Comparison of costs of school closures versus COVID-19 inpatient treatment in Seattle

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Results as of March 19, 2020

Note: The COVID-19 situation is rapidly changing and evolving in Seattle and worldwide. As of March 23, the legal and economic implications of school closures and absenteeism have changed. Please interpret results below with thoughtfulness and caution in light of recent developments.

What do we already know?

Schools in the Seattle school district have recently closed in order to promote social distancing in response to the ongoing COVID-19 epidemic. The economic impacts of such measures are unknown, in particular relative to the costs of treating patients with COVID-19.

What does this report add?

We estimate the costs of parental absenteeism (the income lost as a result of parents staying home to care for their children)due to school closures in Seattle. In parallel, we estimate the potential costs of treating inpatients with COVID-19, and how much of that could be avoided due to social distancing from interventions such as school closures.

What are the implications for public health practice?

If we are able to prevent COVID-19 cases using social distancing due to school closures, the costs saved on inpatient treatment will likely greatly outweigh the cost of absenteeism from a societal perspective despite the difficulties this issue represents for individual families.

Executive summary

- **Purpose:** To estimate costs of absenteeism due to school closures as well as costs of COVID-19 inpatient treatment.
- **Geography:** Seattle, WA, USA
- **Background:** This report is based on results from COVASim (for epidemic projections), Census data, and HCUP data.
- **Economic projections:** We estimate that absenteeism due to school closures in Seattle could cost $13 million per week, at least at the beginning of the closures, for a total of $34 million over 180 days. However, avoiding 20%, 50%, or 75% of COVID-19 cases using social distancing could avoid $2.6 (range 1.2 – 4.3), $6.6 (range 3.0 – 10.8), and $10.0 (range 4.6 – 16.3) billion within 180 days.

Introduction

The novel coronavirus SARS-CoV-2 virus emerged in Wuhan, China, in late Nov or early Dec 2019. As of 19 March 2020, it is responsible for 209,839 confirmed cases and 8,778 deaths of the disease COVID-19 (WHO). After initial emergence in China, travel associated cases started to appear in other parts of the world with strong travel connections to Wuhan (http://rocs.hu-berlin.de/corona/). The first confirmed case in the US was a travel-associated case in Snohomish County, WA, screened on 19 January 2020. In the 6 weeks following to late February, a second presumptive case was identified roughly 10 miles away from where the first case was treated. As of the afternoon of March 18, Washington State reports 1187 confirmed cases and 66 confirmed deaths associated with COVID-19 with the majority from King and Snohomish counties. Beginning on March 17, public schools in Seattle were closed for 6 weeks.

Key inputs and assumptions

Costs of absenteeism due to school closures

To approximate the cost of school closures to parental absenteeism (the income lost as a result of parents staying home to care for their children), we use Seattle census data to find average income of working parents.[1] For the married households, in order to approximate the income from one of the parents alone, we assume 38% of the income to the lower earning parent at risk of loss due to absenteeism, based on the ratio of income for single-income versus dual-income households.[2]

To approximate loss due to absenteeism, we assume that 27% of families would experience absenteeism due to school closures, for an average length of 3 days per week.[3] We multiply weekly expected income loss by a total of 47,422 married, 5,301 male primary, and 11,840 female primary families in Seattle.[4]

Costs of COVID-19 treatment

We additionally approximate potential costs of inpatient treatment for COVID-19. COVID-19 cases are distributed among age groups, and a percent of cases in each age group are assumed to have moderate-high and high severity as shown in Table 1.[5] We assume any patients with moderate-high severity would be hospitalized and with high severity would be in the ICU.

Table 1. Distribution of moderate-high and high severity COVID-19 patients.

Age group	% of COVID-19 cases	% of cases moderate-high severity (hospitalized)	% of cases high severity (ICU)
<20	5	1.6–2.5	0
20-44	29	14.3–20.8	2.0–4.2
45-54	18	21.2–28.3	5.4–10.4
55-64	18	20.5–30.1	4.7–11.2
65-74	12.5	28.6–43.5	8.1–18.8
75-84	12.5	30.5–58.7	10.5–31.0
85+	6	31.3–70.3	6.3–29.0

To calculate costs, we use discharge data from the 2017 National Inpatient Sample (NIS), Healthcare Cost and Utilization Project (HCUP), Agency for Healthcare Research and Quality.[6] Analysis was stratified by age groups <20, 20-44, 45-54, 55-64, 65-74, 75-84, and 85+. To approximate symptoms and treatment similar to COVID-19 we use ICD10 codes as follows:

- Moderate-high severity cases: influenza (ICD10 diagnosis codes J9-J11) and acute respiratory distress syndrome (ARDS, ICD10 diagnosis code J80) with no ventilator (ICD10 procedure code 5A19).
- High severity cases: ARDS (ICD10 diagnosis code J80) and a ventilator (ICD10 procedure code 5A19).

In order to calculate total costs, we apply these expected costs per case to projected epidemiological curves in Seattle over 180 days. Epidemiological projections are based on an individual-based transmission model (COVID-19 Agent-based Simulator, or COVASim). For more details see Appendix 1. COVID-19 transmission takes places on a fixed network of contacts with best-available disease parameters for four scenarios: baseline and a 25%, 50%, and 75% reduction due to social distancing. Uncertainty in costs reflects ranges of severity as shown above as well as confidence intervals from the HCUP data.

Economic analysis

Costs of absenteeism due to school closures

Based on the 2018 U.S. Census, the median income in Seattle is $175,165, $87,773, and $44,813 for married, single male primary, or single female primary families with children under 18, respectively. The expected weekly income loss from absenteeism due to school closure is $209, $273, and $140 respectively for married, male primary, and female primary families.

The total expected loss from absenteeism due to school closures in Seattle is estimated at $13.0 million per week, or a total of $334 million over 180 days. This may be an overestimate during a sustained pandemic response, as many workers will work remotely and therefore not experience income loss to stay home for childcare.

Costs of COVID-19 treatment

Expected costs for treating COVID-19 by age group are shown in Table 2.

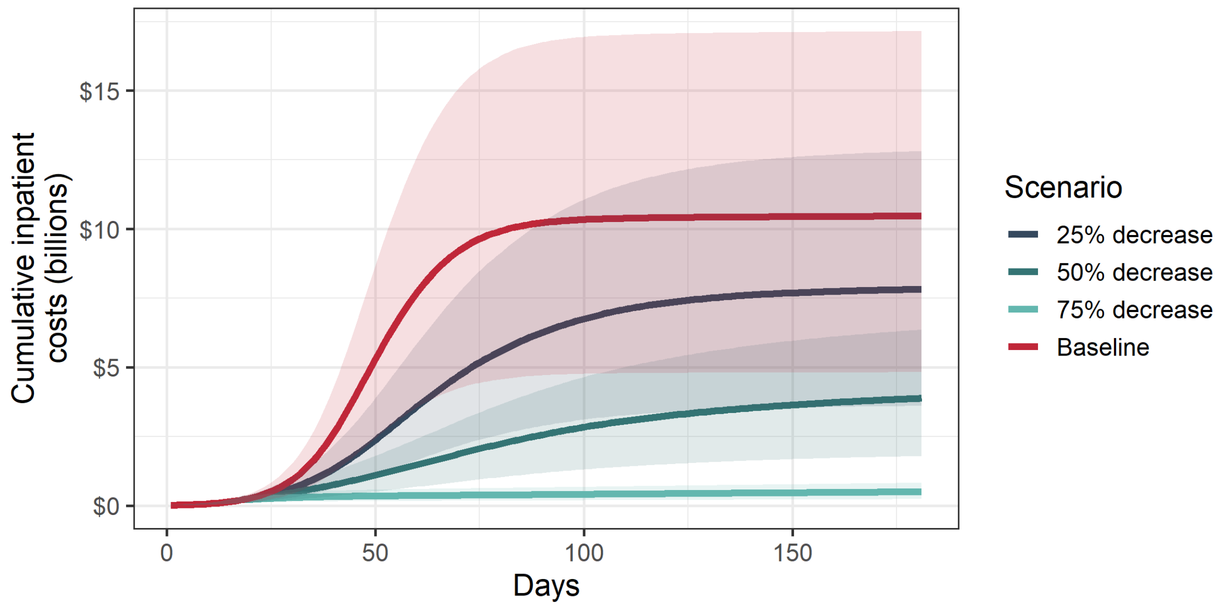
Table 2. Expected costs for inpatient treatment of moderate-severe and severe cases of COVID-19.

Age group	Cost for moderate-high severity (range)	Cost for high severity (range)
<20	$14,800 (0 - 30,400)	$169, 000 (135,300 – 201,200)
20-44	$19,000 (9,700 – 27,600)	$86,800 (78,700 – 94,800)
45-54	$28,900 (10,900 - 47,300)	$86,200 (75,700 – 96,400)
55-64	$24,000 (1,600 – 45,200)	$77,200 (72,200 – 82,100)

65-74	$16,200 (9,600 – 22,800)	$76,900 (71,100 – 82,700)
75-84	$16,900 (10,900 – 22,900)	$59,800 (54,200 – 65,500)
85+	$16,700 (6,200 – 27,500)	$49,100 (39,900 – 58,400)

When costs are applied to projected cases, we find that at 180 days we expect a cumulative total of $10.5 billion (range 4.8 – 17.2) in inpatient care costs at baseline (Figure 1, top). If we could reduce case counts by 25%, 50%, or 75%, we could save $2.6 (range 1.2 – 4.3), $6.6 (range 3.0 – 10.8), and $10.0 (range 4.6 – 16.3) billion at 180 days. It is important to note that with high case counts, the healthcare system in the U.S. would quickly reach capacity, and many patients would not be able to receive treatment. In this case, the direct healthcare costs would be lower, though society would bear other costs both economically and more importantly in human lives.

Figure 1. Estimated cumulative treatment costs for COVID-19 inpatients in Seattle.



Conclusions to date

We find that the costs of inpatient treatment for COVID-19 in Seattle may be an order of magnitude higher than absenteeism costs from school closures. The inpatient costs that could be saved using school closures for social distancing will likely far outweigh the economic costs of absenteeism due to the intervention.

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Appendix 1: Detailed transmission model methods

We applied COVASim, an individual-based COVID transmission model with parameters informed by literature. The simulation begins on 2020-03-17 with an assumed infection prevalence of 0.1%.

Internally, COVID-19 (SARS-CoV-2) infection within each individual is represented by four stages: susceptible, exposed, infectious, recovered (SEIR). The exposed (latent) period prior to the onset of viral shedding is normally distributed with a mean of 4 days and standard deviation of 1 day; this is one day shorter than the 5-day consensus estimate of the incubation period prior to symptom onset (MIDAS-network) to acknowledge reports of pre-symptomatic shedding. The infectious period is normally distributed with mean 8 days and standard deviation 2 days, based on measured upper-respiratory viral shedding after symptom onset (Reference).

Viral transmission from one individual to the next proceeds on a fixed contact network with undirected edges. The degree distribution of the network is Poisson-distributed with rate parameter λ =20. Individual network edges are selected at random. On each day, an infectious individual exposes susceptible "close contacts" (neighboring nodes in the graph) to possible infection. The daily probability of an infectious individual infecting each neighboring susceptible individual is binomially distributed with p = 0.015. With an average of 20 contacts per individual and a mean duration of infectiousness of 8 days, this per-day probability roughly translates to R0 = 2.3. At this time, all infected individuals are equally infectious, and infectivity does not vary on a daily basis or by symptoms. The probability of death for each infection is 1.6%, independent of age or other co-morbidities. Time from infection to death is drawn from a normal distribution with mean of 21 days and standard deviation of 2 days.