health systems established COVID-19–only hospitals as the pandemic progressed, our strategy was informed by the ORTP planning tools, which helped to shape the early planning process. When the first patient was hospitalized at BPH, HCWs were ready to care for that patient and were confident in their training. Having a cadre of nurses, respiratory therapists, and physicians trained in advance to care for patients with COVID-19 was critical in alleviating anxiety, which was expressed by many HCWs throughout the United States. Our model allowed safe care for patients and optimized HCW safety.

The advantages of this model were that PPE use was consolidated, and staff became adept at donning and doffing PPE correctly and identifying best practices to conserve PPE. Concentrating training among a core group of HCWs who then trained others allowed us to quickly train all needed personnel. Having most patients with COVID-19 in one facility allowed patient care protocols to be standardized, bolstered diagnostic and testing capabilities, and facilitated communication among staff.

The main disadvantages of this model of care were that we did not anticipate that patients in Michigan would not be allowed to be transferred to Ohio. This meant that we needed to rapidly duplicate our process in Michigan. Also, transferring critically ill patients at a time when rapid testing was not available meant that patients were transferred with suspected rather than confirmed illness.

Our experience suggests that a hospital dedicated entirely to a novel infection may be a useful strategy for healthcare systems in pandemic planning. This strategy should be considered by large health systems in their advanced planning for future pandemics.

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Monthly trend in mortality and length of stay among coronavirus disease 2019 (COVID-19) patients: Analysis of a nationwide multihospital US database

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Since emerging in the first quarter of 2020, 33.6 million identified cases of coronavirus disease 2019 (COVID-19) caused by severe acute respiratory coronavirus virus 2 (SARS-CoV-2) have been reported, including >603,000 associated deaths in the United States as of mid-July, 2021. Recent evidence suggests that the case fatality rate has been declining among COVID-19 patients, with one study reporting at least a 34% decline over a 3-month period among all age groups. However, these studies have been restricted in their generalizability with samples limited to a single state or health system.

Methods
Using a nationwide, multihospital database, the Premier Healthcare Database (PHD), we identified patients with a diagnosis of COVID-19 (ICD-10-CM U07.1) admitted to an inpatient setting (ie, the first admission was considered the index admission). To be included, hospitals were required to provide continuous inpatient data from April 1, 2020 until July 31, 2020, to the PHD. We...
| Characteristics | April | May | June | July | P Value* |
|-----------------|------|-----|------|------|---------|
| Total No.       | 21,736 | 11,640 | 9,159 | 10,729 |
| Deceased, No. (%) | 4,543 (20.9) | 1,552 (13.3) | 853 (9.3) | 825 (7.7) | <.0001 |
| LOS, d (mean)   | 9.37 (10.12) | 9.02 (9.56) | 7.47 (7.22) | 5.30 (4.31) | <.0001 |
| Age y (continuous) | 64.13 (17.05) | 61.02 (19.28) | 58.04 (19.36) | 58.84 (19.19) | <.0001 |
| Age y (categorical), no. (%) | | | | | |
| <18             | 107 (0.5) | 158 (1.4) | 93 (1.0) | 132 (1.2) | |
| 18–39           | 1,966 (9.0) | 1,629 (14.0) | 1,765 (19.3) | 1,824 (17.0) | <.0001 |
| 40–49           | 2,075 (9.5) | 1,294 (11.1) | 1,134 (12.4) | 1,323 (12.3) | |
| 50–59           | 3,645 (16.8) | 1,906 (16.4) | 1,565 (17.1) | 1,811 (16.9) | |
| 60–69           | 5,029 (23.1) | 2,307 (19.8) | 1,676 (18.3) | 2,110 (19.7) | |
| 70–79           | 4,319 (19.9) | 2,063 (17.7) | 1,519 (16.6) | 1,851 (17.3) | |
| 80+             | 4,595 (21.1) | 2,283 (19.6) | 1,407 (15.4) | 1,578 (15.6) | |
| Sex, no. (%)    | | | | | |
| Male            | 11,656 (53.6) | 5,843 (50.2) | 4,501 (49.1) | 5,282 (49.2) | <.0001 |
| Female          | 10,080 (46.4) | 5,797 (49.8) | 4,658 (50.9) | 5,447 (50.8) | |
| Race, no. (%)   | | | | | |
| White           | 8,649 (39.8) | 5,429 (46.6) | 4,730 (51.6) | 6,091 (56.8) | <.0001 |
| African American| 5,017 (23.1) | 2,573 (22.1) | 2,165 (23.6) | 2,644 (24.6) | |
| Other/Unknown   | 8,070 (37.1) | 3,638 (31.3) | 2,264 (24.7) | 1,994 (18.6) | |
| Payer, no. (%)  | | | | | |
| Commercial      | 4,735 (21.8) | 2,327 (20.0) | 2,251 (24.6) | 2,739 (25.5) | <.0001 |
| Medicare        | 11,589 (53.3) | 5,740 (49.3) | 3,944 (43.1) | 4,854 (45.2) | |
| Medicaid        | 4,020 (18.5) | 2,472 (21.2) | 1,603 (17.5) | 1,661 (15.5) | |
| Other           | 1,392 (6.4) | 1,101 (9.5) | 1,361 (14.9) | 1,475 (13.7) | |
| Marital status, no. (%) | | | | | |
| Single          | 11,867 (54.6) | 6,602 (56.7) | 4,937 (53.9) | 5,609 (52.3) | <.0001 |
| Married         | 8,089 (37.2) | 3,996 (34.3) | 3,658 (39.9) | 4,611 (43.0) | |
| Other/Missing   | 1,780 (8.2) | 1,042 (9.0) | 564 (6.2) | 509 (4.7) | |
| Elixhauser score (continuous), no. (%) | 3.71 (2.27) | 3.71 (2.40) | 3.34 (2.30) | 3.20 (2.16) | <.0001 |
| Elixhauser score (categorical), no. (%) | | | | | |
| 0               | 1,308 (6.0) | 957 (8.2) | 916 (10.0) | 1,067 (9.9) | <.0001 |
| 1–2             | 5,816 (26.8) | 3,007 (25.8) | 2,773 (30.3) | 3,369 (31.4) | |
| 3–4             | 7,336 (33.8) | 3,621 (31.1) | 2,836 (31.0) | 3,559 (33.2) | |
| ≥5              | 7,276 (33.5) | 4,055 (34.8) | 2,634 (28.8) | 2,734 (25.5) | |
| Hospital location, no. (%) | | | | | |
| Urban           | 20,636 (94.9) | 10,892 (93.6) | 8,469 (92.5) | 9,527 (88.8) | <.0001 |
| Rural           | 1,100 (5.1) | 748 (6.4) | 690 (7.5) | 1,202 (11.2) | |
| No. of beds     | | | | | |
| 0–299           | 6,989 (32.2) | 3,720 (32.0) | 2,789 (30.5) | 3,652 (34.0) | .0188 |
| 300–499         | 6,815 (31.4) | 3,659 (31.4) | 2,768 (30.2) | 3,112 (29.0) | |
| ≥500            | 7,332 (36.5) | 4,261 (36.6) | 3,602 (39.3) | 3,965 (37.0) | |
| Teaching hospital, no. (%) | | | | | |
| No              | 8,103 (37.3) | 5,270 (45.3) | 4,722 (51.6) | 5,971 (55.7) | <.0001 |
| Yes             | 13,633 (62.7) | 6,370 (54.7) | 4,437 (48.4) | 4,758 (44.3) | |

(Continued)
examined monthly trends (April 2020–July 2020) in mortality and length of stay (LOS) among the hospitalized patients. Then we assessed the relationship between admission month and study outcomes using a generalized estimating equations (GEE) model accounting for potential clustering of outcomes within hospitals, and adjusting for patient characteristics (age, gender, race, marital status, and payer), comorbidity status (Elixhauser comorbidity index score), provider characteristics (region, number of beds, location, and teaching hospital or not), and treatments for COVID-19 (admit to intensive care unit, use of ventilators, Table 1. (Continued)

| Characteristics          | April No. (%)/Mean (SD) | May No. (%)/Mean (SD) | June No. (%)/Mean (SD) | July No. (%)/Mean (SD) | P Valuea |
|--------------------------|-------------------------|-----------------------|------------------------|------------------------|----------|
| Provider region, no. (%) |                         |                       |                        |                        |          |
| Northeast                | 12,992 (59.8)           | 3,954 (34.0)          | 1,182 (12.9)           | 667 (6.2)              | <.0001   |
| Midwest                  | 3,845 (17.7)            | 3,410 (29.3)          | 1,794 (19.6)           | 1,761 (16.4)           |          |
| West                     | 515 (2.4)               | 311 (2.7)             | 505 (5.5)              | 611 (5.7)              |          |
| South                    | 4,384 (20.2)            | 3,965 (34.1)          | 5,678 (62.0)           | 7,690 (71.7)           |          |
| Admission to ICU         | 5,139 (23.6)            | 2,966 (25.5)          | 2,214 (24.2)           | 2,006 (18.7)           | <.0001   |
| Mechanical ventilator    | 4,192 (19.3)            | 1,823 (15.7)          | 1,010 (11.0)           | 713 (6.6)              | <.0001   |
| Hydroxychloroquine       | 11,344 (52.2)           | 1,060 (9.1)           | 102 (1.1)              | 101 (0.9)              | <.0001   |
| Azithromycin             | 11,253 (51.8)           | 4,631 (39.8)          | 1,010 (11.0)           | 713 (6.6)              | <.0001   |
| Remdesivir               | 79 (0.4)                | 651 (5.6)             | 1,199 (13.1)           | 1,138 (10.6)           | <.0001   |
| convalescent plasma      | 339 (1.6)               | 359 (3.1)             | 285 (3.1)              | 250 (2.3)              | <.0001   |
| Mechanical ventilator    |                         |                       |                        |                        |          |
| Anticoagulants           | 18,905 (87.0)           | 10,244 (88.0)         | 7,875 (86.0)           | 9,117 (85.0)           | <.0001   |
| Dexamethasone            | 1,032 (4.7)             | 958 (8.2)             | 3,143 (34.3)           | 6566 (61.2)            | <.0001   |
| Methylprednisolone       | 5,084 (23.4)            | 2,562 (22.0)          | 1,781 (19.4)           | 1,125 (10.5)           | <.0001   |
| Patients admitted to ICU |                         |                       |                        |                        |          |
| Patients Aged under 18, no. | 5,139                  | 2,966                 | 2,214                  | 2,006                  |          |
| Patients aged 18–39 y, no. | 6.69 (9.35)            | 5.25 (7.65)           | 4.30 (4.05)            | 3.08 (2.75)            | <.0001   |
| Patients aged 40–49 y, no. | 6.26 (8.34)            | 5.66 (7.60)           | 4.55 (4.41)            | 3.66 (3.17)            | <.0001   |
| Patients aged 50–59 y, no. | 3.645                  | 1.906                 | 1.565                  | 1.811                  |          |
| Patients aged 70–79 y, no. | 9.94 (11.46)           | 9.68 (10.23)          | 7.78 (7.78)            | 5.35 (4.30)            | <.0001   |
| Patients aged ≥80 y, no. | 10.58 (10.91)           | 10.39 (10.38)         | 8.81 (7.94)            | 5.84 (4.60)            | <.0001   |
| Patients aged ≥80 y, no. | 4,319                  | 2063                  | 1519                   | 1851                   |          |
| Patients aged ≥80 y, no. | 1,280 (29.8)            | 411 (19.9)            | 232 (15.3)             | 222 (12.0)             | <.0001   |
| Patients aged ≥80 y, no. | 9.33 (9.76)             | 10.63 (10.03)         | 8.86 (7.77)            | 6.08 (4.78)            | <.0001   |
| Patients aged ≥80 y, no. | 4595                   | 2283                  | 1407                   | 1678                   |          |
| Patients aged ≥80 y, no. | 1,671 (36.4)            | 517 (22.6)            | 283 (20.1)             | 303 (18.1)             | <.0001   |
| LOS, d (mean)            | 8.88 (8.63)             | 8.79 (8.35)           | 8.57 (7.26)            | 6.00 (4.49)            | <.0001   |

Note. COVID-19, the novel coronavirus 2; SD, standard deviation; LOS, length of stay; ICU, Intensive care unit.

aP values were based on Pearson’s correlation tests for linear trend for continuous, ordinary, and dichotomous variables; and P values were based on χ² tests for nonordinary categorical variables (eg, race, payer, and marital status).
hydroxychloroquine, azithromycin, remdesivir, convalescent plasma, anticoagulants, dexamethasone, and methylprednisolone). Furthermore, we conducted a stratified GEE analysis according to age. Analyses were performed using R version 4.0.0 software (R Foundation for Statistical Computing, Vienna, Austria).

Results

The final sample included 53,264 COVID-19 patients from 302 hospitals in 4 geographic regions: 118 (39.1%) were admitted in the South, 104 (34.4%) in the Midwest, 62 (20.5%) in the Northeast, and 18 (6.0%) in the West. Furthermore, 21,736 were admitted in April; 11,640 were admitted in May; 9,159 were admitted in June; and 10,729 were admitted in July. The distributions of mortality rate, LOS, and covariates included in the GEE model by admission months in the overall study cohort, in patients admitted to ICU, and in each age group are shown in Table 1. The mean age admission months in the overall study cohort, in patients admitted to ICU, and in each age group are shown in Table 1. The mean age of the patients decreased from 64.1 years (±17.1) in April to 58.8 years (±19.2) in July (P trend < .0001). The mean Elixhauser comorbidity index score, used to assesses comorbidities among study patients, decreased from 3.7 (±2.3) in April to 3.2 (±2.2) in July (P trend < .0001), and the proportion of patients with an index score of 5 and above (indicating high underlying comorbidity burden) fell from 33.5% in April to 25.5% in July (P trend < .0001). The proportion of patients on mechanical ventilation decreased from 19.3% in April to 6.6% in July (P trend < .0001).

The mortality rate among hospitalized COVID-19 patients declined from 20.9% in April to 7.7% in July (P trend < .0001). The LOS also declined during this period, from 9.4 days (±10.1) in April to 5.3 days (±4.3) in July (P trend < .0001). Results from GEE analysis after accounting for the differences in the patient population by admission months indicate that COVID-19 patients admitted in May had 43% lower odds of mortality (odds ratio [OR], 0.57; 95% confidence interval [CI], 0.52–0.62), whereas those admitted in June had 56% lower odds of mortality (OR, 0.44; 95% CI, 0.39–0.49), and those admitted in July had 57% lower odds of mortality (OR, 0.43; 95% CI, 0.39–0.49) compared to patients admitted in April. Compared to the LOS among COVID-19 patients admitted in April, patients admitted in May had an average 4% shorter LOS (adjusted ratio of means, 0.96; 95% CI, 0.94–0.98), whereas patients admitted in June and July had 26% (adjusted ratio of means, 0.74; 95% CI, 0.72–0.76) and 46% (adjusted ratio of means, 0.54; 95% CI, 0.53–0.56) shorter LOS, respectively. The age-stratified GEE analysis revealed that the decrease in mortality was more pronounced in COVID-19 patients aged 60 years or older, and the decrease after June 2020 in LOS was consistent across all age groups. Among patients admitted to an intensive care unit (ICU), the mortality rates were 40.8% in April, 32.9% in May, 27.3% in June, and 27.2% in July (P trend < .0001). The LOS for COVID-19 patients admitted to ICU were 16.6 days (±14.2) in April, 15.5 days (±12.8) in May, 12.3 days (±9.3) in June, and 8.1 days (±5.7) in July (P trend < .0001).

Discussion

In the initial stages of the pandemic in the United States, the patients hospitalized with COVID-19 were mostly older individuals with high comorbidity burden, but as the pandemic has spread, an increasing number of hospitalizations have been reported among younger individuals. The decrease in average age and comorbidity status among COVID-19 cases as the pandemic has progressed has also been reflected in our sample of hospitalized patients. Reductions in mortality, as seen in this study, mirror those from other recent studies. We also observed significant reductions in LOS, especially in June and July (vs April); together with mortality reductions, these reductions suggest that the evolving clinical care for hospitalized COVID-19 patients is producing incremental gains in outcomes. The improvements in mortality and LOS were notable for COVID-19 patients admitted to ICUs, reflecting the incremental treatment gains among more severe cases. Several different medical and public health policy factors may have contributed to these meaningful declines in mortality and LOS: improved clinical experience among physicians, better hospital protocols in patient management, more effective treatment options, increased usage of masks and social distancing measures reducing the volume of hospitalization pressure on healthcare systems.

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