Selectively Caring for the Most Severe COVID-19 Cases Will Delay a Hospital Bed Shortage in Washington

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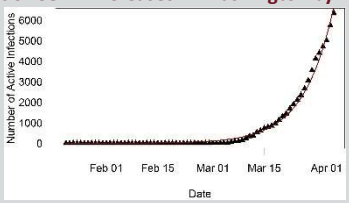
Introduction & Background

The novel disease COVID-19 is spreading rapidly throughout the US, including Washington State [1].

Plot of COVID-19 Cases in Washington by Day



Data includes cases from Jan 21st – April 3rd. Red line shows exponential growth.

The number of active COVID-19 infections in Washington is projected to exceed current capacity of Washington hospitals [1].

Overwhelming hospitals will likely increase the death rate for the disease.

Social distancing will help delay the shortage, but many Washingtonians continue to leave home.

Two other ways to delay the bed shortage are:

1. Add more beds to Washington hospitals
2. Hospitalize fewer COVID-19 patients (i.e. let less serious cases self-isolate)

Neither solution is perfect, but mathematical models can inform which will have a greater effect on delaying a bed shortage.

Questions

When will Washington run out of hospital beds for COVID-19 patients?

How will decreasing the proportion of COVID-19 patients that are hospitalized alter our projection?

How will increasing the number of hospital beds alter our projection?

Methods

1. Fit exponential model i(t) to number of infections by day in WA:

$$i(t) = i(\lambda) * e^{r(t-\lambda)}$$

2. Estimate number of occupied beds b(t) as i(t) times probability of hospitalization given COVID-19 infection (h):

$$b(t) = h * i(\lambda) * e^{r(t-\lambda)}$$

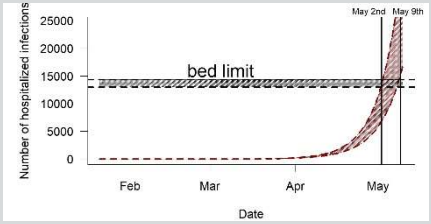
3. Solve for time t at which b(t) equals the number of hospital beds in WA (b_{max}).

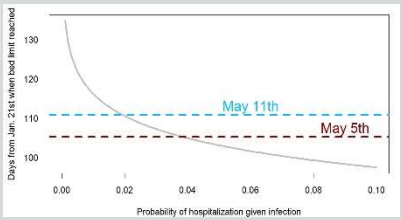
$$t = \frac{\ln\left(\frac{b_{max}}{h * i(\lambda)}\right)}{r} + \lambda$$

4. b_{max} was estimated as 13,650 [3]. h was estimated as 3.8 % [6]. r was estimated as 0.12 using data from Jan 21st – Apr. 3rd [4]. **We assumed these parameters would remain constant into the near future.**
5. λ was set to March 15th to anchor the model in more reliable data.
6. A 5% margin of error was incorporated into r, h, and b_{max} to bound t.

Results

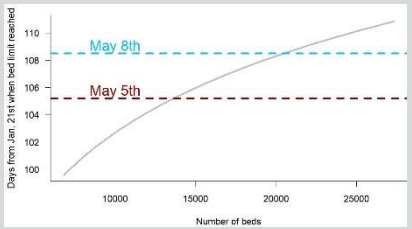
Hospital bed capacity will be exceeded around May 5th: May 2nd – May 9th if we assume 5 % error in parameters.





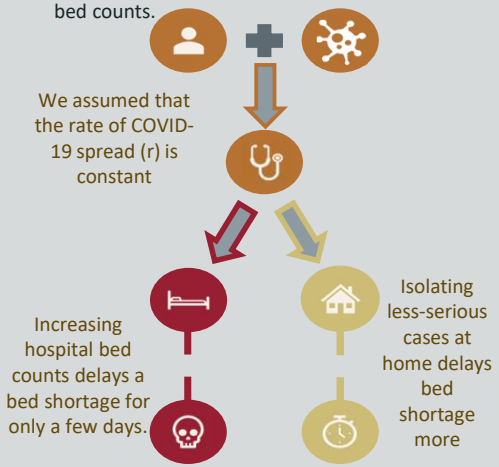
Hospitalizing 50 % fewer patients delays shortage 6 extra days (May 11th)

Adding 50 % more hospital beds only delays shortage 3 extra days (May 8th)



Conclusions

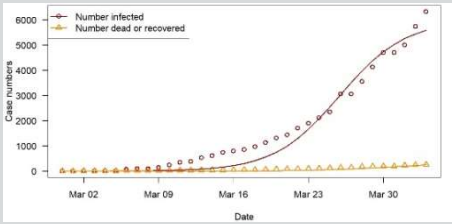
- COVID-19 prevalence is currently growing exponentially in Washington.
- If current rates continue, a bed shortage will occur around May 5th **(May 2nd – May 9th)**.
- Decreasing COVID-19 hospitalizations, such as by having less serious cases self-isolate, delays bed shortage more than the same increase in bed counts.



Continued Research

Many asymptomatic individuals spread COVID-19.

ASIR models[5] were recently developed to account for this behavior and we are attempting to improve their fits to Washington data (see below).



References: 1. John Hopkins Bloomberg School of Public Health. (2020, April 8). What US Hospitals Should Do Now to Prepare for a COVID-19 Pandemic. centerforhealthsecurity.org/cbn/ 2. The Columbian. (2020, April 8). Washington scrambles for hospital beds. Columbian.com/news 3. Washington Department of Health. (2020, April 8) Year End Reports by Hospitals 2018. doh.wa.gov/ 4. Novel Coronavirus (COVID-19) Infection Map.(2020, April 8) hgis.uw.edu/virus/ 5. Gaeta G. (2020, April 8) A simple SIR model with a large set of asymptomatic infectives, arXiv.org 6. The COVID-19 Tracking Project. (2020, April 8). covidtracking.com/ 7. deSolve R package 8. Growthrates R package