

# Health Care Costs of COVID-19 vs Influenza and Pneumonia

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According to World Health Organization statistics, approximately 94 million confirmed cases of COVID-19 and more than 1 million deaths caused by the disease were registered in the United States as of September 7, 2022.<sup>1</sup> COVID-19, which is caused by the SARS-CoV-2 virus, has shown key resemblances to influenza, specifically similar symptoms (eg, fever, cough, shortness of breath) and complications (eg, pneumonia, respiratory failure). Certain vulnerable populations, including older adults and patients with underlying medical conditions, have a greater chance of developing severe forms of illness.

However, COVID-19 is more contagious than influenza and individuals with COVID-19 remain infectious for longer periods of time. One of the unique characteristics of COVID-19 is its ability to cause deadly illness in otherwise healthy individuals, which is less likely with influenza and pneumonia.<sup>2,3</sup>

Respiratory diseases overall represent a significant financial burden. In a study by Bartsch et al, the mean cost of COVID-19 was modeled using a Monte Carlo simulation model and estimated at \$3045. In a recent cost-effectiveness analysis, Sheinson et al estimated the cost of inpatient admissions without respiratory support and inpatient admissions with nonmechanical respiratory support at \$8767 and \$13,282, respectively, and the cost was \$49,631 for patients requiring inpatient admissions with mechanical ventilation.<sup>4</sup> The cost of influenza has also been previously estimated. During the eight 2001-2002 through 2008-2009 seasons in the United States, projected annual influenza-related health care expenditures ranged from \$11.3 million to \$25.6 million and health care costs from \$2.0 billion to \$5.8 billion.<sup>5</sup> A case-control study conducted among patients hospitalized with influenza revealed that median health care costs of patients with influenza-related pneumonia reached \$18,428 vs \$621 for patients with influenza without complications.<sup>6</sup>

The impact of COVID-19 on the financial burden of respiratory disease and how COVID-19 compares with influenza and pneumonia are not well documented. Our study was designed to estimate health care payments using a comprehensive analysis of all COVID-19-related claims during the duration of COVID-19 disease and compare them to payments for influenza or viral pneumonia (IP).

## ABSTRACT

**OBJECTIVES:** To estimate payments for the treatment of COVID-19 compared with that of influenza or viral pneumonia (IP), from the perspective of the US payer.

**STUDY DESIGN:** Retrospective cohort analysis.

**METHODS:** Patients with COVID-19 during the period from October 1, 2020, to February 1, 2021, or IP during the period from October 1, 2018, to February 1, 2019, in the IBM MarketScan databases were identified. The index was defined as the date of the first COVID-19 or IP diagnosis. Patients with COVID-19 were stratified by severity. Variables for all patients included demographics and comorbidities at the time of index and duration of disease. IP and COVID-19 cohorts were matched using propensity scores, and inflation-adjusted all-cause payments (ACP), and disease-specific payments (DSP) for IP vs COVID-19 were estimated using generalized linear models.

**RESULTS:** Matched cohorts included 6332 Medicare (female, 58.5%; mean [SD] age, 75.3 [7.6] years), and 397,532 commercially insured patients (female, 57.6%; mean [SD] age, 34.7 [16.7] years). ACP and DSP were significantly higher in the COVID-19 cohort vs IP cohort. Payments for severe/critical COVID-19 were significantly greater than those for IP, with adjusted marginal incremental DSP and ACP of \$24,852 (95% CI, \$21,573-\$28,132) and \$50,325 (95% CI, \$43,932-\$56,718), respectively. IP was significantly less expensive than moderate COVID-19 for commercial payers but not Medicare. IP was more expensive than mild COVID-19 for all payers.

**CONCLUSIONS:** Payments associated with severe/critical COVID-19 significantly exceeded those associated with IP. For Medicare, IP was more expensive than mild or moderate COVID-19. For commercial payers, IP was less expensive than moderate COVID-19 but more expensive than mild COVID-19.

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## TAKEAWAY POINTS

- ▶ Overall mean payments associated with the treatment of COVID-19 are significantly greater than those associated with treatment of influenza and pneumonia for commercial and Medicare payers.
- ▶ For commercial payers, the incremental all-cause payments for treatment of severe/critical COVID-19 exceeded those of influenza and pneumonia by a mean of \$50,325. For Medicare, the mean incremental payments of severe/critical COVID-19 vs influenza and pneumonia reached \$25,378.
- ▶ Payments for moderate COVID-19 were higher than those for influenza and pneumonia for commercial payers but not for Medicare. Mild COVID-19 cases required lower payments than influenza or pneumonia for all payers.

## METHODS

## Data Sources

The Merative MarketScan Commercial Claims and Encounters (CCAE) and Medicare Supplemental databases were used. The IBM MarketScan databases comprise enrollment information, demographics, and adjudicated inpatient medical, outpatient medical, and outpatient pharmacy claims data collected from more than 300 large, self-insured US employers and more than 25 US health plans for individuals younger than 65 years and their dependents.

## Study Population

This was a retrospective cohort study of patients with COVID-19 compared with the matched cohort of those with IP in the United States. Patients with COVID-19 during the period from October 1, 2020, to February 1, 2021, or with IP during the period from October 1, 2018, to February 1, 2019, were identified in the CCAE and Medicare Supplemental databases. The date of the first COVID-19 or IP diagnosis was defined as *index*; all patients had 6 months or more of continuous enrollment pre- and post index.

In the COVID-19 group, duration of disease (DOD) was determined based on the presence of any 1 COVID-19 sign or symptom (CSS). A complete list of CSSs and their corresponding diagnosis codes are shown in **eAppendix Table 1** (eAppendix available at [ajmc.com](https://www.ajmc.com)). For each patient with COVID-19, CSS diagnoses were identified starting 5 days before the COVID-19 index event. Diagnoses listed prior to the index date were used because patients often presented with CSSs before being tested for and receiving a diagnosis of COVID-19. (For many patients with mild and moderate disease, most health care use happened prior to index.) COVID-19 was considered ongoing as long as the gap between distinct CSS diagnoses was less than 35 days. When a new diagnosis was identified after a 35-day gap, it was assumed that this might be a new condition. This rule was used because most CSSs are very generic in nature (eg, cough, headache) and their potential association with index COVID-19 may thus decline as the time gap in diagnosis dates increases. The decision to use a 35-day gap (vs a shorter or longer gap) was based on a review of histograms of time gaps for CSS conditions for all patients. For patients with mild or moderate COVID-19 with no health

care events in the database after their COVID-19 index code, it was assumed they would have a DOD of 9 days following that last COVID-19 diagnosis. In our study, the minimum DOD of any symptomatic patient was 14 days. This was based on prior publications on disease duration.<sup>7,8</sup> Patients with no CSS diagnoses in the 5 days prior to and up to 35 days after index were considered asymptomatic and excluded from the study.

COVID-19 cases were categorized by disease severity (mild, moderate, or severe/critical [S/C]) using the signs and symptoms definitions from

the Janssen phase 3 ENSEMBLE clinical trial (NCT04505722) definition of severity, as shown in **eAppendix Table 2**. The definitions of mild and S/C cases in the Janssen trial are very similar to those of the National Institutes of Health (**eAppendix Table 3**). Both the mild and moderate Janssen trial definitions also include very detailed descriptions of diagnoses and capture all the signs and symptoms typically described in the literature as being associated with COVID-19. These definitions of disease severity allow for a very unambiguous, and exhaustive, categorization of disease as mild, moderate, or S/C.

In the IP group, DOD was defined from first diagnosis to last related visit/prescription, with a maximum 35-day gap between visits/prescriptions. Costs incurred within the 5 days prior to index were also included, as was done in the COVID-19 group, to ensure consistent cost calculations in both groups.

## Variable Creation

Variables included (1) patient demographics at index and comorbidities (identified from 7 months to 1 month prior to index date): age, sex, geographic location, diseases as per Elixhauser Comorbidity Index (ECI), specific health conditions not included in ECI (pregnancy, functional impairment [visual/hearing]), and duration of continuous enrollment post index; (2) preindex care, from 7 months to 1 month before index: count of all prescriptions, vaccinations, and total payments for health care in the period 7 months to 1 month preindex; and (3) concurrent diagnostic variables (from 15 days before index to end of study) for the COVID-19 group: diagnoses for signs and symptoms indicative of COVID-19 (these variables were also captured to identify concurrent signs and symptoms related to IP), duration of inpatient admission, duration of intensive care unit (ICU) admission, ventilation type, treatments received, and discharge status. Preindex care and ECI were calculated using a 6-month window, from 7 months to 1 month before index. The 1-month preindex cutoff was required to avoid including diagnoses and care related to the index disease in the list of comorbidities and costs (especially in the COVID-19 cohort, in which patients may have developed symptoms prior to testing positive). The 6-month window for comorbidity identification and preindex cost, resulting in a start time 7 months preindex, was

required to allow identification of most key chronic diseases, which would require at least 1 visit in a 6-month time frame.

The outcomes were (1) all-cause payments (ACP) for inpatient and outpatient visits and prescriptions (for commercially insured patients with prescription coverage) for the entire duration of the disease and (2) disease-specific payments (DSP) for inpatient and outpatient visits and prescriptions associated with CSSs (for the COVID-19 cohorts) or care associated with IP diagnoses specifically.

**Data Analysis**

Descriptive statistics were reported for all study variables and outcomes by payer (commercial vs Medicare supplemental), disease group (COVID-19 vs IP), and severity (for patients with COVID-19) as means and SDs for continuous variables and frequencies and percentages for categorical variables. Adjusted payments and health care utilization were estimated for each payer/disease group/severity separately using generalized linear models (GLMs) (family:  $\gamma$ ; link: log).

IP and COVID-19 cohorts were matched 1:1 on age, sex, and comorbidities (R package MatchIt; distance: GLM; method: nearest). Inflation-adjusted payments to the 2021 consumer price index for IP vs COVID-19, and IP vs each severity of COVID-19, were estimated using GLMs with  $\gamma$  distribution and log link.

**RESULTS**

The study included 3166 patients with IP and 19,914 patients with COVID-19 identified in the Medicare supplemental database, and 333,209 patients with IP and 363,448 patients with COVID-19 identified in the commercial database. Baseline demographic characteristics and comorbidities for the IP and COVID-19 cohorts are shown in **Table 1**. In the commercial cohort, the patients with IP were significantly younger and had fewer comorbidities compared with patients with COVID-19. Hypertension, diabetes, hypothyroidism, obesity, and depression were nearly twice as prevalent in the COVID-19 cohort compared with the IP cohort, as shown in **eAppendix Table 4**. In the Medicare supplemental cohort, the mean ages of patients in the IP and COVID-19 groups were similar (75.2 and 75.9, respectively). However, the mean (SD) ECI score was significantly higher in the COVID-19 cohort vs the IP cohort (3.2 [2.5] vs 2.6 [2.3]). All comorbidities were significantly more prevalent in the COVID-19 cohort compared with the IP cohort, except for lymphoma, metastatic cancer, and rheumatoid arthritis (**eAppendix Table 4**).

Crude, unadjusted payments for all-cause and disease-specific treatments for the IP and COVID-19 cohorts are shown in **Table 2**. In the commercial cohort, patients with IP had mean ACP and

**TABLE 1.** Baseline Demographic Characteristics/Comorbidities of Patients With COVID-19 vs IP Before Propensity Score Matching

Patient demographic characteristic/comorbidity	Commercial population		Medicare supplemental population	
	IP	COVID-19	IP	COVID-19
n	333,209	363,448	3166	19,914
Age in years, mean (SD)	23.8 (18.7)	39.9 (15.7)	75.2 (7.61)	75.9 (7.4)
Female, n (%)	178,908 (53.7)	199,988 (55.0)	1852 (58.5)	10,487 (52.7)
Severity (for COVID-19), n (%)				
Mild		156,177 (43.0)		4105 (20.6)
Moderate		180,019 (49.5)		9019 (45.3)
Severe/critical		27,252 (7.5)		6790 (34.1)
Elixhauser Comorbidity Index score, n (%)				
0	246,026 (73.8)	206,070 (56.7)	596 (18.8)	2622 (13.2)
1-2	74,161 (22.3)	117,938 (32.4)	1198 (37.8)	6465 (32.5)
3-4	10,838 (3.3)	30,970 (8.5)	829 (26.2)	5850 (29.4)
> 4	2184 (0.7)	8470 (2.3)	543 (17.2)	4977 (25.0)
Elixhauser Comorbidity Index score, mean (SD)	0.4 (0.9)	0.9 (1.3)	2.6 (2.3)	3.2 (2.5)

IP, influenza or viral pneumonia.

DSP less than \$3000, with very large SDs, indicative of the large spread of payments in this cohort (mean [SD] ACP, \$2326 [\$22,372]; mean [SD] DSP, \$859 [\$9,459]). The 95th percentile reached \$6183, suggesting that 5% of the IP cohort had payments at or above \$6183. In the Medicare supplemental cohort, these payments were higher, with mean (SD) payments of \$12,365 (\$37,821) for ACP and \$3697 (\$12,720) for DSP, and the 95th percentile of ACP reaching \$51,205. For COVID-19, commercial ACP and DSP increased nearly 50-fold between mild and S/C cases: ACP for mild cases reached a mean (SD) cost of \$950 (\$4330), whereas the mean ACP for S/C was \$56,277 (\$128,561). A similar increase was observed in DSP (mild: \$358 [\$1592]; S/C: \$28,679 [\$80,891]). Medicare payments were generally lower but also showed a significant increase between mild and SC cases (mean [SD] ACP, mild: \$2255 [\$8351]; S/C: \$35,605 [\$45,562]). The 95th percentile for S/C cases, in both commercial and Medicare supplemental populations, required ACP that exceeded \$100,000.

A propensity score matching methodology was applied to control for differences in demographic characteristics between patients with COVID-19 and patients with IP. Two cohorts were created, matching for age, sex, and ECI. The changes in pre- to postmatching balance of covariates are shown in **eAppendix Figure 1** (for the commercial cohort) and **eAppendix Figure 2** (for the Medicare supplemental cohort).

After matching, baseline demographic characteristics were similar for patients with COVID-19 and patients with IP, as shown in **Table 3**. In the commercial and Medicare supplemental cohorts, 198,766 and 3166 patients with IP were matched to the same number of patients with COVID-19, respectively. The severity distributions in the COVID-19 cohort were as follows: 46.3% mild, 48.0% moderate,

**TABLE 2.** Unadjusted Payments: Mean (SD) and 90th and 95th Percentile Payments by Disease Type (IP vs COVID-19), and for COVID-19, by Severity

Payer	Condition	All-cause payments			Disease-specific payments		
		Mean (SD)	90th percentile	95th percentile	Mean (SD)	90th percentile	95th percentile
Commercial	IP	\$2326 (\$22,372)	\$2572	\$6183	\$859 (\$9459)	\$1099	\$2265
	COVID-19: mild	\$950 (\$4330)	\$1580	\$3153	\$358 (\$1592)	\$622	\$1236
	COVID-19: moderate	\$3800 (\$13,953)	\$7831	\$16,306	\$1620 (\$6498)	\$3848	\$6866
	COVID-19: severe/critical	\$56,277 (\$128,561)	\$103,418	\$178,065	\$28,679 (\$80,891)	\$55,163	\$96,765
Medicare	IP	\$12,365 (\$37,821)	\$15,706	\$51,205	\$3697 (\$12,720)	\$10,349	\$15,706
	COVID-19: mild	\$2255 (\$8351)	\$4595	\$12,021	\$432 (\$1807)	\$932	\$1601
	COVID-19: moderate	\$6990 (\$13,679)	\$19,419	\$28,658	\$1581 (\$6494)	\$3877	\$9585
	COVID-19: severe/critical	\$35,605 (\$45,562)	\$70,992	\$102,248	\$10,885 (\$29,312)	\$29,160	\$44,914

IP, influenza or viral pneumonia.

**TABLE 3.** Baseline Demographic Characteristics/Comorbidities of Patients With COVID-19 vs IP After Propensity Score Matching

Patient demographic characteristic/comorbidity	Commercial population		Medicare supplemental population	
	IP	COVID-19	IP	COVID-19
n	198,766	198,766	3166	3166
Age in years, mean (SD)	34.45 (17.14)	35.03 (16.36)	75.25 (7.61)	75.31 (7.63)
Female, n (%)	114,538 (57.6)	114,538 (57.6)	1852 (58.5)	1852 (58.5)
Severity (for COVID-19), n (%)				
Mild		92,059 (46.3)		732 (23.1)
Moderate		95,426 (48.0)		1441 (45.5)
Severe/critical		11,281 (5.7)		993 (31.4)
Elixhauser Comorbidity Index score, n (%)				
0	129,049 (64.9)	129,049 (64.9)	596 (18.8)	596 (18.8)
1-2	56,901 (28.6)	56,901 (28.6)	1198 (37.8)	1198 (37.8)
3-4	10,637 (5.4)	10,637 (5.4)	829 (26.2)	829 (26.2)
> 4	2179 (1.1)	2179 (1.1)	543 (17.2)	543 (17.2)
Elixhauser Comorbidity Index score, mean (SD)	0.61 (1.07)	0.63 (1.10)	2.58 (2.26)	2.65 (2.37)

IP, influenza or viral pneumonia.

and 5.7% S/C in the commercial cohort, and 23.1% mild, 45.5% moderate, and 31.4% S/C in the Medicare supplemental cohort. The rates of comorbidities in the matched cohorts were well balanced, as shown in [eAppendix Table 4](#).

ACP and DSP for the entire duration of IP or COVID-19, for commercial and Medicare supplemental patients, are shown in [Table 4](#). IP includes all patient severities, and COVID-19 is subdivided by disease severity.

In the commercial population, payments for IP, both ACP and DSP, were between those required for mild and moderate COVID-19. The ACP for treatment of IP, mild COVID-19, and moderate COVID-19 were \$2985 (95% CI, \$2856-\$3114), \$1259 (95% CI, \$1189-\$1327), and \$4068 (95% CI, \$3859-\$4276), respectively. The DSP for IP, mild COVID-19, and moderate COVID-19 were \$980 (95% CI, \$948-\$1013),

\$467 (95% CI, \$446-\$490), and \$1753 (95% CI, \$1674-\$1832), respectively.

For Medicare supplemental patients, IP payments were between those required for moderate and S/C COVID-19. The ACP for treatment of IP, moderate COVID-19, and S/C COVID-19 were \$11,726 (95% CI, \$10,510-\$12,943), \$7175 (95% CI, \$6145-\$8205), and \$37,105 (95% CI, \$30,992-\$43,218), respectively. DSP for the same were \$3466 (95% CI, \$3092-\$3840), \$2280 (95% CI, \$1923-\$2637), and \$13,631 (95% CI, \$11,136-\$16,125), respectively.

For both commercially insured and Medicare supplemental patients, IP required payments were significantly lower than those required for S/C COVID-19 disease. Similar findings were observed for ACP and DSP. The mean incremental ACP from IP to S/C COVID-19 was \$50,325 (95% CI, \$43,932-\$56,718) for commercially insured patients and \$25,378 (95% CI, \$19,248-\$31,508) for Medicare supplemental patients. The mean incremental DSP from IP to S/C COVID-19 was \$24,852 (95% CI, \$21,573-\$28,132) for commercially insured patients and \$10,164 (95% CI, \$7652-\$12,676) for Medicare supplemental patients.

## DISCUSSION

This study was designed to assess from the perspective of the US payer health care payments associated with COVID-19 compared with those associated with IP. Payments for IP were lower than those associated with S/C COVID-19 for all payers. For moderate COVID-19 cases, payments for IP were higher in the Medicare population, but lower for commercial payers. IP was more expensive than mild COVID-19 for all payers.

We analyzed DSP in addition to ACP in an effort to narrow down payments to those most likely caused by the disease. As mentioned

earlier, DSP included payments associated with an exact diagnosis of IP or, for the COVID-19 cohorts, of a sign or symptom of COVID-19. Ancillary services, such as laboratory testing or imaging, without the exact mention of those diagnoses were not included in the DSP calculation. It is therefore very likely that DSP may underestimate the cost of care for IP and COVID-19. This is particularly true for IP, where claims had to include an exact diagnosis of influenza or pneumonia. For COVID-19, because of the novelty of the codes and broad presentation of the disease, services associated with any CSS diagnosis were included in the disease-specific calculations. The methodology for calculating DSP was therefore more restrictive for IP than for COVID-19 but, as stated earlier, potentially underestimated costs in both cases. The ACP, however, did include all care received during the duration of the disease, for both IP and COVID-19. The ACP could, however, have included some unrelated emergency care provided during the ongoing IP or COVID-19. However, during an IP or COVID-19 ongoing disease, it is unlikely that expensive, unrelated elective care would have been undertaken.<sup>9</sup> The true cost of COVID-19 and IP to payers thus may be most comparable to that of the ACP.

Payments for COVID-19 and IP had wide ranges, as shown by SDs in unadjusted payments. For COVID-19, the increase in payments from mean to the 90th and 95th percentiles was significant, with the top 10th and top 5th percentiles of patients in the moderate and S/C categories having 2 and 3 times higher payments than average, respectively. For IP, the increase affected only the top 5th percentile, with most payments remaining relatively even up to the top 10th percentile of patients and then increasing significantly (approximately 3-fold) for the top 5% of patients.

For patients with COVID-19, we analyzed payments as a function of severity, as payments for patients with S/C disease were more than 50 times higher than those for patients with mild disease in the commercial cohort and nearly 15 times higher in the Medicare supplemental cohort. This finding is not surprising, considering the range of symptoms and severities associated with COVID-19, but it does highlight the importance of stratifying COVID-19 cases by severity for any economic analysis.

To the best of our knowledge, no US-based comparative studies on health care payments of patients with mild, moderate, and severe COVID-19 vs influenza have previously been published. In a multicenter, retrospective cohort study conducted in Japan, health care resource utilization was higher in hospitalized patients with COVID-19 vs influenza. During the entire hospitalization period, patients with COVID-19 had higher ICU admission and need for mechanical ventilation than patients with influenza (ICU admission,

**TABLE 4.** Adjusted and Incremental Payments of Patients With IP vs COVID-19 Stratified by Severity of Disease

	Commercial	Medicare
All-cause payments, mean (95% CI)		
IP	\$2985 (\$2856-\$3114)	\$11,726 (\$10,510-\$12,943)
Mild COVID-19	\$1259 (\$1189-\$1327) <sup>a</sup>	\$2803 (\$2237-\$3369) <sup>a</sup>
Moderate COVID-19	\$4068 (\$3859-\$4276) <sup>b</sup>	\$7175 (\$6145-\$8205) <sup>a</sup>
Severe/critical COVID-19	\$53,311 (\$46,903-\$59,717) <sup>b</sup>	\$37,105 (\$30,992-\$43,218) <sup>b</sup>
Disease-specific payments, mean (95% CI)		
IP	\$980 (\$948-\$1013)	\$3466 (\$3092-\$3840)
Mild COVID-19	\$467 (\$446-\$490) <sup>a</sup>	\$657 (\$510-\$803) <sup>a</sup>
Moderate COVID-19	\$1753 (\$1674-\$1832) <sup>b</sup>	\$2280 (\$1923-\$2637) <sup>a</sup>
Severe/critical COVID-19	\$25,833 (\$22,555-\$29,112) <sup>b</sup>	\$13,631 (\$11,136-\$16,125) <sup>b</sup>
All-cause incremental payments, mean (95% CI)		
From IP to severe/critical COVID-19	\$50,325 (\$43,932-\$56,718)	\$25,378 (\$19,248-\$31,508)
Disease-specific incremental payments, mean (95% CI)		
From IP to severe/critical COVID-19	\$24,852 (\$21,573-\$28,132)	\$10,164 (\$7652-\$12,676)

IP, influenza or viral pneumonia.

<sup>a</sup>Indicates COVID-19 payments that are significantly lower than the corresponding IP payments.

<sup>b</sup>Indicates COVID-19 payments that are significantly higher than the corresponding IP payments.

5.6% vs 1.1%; mechanical ventilation, 3.3% vs 2.5%; all  $P < .0001$ ). Moreover, in the adjusted model, patients hospitalized with COVID-19 were at a higher risk of in-hospital mortality than patients with influenza (odds ratio, 1.83; 95% CI, 1.64-2.04).<sup>10</sup> Pawelka et al also reported that hospitalized patients with COVID-19 had higher length of stay, rate of complications, and in-hospital mortality than those with influenza, even in a population with fewer comorbidities.<sup>11</sup>

### Limitations

Our study has the following limitations. A major assumption in the analysis was the maximum 35-day gap between diagnoses or care related to COVID-19. This maximum gap in care was required, as CSSs are generic (eg, headache, myalgia, gastrointestinal symptoms) and patients may return with these common signs and symptoms irrespective of their initial case of COVID-19. Therefore, our analysis is conservative, as care due to the initial COVID-19 infection with a time gap in care greater than 35 days would not be included in our payment analysis. Our study used 2 types of payments (DSP and ACP), as discussed earlier, neither representing the exact amounts paid for the treatment of IP or COVID-19. These 2 values provide a range, with the true payment being possibly closer to the ACP, as described earlier. Another limitation is that patients with IP were not stratified by severity. Our analysis of the 90th and 95th percentiles was designed to evaluate payments in the top 10th and top 5th percentiles of patients to address this limitation. We also limited our analysis of the IP cohort to the period between October 2018

and February 2019 and the COVID-19 cohort to the period between October 2020 and February 2021. These time frames were selected to exclude overlap in the IP cohort of COVID-19 cases. Continuous changes in health care, new variants of COVID-19, and increased vaccination rates may, however, affect cost estimates.

## CONCLUSIONS

Costs for patients with IP were shown to be far lower than those of patients with S/C COVID-19, even in the Medicare supplemental population, where IP may cause significant health risks. Payments associated with IP were comparable with those of mild to moderate COVID-19. Our findings thus highlight the key economic differences between COVID-19 and IP and the economic burden of COVID-19 vs IP. Reducing the proportion of patients who develop S/C COVID-19, which is possible through vaccination and treatment, is key to lessening the economic burden of COVID-19 and potentially leveling it to that of IP. ■

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**eAppendix Table 1. COVID-19 Signs and Symptoms**

COVID-19 Sign or Symptom Category	code (ICD10)	Short Code Description
Acute Respiratory Distress Syndrome	J80	Acute respiratory distress syndrome
Acute Respiratory Distress Syndrome	R0603	Acute respiratory distress syndrome
Acute Respiratory Failure	J9600	Acute respiratory failure unspecified whether with hypoxia or hypercapnia
Acute Respiratory Failure	J9601	Acute respiratory failure with hypoxia
Acute Respiratory Failure	J9602	Acute respiratory failure with hypercapnia
Acute Respiratory Failure	J9620	Acute and chronic respiratory failure unspecified whether with hypoxia or hypercapnia
Acute Respiratory Failure	J9621	Acute and chronic respiratory failure with hypoxia
Acute Respiratory Failure	J9690	Respiratory failure unspecified unspecified whether with hypoxia or hypercapnia
Acute Respiratory Failure	J9691	Respiratory failure unspecified with hypoxia
Chest Pain	J208	Acute bronchitis due to other specified organisms
Chest Pain	J209	Acute bronchitis unspecified
Chest Pain	J22	Unspecified acute lower respiratory infection
Chest Pain	J40	Bronchitis not specified as acute or chronic
Chest Pain	J9809	Other diseases of bronchus not elsewhere classified
Chest Pain	R071	Chest pain on breathing
Chest Pain	R072	Precordial pain
Chest Pain	R0781	Pleurodynia
Chest Pain	R0789	Other chest pain
Chest Pain	R079	Chest pain unspecified
Chills	R6883	Chills (without fever)
Coma	R4020	Unspecified coma
Coma	R402110	Coma scale eyes open never unspecified time
Coma	R402111	Coma scale eyes open never in the field [EMT or ambulance]
Coma	R402112	Coma scale eyes open never at arrival to emergency department
Coma	R402113	Coma scale eyes open never at hospital admission
Coma	R402114	Coma scale eyes open never 24 hours or more after hospital admission
Coma	R402120	Coma scale eyes open to pain unspecified time
Coma	R402121	Coma scale eyes open to pain in the field [EMT or ambulance]
Coma	R402122	Coma scale eyes open to pain at arrival to emergency department
Coma	R402123	Coma scale eyes open to pain at hospital admission
Coma	R402124	Coma scale eyes open to pain 24 hours or more after hospital admission
Coma	R402130	Coma scale eyes open to sound unspecified time
Coma	R402131	Coma scale eyes open to sound in the field [EMT or ambulance]
Coma	R402132	Coma scale eyes open to sound at arrival to emergency department
Coma	R402133	Coma scale eyes open to sound at hospital admission
Coma	R402134	Coma scale eyes open to sound 24 hours or more after hospital admission
Coma	R402140	Coma scale eyes open spontaneous unspecified time
Coma	R402141	Coma scale eyes open spontaneous in the field [EMT or ambulance]

Coma	R402142	Coma scale eyes open spontaneous at arrival to emergency department
Coma	R402143	Coma scale eyes open spontaneous at hospital admission
Coma	R402144	Coma scale eyes open spontaneous 24 hours or more after hospital admission
Coma	R402210	Coma scale best verbal response none unspecified time
Coma	R402211	Coma scale best verbal response none in the field [EMT or ambulance]
Coma	R402212	Coma scale best verbal response none at arrival to emergency department
Coma	R402213	Coma scale best verbal response none at hospital admission
Coma	R402214	Coma scale best verbal response none 24 hours or more after hospital admission
Coma	R402220	Coma scale best verbal response incomprehensible words unspecified time
Coma	R402221	Coma scale best verbal response incomprehensible words in the field [EMT or ambulance]
Coma	R402222	Coma scale best verbal response incomprehensible words at arrival to emergency department
Coma	R402223	Coma scale best verbal response incomprehensible words at hospital admission
Coma	R402224	Coma scale best verbal response incomprehensible words 24 hours or more after hospital admission
Coma	R402230	Coma scale best verbal response inappropriate words unspecified time
Coma	R402231	Coma scale best verbal response inappropriate words in the field [EMT or ambulance]
Coma	R402232	Coma scale best verbal response inappropriate words at arrival to emergency department
Coma	R402233	Coma scale best verbal response inappropriate words at hospital admission
Coma	R402234	Coma scale best verbal response inappropriate words 24 hours or more after hospital admission
Coma	R402240	Coma scale best verbal response confused conversation unspecified time
Coma	R402241	Coma scale best verbal response confused conversation in the field [EMT or ambulance]
Coma	R402242	Coma scale best verbal response confused conversation at arrival to emergency department
Coma	R402243	Coma scale best verbal response confused conversation at hospital admission
Coma	R402244	Coma scale best verbal response confused conversation 24 hours or more after hospital admission
Coma	R402250	Coma scale best verbal response oriented unspecified time
Coma	R402251	Coma scale best verbal response oriented in the field [EMT or ambulance]
Coma	R402252	Coma scale best verbal response oriented at arrival to emergency department
Coma	R402253	Coma scale best verbal response oriented at hospital admission
Coma	R402254	Coma scale best verbal response oriented 24 hours or more after hospital admission
Coma	R402310	Coma scale best motor response none unspecified time
Coma	R402311	Coma scale best motor response none in the field [EMT or ambulance]
Coma	R402312	Coma scale best motor response none at arrival to emergency department
Coma	R402313	Coma scale best motor response none at hospital admission
Coma	R402314	Coma scale best motor response none 24 hours or more after hospital admission
Coma	R402320	Coma scale best motor response extension unspecified time
Coma	R402321	Coma scale best motor response extension in the field [EMT or ambulance]
Coma	R402322	Coma scale best motor response extension at arrival to emergency department
Coma	R402323	Coma scale best motor response extension at hospital admission
Coma	R402324	Coma scale best motor response extension 24 hours or more after hospital admission
Coma	R402330	Coma scale best motor response abnormal unspecified time



Coma	R402331	Coma scale best motor response abnormal in the field [EMT or ambulance]
Coma	R402332	Coma scale best motor response abnormal at arrival to emergency department
Coma	R402333	Coma scale best motor response abnormal at hospital admission
Coma	R402334	Coma scale best motor response abnormal 24 hours or more after hospital admission
Coma	R402340	Coma scale best motor response flexion withdrawal unspecified time
Coma	R402341	Coma scale best motor response flexion withdrawal in the field [EMT or ambulance]
Coma	R402342	Coma scale best motor response flexion withdrawal at arrival to emergency department
Coma	R402343	Coma scale best motor response flexion withdrawal at hospital admission
Coma	R402344	Coma scale best motor response flexion withdrawal 24 hours or more after hospital admission
Coma	R402350	Coma scale best motor response localizes pain unspecified time
Coma	R402351	Coma scale best motor response localizes pain in the field [EMT or ambulance]
Coma	R402352	Coma scale best motor response localizes pain at arrival to emergency department
Coma	R402353	Coma scale best motor response localizes pain at hospital admission
Coma	R402354	Coma scale best motor response localizes pain 24 hours or more after hospital admission
Coma	R402360	Coma scale best motor response obeys commands unspecified time
Coma	R402361	Coma scale best motor response obeys commands in the field [EMT or ambulance]
Coma	R402362	Coma scale best motor response obeys commands at arrival to emergency department
Coma	R402363	Coma scale best motor response obeys commands at hospital admission
Coma	R402364	Coma scale best motor response obeys commands 24 hours or more after hospital admission
Coma	R40241	Glasgow coma scale score 13-15
Coma	R40242	Glasgow coma scale score 9-12
Coma	R40243	Glasgow coma scale score 3-8
Coma	R40244	Other coma without documented Glasgow coma scale score or with partial score reported
Confusion	R410	Disorientation unspecified
Confusion	R4182	Altered mental status unspecified
Confusion	R41840	Attention and concentration deficit
Confusion	R41841	Cognitive communication deficit
Confusion	R4189	Other symptoms and signs involving cognitive functions and awareness
Confusion	R419	Unspecified symptoms and signs involving cognitive functions and awareness
Confusion	R42	Dizziness and giddiness
Congestion	R0989	Other specified symptoms and signs involving the circulatory and respiratory systems
Cough	R05	Cough
Eye Disorders	H578	Other specified disorders of eye and adnexa
Eye Disorders	H579	Unspecified disorder of eye and adnexa
Fatigue	R5383	Other fatigue
Fever	R5081	Fever presenting with conditions classified elsewhere
Fever	R509	Fever unspecified
Gastrointestinal Symptoms	K529	Noninfective gastroenteritis and colitis unspecified
Gastrointestinal Symptoms	R1013	Epigastric pain
Gastrointestinal Symptoms	R1030	Lower abdominal pain unspecified

Gastrointestinal Symptoms	R1084	Generalized abdominal pain
Gastrointestinal Symptoms	R109	Unspecified abdominal pain
Gastrointestinal Symptoms	R110	Nausea
Gastrointestinal Symptoms	R111	Vomiting
Gastrointestinal Symptoms	R1110	Vomiting unspecified
Gastrointestinal Symptoms	R1111	Vomiting without nausea
Gastrointestinal Symptoms	R1112	Projectile vomiting
Gastrointestinal Symptoms	R1113	Vomiting of fecal matter
Gastrointestinal Symptoms	R1114	Bilious vomiting
Gastrointestinal Symptoms	R112	Nausea with vomiting unspecified
Gastrointestinal Symptoms	R197	Diarrhea unspecified
Headache	R51	Headache
Hepatic Failure	K7200	Acute and subacute hepatic failure without coma
Hepatic Failure	K7201	Acute and subacute hepatic failure with coma
Hepatic Failure	K7290	Hepatic failure unspecified without coma
Hepatic Failure	K7291	Hepatic failure unspecified with coma
Hypoxemia	R0902	Hypoxemia
Malaise	R531	Weakness
Malaise	R5381	Other malaise
Malaise	R55	Syncope and collapse
Malaise	R69	Illness unspecified
Myalgia	M791	Myalgia
Myalgia	M7910	Myalgia
Myalgia	M7912	Myalgia
Myalgia	M7918	Myalgia
Neurological Symptoms	R401	Stupor
Neurological Symptoms	R404	Transient alteration of awareness
Neurological Symptoms	R4701	Aphasia
Neurological Symptoms	R471	Dysarthria and anarthria
Neurological Symptoms	R4781	Slurred speech
Neurological Symptoms	R4789	Other speech disturbances
Neurological Symptoms	R479	Unspecified speech disturbances
Pain	R52	Pain unspecified
Pneumonia	J1281	Pneumonia due to SARS-associated coronavirus
Pneumonia	J1289	Other viral pneumonia
Pneumonia	J129	Pneumonia
Pneumonia	J181	Lobar pneumonia unspecified organism
Pneumonia	J188	Other pneumonia unspecified organism
Pneumonia	J189	Pneumonia unspecified organism
Pneumonia	R918	Other nonspecific abnormal finding of lung field
Rash	R21	Rash and other nonspecific skin eruption

Runny Nose	R0981	Nasal congestion
Sepsis	A4151	Sepsis due to Escherichia coli [E. coli]
Sepsis	A4189	Other specified sepsis
Sepsis	A419	Sepsis unspecified organism
Sepsis	R6520	Severe sepsis without septic shock
Sepsis	R6521	Severe sepsis with septic shock
Shortness of Breath	J9811	Atelectasis
Shortness of Breath	J988	Other specified respiratory disorders
Shortness of Breath	R0600	Dyspnea unspecified
Shortness of Breath	R0602	Shortness of breath
Shortness of Breath	R0609	Other forms of dyspnea
Somnolence	R400	Somnolence
Sore Throat	J029	Acute pharyngitis unspecified
Sore Throat	J069	Acute upper respiratory infection unspecified
Sore Throat	R070	Pain in throat
Sore Throat	R1310	Dysphagia unspecified
Sore Throat	R1312	Dysphagia oropharyngeal phase
Tachycardia	I471	Supraventricular tachycardia
Tachycardia	R000	Tachycardia unspecified
Taste and Smell Disturbances	R430	Anosmia
Taste and Smell Disturbances	R431	Parosmia
Taste and Smell Disturbances	R432	Parageusia
Taste and Smell Disturbances	R438	Other disturbances of smell and taste
Taste and Smell Disturbances	R439	Unspecified disturbances of smell and taste
Thrombosis	I82401	Acute embolism and thrombosis of unspecified deep veins of right lower extremity
Thrombosis	I82402	Acute embolism and thrombosis of unspecified deep veins of left lower extremity
Thrombosis	I82403	Acute embolism and thrombosis of unspecified deep veins of lower extremity bilateral
Thrombosis	I82409	Acute embolism and thrombosis of unspecified deep veins of unspecified lower extremity
Thrombosis	I82411	Acute embolism and thrombosis of right femoral vein
Thrombosis	I82412	Acute embolism and thrombosis of left femoral vein
Thrombosis	I82413	Acute embolism and thrombosis of femoral vein bilateral
Thrombosis	I82419	Acute embolism and thrombosis of unspecified femoral vein
Thrombosis	I82421	Acute embolism and thrombosis of right iliac vein
Thrombosis	I82422	Acute embolism and thrombosis of left iliac vein
Thrombosis	I82423	Acute embolism and thrombosis of iliac vein bilateral
Thrombosis	I82429	Acute embolism and thrombosis of unspecified iliac vein
Thrombosis	I82431	Acute embolism and thrombosis of right popliteal vein
Thrombosis	I82432	Acute embolism and thrombosis of left popliteal vein
Thrombosis	I82433	Acute embolism and thrombosis of popliteal vein bilateral
Thrombosis	I82439	Acute embolism and thrombosis of unspecified popliteal vein
Thrombosis	I82441	Acute embolism and thrombosis of right tibial vein

Thrombosis	I82442	Acute embolism and thrombosis of left tibial vein
Thrombosis	I82443	Acute embolism and thrombosis of tibial vein bilateral
Thrombosis	I82449	Acute embolism and thrombosis of unspecified tibial vein
Thrombosis	I82491	Acute embolism and thrombosis of other specified deep vein of right lower extremity
Thrombosis	I82492	Acute embolism and thrombosis of other specified deep vein of left lower extremity
Thrombosis	I82493	Acute embolism and thrombosis of other specified deep vein of lower extremity bilateral
Thrombosis	I82499	Acute embolism and thrombosis of other specified deep vein of unspecified lower extremity
Thrombosis	I824Y1	Acute embolism and thrombosis of unspecified deep veins of right proximal lower extremity
Thrombosis	I824Y2	Acute embolism and thrombosis of unspecified deep veins of left proximal lower extremity
Thrombosis	I824Y3	Acute embolism and thrombosis of unspecified deep veins of proximal lower extremity bilateral
Thrombosis	I824Y9	Acute embolism and thrombosis of unspecified deep veins of unspecified proximal lower extremity
Thrombosis	I824Z1	Acute embolism and thrombosis of unspecified deep veins of right distal lower extremity
Thrombosis	I824Z2	Acute embolism and thrombosis of unspecified deep veins of left distal lower extremity
Thrombosis	I824Z3	Acute embolism and thrombosis of unspecified deep veins of distal lower extremity bilateral
Thrombosis	I824Z9	Acute embolism and thrombosis of unspecified deep veins of unspecified distal lower extremity
Wheezing	R062	Wheezing

**eAppendix Table 2:** Definition of Disease Severity based on available COVID-19 Signs and Symptoms shown in Table S1, admission type (inpatient, ICU) and treatment (ventilator use). The classification of disease is based on the Janssen ENSEMBLE Phase 3 clinical trial.

Severity	Definition	Identification using Database Variable (Signs and symptoms, admissions and ventilator/ICU use)
Mild	<p><b>One of the following symptoms:</b> fever (<math>\geq 38.0^{\circ}\text{C}</math> or <math>\geq 100.4^{\circ}\text{F}</math>), sore throat, malaise (loss of appetite, generally unwell, fatigue, physical weakness), headache, muscle pain (myalgia), gastrointestinal symptoms, cough, chest congestion, runny nose, wheezing, skin rash, eye irritation or discharge, chills, new or changing olfactory or taste disorders, red or bruised looking feet or toes, or shaking chills or rigors.</p>	<p><b>At least 1 of:</b> Chills, cough, chest congestion, fever, eye irritation or discharge, headache, GS, malaise, myalgia, OTD, runny nose, skin rash, sore throat, wheezing - and:  <b>Do not qualify as moderate or severe</b></p>
Moderate	<p><b>Any 1 of the following new or worsening signs or symptoms:</b> Respiratory rate <math>\geq 20</math> breaths/minute, abnormal saturation of oxygen (SpO<sub>2</sub>) but still <math>&gt;93\%</math> on room air at sea level, clinical or radiologic evidence of pneumonia, radiologic evidence of deep vein thrombosis (DVT), shortness of breath or difficulty breathing</p> <p><b>Any 2 of the following new or worsening signs or symptoms:</b> Fever (<math>\geq 38.0^{\circ}\text{C}</math> or <math>\geq 100.4^{\circ}\text{F}</math>), heart rate <math>\geq 90</math> beats/minute, shaking chills or rigors, sore throat, cough, malaise as evidenced by 1 or more of the following: - Loss of appetite - Generally unwell - Fatigue - Physical weakness, headache, muscle pain (myalgia), Gastrointestinal symptoms (diarrhea, vomiting, nausea, abdominal pain), new or changing olfactory or taste disorders, red or bruised looking feet or toes</p>	<p><b>At least 1 of:</b> DVT, pneumonia, shortness of breath (may be coded as outpatient-only ARF/ARDS), tachypnea, hypoxemia, or:</p> <p><b>At least 2 of:</b> Chills or rigors, cough, fever, gastrointestinal symptoms, headache, malaise, myalgia, new or changing olfactory or taste disorders, skin rash, sore throat, tachycardia - and:  <b>Do not qualify as severe/critical</b></p>
Severe / Critical	<p><b>Clinical signs at rest indicative of severe systemic illness</b> (respiratory rate <math>\geq 30</math> breaths/minute, heart rate <math>\geq 125</math> beats/minute, oxygen saturation (SpO<sub>2</sub>) <math>\leq 93\%</math> on room air at sea level, or partial pressure of oxygen/fraction of inspired oxygen (PaO<sub>2</sub>/FiO<sub>2</sub>)- Respiratory failure (defined as needing high-flow oxygen, non-invasive ventilation, mechanical ventilation, or</p>	<p><b>Severe systemic illness characterized by inpatient admission with at least 1 of:</b> hypoxemia, hepatic failure, neurological</p>

	<p>extracorporeal membrane oxygenation [ECMO]) - Evidence of shock (defined as systolic blood pressure (defined as systolic blood pressure &lt; 90 mm Hg, diastolic blood pressure &lt; 60 mm Hg, or requiring vasopressors) - Significant acute renal, hepatic, or neurologic dysfunction - Admission to the ICU - Death</p>	<p>dysfunction, renal failure, shock, tachypnea, tachycardia, respiratory failure/distress</p> <p>or mechanical ventilation or ECMO</p> <p>or ICU admission (death not identifiable in database)</p>
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**eAppendix Table 3: NIH Classification of Disease**

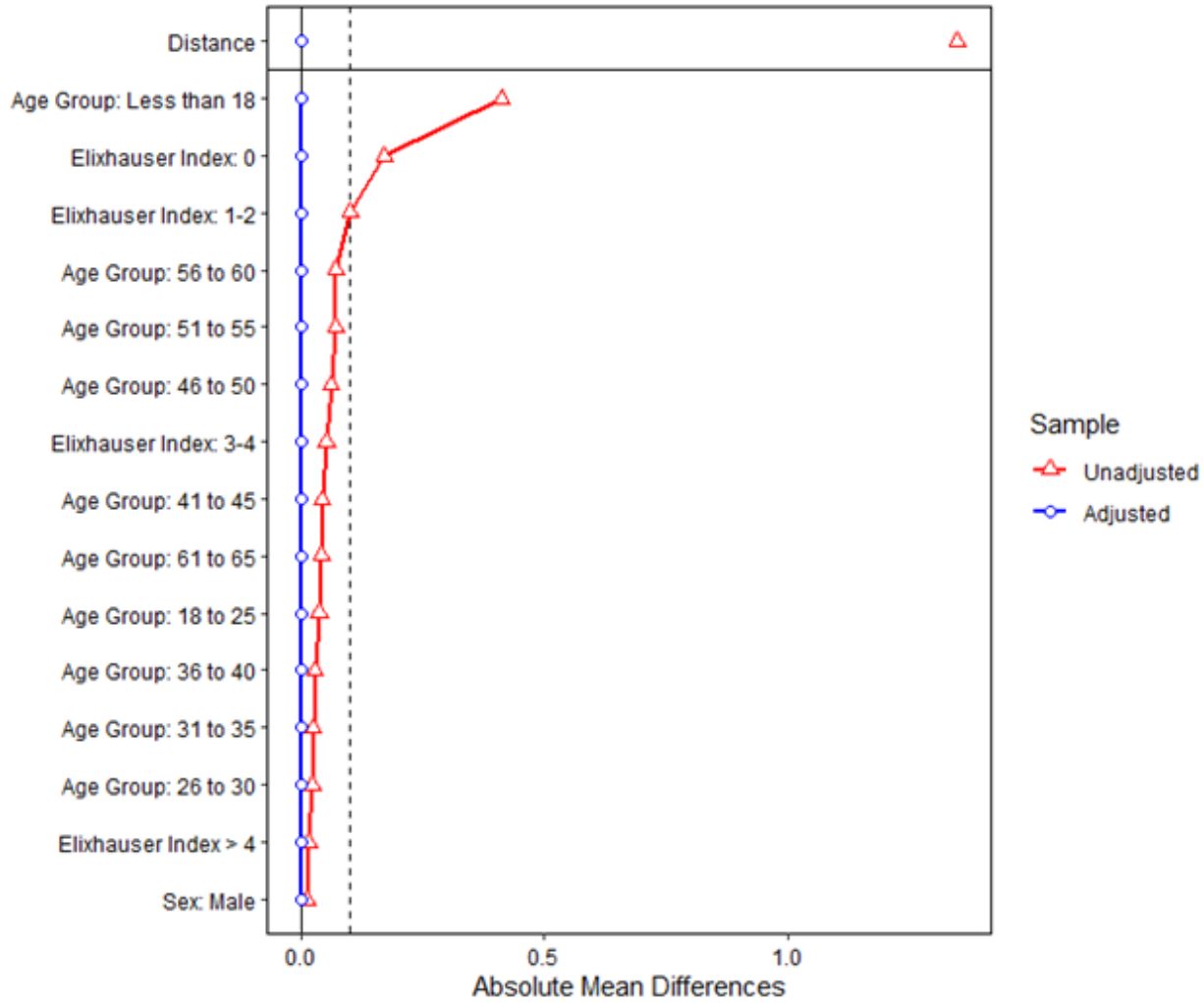
<b>Severity</b>	<b>Definition</b>
Mild	<ul style="list-style-type: none"><li>• <i>Mild Illness:</i> Individuals who have any of the various signs and symptoms of COVID-19 (e.g., fever, cough, sore throat, malaise, headache, muscle pain, nausea, vomiting, diarrhea, loss of taste and smell) but who do not have shortness of breath, dyspnea, or abnormal chest imaging.</li></ul>
Moderate	<ul style="list-style-type: none"><li>• <i>Moderate Illness:</i> Individuals who show evidence of lower respiratory disease during clinical assessment or imaging and who have an oxygen saturation (SpO<sub>2</sub>) ≥94% on room air at sea level.</li></ul>
Severe or critical	<ul style="list-style-type: none"><li>• <i>Severe Illness:</i> Individuals who have SpO<sub>2</sub> &lt;94% on room air at sea level, a ratio of arterial partial pressure of oxygen to fraction of inspired oxygen (PaO<sub>2</sub>/FiO<sub>2</sub>) &lt;300 mm Hg, a respiratory rate &gt;30 breaths/min, or lung infiltrates &gt;50%.</li><li>• <i>Critical Illness:</i> Individuals who have respiratory failure, septic shock, and/or multiple organ dysfunction.</li></ul>

**eAppendix Table 4:** Comorbidities in Patients with Influenza/Pneumonia and COVID-19, in the Commercial and Medicare database, before and after matching

	Commercial Cohort				Medicare Cohort			
	Pre-Matching		Post-Matching		Pre-Matching		Post-Matching	
	IP	COVID-19	IP	COVID-19	IP	COVID-19	IP	COVID-19
Elixhauser 1: Congestive heart failure	1,083 ( 0.3)	3,625 ( 1.0)	1054 (0.5)	1054 (0.5)	349 ( 11.0)	2,838 ( 14.3)	349 (11.0)	351 (11.1)
Elixhauser 2: Cardiac Arrhythmia	5,454 ( 1.6)	12,888 ( 3.5)	4778 (2.4)	4843 (2.4)	636 ( 20.1)	4,740 ( 23.8)	636 (20.1)	619 (19.6)
Elixhauser 3: Valvular disease	2,275 ( 0.7)	4,967 ( 1.4)	1973 (1.0)	1770 (0.9)	290 ( 9.2)	2,028 ( 10.2)	290 (9.2)	264 (8.3)
Elixhauser 4: Pulmonary circulation disorders	483 ( 0.1)	1,623 ( 0.4)	453 (0.2)	503 (0.3)	95 ( 3.0)	714 ( 3.6)	95 (3.0)	90 (2.8)
Elixhauser 5: Peripheral vascular disorders	1,220 ( 0.4)	3,656 ( 1.0)	1181 (0.6)	1165 (0.6)	376 ( 11.9)	3,054 ( 15.3)	376 (11.9)	389 (12.3)
Elixhauser 6: Hypertension Uncomplicated	25,440 ( 7.6)	70,494 (19.4)	25319 (12.7)	25977 (13.1)	1,788 ( 56.5)	12,952 ( 65.0)	1788 (56.5)	1830 (57.8)
Elixhauser 7: Hypertension Complicated	1,538 ( 0.5)	5,445 ( 1.5)	1516 (0.8)	1735 (0.9)	348 ( 11.0)	3,216 ( 16.1)	348 (11.0)	418 (13.2)
Elixhauser 8: Paralysis	341 ( 0.1)	540 ( 0.1)	229 (0.1)	225 (0.1)	21 ( 0.7)	244 ( 1.2)	21 (0.7)	27 (0.9)
Elixhauser 9: Other neurological disorders	3,185 ( 1.0)	4,511 ( 1.2)	2146 (1.1)	2028 (1.0)	160 ( 5.1)	1,618 ( 8.1)	160 (5.1)	194 (6.1)
Elixhauser 10: Chronic pulmonary disease	23,062 ( 6.9)	23,421 ( 6.4)	13421 (6.8)	10841 (5.5)	592 ( 18.7)	3,862 ( 19.4)	592 (18.7)	502 (15.9)
Elixhauser 11: Diabetes Uncomplicated	8,945 ( 2.7)	26,678 ( 7.3)	8655 (4.4)	9437 (4.7)	654 ( 20.7)	5,657 ( 28.4)	654 (20.7)	803 (25.4)
Elixhauser 12: Diabetes Complicated	5,791 ( 1.7)	18,793 ( 5.2)	5527 (2.8)	6579 (3.3)	489 ( 15.4)	4,621 ( 23.2)	489 (15.4)	626 (19.8)
Elixhauser 13: Hypothyroidism	10,497 ( 3.2)	22,657 ( 6.2)	10131 (5.1)	9130 (4.6)	581 ( 18.4)	3,861 ( 19.4)	581 (18.4)	531 (16.8)
Elixhauser 14: Renal failure	1,384 ( 0.4)	5,121 ( 1.4)	1330 (0.7)	1603 (0.8)	359 ( 11.3)	3,274 ( 16.4)	359 (11.3)	412 (13.0)
Elixhauser 15: Liver disease	2,664 ( 0.8)	7,494 ( 2.1)	2610 (1.3)	2746 (1.4)	81 ( 2.6)	684 ( 3.4)	81 (2.6)	97 (3.1)
Elixhauser 16: Peptic ulcer disease excluding bleeding	323 ( 0.1)	829 ( 0.2)	310 (0.2)	277 (0.1)	19 ( 0.6)	149 ( 0.7)	19 (0.6)	21 (0.7)
Elixhauser 17: AIDS/HIV	230 ( 0.1)	1,054 ( 0.3)	229 (0.1)	398 (0.2)	1 ( 0.0)	6 ( 0.0)	1 (0.0)	2 (0.1)
Elixhauser 18: Lymphoma	390 ( 0.1)	770 ( 0.2)	366 (0.2)	267 (0.1)	49 ( 1.5)	262 ( 1.3)	49 (1.5)	31 (1.0)
Elixhauser 19: Metastatic cancer	343 ( 0.1)	1,099 ( 0.3)	334 (0.2)	401 (0.2)	50 ( 1.6)	314 ( 1.6)	50 (1.6)	39 (1.2)
Elixhauser 20: Solid tumor without Metastasis	2,483 ( 0.7)	6,235 ( 1.7)	2405 (1.2)	2287 (1.2)	308 ( 9.7)	2,022 ( 10.2)	308 (9.7)	270 (8.5)
Elixhauser 21: Rheumatoid Arthritis/collagen	3,566 ( 1.1)	8,917 ( 2.5)	3333 (1.7)	3664 (1.8)	208 ( 6.6)	1,177 ( 5.9)	208 (6.6)	157 (5.0)
Elixhauser 22: Coagulopathy	1,239 ( 0.4)	2,847 ( 0.8)	1096 (0.6)	1043 (0.5)	92 ( 2.9)	785 ( 3.9)	92 (2.9)	97 (3.1)
Elixhauser 23: Obesity	14,658 ( 4.4)	37,436 (10.3)	13227 (6.7)	15553 (7.8)	345 ( 10.9)	3,265 ( 16.4)	345 (10.9)	438 (13.8)
Elixhauser 24: Weight loss	1,332 ( 0.4)	2,138 ( 0.6)	979 (0.5)	999 (0.5)	71 ( 2.2)	669 ( 3.4)	71 (2.2)	68 (2.1)
Elixhauser 25: Fluid and electrolyte disorders	3,370 ( 1.0)	7,178 ( 2.0)	2761 (1.4)	2600 (1.3)	249 ( 7.9)	2,112 ( 10.6)	249 (7.9)	233 (7.4)
Elixhauser 26: Blood loss anemia	610 ( 0.2)	1,467 ( 0.4)	584 (0.3)	581 (0.3)	37 ( 1.2)	305 ( 1.5)	37 (1.2)	43 (1.4)
Elixhauser 27: Deficiency anemia	3560 ( 1.1)	8,434 ( 2.3)	3079 (1.5)	3353 (1.7)	149 ( 4.7)	1,455 ( 7.3)	149 (4.7)	190 (6.0)
Elixhauser 28: Alcohol abuse	1,005 ( 0.3)	2,332 ( 0.6)	973 (0.5)	908 (0.5)	12 ( 0.4)	222 ( 1.1)	12 (0.4)	23 (0.7)
Elixhauser 29: Drug abuse	1,078 ( 0.3)	3,009 ( 0.8)	1004 (0.5)	1280 (0.6)	31 ( 1.0)	225 ( 1.1)	31 (1.0)	33 (1.0)
Elixhauser 30: Psychoses	277 ( 0.1)	640 ( 0.2)	244 (0.1)	289 (0.1)	19 ( 0.6)	221 ( 1.1)	19 (0.6)	24 (0.8)
Elixhauser 31: Depression	18,484 ( 5.5)	34,288 ( 9.4)	15229 (7.7)	16440 (8.3)	377 ( 11.9)	3,200 ( 16.1)	377 (11.9)	401 (12.7)



**eAppendix Figure 1:** Pre- vs post-matching balance of age, sex and Elixhauser comorbidity index category, in the Commercial cohorts.



**eAppendix Figure 2:** Pre- vs post-matching balance of age, sex and Elixhauser comorbidity index category, in Medicare Supplemental cohorts.

