COVID-19: Update on Epidemiology & Costs

By: The Avalon Health Economics Team

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The number of global deaths attributable to coronavirus (COVID-19) recently passed 120,000,[1] with more than 1.8 million confirmed cases worldwide.[2] Compared to motor vehicle fatalities, of which there are globally more than one million each year, the viral deaths may seem like a small number. But in the case of COVID-19, all of these deaths occurred in a three-month period and at the hand of a single poorly understood novel pathogen able to travel through populations at exponential rates, often lying undetected in asymptomatic carriers.[3] In this sense, COVID-19 poses a greater danger threat than the more common and better understood drivers of mortality.

The U.S. is increasingly bearing the brunt of the disease; today's counts are close to 600,000 confirmed cases and close to 25,000 deaths.[1] For many U.S. cities, peak caseloads are yet to come. Some of these cities where disease is just beginning to spread rapidly are populous and expected to contribute a substantial number of new cases and deaths in the coming weeks.

In a previous blog, we investigated some of the basic characteristics of COVID-19. In this blog entry, we focus on two increasingly important topics: epidemiology and costs. We define epidemiology broadly, including an up-to-date review of the key published medical literature on COVID-19. Following that, our discussion of costs focuses in part on the direct medical costs (which probably for good reasons has been relatively under-reported) and in part on the broader costs to the economy.

Epidemiology

The basic epidemiology of COVID-19 is by now fairly well reported, though data varies widely from country to country and from study to study. In terms of total number of confirmed cases, Europe continues to have the highest number of cases, but the Americas are close behind and have yet to reach the "plateau" that seems to have been recently achieved in China and Europe.[2] In the U.S., for example, the cumulative disease incidence was 56.2 per 100,000 population as of March 31 but more than doubled to 119.6 per 100,000 just one week later (by April 7, 2020).[4]

New York continues to be the hardest-hit state, with the majority of its cases located in the densely populated New York City. New Jersey, Michigan, Louisiana, California, Massachusetts, Pennsylvania, Florida, and Illinois are also on the steep part of the COVID-19 incidence curves and are expected to worsen in the upcoming weeks. Each of these states include at least one large major U.S. city, which will likely exacerbate disease spread in the coming weeks. Under the current social distancing guidelines, caseload declines are not expected until late April and early May, but it is likely that a relaxing of distancing guidelines will result in some new spikes in incidence, especially in the cities that were slow to enforce business closures and distancing.

Another clinically important fact emerging from the initial epidemiological studies is the comorbidities associated with disease progression. Early reports from China, many of which have already been published in the peer-reviewed medical literature, indicated that older patients were significantly more vulnerable to disease progression. For example, Chen et al. observed that in a sample of 800 COVID-19 patients, the median age of deceased patients was 68, whereas the median age of recovered patients was 51.[5]

Similar to the age effect, the virus affects men significantly worse than women; in the same Chen et al. study, 73% of the deceased were men compared to 55% of the women. Early reports also identified cardiovascular disease as an important risk factor.[5-7]. In one study, more than 85% of severe COVID-19 patients had diabetes or cardiovascular disease.[8] More recent reports have also identified hypertension, diabetes, and obesity as important risk factors for disease progression.[7, 9-14] Some lifestyle factors have also emerged as important; history of smoking, for example, was associated with an odds ratio of 14.29 (95% confidence interval: 1.58-25.00; $p = 0.018$) in one study.[11]

Very recent data from the U.S. Centers for Disease Control and Prevention (CDC) surveillance program have found consistent patterns. Based on data from the 14 most populous states between March 1-28, individuals over the age of 65 were more than three times as likely to be hospitalized compared to the cohort average.[15]. Surprisingly, 89% of those hospitalized had at least one underlying medical condition; in the over age 65 group, more than 94% had at least one underlying condition. The important underlying conditions were hypertension (49.7%), obesity (48.3%), diabetes (28.3%), cardiovascular disease (27.8%), and asthma (17.0%). With the exception of obesity and asthma, both of which appear to be disproportionately affecting younger COVID-19 patients, most underlying conditions are more prevalent in older patients.

Finally, significant differences in death rates have also been reported between countries, and these differences have been the subject of debate.[16, 17] However, these differences are generally explained by two factors: (1) differences in demographics (e.g., proportion of the at-risk population over age 65 or obese);[18, 19] and (2) differences in health system affects, mainly the proportion of the at-risk population who have access to testing. For example, Germany reports a substantially lower death date (< 2%) than the US or UK (3-5%), due mainly to its larger denominator (i.e., more testing results in a larger proportion of healthier cases counted).

Costs

Of course, the most pressing public health challenge now is containing the spread of disease and minimizing the humanistic impact imposed by morbidity and mortality. But given the scale of the disease, it is increasingly impossible to ignore the cost side of the equation. In the 14-state CDC study, the U.S. hospitalization rate among COVID-19 patients was 4.6 per 100,000 population for the month of March 2020. Extrapolating to the national, annual level, this translates to about 182,000 hospitalizations annually. But this is based only on the incidence of COVID-19 of about 460,000 (as of April 11, 2020). On an annual basis, for 2020, the total

incidence of COVID-19 could be between 784,168 (70% growth between now and end of year) and 1,383,825 (based on linearly extrapolating the quarterly rate to an annual rate).

Hospitalized COVID-19 patients are charged an average of $73,000 per stay, of which insurers have been paying about half and hospitals have generally been accepting those amounts as payment in full.[20] Using pneumonia as a proxy for the novel coronavirus, another source estimates that an inpatient admission could cost over $20,000 [21], and ventilator support has the potential to increase this cost to more than $88,000 per case. Similarly, according to FAIR Health, the average inpatient charges per patient for cases involving pneumonia ranges from $42,486 and $74,310 depending on case severity.[22]

Thus, taking each of these estimates into consideration, the average hospitalization cost for a COVID-19 patient appears to be about $60,000 per case. Outpatient cases (i.e., diagnosed and managed pharmacologically in outpatient clinics or at home) are likely to incur about $2,500 in costs per case, assuming a mix of over-the-counter and prescription drugs.[8, 23, 24] Assuming that the inpatient cases also incur outpatient costs post-discharge, it seems reasonable to assume that the average direct medical costs per COVID-19 case is about $62,500. Again, these are simply direct medical costs; with a disease like COVID-19 one would expect substantial indirect costs associated with work productivity and care-giver burden. There may also be substantial litigation costs stemming from exposure to the virus. Thus, this direct per-case cost is clearly an underestimate of actual case-level costs.

We used these per-case cost data to develop a simple COVID-19 cost simulation model. Given current hospitalization rates and costs, and estimated outpatient costs (applied to all cases), we calculated two estimates: a “base case,” which assumes that the U.S. caseload grows another 70% between now and the end of the year, to 784,168 cases; and a “worse case” where the quarterly case load triples to 1,383,825. Based on the estimates for direct medical costs per case, the total direct medical costs for the base case and worse case are estimated to be $20 billion and $35 billion, respectively.

Depending on assumptions and how episodes of care are defined, some other estimates are much higher than this; for example, the FAIR Health study estimates that the total annual cost of all hospitalized COVID-19 patients could range from $362 billion to $1.449 trillion nationally.[22] We tend to think that the estimates will fall more in range of our simulation model, in part because we use more recent CDC hospitalization rate data than does the FAIR Health study. However, the wide range of estimates is illustrative of the uncertainty surrounding the disease incidence over the next several months, and how the disease will impact some of the exceptionally vulnerable populations yet to be exposed.

Again, these estimates ignore indirect medical costs, and much of those indirect costs will be attributable to the impact on the economy. In the short run, the hospitality, entertainment, and travel industries have been and will continue to be affected very negatively by social distancing; other industries tied to those will be the next round of businesses to feel the effects of the disruption.[25] There will inevitably be an economic recession of sorts globally and in the U.S., but the extent of that recession is unclear. Unlike past recessions, in the U.S. most of the

underlying fundamentals of the economy were relatively strong prior to the pandemic; perhaps there were some sagging sectors and some overvalued businesses and industries, but it is unlikely that those pre-existing conditions were sufficient to impede a recovery. Thus, the main challenge might be one of uncertainty and lack of confidence. As the data and knowledge base for COVID-19 grow, however, there is a good chance that we can reduce some of the impact uncertainty.

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