

Supplement

Derivation of Equation (2) in the Main Text

Let p (where $1 > p > 0$) denote the proportion of individuals in the entire population who are COVID-19 cases, that is, the *prevalence* of COVID-19. Let q (where $1 > q > 0$) denote the proportion of all COVID-19 cases that are *severe*, that is, hospitalized *because* of their illness. We make the key assumption that those individuals without COVID-19 have the same probability g of hospitalization (where $1 > g > 0$) as those with non-severe COVID-19. The proportion of individuals in the population who do not have COVID-19 *and* are hospitalized is thus $g(1 - p)$. The proportion who have non-severe COVID-19 *and* are incidentally hospitalized as $g(1 - q)p$, while the proportion who have severe COVID-19 *and* are hospitalized as qp .

Let c (where $1 > c > 0$) denote the fraction of all hospitalized individuals who are COVID-19-positive, whether those individuals are severe or non-severe cases. Utilizing the foregoing expressions, we have $c = \frac{g(1-q)p+qp}{g(1-p)+(1-q)p+qp}$. We can write the odds that a hospitalized patient is COVID-positive as $\frac{c}{1-c} = \frac{g(1-q)p+qp}{g(1-p)}$, which can be rewritten as $\left(\frac{p(1-q)}{1-p}\right) \left(\frac{g(1-q)+q}{g(1-q)}\right)$. Utilizing the definition of π in equation (1) in the main text and rearranging terms gives:

$$\pi = (1 - q) \left(\frac{p}{1 - p} \right) / \left(\frac{c}{1 - c} \right) \quad (2).$$

Derivation of Equation (3) in the Main Text

Let $h(t)$ denote the incidence rate of SARS-CoV-2 infection at time $t \geq 0$. We assume that incidence is growing exponentially, that is, $h(t) = h_0 e^{\rho t}$, where $h_0, \rho > 0$. Let the duration $s > 0$ of infection have an exponential distribution with mean $1/\theta$, where $\theta > 0$, so that the cumulative distribution function of s is $F(s) = 1 - e^{-\theta s}$ and the corresponding survival function is $G(s) = 1 - F(s) = e^{-\theta s}$. Given these functional forms for h and G , the prevalence of COVID-19 at time t is $p(t) = \int_0^t h(u)G(t - u) du = \frac{h_0}{\rho + \theta} (e^{\rho t} - e^{-\theta t})$. For sufficiently large t , the second term inside the parentheses gets small, so that we have:

$$p(t) \approx \frac{1}{\rho + \theta} h(t) \quad (3).$$

Tables

Table S1. Data Underlying Figure 2. ^a

<i>Week Ending</i>	<i>Total Hospital Inpatients</i>	<i>COVID-19 Positive Inpatients</i>	<i>Percent COVID-19 Positive (c)</i>
6/25/21	103,859	2,409	2.32
7/2/21	102,030	2,652	2.60
7/9/21	105,387	3,426	3.25
7/16/21	106,785	4,857	4.55
7/23/21	107,265	7,354	6.86
7/30/21	107,556	10,500	9.76
8/6/21	107,758	13,875	12.88
8/13/21	108,483	16,537	15.24
8/20/21	108,509	18,079	16.66
8/27/21	108,193	18,115	16.74
9/3/21	107,151	17,575	16.40
9/10/21	109,515	16,130	14.73
9/17/21	108,878	14,470	13.29
9/24/21	108,083	12,598	11.66
10/1/21	107,455	10,793	10.04
10/8/21	107,605	9,480	8.81
10/15/21	107,123	8,348	7.79
10/22/21	107,114	7,261	6.78
10/29/21	106,776	6,774	6.34
11/5/21	107,227	6,426	5.99
11/12/21	107,658	6,646	6.17
11/19/21	105,426	7,083	6.72
11/26/21	104,164	7,897	7.58
12/3/21	109,395	8,962	8.19
12/10/21	109,638	9,873	9.01
12/17/21	107,399	10,616	9.88
12/24/21	101,122	13,797	13.64
12/31/21	106,676	21,126	19.80
1/7/22	109,725	27,621	25.17

a. Total Hospital Inpatients and COVID-19 Positive Inpatients are 7-day averages. $c = 100 \times (\text{COVID-19 Positive}) \div (\text{Total Inpatients})$. Source: U.S. Department of Health and Human Services [26].

Figures

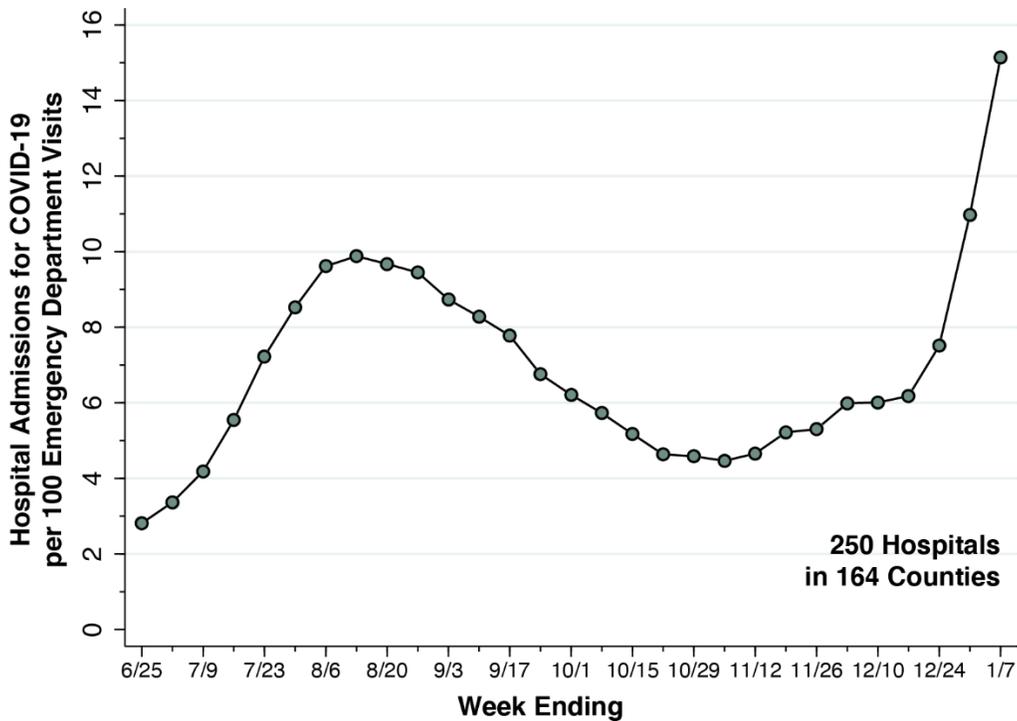


Figure S1. Hospital Admissions for COVID-19 per 100 Emergency Department Visits in a Cohort of 250 High-Volume Hospitals, Weeks Ending June 25, 2021, through January 7, 2022. See Technical Notes to Figure S1 below.

Technical Notes to Figure S1.

The data source was U.S. Department of Health and Human Services [26], as described under *Data: Cohort of 250 High-Volume Hospitals* in the section on Methods and Data in the main text.

Emergency department visits to each of the cohort hospitals was derived from the variable *previous_day_covid_ED_visits_7_day_sum*, defined as “Sum of total number of ED visits who were seen on the previous calendar day who had a visit related to COVID-19 (meets suspected or confirmed definition or presents for COVID diagnostic testing – do not count patients who present for pre-procedure screening) reported in 7-day period.”

Hospital admissions were determined as the sum of two variables:

- a) *previous_day_admission_adult_covid_confirmed_7_day_sum*, defined as “Sum of number of patients who were admitted to an adult inpatient bed on the previous calendar

day who had confirmed COVID-19 at the time of admission reported in the 7-day period.”

- b) *previous_day_admission_pediatric_covid_confirmed_7_day_sum*, defined as “Sum of number of pediatric patients who were admitted to an inpatient bed, including NICU, PICU, newborn, and nursery, on the previous calendar day who had confirmed COVID-19 at the time of admission.”