

Patient Characteristics and Costs Associated With COVID-19-Related Medical Care Among Medicare Fee-for-Service Beneficiaries

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Background: New cases of COVID-19 continue to occur daily in the United States, and the need for medical treatments continues to grow. Knowledge of the direct medical costs of COVID-19 treatments is limited.

Objective: To examine the characteristics of older adults with COVID-19 and their costs for COVID-19-related medical care.

Design: Retrospective observational study.

Setting: Medical claims for Medicare fee-for-service (FFS) beneficiaries.

Patients: Medicare FFS beneficiaries aged 65 years or older who had a COVID-19-related medical encounter during April through December 2020.

Measurements: Patient characteristics and direct medical costs of COVID-19-related hospitalizations and outpatient visits.

Results: Among 28.1 million Medicare FFS beneficiaries, 1 181 127 (4.2%) sought COVID-19-related medical care. Among these patients, 23.0% had an inpatient stay and 4.2% died during hospitalization. The majority of the patients were

female (57.0%), non-Hispanic White (79.6%), and residents of an urban county (77.2%). Medicare FFS costs for COVID-19-related medical care were \$6.3 billion; 92.6% of costs were for hospitalizations. The mean hospitalization cost was \$21 752, and the mean length of stay was 9.2 days; hospitalization cost and length of stay were higher if the patient needed a ventilator (\$49 441 and 17.1 days) or died (\$32 015 and 11.3 days). The mean cost per outpatient visit was \$164. Patients aged 75 years or older were more likely to be hospitalized, but their hospitalizations were associated with lower costs than for younger patients. Male sex and non-White race/ethnicity were associated with higher probability of being hospitalized and higher medical costs.

Limitation: Results are based on Medicare FFS patients.

Conclusion: The COVID-19 pandemic has resulted in substantial disease and economic burden among older Americans, particularly those of non-White race/ethnicity.

Primary Funding Source: None.

Ann Intern Med. doi:10.7326/M21-1102

Annals.org

For author, article, and disclosure information, see end of text.

This article was published at Annals.org on 1 June 2021.

As of 15 April 2021, more than 31.1 million confirmed COVID-19 cases and more than 560 000 deaths had been reported in the United States (1). These numbers are expected to increase, and the need for COVID-19 testing and treatments continues. The Families First Coronavirus Response Act ensures zero patient cost sharing for COVID-19 testing to anyone in the United States (2). Treatment after COVID-19 diagnosis is not free; payment is shared by patients, insurance payers, and health care providers, and the amount for which each stakeholder is responsible depends on the patient's insurance status and coverage.

Knowledge of the direct medical costs of COVID-19 treatments is limited. One published study used a simulation model to project direct medical costs during the course of COVID-19, including costs of ambulatory care, telephone consultations, over-the-counter medications, hospitalization, and postdischarge care (3). Because COVID-19-specific medical costs were not available, the study used costs of influenza and pneumonia care as proxies. Another report also used costs of influenza and pneumonia care to project COVID-19-related hospitalization costs (4).

The current study used a large administrative data set to examine characteristics and hospitalization risks among patients with COVID-19 who were aged 65 years or older—the age group most vulnerable to severe COVID-19 illness (5)—and to estimate the costs of hospitalizations and outpatient visits associated with the disease. Although studies

have examined characteristics of patients with COVID-19 and hospitalization risks in the older population, these studies were based on small samples, used data from the first few months of the pandemic, and focused on countries outside the United States (6–8). Understanding the medical costs specific to COVID-19 is crucial, particularly for health care providers, insurance payers, and U.S. health care systems, because it provides information needed to plan and allocate resources to treat patients with COVID-19 and also provides insights into the financial sustainability of the U.S. health care system in combating the pandemic. The cost estimates could also be used to assess the economic value of COVID-19 vaccination, which could inform recommendations on immunization schedules as the vaccine becomes available to the general U.S. population.

METHODS

Data

This study used 2020 Medicare fee-for-service (FFS) administrative claims data managed by the Centers for

See also:

Editorial comment

Medicare & Medicaid Services (CMS) (9). The CMS FFS database includes about 38 million Medicare beneficiaries enrolled in an FFS insurance plan, representing 62% of the total Medicare population (10). We used 4 data files: 1) the inpatient file, which contains institutional claims submitted by inpatient hospital providers; 2) the outpatient file, which contains institutional claims submitted by institutional outpatient providers (for example, hospital outpatient departments); 3) the carrier file, which contains noninstitutional claims submitted by individual providers and certain free-standing facilities (for example, clinical laboratories and ambulance service providers); and 4) the Master Beneficiary Summary files, which contain beneficiaries' enrollment and demographic information.

Although data through February 2021 are currently available, there is a lag between the date of service and when the claim is processed (11). Accordingly, our analysis included data from 1 April to 31 December 2020.

Study Population and Outcome Measure

The study population included adults aged 65 years or older who resided in any state or the District of Columbia; had a COVID-19-related hospitalization or outpatient visit claim with a date of outpatient visit, in-hospital death, or hospital discharge during 1 April through 31 December 2020; and were continuously enrolled in a Medicare FFS Part A and Part B insurance plan during the entire study period or until death. COVID-19-related medical encounters were identified if a medical claim included a principal or first-listed diagnosis code of U07.1, the International Classification of Diseases, Tenth Revision code that CMS has used since April 2020 to identify such encounters. One hospitalization may have had several claim records and, in a few cases (<1%), patients had more than 1 hospitalization associated with COVID-19. Evidence suggests that COVID-19 reinfections are rare (12, 13); therefore, we combined hospitalization claims if admission dates occurred within 6 months of the discharge date of the previous COVID-19-related hospitalization. Severe cases were defined as those requiring ventilator support and/or involving death. We used Medicare Severity Diagnosis Related Group codes 207 and 208 to define hospitalizations requiring ventilator support (14).

We examined patient characteristics and direct medical costs of COVID-19-related hospitalizations and outpatient visits. Patient characteristics included age (65 to 74, 75 to 84, and ≥ 85 years), sex (male vs. female), race/ethnicity (non-Hispanic White, non-Hispanic Black, Hispanic, Asian/Pacific Islander, and other), and county of residence (urban vs. rural). We determined whether a county was urban or rural on the basis of the National Center for Health Statistics classification schemes, and we defined rural counties as those in the 2 non-metropolitan categories and urban counties as those in the 4 metropolitan categories (15). We excluded patients who were missing information on selected characteristics (1.4% [$n = 16\,786$]). Medical costs were defined as the sum of patients' cost sharing (deductibles, coinsurance, and copayments) and Medicare reimbursements for inpatient and outpatient services. Costs for prescription drugs and costs incurred in long-term care facilities (for example, nursing homes and skilled-nursing facilities) were not considered. Our costs were based on Medicare reimbursements, which

likely differed from costs for providers and hospitals because COVID-19 does not have historical costs on which the Medicare diagnosis-related group payment system is based. When calculating costs, we excluded the 1.0% ($n = 2670$) of inpatient claims and the 5.0% ($n = 151\,581$) of outpatient claims that had a reimbursement amount of zero, which resulted from Medicare being the secondary payer (that is, the patient was covered by another insurance plan, such as workers' compensation) (16).

Statistical Analysis

Descriptive statistics were used to examine patient characteristics and the mean cost per COVID-19-related outpatient visit and hospitalization. Though we report median cost, we focused on mean cost because our goal was to provide key parameters to calculate total medical costs associated with COVID-19. We used logistic regressions to examine associations between patient characteristics and the probability of being hospitalized; we estimated the adjusted probability of hospitalization and the adjusted risk difference with respect to the reference group for each characteristic. We used linear regressions to examine associations between patient characteristics and COVID-19-related medical costs. All analyses of patient characteristics and medical costs were examined separately based on 5 medical outcomes: outpatient visits only, all hospitalizations, hospitalizations without ventilator support and death, hospitalizations with ventilator support, and in-hospital death. The last 2 outcomes were not mutually exclusive. We used robust SEs clustered at the state level in all regressions to account for the nonindependence of observations within the same state.

We sought to determine if and to what extent disease trends changed among the study population in April through December 2020. We present monthly trends in the number of patients and in the mean hospitalization cost by the month of outpatient visits and hospitalization discharge date. Because the same patient could seek COVID-19-related medical care across different months, we assigned the patient to the month that he or she made the first outpatient visit or had his or her inpatient stay. Statistical analyses were performed using Stata, version 16 (StataCorp).

This study was reviewed by the Centers for Disease Control and Prevention (CDC) and was conducted in accordance with applicable federal law and CDC policy. As an analysis of secondary data without identifiers, the study did not require institutional review board review.

Role of the Funding Source

This study received no external funding.

RESULTS

Patient Characteristics

During April through December 2020, 28.1 million Medicare FFS beneficiaries met our inclusion criteria, and 1 181 127 (4.2%) sought COVID-19-related medical care. Of these patients, 77.0% ($n = 909\,814$) had outpatient visits only, and 23.0% ($n = 271\,313$) had an inpatient stay (Table 1). Among hospitalized patients, 97.0%

Table 1. Characteristics of Patients With COVID-19*

Characteristic	All Patients (n = 1 181 127)	Outpatient Visit Only (n = 909 814)	Hospitalization†			
			All (n = 271 313)	Excluding Death or Ventilator (n = 215 455)	Ventilator (n = 21 775)‡	Death (n = 50 065)‡
Age, %						
65–74 y	43.3	45.2	36.6	38.1	46.8	27.8
75–84 y	32.9	31.6	37.2	36.9	40.3	38.3
≥85 y	23.8	23.2	26.3	25.0	12.9	33.9
Sex, %						
Female	57.0	58.8	51.0	52.6	41.8	44.6
Male	43.0	41.2	49.0	47.4	58.3	55.5
Race/ethnicity, %						
Non-Hispanic White	79.6	81.4	73.6	74.9	63.0	69.3
Non-Hispanic Black	9.4	8.4	12.6	12.2	17.2	13.6
Hispanic	7.4	6.9	9.3	8.8	13.8	11.5
Asian/Pacific Islander	2.1	2.1	2.4	2.3	2.9	2.9
Other	1.5	1.3	2.0	1.9	3.1	2.7
County of residence, %						
Rural	22.8	22.5	23.8	23.7	25.3	23.6
Urban	77.2	77.5	76.3	76.3	74.7	76.4

* Source: Centers for Medicare & Medicaid Services Medicare fee-for-service administrative claims data for April through December 2020. This analysis included 1 181 127 patients with COVID-19 who were aged ≥65 years; resided in any state or the District of Columbia; and had a COVID-19–related hospitalization or outpatient visit claim with a date of visit, in-hospital death, or hospital discharge during April through December 2020. The International Classification of Diseases, Tenth Revision code U07.1 was used to identify COVID-19–related outpatient visits and hospitalizations, and the Medicare Severity Diagnosis Related Group codes 207 and 208 were used to identify hospitalized patients with COVID-19 who needed ventilator support.

† Includes hospitalized patients with or without outpatient visits; 97.0% of hospitalized patients had ≥1 outpatient visit.

‡ Hospitalized patients who died and those who needed ventilator support were not mutually exclusive.

(n = 263 056) also had outpatient visits, 8.0% (n = 21 775) needed ventilator support, and 18.5% (n = 50 065) died during hospitalization; 68.1% (n = 34 083) of patients who died in the hospital did not have ventilator support. Most patients were female (57.0%), non-Hispanic White (79.6%), and residents of an urban county (77.2%). Patients aged 65 to 74 years accounted for the largest proportion (43.3%), followed by those aged 75 to 84 years (32.9%) and those aged 85 years or older (23.8%).

The characteristics of hospitalized patients were similar to those of patients with outpatient visits only, with some exceptions. First, Medicare beneficiaries aged 65 to 74 years accounted for the largest proportion of patients with outpatient visits only, whereas patients aged 75 years or older accounted for 72.2% of those who died during hospitalization. Similarly, males accounted for a larger proportion of patients who died (55.5%) and a larger proportion of those who needed ventilator support (58.3%), but the majority of patients with outpatient visits only were female. Second, although non-Hispanic Black and Hispanic patients respectively made up 8.4% and 6.9% of patients with outpatient visits only, they accounted for 17.2% and 13.8% of hospitalized patients requiring ventilator support and 13.6% and 11.5% of inpatient deaths.

Among Medicare beneficiaries who sought medical care associated with COVID-19, the probabilities of being hospitalized for those aged 75 to 84 years and those

aged 85 years or older were 7.3 (95% CI, 6.7 to 7.8) and 7.7 (CI, 6.4 to 9.0) percentage points higher and the probabilities of dying in the hospital were 2.9 (CI, 2.6 to 3.1) and 4.7 (CI, 4.1 to 5.3) percentage points higher than for those aged 65 to 74 years, respectively (Table 2). The probabilities for male patients to be hospitalized and to die in the hospital were 6.2 (CI, 5.8 to 6.6) and 2.5 (CI, 2.3 to 2.6) percentage points higher than for female patients, respectively. Compared with non-Hispanic White patients, the probability of being hospitalized was higher among non-Hispanic Black (10.8 [CI, 9.6 to 11.9] percentage points), Hispanic (8.8 [CI, 7.6 to 10.0] percentage points), and Asian/Pacific Islander (5.4 [CI, 1.8 to 9.0] percentage points) patients. These racial/ethnic groups were also more likely to die or need ventilator support during hospitalization than non-Hispanic White patients. Finally, patients residing in urban counties were 2.2 (CI, –3.4 to –1.0) percentage points less likely to be hospitalized than those residing in rural counties.

Costs of COVID-19–Related Outpatient Visits and Hospitalizations

During April through December 2020, total medical costs for COVID-19–related medical care for patients in this study were \$6.3 billion, with \$466.8 million (7.4%) for outpatient visits and \$5.8 billion (92.6%) for hospitalizations (Table 3). Most hospitalization costs (67.4% [\$3.9 billion])

Table 2. Association of Patient Demographic Characteristics With Hospitalization*

Characteristic	All Hospitalizations		Excluding Death or Ventilator		Ventilator		Death	
	Adjusted Probability (95% CI), %	aRD (95% CI), percentage points	Adjusted Probability (95% CI), %	aRD (95% CI), percentage points	Adjusted Probability (95% CI), %	aRD (95% CI), percentage points	Adjusted Probability (95% CI), %	aRD (95% CI), percentage points
Probability of hospitalization, %†		23.0		18.2		1.8		4.2
Age								
65–74 y (reference)	19.0 (18.1 to 20.0)	–	15.8 (14.9 to 16.7)	–	1.9 (1.8 to 2.1)	–	2.7 (2.5 to 2.8)	–
75–84 y	25.9 (24.6 to 27.3)	7.3 (6.7 to 7.8)	20.5 (19.2 to 21.8)	4.9 (4.3 to 5.4)	2.2 (2.1 to 2.4)	0.3 (0.2 to 0.3)	4.9 (4.6 to 5.2)	2.9 (2.6 to 3.1)
≥85 y	26.2 (24.6 to 27.9)	7.7 (6.4 to 9.0)	19.7 (18.0 to 21.3)	4.1 (3.0 to 5.3)	1.1 (0.9 to 1.2)	–0.9 (–1.1 to –0.8)	6.4 (5.8 to 7.1)	4.7 (4.1 to 5.3)
Sex								
Female (reference)	20.3 (19.3 to 21.4)	–	16.7 (15.7 to 17.8)	–	1.5 (1.4 to 1.6)	–	3.6 (3.4 to 3.9)	–
Male	26.5 (25.2 to 27.8)	6.2 (5.8 to 6.6)	20.3 (19.0 to 21.6)	3.6 (3.2 to 3.9)	2.4 (2.3 to 2.6)	1.0 (1.0 to 1.1)	5.7 (5.3 to 6.1)	2.5 (2.3 to 2.6)
Race/ethnicity								
Non-Hispanic White (reference)	21.1 (20.1 to 22.2)	–	17.1 (16.0 to 18.1)	–	1.4 (1.3 to 1.5)	–	3.2 (3.0 to 3.5)	–
Non-Hispanic Black	31.7 (30.0 to 33.3)	10.8 (9.6 to 11.9)	24.2 (22.7 to 25.8)	7.3 (6.4 to 8.2)	3.4 (3.1 to 3.7)	2.2 (1.9 to 2.4)	6.6 (5.7 to 7.4)	3.2 (2.5 to 3.9)
Hispanic	29.6 (27.9 to 31.4)	8.8 (7.6 to 10.0)	21.9 (20.3 to 23.6)	5.0 (4.0 to 6.0)	3.4 (3.2 to 3.6)	2.3 (2.0 to 2.5)	7.0 (6.5 to 7.4)	3.6 (3.1 to 4.1)
Asian/Pacific Islander	26.2 (22.3 to 30.2)	5.4 (1.8 to 9.0)	19.9 (16.7 to 23.0)	2.9 (0.1 to 5.7)	2.6 (2.1 to 3.2)	1.4 (0.9 to 2.0)	5.8 (4.7 to 6.8)	2.4 (1.4 to 3.4)
Other	31.6 (27.1 to 36.1)	10.9 (6.6 to 15.2)	22.9 (19.9 to 25.9)	6.1 (3.4 to 8.8)	3.6 (2.9 to 4.3)	2.6 (1.8 to 3.5)	7.9 (6.4 to 9.5)	4.8 (3.1 to 6.5)
County of residence								
Rural (reference)	24.7 (24.0 to 25.4)	–	19.4 (18.8 to 20.0)	–	2.2 (2.0 to 2.3)	–	4.7 (4.5 to 4.9)	–
Urban	22.5 (21.1 to 23.9)	–2.2 (–3.4 to –1.0)	17.9 (16.5 to 19.3)	–1.5 (–2.7 to –0.3)	1.8 (1.6 to 1.9)	–0.4 (–0.6 to –0.2)	4.1 (3.8 to 4.5)	–0.6 (–0.9 to –0.2)

aRD = adjusted risk difference with respect to the reference category.

* Source: Centers for Medicare & Medicaid Services Medicare fee-for-service administrative claims data for April through December 2020. This analysis included 1 181 127 patients with COVID-19 who were aged ≥65 years; resided in any state or the District of Columbia; and had a COVID-19–related hospitalization or outpatient visit claim with a date of visit, in-hospital death, or hospital discharge during April through December 2020. The International Classification of Diseases, Tenth Revision code U07.1 was used to identify COVID-19–related hospitalizations, and the Medicare Severity Diagnosis Related Group codes 207 and 208 were used to identify hospitalized patients with COVID-19 who needed ventilator support. All logistic regressions used robust SEs clustered at the state level to account for the nonindependence of observations within the same state.

† Number of patients for each hospitalization outcome divided by total number of patients with COVID-19 (n = 1 181 127).

were for hospitalizations that did not require ventilator support or involve death. However, 18.3% (\$1.1 billion) and 27.2% (\$1.6 billion) of hospitalization costs were for those requiring ventilator support and those involving death, although they accounted for only 8.0% and 18.5% of total hospitalizations, respectively.

The mean cost per hospitalization was \$21 752, and the mean length of inpatient stay was 9.2 days. Mean cost was higher if the patient died in the hospital (\$32 015) and was highest if the patient needed ventilator support during hospitalization (\$49 441). The mean cost per outpatient visit for patients who were not hospitalized was \$164; the mean number of outpatient visits per patient was 3.2.

Table 3 presents mean costs by patient characteristics. Male patients incurred higher medical costs than female patients, regardless of medical outcome. The mean hospitalization cost decreased with increasing age; patients aged 65 to 74 years incurred the highest costs compared with patients in older age groups. Non-Hispanic White patients had the lowest outpatient cost (\$161 [CI, \$152 to \$169]) and hospitalization cost (\$20 382 [CI, \$19 267 to \$21 498]) compared with patients in all other racial and ethnic groups, regardless of medical outcome. Finally, cost per outpatient visit was lower for urban residents (\$156 [CI, \$131 to \$182]) than rural residents (\$196 [CI, \$184 to \$208]).

Table 3. COVID-19-Related Medical Costs per Outpatient Visit and per Hospitalization, by Patient Demographic Characteristics*

Characteristic	Outpatient Visits (n = 2 844 298)	Hospitalizations†			
		All (n = 268 706)	Excluding Death or Ventilator (n = 213 340)	Ventilator (n = 21 606)‡	Death (n = 49 602)‡
Mean visits per patient, n	3.2	-	-	-	-
Mean length of stay, d	-	9.2	8.4	17.1	11.3
Median length of stay, d	-	6	6	15	9
Total cost, \$	466 849 888	5 844 843 520	3 938 161 152	1 068 212 224	1 588 009 856
Mean cost, \$	164	21 752	18 460	49 441	32 015
Median cost, \$	98	16 254	15 593	44 176	20 924
Mean cost (95% CI), by patient characteristic, \$					
Age					
65-74 y (reference)	166 (157-175)	23 916 (22 208-25 624)	19 405 (18 024-20 786)	53 641 (50 674-56 608)	42 475 (40 129-44 821)
75-84 y	168 (156-179)	21 837 (19 852-23 823)	18 424 (16 773-20 074)	47 361 (43 643-51 080)	32 613 (29 302-35 924)
≥85 y	157 (143-172)	18 637 (16 426-20 849)	17 078 (15 224-18 932)	40 706 (36 449-44 964)	22 794 (18 847-26 740)
Sex					
Female (reference)	160 (150-170)	20 536 (19 192-21 879)	17 897 (16 810-18 984)	48 952 (46 326-51 578)	29 753 (28 183-31 324)
Male	169 (156-182)	23 019 (21 302-24 736)	19 085 (17 735-20 434)	49 792 (46 007-53 577)	33 839 (31 427-36 251)
Race/ethnicity					
Non-Hispanic White (reference)	161 (152-169)	20 382 (19 267-21 498)	17 666 (16 730-18 603)	47 288 (45 344-49 232)	29 540 (28 338-30 742)
Non-Hispanic Black	164 (149-179)	23 819 (21 835-25 803)	19 731 (18 014-21 448)	48 995 (44 906-53 083)	34 586 (31 909-37 263)
Hispanic	186 (160-212)	27 309 (23 831-30 787)	21 791 (19 344-24 238)	57 295 (49 065-65 524)	40 485 (34 402-46 569)
Asian/Pacific Islander	183 (149-217)	26 435 (23 741-29 128)	21 769 (19 297-24 241)	55 318 (50 578-60 059)	39 130 (36 502-41 759)
Other	211 (174-248)	27 507 (24 579-30 436)	22 303 (19 643-24 963)	55 410 (50 447-60 374)	38 921 (35 487-42 355)
County of residence					
Rural (reference)	196 (184-208)	20 746 (20 104-21 388)	17 466 (16 878-18 054)	47 573 (45 942-49 204)	30 825 (29 886-31 764)
Urban	156 (131-182)	22 066 (19 675-24 457)	18 769 (16 787-20 750)	50 074 (45 108-55 039)	32 383 (29 360-35 405)

* Source: Centers for Medicare & Medicaid Services Medicare fee-for-service administrative claims data for April through December 2020. This analysis excluded COVID-19 medical encounters with zero Medicare reimbursements and combined hospitalization claims for the same patient if hospital admission dates occurred within 6 months of the discharge date of the previous COVID-19-related hospitalization. The analysis included 2 844 298 COVID-19-related outpatient visits and 268 706 COVID-19-related hospitalizations. The International Classification of Diseases, Tenth Revision code U07.1 was used to identify COVID-19-related outpatient visits and hospitalizations, and the Medicare Severity Diagnosis Related Group codes 207 and 208 were used to identify hospitalized patients with COVID-19 who needed ventilator support.

† This category included hospitalized patients with or without outpatient visits; 97.0% of hospitalized patients had ≥1 outpatient visit.

‡ Hospitalized patients who died and those who needed ventilator support were not mutually exclusive.

Cost per outpatient visit was \$7.8 (CI, \$5.2 to \$10.5) higher and cost per hospitalization was \$2250 (CI, \$1906 to \$2594) higher for male than female patients (Table 4). Compared with patients aged 65 to 74 years, hospitalization cost was \$1712 (CI, -\$1937 to -\$1488) lower for patients aged 75 to 84 years and \$4590 (CI, -\$5007 to -\$4173) lower for patients aged 85 years or older; the corresponding cost differences were \$9349 (CI, -\$10 204 to -\$8494) and \$18 747 (CI, -\$20 179 to -\$17 315), respectively, when we looked at in-hospital death. All racial/ethnic groups, particularly Hispanics and Asian/Pacific Islanders, incurred higher medical costs than non-Hispanic Whites; outpatient costs for Hispanics and Asian/Pacific Islanders were at least \$30 higher and their

costs for hospitalizations involving death or requiring ventilator support were at least \$8447 higher than among non-Hispanic Whites. Finally, outpatient cost for urban patients was \$42 (CI, -\$53 to -\$30) lower than for patients in rural counties, and hospitalization cost was \$968 (CI, -\$528 to \$2464) higher for patients in urban counties.

Monthly Trends in the Number of Patients With COVID-19 and Hospitalization Costs

The number of patients with COVID-19 generally increased during the study period (Figure, top). The increase primarily occurred during September to December 2020, with patient counts in inpatient and outpatient care more than quadrupling. Trends in the

Table 4. Adjusted Average Differences and 95% CIs in COVID-19–Related Medical Costs, by Patient Demographic Characteristics*

Characteristic	Adjusted Average Cost Difference (95% CI), \$				
	Outpatient Visits (n = 2 844 298)	All (n = 268 706)	Excluding Death or Ventilator (n = 213 340)	Hospitalizations Ventilator (n = 21 606)	Death (n = 49 602)
Age (reference: 65–74 y)					
75–84 y	3.1 (0.2 to 5.9)	–1712 (–1937 to –1488)	–752 (–977 to –526)	–6093 (–6808 to –5378)	–9349 (–10 204 to –8494)
≥85 y	–3.7 (–9.6 to 2.1)	–4590 (–5007 to –4173)	–1931 (–2350 to –1511)	–13 047 (–14 341 to –11 753)	–18 747 (–20 179 to –17 315)
Sex (reference: female)					
Male	7.8 (5.2 to 10.5)	2250 (1906 to 2594)	1111 (865 to 1358)	718 (–454 to 1889)	2878 (2113 to 3643)
Race/ethnicity (reference: Non-Hispanic White)					
Non-Hispanic Black	6.9 (1.1 to 12.6)	3012 (2272 to 3753)	1805 (1151 to 2459)	1413 (–682 to 3508)	3270 (1839 to 4700)
Hispanic	30.3 (12.3 to 48.3)	6411 (4268 to 8555)	3803 (2477 to 5128)	9489 (3571 to 15 408)	9040 (4513 to 13 568)
Asian/Pacific Islander	29.9 (4.9 to 54.8)	5814 (4402 to 7227)	3819 (2479 to 5159)	8447 (5500 to 11 394)	9849 (8139 to 11 558)
Other	45.2 (19.7 to 70.7)	6882 (5076 to 8689)	4648 (2894 to 6403)	7938 (4974 to 10 902)	7349 (5083 to 9616)
County of residence (reference: rural)					
Urban	–41.5 (–53.0 to –30.1)	968 (–528 to 2464)	1061 (–177 to 2298)	1940 (–731 to 4610)	1392 (–345 to 3128)

* Source: Centers for Medicare & Medicaid Services Medicare fee-for-service administrative claims data for April through December 2020. The estimates are the results of a regression analysis. The International Classification of Diseases, Tenth Revision code U07.1 was used to identify COVID-19–related outpatient visits and hospitalizations, and the Medicare Severity Diagnosis Related Group codes 207 and 208 were used to identify hospitalized patients with COVID-19 who needed ventilator support. All regressions used robust SEs clustered at the state level to account for the nonindependence of observations within the same state.

number of hospitalized patients who needed a ventilator or died in the hospital were flat during the study period. For all hospitalization types, the mean cost per hospitalization increased in May and June 2020 and decreased in July 2020; during July to December 2020, the mean hospitalization cost remained steady (Figure, bottom).

DISCUSSION

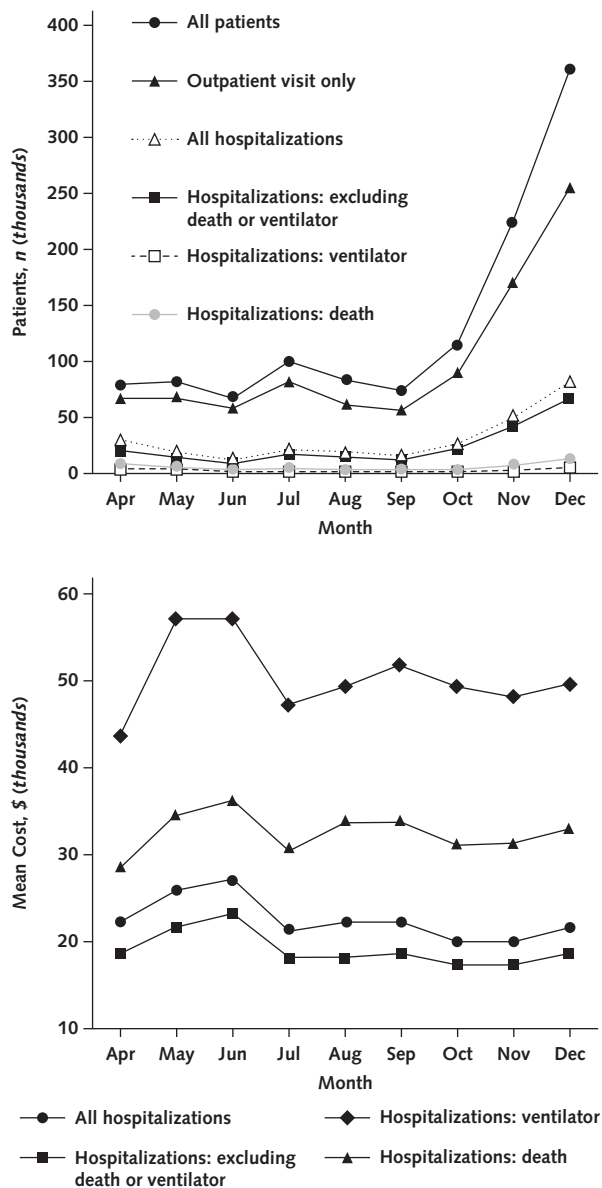
As of 23 January 2021, the U.S. hospitalization rate for COVID-19 was 15.7 per 100 000 persons (17) and the mortality rate was 1.7% (1). Using the uniquely large and representative sample of Medicare FFS beneficiaries, this study showed that COVID-19 disease burden among adults aged 65 years or older was substantially higher than in the general U.S. population: The hospitalization rate was more than 60 times higher (966 per 100 000 Medicare FFS beneficiaries), and the mortality rate was 2.5 times higher (4.2%). Existing data and studies have shown that age and sex are associated with COVID-19 mortality (1, 7, 18, 19). As of 1 March 2021, the CDC COVID Data Tracker reported that the mortality rate was 9.9% among adults aged 65 years or older versus 0.4% among those aged 64 years or younger (1). Yanez and colleagues (19) reported that the mortality rate was more than 62 times higher among adults aged 65 years or older compared with those aged 54 years or younger

and was 77% higher in men than in women. Our results are consistent with these findings.

One novel finding from this study is that costs of COVID-19–related hospitalization decreased with age for the 5 medical outcomes considered. Possible reasons include higher mortality rates among older patients, resulting in shorter hospital stays and lower costs (our finding that the inpatient length of stay was shorter among patients aged ≥75 years than among those aged 65 to 74 years is consistent with this); the lower likelihood of younger adults to become seriously ill (those who reached the point of hospitalization may have had substantial risks and complications [20]); and less aggressive care with increasing age. Previous studies found that the percentage of hospital admissions that included intensive care unit stays decreased with age, as did the frequency of ventilator use, and that among patients admitted to an intensive care unit, older age was associated with higher rates of decisions to withhold aggressive care (21–23).

We found that 68.1% of patients who died in the hospital did not have ventilator support. The main reason might be related to age. Our data indicated that 80% of these patients were aged 75 years or older. Mortality rates were higher among older patients; the probability of dying before receiving ventilator support might be higher among older than younger hospitalized patients (24). Existing studies

Figure. Number of patients with COVID-19 (*top*) and costs per COVID-19–related hospitalization (*bottom*), by month.



Source: Centers for Medicare & Medicaid Services Medicare fee-for-service administrative claims data for April through December 2020. The International Classification of Diseases, Tenth Revision code U07.1 was used to identify COVID-19–related outpatient visits and hospitalizations, and the Medicare Severity Diagnosis Related Group codes 207 and 208 were used to identify hospitalized patients with COVID-19 who needed ventilator support. The analysis of the number of patients with COVID-19 included 1 181 127 patients who were aged ≥65 years; resided in any state or the District of Columbia; and had a COVID-19–related hospitalization or outpatient visit claim with a date of visit, in-hospital death, or hospital discharge during April through December 2020. The analysis of costs per COVID-19–related hospitalization included 268 706 hospitalizations.

and our study showed decreasing ventilator use with advancing age of patients with COVID-19 (25, 26). As mentioned earlier, older patients were more likely to decline aggressive care. One published study also

showed that ventilator use was not associated with mortality among older patients with COVID-19 (26). When considering the potential complications of using ventilators and the probability of survival, providers might also be less likely to recommend ventilator support to older patients. This could also explain why a large proportion of older patients died without ventilator support.

Our findings on hospitalization cost (\$21 752), length of stay (9.2 days), and outpatient cost (\$164) were higher than assumptions used in existing studies. Bartsch and colleagues (3) assumed a cost per COVID-19 outpatient visit of \$142 and a cost per COVID-19 hospitalization of \$6887 to \$12 264, depending on patients' age and disease severity. Using these assumptions, they projected that the median cost during the course of a COVID-19 case that needed only outpatient visits was \$96 for adults aged 65 years or older; for cases requiring an inpatient stay, the median cost was \$14 859 for adults aged 65 to 84 years and \$11 900 for adults aged 85 years or older (3). Using the Medicare reimbursement rate for hospitalizations for influenza and pneumonia, and assuming a length of 6 days for a COVID-19 inpatient stay, FAIR Health estimated an average hospitalization cost of \$10 561 per Medicare patient (4). Our results show that the economic burden of COVID-19 is greater than previous studies have suggested. Furthermore, our estimates of the economic burden are likely conservative due to the exclusion of costs incurred in other medical settings and potential long-term sequelae (27, 28).

We observed racial and ethnic disparities in COVID-19–related costs: Racial and ethnic minority patients incurred higher medical costs than non-Hispanic White patients, and non-Hispanic Black and Hispanic patients accounted for disproportionately high numbers of hospitalizations requiring ventilator support and inpatient deaths. As of this writing, 3 COVID-19 vaccines have been authorized for emergency use (29). A nationally representative survey conducted in December 2020 tracked the public's attitudes and experiences with COVID-19 vaccination and reported that 35% of Black adults definitely or probably would not get vaccinated (30); our study found that this population had a higher probability of being hospitalized and higher medical costs per hospitalization. Taken together, our findings suggest that identifying effective strategies to promote COVID-19 vaccine uptake among disproportionately affected racial and ethnic minority populations is critical.

Although public health officials and health care professionals have persistently noted high risks for severe COVID-19 illness among older adults and have strongly advised limiting in-person interactions with other people in addition to other infection control practices (5), our data showed an increasing trend in the number of patients with COVID-19, with the number of hospitalized patients more than quadrupling between September and December 2020. However, the number of severe cases requiring hospitalization was steady during the study period, and the mean hospitalization cost decreased in July 2020 and then remained stable. In addition to providers' growing

knowledge about the virus and experiences with treating patients, these results might also be due to new treatments developed over the course of the pandemic (29).

This study has limitations. First, it is based on Medicare FFS claims files because data on managed care claims are not available. Therefore, the results are not generalizable to all Medicare beneficiaries. However, we suspect that the results regarding the characteristics of patients with COVID-19 would be similar between Medicare FFS and managed care beneficiaries given that our results were consistent with those of existing studies that used various data sources (18, 19, 31). Previous studies have documented similar reimbursement rates between Medicare FFS and managed care plans over time (32, 33), suggesting that COVID-19-related medical costs between FFS and managed care beneficiaries might also be similar. However, further investigation is needed to verify the COVID-19-related medical costs of Medicare managed care enrollees. Second, the CMS Medicare database is generated from insurance claims; thus, this study did not capture people with asymptomatic COVID-19 and patients with minor symptoms that did not require medical attention, those who died before receiving care, or those who were misdiagnosed as not having COVID-19. However, misdiagnosis is becoming less common as providers gain knowledge about the virus, and most providers would submit claims to receive payments. In addition, this limitation should not affect our cost estimates because patients who did not seek care would not be included in the analysis.

Using data covering the claims of 28.1 million Medicare FFS beneficiaries, this study showed a high hospitalization and mortality rate among older Americans with COVID-19. The disease and economic burden of COVID-19 was higher among the racial and ethnic minority populations than among non-Hispanic White patients. As the pandemic continues, it is critical to continuously promote mitigation behaviors and vaccination among older adults to prevent infection and transmission of the virus. Identifying effective strategies to promote vaccine uptake is critical, and efforts are particularly needed among non-White persons aged 65 years or older to mitigate the increased disease and economic burden of COVID-19.

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Disclaimer: The findings and conclusions of this study are those of the authors and do not necessarily represent the official position of the Centers for Disease Control and Prevention.

Disclosures: Authors have reported no disclosures of interest. Forms can be viewed at www.acponline.org/authors/icmje/ConflictOfInterestForms.do?msNum=M21-1102.

Reproducible Research Statement: *Study protocol and data set:* Not available. *Statistical code:* Available from Dr. Tsai (e-mail, ytsai@cdc.gov).

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