed to spontaneous behavior change)
- We used an SEIR (Susceptible-Exposed-Infectious-Recovered) model framework.
- We fit models using the LEMMA package in R, which implements Markov Chain Monte Carlo Methods via Stan.
- Our model utilized aggregated hospitalization and death data for St. Louis city and county residents admitted to nearly all hospitals in the metropolitan area. We used hospitalization and deaths as they are less susceptible to bias from differences in testing rates.
- We first fit a real-life model to estimate changes in transmission after the July 3, 2020 mask mandate, and then estimated counterfactual scenarios.

Table 1. Prior distributions for SEIR model parameters. All priors were normal distributions with the means and standard deviations listed.

Model Parameter	Mean ± SD	Model Parameter	Mean ± SD
Basic Reproduction Number	3.32 ± 0.26	**Length of Hospital Stay (days; for those not admitted to the ICU)**	5.0 ± 4.4
Mean Number of Individuals Initially Exposed	3.33	**Length of ICU Stay (days)**	7.0 ± 5.2
Latent Period (days)	3.3 ± 2.0	**Hospitalization Rate (of all infected)**	0.06 ± 0.02
Duration of Infectiousness (days, for those not hospitalized)	5 ± 1	**ICU Admission Rate (of all hospitalized)**	0.26 ± 0.03
Time from Onset of Infectiousness to Hospitalization (days)	5.6 ± 2	**Mortality Rate (of all in ICU)**	0.36 ± 0.09

RESULTS

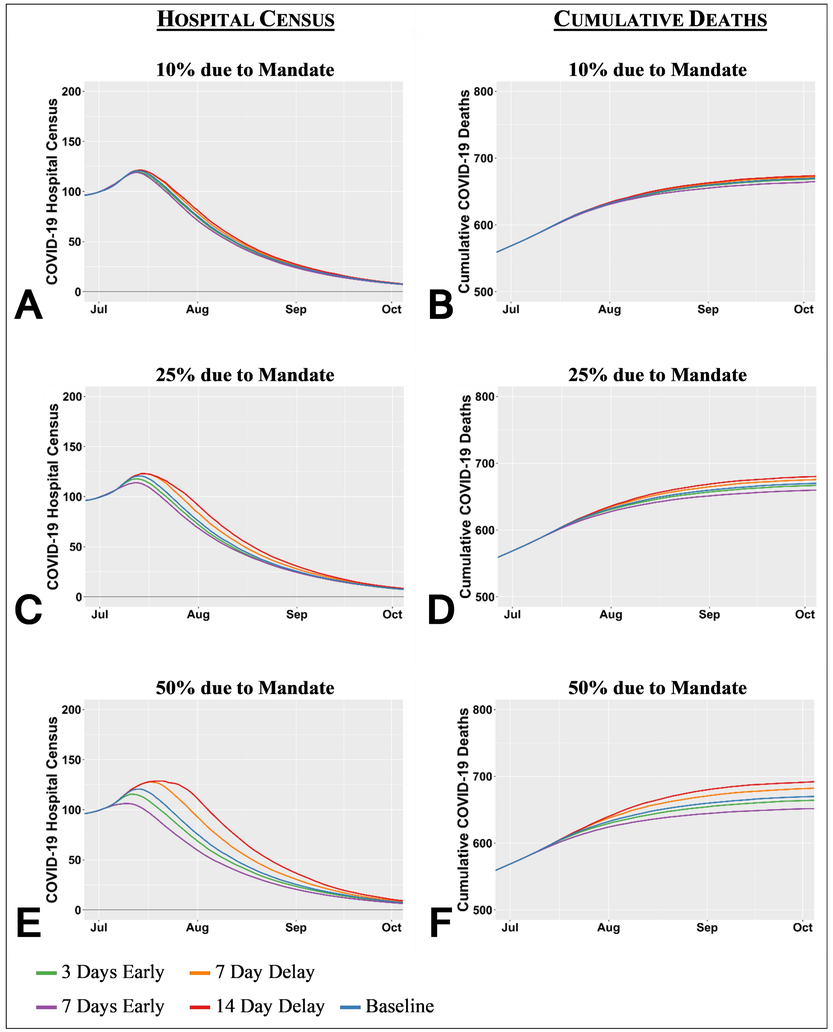

Figure. Hospital census and cumulative deaths in the real-life (baseline) model and in 12 counterfactual scenarios which vary mask mandate timing (3 or 7 days earlier, or 7 or 14 days delayed) and percentage of increase in masking that is attributed to the mask mandate (Panels A-B: 10%, Panels C-D: 25%, and Panels E-F: 50%).

Table 2. Date of return to baseline hospital census (i.e., hospital census on June 26, 2020), and number of days to return to baseline census, assuming that 10%, 25%, or 50% of observed changes were due to the mandate. Real life scenario included for comparison.

		Real life	10%	25%	50%
Time to Baseline	**7 days early**	July 25 (29 days)	July 24 (28 days)	July 22 (26 days)	July 18 (22 days)
	3 days early	July 25 (29 days)	July 25 (29 days)	July 24 (28 days)	July 22 (26 days)
	7 day delay	July 25 (29 days)	July 26 (30 days)	July 28 (32 days)	July 31 (35 days)
	14 day delay	July 25 (29 days)	July 27 (31 days)	July 31 (35 days)	August 6 (41 days)

CONCLUSIONS

- The impact of mask mandates is is highly context-dependent and depends both on the timing and percent of increased masking that is attributed to the mandate.
- Implementing a mandate even a few days earlier is associated with fewer cumulative hospitalizations and earlier return to baseline, even in contexts when relatively small amounts of behavior change is due to the mandate (e.g., 25%)
- Although COVID-19 burden is lower, earlier implementation also leads to slightly longer overall duration of the mask mandate.
- Given wide variations in public behavior, locally-tailored models are essential for estimating the impact of interventions and informing the local public health response.

REFERENCES

1. Chu DK, Akl EA, Duda S, Solo K, Yaacoub S, Schünemann HJ, et al. Physical distancing, face masks, and eye protection to prevent person-to-person transmission of SARS-CoV-2 and COVID-19: a systematic review and meta-analysis. The Lancet. 2020;395: 1973–1987. doi:10.1016/S0140-6736(20)31142-9
2. Eikenberry SE, Mancuso M, Iboi E, Phan T, Eikenberry K, Kuang Y, et al. To mask or not to mask: Modeling the potential for face mask use by the general public to curtail the COVID-19 pandemic. Infectious Disease Modelling. 2020;5: 293–308. doi:10.1016/j.idm.2020.04.001

ACKNOWLEDGEMENTS

We wish to thank Laura Balzer and James Peng for their involvement in the development of LEMMA, as well as Jann Paul Mattern and Mikala Caton for developing the Santa Cruz County COVID-19 model upon which LEMMA is based. We are grateful to Hilary Babcock and Anna Bershteyn for their advice in developing the study and editing the manuscript.