Supplementary Online Content

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This supplementary material has been provided by the authors to give readers additional information about their work.
**eFigure 1.** Flow diagram describing selection of cases in the analytic cohort.
**eFigure 2.** Distribution of hospital COVID-19 burden.
A. Emergency surgery case volumes.

B. Urgent surgery case volumes.

**Figure 3.** Emergent and Urgent Surgical Case Volumes Stratified by Hospital COVID-19 burden. The baseline period is between January 1, 2018, to February 29, 2020 and the surge period is between March 1, 2020, and May 31, 2020. Monthly case volumes were normalized by dividing monthly case volumes by mean case volume during the baseline period (January 1, 2018, to February 29, 2020).
eFigure 4. Changes in the proportion of all patients undergoing (A) emergency surgery and (B) urgent surgery who have either Medicaid or no insurance. The baseline period is between January 1, 2018, to February 29, 2020 and the surge period is between March 1, 2020, and May 31, 2020. Monthly case volumes were normalized by dividing monthly case volumes by mean case volume during the baseline period (January 1, 2018, to February 29, 2020).
### eTable 1. Patient characteristics grouped by payer status.

|                          | Total     | Commercial Insurance | Medicare   | Medicaid   | Uninsured | Other payer |
|--------------------------|-----------|----------------------|------------|------------|-----------|-------------|
|                          | 2,950,147 | 1,000,068 (33.9)     | 1,427,791  | 321,600    | 59,729    | 140,959     |
| **COVID Surgery Category** |           |                      |            |            |           |             |
| <= 5%                    | 1,414,204 | 468,163 (46.8)       | 708,879    | 141,802    | 32,403    | 62,957      |
| 5.1-10%                  | 513,795   | 161,309 (16.1)       | 243,337    | 57,993     | 16,520    | 34,636      |
| 10.1-25%                 | 607,068   | 227,763 (22.8)       | 286,627    | 63,070     | 6,199     | 23,409      |
| >25%                     | 415,080   | 142,833 (14.3)       | 188,948    | 58,735     | 4,607     | 19,957      |
| **Time Period**          |           |                      |            |            |           |             |
| Baseline                 | 2,747,236 | 935,033 (93.5)       | 1,329,865  | 296,969    | 54,416    | 130,953     |
| Surge                    | 202,911   | 65,035 (6.5)         | 97,926     | 24,631     | 5,313     | 10,006      |
| **Admission status**     |           |                      |            |            |           |             |
| Emergent                 | 894,029   | 232,370 (23.2)       | 434,120    | 137,625    | 38,445    | 51,469      |
| Urgent                   | 278,239   | 82,336 (8.2)         | 141,150    | 34,280     | 7,538     | 12,935      |
| Elective                 | 1,777,879 | 685,362 (68.5)       | 852,521    | 149,695    | 13,746    | 76,555      |
| **Sex**                  |           |                      |            |            |           |             |
| Male                     | 1,399,395 | 478,146 (47.8)       | 651,372    | 146,667    | 33,508    | 89,702      |
| Female                   | 1,550,752 | 521,922 (52.2)       | 776,419    | 174,933    | 26,221    | 51,257      |
| **Age**                  |           |                      |            |            |           |             |
| 18-30                    | 149,731   | 74,078 (7.4)         | 4,782      | 47,672     | 10,326    | 12,873      |
| 31-50                    | 521,567   | 282,782 (28.3)       | 52,258     | 121,455    | 24,329    | 40,743      |
| 51-64                    | 918,197   | 531,128 (53.1)       | 170,981    | 137,770    | 21,532    | 56,786      |
| 65-74                    | 792,220   | 93,631 (9.4)         | 664,564    | 9,716      | 2,321     | 21,988      |
| 75-79                    | 273,891   | 11,351 (1.1)         | 254,771    | 2,537      | 612       | 4,680       |
| 80-84                    | 162,233   | 4,426 (0.4)          | 153,818    | 1,475      | 349       | 2,165       |
| 85-89                    | 86,588    | 1,879 (0.2)          | 82,723     | 664        | 143       | 1,179       |
| 90 -                     | 45,720    | 793 (0.1)            | 43,954     | 311        | 117       | 545         |
| **Race**                 |           |                      |            |            |           |             |
| White                    | 2,299,899 | 802,875 (80.3)       | 1,183,060  | 182,522    | 35,171    | 96,271      |
| Black                    | 381,772   | 110,739 (11.1)       | 156,203    | 78,347     | 11,926    | 24,557      |
| Asian                    | 59,472    | 23,072 (2.3)         | 22,852     | 9,587      | 1,160     | 2,801       |
| Other race               | 209,004   | 63,382 (6.3)         | 65,676     | 51,144     | 11,472    | 17,330      |
| Covid-19 positive*       | 1,969     | 429 (0.66)           | 936 (0.96) | 440 (1.79) | 40 (0.75)  | 124 (1.24)  |

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| Condition                                | Cases  | Percentage |
|------------------------------------------|--------|------------|
| Congestive heart failure                 | 201,371 (0.07) | 151,684 (0.11) | 16,735 (0.05) | 1,840 (0.03) | 5,511 (0.04) |
| Valvular disease                         | 129,786 (0.04) | 97,321 (0.07) | 7,212 (0.02) | 0,927 (0.02) | 3,017 (0.02) |
| Pulmonary circulation disorder           | 12,581 (0.004) | 6,185 (0.004) | 2,465 (0.01) | 0,334 (0.01) | 535 (0.004) |
| Peripheral vascular disease              | 201,634 (0.07) | 135,150 (0.09) | 18,970 (0.06) | 2,799 (0.05) | 6,733 (0.05) |
| Hypertension                             | 1,566,188 (0.53) | 934,311 (0.65) | 134,430 (0.42) | 19,985 (0.33) | 62,059 (0.44) |
| Paralysis                                | 108,107 (0.04) | 62,310 (0.04) | 16,902 (0.05) | 2,160 (0.04) | 4,418 (0.03) |
| Other neurological disorders             | 167,790 (0.06) | 110,933 (0.08) | 17,877 (0.06) | 1,782 (0.03) | 5,534 (0.04) |
| Chronic pulmonary disease                | 532,640 (0.18) | 304,540 (0.21) | 66,159 (0.21) | 5,911 (0.1) | 21,460 (0.15) |
| Diabetes, uncomplicated                  | 301,110 (0.1) | 161,774 (0.11) | 28,861 (0.09) | 3,907 (0.07) | 14,108 (0.1) |
| Diabetes, complicated                    | 419,771 (0.14) | 263,725 (0.18) | 46,971 (0.15) | 7,747 (0.13) | 16,787 (0.12) |
| Hypothyroidism                           | 407,625 (0.14) | 261,064 (0.18) | 23,262 (0.07) | 2,674 (0.04) | 11,945 (0.08) |
| Renal failure                            | 344,421 (0.12) | 255,811 (0.18) | 24,810 (0.08) | 2,716 (0.05) | 9,659 (0.07) |
| Liver disease                            | 141,471 (0.05) | 59,453 (0.04) | 25,308 (0.08) | 3,421 (0.06) | 6,222 (0.04) |
| Peptic ulcer disease                     | 23,758 (0.01) | 13,134 (0.01) | 3,248 (0.01) | 0,559 (0.01) | 888 (0.01) |
| AIDS/HIV                                 | 5,634 (0.002) | 2,443 (0.002) | 1,634 (0.01) | 0,116 (0.002) | 299 (0.002) |
| Lymphoma                                 | 16,384 (0.01) | 10,863 (0.01) | 1,009 (0) | 0,114 (0.002) | 470 (0.003) |
| Metastatic cancer                        | 114,544 (0.04) | 55,295 (0.04) | 12,122 (0.04) | 1,410 (0.02) | 3,321 (0.02) |
| Solid tumor without metastasis           | 64,960 (0.02) | 36,882 (0.03) | 6,100 (0.02) | 0,704 (0.01) | 2,197 (0.02) |
| Rheumatoid arthritis                     | 114,375 (0.04) | 71,819 (0.05) | 8,529 (0.03) | 0,751 (0.01) | 3,424 (0.02) |
| Coagulopathy                             | 108,160 (0.04) | 61,083 (0.04) | 13,653 (0.04) | 1,980 (0.03) | 4,345 (0.03) |
| Obesity                                  | 681,014 (0.23) | 316,807 (0.22) | 74,563 (0.23) | 11,198 (0.19) | 31,535 (0.22) |
| Weight loss                              | 172,439 (0.06) | 99,610 (0.07) | 24,615 (0.08) | 2,902 (0.05) | 5,729 (0.04) |
| Fluid & electrolyte disorder             | 360,323 (0.12) | 202,047 (0.14) | 50,019 (0.16) | 10,473 (0.18) | 14,315 (0.1) |
| Blood loss anemia                        | 22,258 (0.01) | 10,616 (0.01) | 4,259 (0.01) | 0,480 (0.01) | 776 (0.01) |
| Deficiency anemia                        | 356,635 (0.12) | 211,117 (0.15) | 45,839 (0.14) | 6,368 (0.11) | 12,429 (0.09) |
| Alcohol abuse                            | 80,421 (0.03) | 30,762 (0.02) | 19,987 (0.06) | 4,075 (0.07) | 5,130 (0.04) |
| Drug abuse                               | 60,372 (0.02) | 18,768 (0.01) | 24,454 (0.08) | 3,302 (0.06) | 3,708 (0.03) |
| Psychoses                                | 83,291 (0.03) | 43,024 (0.03) | 19,267 (0.06) | 1,333 (0.02) | 3,873 (0.03) |
| Depression                               | 423,122 (0.14) | 222,569 (0.16) | 46,268 (0.08) | 17,977 (0.13) |
| Procedure                                | AAA repair | 3,621 (0.12) | 956 (0.1) | 2,105 (0.15) | 351 (0.11) | 73 (0.12) | 136 (0.1) |
| Amputation                               | 132,707 (4.5) | 74,016 (5.18) | 24,250 (7.54) | 4,888 (8.18) | 6,998 (4.96) |
| Appendectomy                             | 78,680 (2.67) | 37,697 (3.77) | 19,042 (1.33) | 12,127 (3.77) | 5,445 (9.12) | 4,369 (3.1) |
| Bile duct, liver or pancreas             | 87,594 (2.97) | 36,238 (2.54) | 10,388 (3.23) | 1,535 (2.57) | 3,418 (2.42) |
| Cardiac surgery                          | 131,796 (4.47) | 65,208 (4.57) | 13,327 (4.14) | 2,010 (3.37) | 4,551 (3.23) |
| Procedure                      | First Quarter | Second Quarter | Third Quarter | Fourth Quarter | Year Total |
|--------------------------------|---------------|----------------|--------------|----------------|-------------|
| CABG                           | 101,909 (3.45)| 54,850 (3.84)  | 8,259 (2.57) | 2,338 (3.91)   | 4,033 (2.86) |
| Carotid endarterectomy         | 37,283 (1.26) | 27,730 (1.94)  | 1,810 (0.56) | 384 (0.64)     | 0,936 (0.66) |
| Cholecystectomy                | 155,052 (5.26)| 57,448 (4.02)  | 26,826 (8.34)| 9,786 (16.38)  | 7,544 (5.35) |
| Colon surgery                  | 208,139 (7.06)| 96,176 (6.74)  | 22,051 (6.86)| 3,856 (6.46)   | 6,931 (4.92) |
| Craniotomy                     | 230,533 (7.81)| 95,486 (6.69)  | 32,648 (10.15)| 5,524 (9.25)   | 10,867 (7.71) |
| Spinal fusion                  | 280,584 (9.51)| 130,315 (9.13) | 26,726 (8.31)| 2,455 (4.11)   | 25,636 (18.2) |
| Fracture surgery               | 178,368 (6.05)| 98,266 (6.88)  | 20,038 (6.23)| 6,725 (11.26)  | 17,155 (12.2) |
| Gastric surgery                | 137,453 (4.66)| 39,892 (2.79)  | 21,615 (6.72)| 2,244 (3.76)   | 4,602 (3.26) |
| Hip arthroplasty               | 331,585 (11.24)| 202,792 (14.2)| 18,453 (5.74)| 1,714 (2.87)   | 9,667 (6.86) |
| Knee arthroplasty              | 345,283 (11.7)| 198,997 (13.9)| 17,004 (5.29)| 922 (1.54)     | 12,740 (9.04) |
| Laminectomy                    | 68,394 (2.32)| 34,212 (2.4)   | 6,599 (2.05) | 902 (1.51)     | 4,663 (3.31) |
| Peripheral vascular bypass     | 38,647 (1.31)| 23,607 (1.65)  | 4,860 (1.51) | 685 (1.15)     | 1,430 (1.01) |
| Small bowel surgery            | 122,676 (4.16)| 45,232 (3.17)  | 17,216 (5.35)| 2,167 (3.63)   | 4,517 (3.2) |
| Thoracic surgery               | 131,991 (4.47)| 66,068 (4.63)  | 14,166 (4.4) | 2,586 (4.33)   | 4,879 (3.46) |
| Exploratory laparotomy         | 147,852 (5.01)| 60,111 (4.21)  | 22,886 (7.12)| 3,490 (5.84)   | 5,887 (4.18) |
| Death                          | 50,816 (1.72)| 31,943 (2.24)  | 6,142 (1.91) | 1,416 (2.37)   | 2,157 (1.53) |

* percentage of patients who tested COVID-19 positive during the Surge Period
**eTable 2.** Model examining the association between changes in all-cause inpatient mortality and hospital COVID-19 burden.

| Hospital COVID Burden | All Surgery | Elective Surgery | Urgent Surgery | Emergent Surgery |
|-----------------------|-------------|------------------|----------------|------------------|
|                       | AOR (95% CI) | P                | AOR (95% CI)  | P                | AOR (95% CI)  | P                |
| <= 5%                 | reference   | reference        | reference      | reference        |
| 5.1-10.0%             | 0.99 (0.88,1.12) | 0.923            | 1.03 (0.87,1.22) | 0.752            | 1.16 (0.99,1.35) | 0.661            | 0.94 (0.83,1.07) | 0.370            |
| 10.1-25.0%            | 0.94 (0.86,1.03) | 0.215            | 0.88 (0.76,1.02) | 0.091            | 1.12 (0.96,1.3)  | 0.141            | 0.92 (0.84,1.01) | 0.083            |
| >25%                  | 0.88 (0.78,0.99) | 0.040            | 0.84 (0.69,1.01) | 0.059            | 1.2 (0.99,1.44)  | 0.057            | 0.85 (0.76,0.96) | 0.007            |
| Time Period           |             |                  |                |                  |
| Baseline              | reference   | reference        | reference      | reference        |
| Surge                 | 0.9 (0.85,0.94) | <.001            | 1 (0.87,1.14)  | 0.956            | 0.83 (0.75,0.93) | 0.001            | 0.89 (0.84,0.95) | <.001            |
| Hospital COVID burden X Surge |     |                  |                |                  |
| <=5% X Surge          | reference   | reference        | reference      | reference        |
| 5.1-10.0% X Surge     | 1.05 (0.96,1.15) | 0.299            | 1.02 (0.77,1.33) | 0.909            | 1.07 (0.86,1.34) | 0.531            | 1.06 (0.95,1.18) | 0.316            |
| 10.1-25.0% X Surge    | 1.13 (1.03,1.24) | 0.013            | 1.27 (1.01,1.6)  | 0.044            | 1.05 (0.8,1.37)  | 0.739            | 1.1 (1.12) | 0.056            |
| >25% X Surge          | 1.38 (1.24,1.53) | <.001            | 0.94 (0.66,1.33) | 0.719            | 1.59 (1.27,2)    | <.001            | 1.4 (1.24,1.59) | <.001            |
| Admission status      |             |                  |                |                  |
| Emergent              | 4.68 (4.4,4.98) | <.001            |                  |                  |
| Urgent                | 4.03 (3.73,4.36) | <.001            |                  |                  |
| Race                  |             |                  |                |                  |
| White                 | reference   | reference        | reference      | reference        |
| Black                 | 1.02 (0.97,1.07) | 0.466            | 1.15 (1.04,1.26) | 0.006            | 0.99 (0.91,1.08) | 0.809            | 1 (0.95,1.06) | 0.865            |
| Asian                 | 1 (0.93,1.08) | 0.966            | 1.32 (1.13,1.55) | <.001            | 1.16 (1.13) | 0.047            | 0.91 (0.84,1) | 0.052            |
| Other race            | 1.07 (1,1.14) | 0.045            | 1.15 (1.02,1.29) | 0.019            | 1.18 (1.07,1.3)  | 0.001            | 1.02 (0.95,1) | 0.556            |
| Payer                 |             |                  |                |                  |
| Commercial insurance  | reference   | reference        | reference      | reference        |
| Medicare              | 1.27 (1.21,1.33) | <.001            | 1.38 (1.26,1.52) | <.001            | 1.18 (1.07,1.29) | <.001            | 1.22 (1.16,1.29) | <.001            |
| Medicaid              | 1.29 (1.23,1.36) | <.001            | 1.4 (1.24,1.58)  | <.001            | 1.23 (1.12,1.36) | <.001            | 1.23 (1.16,1.3) | <.001            |
| Uninsured             | 1.73 (1.54,1.94) | <.001            | 2.03 (1.53,2.69) | <.001            | 1.49 (1.23,1.79) | <.001            | 1.61 (1.43,1.83) | <.001            |
| Other payer           | 1.43 (1.32,1.55) | <.001            | 1.58 (1.36,1.83) | <.001            | 1.1 (0.95,1.28)  | 0.215            | 1.43 (1.31,1.57) | <.001            |
### Sex

|          | Male                        | Reference | p       | Reference | p       | Reference | p       | Reference | p       |
|----------|-----------------------------|-----------|---------|-----------|---------|-----------|---------|-----------|---------|
| Female   |                             |           | <.001   |           | <.001   |           | <.001   |           | <.001   |
| Age      |                             |           |         |           |         |           |         |           |         |
| 18-30    |                             |           | <.001   |           | <.001   |           | <.001   |           | <.001   |
| 31-50    |                             |           |         |           | <.001   | <.001    | <.001   | <.001    | <.001   |
| 51-64    |                             |           | <.001   |           | <.001   | <.001    | <.001   | <.001    | <.001   |
| 65-74    |                             |           |         |           | <.001   | <.001    | <.001   | <.001    | <.001   |
| 75-79    |                             |           | <.001   |           | <.001   | <.001    | <.001   | <.001    | <.001   |
| 80-84    |                             |           |         |           | <.001   | <.001    | <.001   | <.001    | <.001   |
| 85-89    |                             |           | <.001   |           | <.001   | <.001    | <.001   | <.001    | <.001   |
| 90+      |                             |           |         |           | <.001   | <.001    | <.001   | <.001    | <.001   |
| Covid positive |                         |           | <.001   |           | <.001   |           | <.001   |           | <.001   |

### Comorbidity

| Condition                        | Male   | Female | Age 18-30 | Age 31-50 | Age 51-64 | Age 65-74 | Age 75-79 | Age 80-84 | Age 85-89 | Age 90+ |
|----------------------------------|--------|--------|------------|------------|------------|------------|------------|------------|------------|----------|
| Congestive heart failure         | 1.88   | <.001  | 2.78       | 1.04       | 0.94       | 0.90       | 1.26       | 1.09       | 1.07     | 0.044    |
| Valvular disease                 | 1.29   | <.001  | 1.97       | 1.34       | 1.74       | 1.29       | 1.09       | 1.09       | 1.07     | 0.044    |
| Pulmonary circulation disorder   | 1.57   | <.001  | 3.49       | 1.6       | 1.48       | 1.74       | 1.26       | 1.09       | 1.07     | 0.044    |
| Peripheral vascular disease      | 1.73   | <.001  | 1.92       | 1.6       | 1.67       | 1.48       | 1.48       | 1.13       | 1.13     | 0.044    |
| Hypertension                     | 1.01   | <.001  | 1.2        | 1.2       | 1.09       | 1.09       | 1.07       | 1.07       | 1.07     | 0.044    |
| Paralysis                        | 1.19   | <.001  | 2.05       | 1.26       | 1.09       | 1.09       | 1.07       | 1.07       | 1.07     | 0.044    |
| Other neurological disorders     | 1.13   | <.001  | 1.26       | 1.09       | 1.09       | 1.09       | 1.07       | 1.07       | 1.07     | 0.044    |
| Chronic pulmonary disease        | 1.17   | <.001  | 1.19       | 1.16       | 1.13       | 1.13       | 1.13       | 1.13       | 1.13     | 0.044    |
| Diabetes, uncomplicated          | 0.96   | <.001  | 0.85       | 0.94       | 1.01       | 1.01       | 1.01       | 1.01       | 1.01     | 0.044    |
| Diabetes, complicated            | 1.07   | <.001  | 1.1        | 1.05       | 1.05       | 1.05       | 1.05       | 1.05       | 1.05     | 0.044    |
| Hypothyroidism                   | 0.98   | <.001  | 1.05       | 1.01       | 1.05       | 1.05       | 1.05       | 1.05       | 1.05     | 0.044    |
| Renal failure                    | 1.61   | <.001  | 1.95       | 1.61       | 1.54       | 1.54       | 1.54       | 1.54       | 1.54     | 0.044    |
| Liver disease                    | 1.43   | <.001  | 1.66       | 1.51       | 1.39       | 1.39       | 1.39       | 1.39       | 1.39     | 0.044    |
| Peptic ulcer disease             | 1.43   | <.001  | 1.61       | 1.41       | 1.4       | 1.4        | 1.4        | 1.4        | 1.4      | 0.044    |
| AIDS/HIV                         | 1.04   | <.001  | 1.11       | 0.88       | 1.05       | 1.05       | 1.05       | 1.05       | 1.05     | 0.044    |
| Lymphoma                         | 1.36   | <.001  | 1.36       | 1.46       | 1.3        | 1.3        | 1.3        | 1.3        | 1.3      | 0.044    |
| Metastatic cancer                | 1.45   | <.001  | 1.65       | 1.32       | 1.38       | 1.38       | 1.38       | 1.38       | 1.38     | 0.044    |
| Solid tumor without metastasis   | 0.93   | <.001  | 1.12       | 0.89       | 0.9        | 0.9        | 0.9        | 0.9        | 0.9      | 0.044    |
| Rheumatoid arthritis             | 1.14   | <.001  | 1.2        | 1.06       | 1.13       | 1.13       | 1.13       | 1.13       | 1.13     | 0.044    |
| Coagulopathy                     | 2.53   | <.001  | 2.07       | 2.31       | 2.63       | 2.63       | 2.63       | 2.63       | 2.63     | 0.044    |
| Obesity                          | 1.07   | <.001  | 1.25       | 1.1        | 1.01       | 1.01       | 1.01       | 1.01       | 1.01     | 0.044    |
| Procedure | Odds Ratio (95% CI) | p-Value |
|-----------|--------------------|---------|
| AAA repair | 18.57 (15.76, 21.89) | <.001 |
| Amputation | 1.65 (1.52, 1.8) | <.001 |
| Appendectomy | 1.32 (1.16, 1.5) | <.001 |
| Bile duct, liver or pancreas | 5.42 (4.87, 6.03) | <.001 |
| Cardiac surgery | 10.8 (9.73, 11.98) | <.001 |
| CABG | 2.93 (2.62, 3.28) | <.001 |
| CABG with IMA (no vein) | 3.51 (2.85, 4.33) | <.001 |
| Carotid endarterectomy | 0.99 (0.81, 1.2) | <.001 |
| Cholecystectomy | reference | reference |
| Colon surgery | 5.72 (5.29, 6.19) | <.001 |
| Cranietomy | 12.06 (10.91, 13.34) | <.001 |
| Spinal fusion | 1.62 (1.45, 1.82) | <.001 |
| Fracture surgery | 0.93 (0.84, 1.02) | <.001 |
| Gastric surgery | 4.57 (4.15, 5.03) | <.001 |
| Hip arthroplasty | 0.92 (0.83, 1.02) | 0.004 |
| Knee arthroplasty | 0.4 (0.34, 0.47) | <.001 |
| Laminectomy | 1.38 (1.21, 1.58) | <.001 |
| Peripheral vascular bypass | 4.18 (3.74, 4.67) | <.001 |
| Small bowel surgery | 4.89 (4.48, 5.33) | <.001 |
| Thoracic surgery | 5.58 (5.1, 6.11) | <.001 |
| Exploratory laparotomy | 4.49 (4.15, 4.86) | <.001 |
|                      | All Hospitals | Hospital COVID19 <= 5% | Hospital COVID19 5.1-10% | Hospital COVID19 10.1-25% | Hospital COVID19 >25% |
|----------------------|---------------|------------------------|--------------------------|---------------------------|----------------------|
| **Payer**            |               |                        |                          |                           |                      |
| Commercial insurance | reference     | reference              | reference                | reference                 | reference            |
| Medicare             | 1.28 (1.22,1.34) | <.001                  | 1.22 (1.12,1.32)         | <.001                     | 1.38 (1.26,1.51)     | <.001                | 1.27 (1.17,1.37)     | <.001                | 1.35 (1.21,1.5)      | <.001                |
| Medicaid             | 1.29 (1.22,1.36) | <.001                  | 1.27 (1.17,1.37)         | <.001                     | 1.4 (1.27,1.55)      | <.001                | 1.21 (1.08,1.35)     | <.001                | 1.35 (1.19,1.53)     | <.001                |
| Uninsured            | 1.75 (1.55,1.98) | <.001                  | 1.49 (1.28,1.75)         | <.001                     | 1.81 (1.45,2.27)     | <.001                | 2.42 (1.91,3.07)     | <.001                | 2.25 (1.4,3.6)       | 0.001                |
| Other payer          | 1.42 (1.31,1.54) | <.001                  | 1.31 (1.16,1.47)         | <.001                     | 1.39 (1.13,1.69)     | 0.001                | 1.62 (1.42,1.85)     | 0.001                | 1.64 (1.4,1.92)      | <.001                |
| **Time Period**      |               |                        |                          |                           |                      |
| Baseline             |               |                        |                          |                           |                      |
| Surge                | 0.97 (0.91,1.05) | 0.477                  | 0.91 (0.82,1.02)         | 0.105                     | 0.88 (0.77,1)        | 0.056                | 1.11 (0.96,1.28)     | 0.169                | 1.15 (0.95,1.4)      | 0.158                |
| Payer X Surge        |               |                        |                          |                           |                      |
| Commercial insurance | reference     | reference              | reference                | reference                 | reference            |
| Medicare X Surge     | 0.95 (0.88,1.03) | 0.233                  | 0.94 (0.83,1.07)         | 0.367                     | 1.06 (0.89,1.26)     | 0.504                | 0.88 (0.75,1.02)     | 0.098                | 1.01 (0.81,1.25)     | 0.951                |
| Medicaid X Surge     | 1.08 (0.96,1.2)  | 0.204                  | 1.03 (0.85,1.24)         | 0.778                     | 1.19 (0.96,1.48)     | 0.118                | 1.03 (0.82,1.3)      | 0.790                | 1.13 (0.86,1.48)     | 0.378                |
| Uninsured X Surge    | 1.09 (0.9,1.32)  | 0.381                  | 1.23 (0.93,1.62)         | 0.147                     | 1.1 (0.76,1.58)      | 0.619                | 0.85 (0.47,1.54)     | 0.601                | 1.28 (0.65,2.52)     | 0.468                |
| Other payer X Surge  | 1.17 (1.01,1.36) | 0.040                  | 1.2 (0.96,1.52)          | 0.114                     | 1.29 (0.99,1.68)     | 0.059                | 1.19 (0.85,1.67)     | 0.303                | 1.07 (0.65,1.77)     | 0.775                |
| **Admission status** |               |                        |                          |                           |                      |
| Emergent             | 4.67 (4.39,4.98) | <.001                  | 4.79 (4.34,5.28)         | <.001                     | 4.36 (3.77,5.05)     | <.001                | 4.84 (4.38,5.33)     | <.001                | 4.54 (3.88,5.31)     | <.001                |
| Urgent               | 4.06 (3.76,4.38) | <.001                  | 3.73 (3.3,4.21)          | <.001                     | 4.09 (3.54,4.72)     | <.001                | 4.49 (3.9,5.16)      | <.001                | 5.12 (4.25,6.18)     | <.001                |
| Elective             |               |                        |                          |                           |                      |
| Male                 |               | reference              | reference                | reference                 | reference            |
| Female               | 0.93 (0.91,0.96) | <.001                  | 0.96 (0.92,0.99)         | 0.015                     | 0.94 (0.89,1)        | 0.039                | 0.94 (0.89,1)        | 0.035                | 0.85 (0.81,0.9)      | <.001                |
| Age                  |               |                        |                          |                           |                      |
| 18-30                |               | reference              | reference                | reference                 | reference            |
| 31-50                | 1.12 (1.05,1.21) | 0.002                  | 1.12 (1.02,1.22)         | 0.015                     | 1.08 (0.89,1.32)     | 0.428                | 1.22 (1.08,1.37)     | 0.001                | 1.07 (0.85,1.35)     | 0.566                |

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| Comorbidities                  | Odds Ratio | 95% CI        | p-value |
|-------------------------------|------------|---------------|---------|
| **Covid positive**            |            |               |         |
| Congestive heart failure      | 1.88       | (1.82,1.94)   | <.001   |
| Valvular disease              | 1.28       | (1.23,1.34)   | <.001   |
| Pulmonary circulation disorder| 1.57       | (1.45,1.7)    | <.001   |
| Peripheral vascular disease   | 1.73       | (1.67,1.78)   | <.001   |
| Hypertension                  | 1.01       | (0.98,1.05)   | 0.419   |
| Paralysis                     | 1.19       | (1.14,1.25)   | 0.112   |
| Other neurological disorders  | 1.13       | (1.09,1.17)   | <.001   |
| Chronic pulmonary disease     | 1.17       | (1.13,1.21)   | <.001   |
| Diabetes, uncomplicated       | 0.96       | (0.92,1)      | 0.044   |
| Diabetes, complicated         | 1.07       | (1.04,1.1)    | 0.031   |
| Hypothyroidism                | 0.98       | (0.96,1.01)   | 0.153   |
| Renal failure                 | 1.61       | (1.56,1.66)   | 0.456   |
| Liver disease                 | 1.44       | (1.38,1.49)   | <.001   |
| Peptic ulcer disease          | 1.43       | (1.33,1.52)   | <.001   |
| AIDS/HIV                      | 1.05       | (0.87,1.27)   | 0.636   |
| Lymphoma                      | 1.35       | (1.24,1.48)   | 0.015   |
| Metastatic cancer             | 1.45       | (1.39,1.51)   | <.001   |
| Solid tumor without metastasis| 0.93       | (0.88,0.98)   | 0.009   |
| Rheumatoid arthritis          | 1.14       | (1.08,1.19)   | <.001   |
| Coagulopathy                  | 2.53       | (2.42,2.64)   | <.001   |
| Obesity                       | 1.07       | (1.03,1.11)   | <.001   |
| Weight loss                   | 1.4        | (1.34,1.46)   | <.001   |
| Fluid & electrolyte disorder  | 2.3        | (2.23,2.37)   | <.001   |
| Blood loss anemia             | 0.8        | (0.73,0.88)   | <.001   |
| Deficiency anemia             | 0.95       | (0.92,0.99)   | 0.005   |
| Alcohol abuse                 | 1.18       | (1.12,1.23)   | <.001   |

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| Procedure                      | Drug abuse       | 0.87 (0.81,0.95) | 0.001 | 0.9 (0.8,1.01) | <.001 | 0.84 (0.71,0.99) | 0.018 | 0.79 (0.65,0.96) | 0.016 | 0.97 (0.85,1.12) | 0.716 |
|-------------------------------|------------------|-----------------|-------|----------------|-------|------------------|-------|------------------|-------|------------------|-------|
| AAA repair                    | 18.6 (15.8,21.9) | <.001 | 17.5 (14.1,21.7) | <.001 | 18.8 (12.5,28.3) | <.001 | 19.8 (13.3,29.5) | <.001 | 19.6 (11.8,32.5) | <.001 |
| Amputation                    | 1.65 (1.51,1.8)  | <.001 | 1.57 (1.38,1.78) | <.001 | 1.6 (1.3,1.9)    | <.001 | 1.8 (1.4,2.2)    | <.001 | 2 (1.6,2.4)      | <.001 |
| Appendectomy                  | 1.32 (1.16,1.5)  | <.001 | 1.39 (1.14,1.69) | 0.001 | 1.1 (0.8,1.5)    | 0.478 | 1.3 (1.1,1.7)    | 0.046 | 1.5 (1.1,2.1)    | 0.014 |
| Bile duct, liver or pancreas  | 5.41 (4.86,6.01) | <.001 | 5.05 (4.35,9.3)  | <.001 | 5.3 (4.1,6.8)    | <.001 | 5.7 (4.7,6.9)    | <.001 | 6.5 (4.8,8.8)    | <.001 |
| Cardiac surgery               | 10.75 (9.69,11.92)| <.001 | 10 (8.61,11.61)  | <.001 | 11.7 (9.3,14.8)  | <.001 | 11.2 (8.7,14.3)  | <.001 | 11.6 (8.9,15.2)  | <.001 |
| CAGB                          | 2.92 (2.61,3.27) | <.001 | 3.04 (2.62,3.52) | <.001 | 2.8 (2.2,3.7)    | <.001 | 2.8 (2.1,3.7)    | <.001 | 2.6 (1.9,3.7)    | <.001 |
| CAGB with IMA (no vein)       | 3.48 (2.82,4.3)  | <.001 | 4.23 (3.28,5.46) | <.001 | 4.1 (2.8,6.1)    | <.001 | 1.6 (0.9,3)      | 0.107 | 3.9 (2.3,6.7)    | <.001 |
| Carotid endarterectomy        | 0.99 (0.81,1.2)  | 0.882 | 0.8 (0.6,1.08)  | 0.147 | 1.3 (0.9,1.9)    | 0.227 | 1.3 (0.9,1.9)    | 0.220 | 0.7 (0.3,1.6)    | 0.413 |
| Cholecystectomy               | reference        | reference      | reference | reference       | reference | reference | reference | reference | reference |
| Colon surgery                 | 5.71 (5.28,6.17) | <.001 | 5.62 (5.01,6.3)  | <.001 | 5.5 (4.65,6.5)   | <.001 | 5.74 (4.86,8.5)  | <.001 | 6.36 (5.05,9)    | <.001 |
| Craniotomy                    | 12.07 (10.92,13.34)| <.001 | 11.15 (9.63,12.9) | <.001 | 13.37 (10.69,16.73) | <.001 | 11.76 (9.39,14.73) | <.001 | 14.19 (10.8,20) | <.001 |
| Spinal fusion                 | 1.62 (1.45,1.81) | <.001 | 1.54 (1.32,1.79) | <.001 | 1.46 (1.13,1.89) | 0.004 | 1.73 (1.33,2.25) | <.001 | 2.03 (1.42,0)    | <.001 |
| Fracture surgery              | 0.93 (0.84,1.02) | 0.127 | 0.85 (0.75,0.97) | 0.019 | 0.95 (0.77,1.17) | 0.640 | 0.89 (0.68,1.17) | 0.403 | 1.2 (0.9,1.0)    | 0.86 |
| Gastric surgery               | 4.55 (4.14,5.01) | <.001 | 4.64 (3.99,5.39) | <.001 | 4.44 (3.53,5.58) | <.001 | 4.67 (3.86,6.65) | <.001 | 4.48 (3.67,0)    | <.001 |
| Hip arthroplasty              | 0.92 (0.83,1.02) | 0.116 | 0.84 (0.73,0.97) | 0.014 | 0.9 (0.71,1.15)  | 0.400 | 1.04 (0.82,1.31) | 0.776 | 1.12 (0.85,0)    | 0.431 |
| Knee arthroplasty             | 0.4 (0.33,0.47)  | <.001 | 0.34 (0.26,0.44) | <.001 | 0.32 (0.21,0.49) | <.001 | 0.51 (0.37,0.71) | <.001 | 0.58 (0.41,0)    | 0.003 |
| Laminectomy                   | 1.38 (1.2,1.57)  | <.001 | 1.4 (1.16,1.69)  | <.001 | 0.99 (0.73,1.35) | 0.973 | 1.49 (1.12,1.98) | 0.006 | 1.69 (1.09,0)    | 0.018 |
| Peripheral vascular bypass    | 4.17 (3.74,4.66) | <.001 | 3.86 (3.28,4.54) | <.001 | 3.4 (2.65,4.37)  | <.001 | 5.05 (4.06,9.29) | <.001 | 5 (4,0)          | <.001 |
| Small bowel surgery           | 4.88 (4.47,5.33) | <.001 | 4.69 (4.13,5.33) | <.001 | 4.53 (3.74,5.48) | <.001 | 5.12 (4.22,6.2)  | <.001 | 5.88 (4.59,0)    | <.001 |
| Thoracic surgery              | 5.56 (5.08,6.08) | <.001 | 5.11 (4.5,5.8)   | <.001 | 5.5 (4.45,6.79)  | <.001 | 6.32 (5.14,7.7)  | <.001 | 6.37 (4.91,0)    | <.001 |
| Exploratory laparotomy        | 4.49 (4.14,4.86) | <.001 | 4.26 (3.79,4.78) | <.001 | 4.59 (3.89,5.4)  | <.001 | 4.91 (4.06,9.54) | <.001 | 4.62 (3.71,0)    | <.001 |

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| Table 4. Model Coefficients for DDD model examining the association between changes in all-cause inpatient mortality and payer status & hospital COVID-19 burden |
|---------------------------------------------------------------|
| **Payer** | AOR (95% CI) | P |
| Commercial insurance | reference | |
| Medicare | 1.26 (1.17 , 1.35) | <.001 |
| Medicaid | 1.27 (1.17 , 1.38) | <.001 |
| Uninsured | 1.51 (1.28 , 1.77) | <.001 |
| Other payer | 1.32 (1.17 , 1.48) | <.001 |
| **Time Period** |  |  |
| Baseline | reference | |
| Surge | 0.91 (0.82 , 1.02) | 0.097 |
| **Payer X Surge** |  |  |
| Commercial insurance X Surge | reference | |
| Medicare X Surge | 0.95 (0.83 , 1.07) | 0.385 |
| Medicaid X Surge | 1.03 (0.85 , 1.24) | 0.772 |
| Uninsured X Surge | 1.22 (0.93 , 1.61) | 0.152 |
| Other payer X Surge | 1.21 (0.96 , 1.52) | 0.107 |
| **Hospital COVID Burden** |  |  |
| <= 5% | reference | |
| 5.1-10.0% | 0.98 (0.84 , 1.13) | 0.754 |
| 10.1-25.0% | 0.92 (0.82 , 1.05) | 0.211 |
| >25% | 0.84 (0.71 , 0.99) | 0.039 |
| **Hospital COVID burden X Surge** |  |  |
| <=5% X Surge | reference | |
| 5.1-10% X Surge | 0.96 (0.8 , 1.14) | 0.632 |
| 10.1-25% X Surge | 1.2 (1 , 1.42) | 0.045 |
| >25% X Surge | 1.33 (1.07 , 1.66) | 0.010 |
| **Payer X Hospital COVID-19 burden** |  |  |
| Medicare X COVID-19 (5.1-10%) | 1.01 (0.91 , 1.12) | 0.822 |
| Medicare X COVID-19 (10.1-25%) | 1.02 (0.92 , 1.12) | 0.738 |
| Medicare X COVID-19 (>25%%) | 1.06 (0.94 , 1.18) | 0.335 |
| Medicaid X COVID-19 (5.1-10%) | 1.06 (0.93 , 1.21) | 0.375 |
| Medicaid X COVID-19 (10.1-25%) | 0.96 (0.83 , 1.11) | 0.518 |
| Medicaid X COVID-19 (>25%) | 1.07 (0.93 , 1.25) | 0.347 |
| Uninsured X COVID-19 (5.1-10%) | 1.18 (0.89 , 1.56) | 0.252 |
| Uninsured X COVID-19 (10.1-25%) | 1.6 (1.2 , 2.13) | 0.001 |
| Comparison                                      | Odds Ratio 95% CI      | p-value |
|------------------------------------------------|------------------------|---------|
| Uninsured X COVID-19 (>25%)                   | 1.48 (0.91, 2.4)       | 0.117   |
| Other payer X COVID-19 (5.1-10%)              | 1.02 (0.81, 1.3)       | 0.841   |
| Other payer X COVID-19 (10.1-25%)             | 1.24 (1.04, 1.47)      | 0.017   |
| Other payer X COVID-19 (>25%)                 | 1.27 (1.03, 1.57)      | 0.027   |
| Payer X Hospital COVID-19 burden X Surge      |                        |         |
| Medicare X COVID-19 (5.1-10%)                 | 1.12 (0.9, 1.39)       | 0.321   |
| Medicare X COVID-19 (10.1-25%) X Surge        | 0.93 (0.76, 1.13)      | 0.463   |
| Medicare X COVID-19 (>25%) X Surge            | 1.04 (0.81, 1.33)      | 0.754   |
| Medicaid X COVID-19 (5.1-10%) X Surge         | 1.16 (0.87, 1.55)      | 0.318   |
| Medicaid X COVID-19 (10.1-25%) X Surge        | 0.98 (0.73, 1.33)      | 0.914   |
| Medicaid X COVID-19 (>25%) X Surge            | 1.1 (0.79, 1.51)       | 0.579   |
| Uninsured X COVID-19 (5.1-10%) X Surge        | 0.9 (0.57, 1.42)       | 0.645   |
| Uninsured X COVID-19 (10.1-25%) X Surge       | 0.7 (0.37, 1.35)       | 0.290   |
| Uninsured X COVID-19 (>25%) X Surge           | 1.04 (0.51, 2.12)      | 0.909   |
| Other payer X COVID-19 (5.1-10%) X Surge      | 1.06 (0.74, 1.5)       | 0.758   |
| Other payer X COVID-19 (10.1-25%) X Surge     | 0.97 (0.64, 1.47)      | 0.894   |
| Other payer X COVID-19 (>25%) X Surge         | 0.89 (0.52, 1.5)       | 0.658   |
| Admission status                              |                        |         |
| Emergent                                       | 4.69 (4.41, 4.99)      | <.001   |
| Urgent                                         | 4.04 (3.73, 4.36)      | <.001   |
| Elective reference                             |                         |         |
| Sex                                            |                         |         |
| Male                                           |                         |         |
| Female                                         | 0.94 (0.91, 0.96)      | <.001   |
| Age                                            |                         |         |
| 18-30                                          |                         |         |
| 31-50                                          | 1.12 (1.05, 1.21)      | 0.001   |
| 51-64                                          | 1.49 (1.38, 1.6)       | <.001   |
| 65-74                                          | 1.81 (1.67, 1.96)      | <.001   |
| 75-79                                          | 2.14 (1.97, 2.33)      | <.001   |
| 80-84                                          | 2.38 (2.18, 2.59)      | <.001   |
| 85-89                                          | 2.67 (2.44, 2.93)      | <.001   |
| 90+                                            | 3.36 (3.06, 3.7)       | <.001   |
| Covid positive                                 | 5.53 (4.73, 6.47)      | <.001   |
| Comorbidity                                    |                         |         |
| Congestive heart failure                       | 1.88 (1.82, 1.94)      | <.001   |
| Valvular disease                               | 1.29 (1.23, 1.34)      | <.001   |
| Condition                                      | Odds Ratio (95% CI) | P-value |
|------------------------------------------------|---------------------|---------|
| Pulmonary circulation disorder                 | 1.57 (1.45, 1.7)    | <.001   |
| Peripheral vascular disease                    | 1.73 (1.67, 1.78)   | <.001   |
| Hypertension                                   | 1.01 (0.98, 1.05)   | 0.440   |
| Paralysis                                      | 1.19 (1.14, 1.25)   | <.001   |
| Other neurological disorders                   | 1.13 (1.09, 1.17)   | <.001   |
| Chronic pulmonary disease                      | 1.17 (1.13, 1.21)   | <.001   |
| Diabetes, uncomplicated                         | 0.96 (0.92, 1)      | 0.060   |
| Diabetes, complicated                          | 1.07 (1.04, 1.1)    | <.001   |
| Hypothyroidism                                 | 0.98 (0.96, 1.01)   | 0.115   |
| Renal failure                                  | 1.61 (1.56, 1.66)   | <.001   |
| Liver disease                                  | 1.44 (1.38, 1.49)   | <.001   |
| Peptic ulcer disease                           | 1.43 (1.33, 1.52)   | <.001   |
| AIDS/HIV                                       | 1.05 (0.87, 1.27)   | 0.604   |
| Lymphoma                                       | 1.36 (1.24, 1.48)   | <.001   |
| Metastatic cancer                              | 1.45 (1.39, 1.52)   | <.001   |
| Solid tumor without metastasis                 | 0.93 (0.88, 0.98)   | 0.010   |
| Rheumatoid arthritis                           | 1.14 (1.08, 1.19)   | <.001   |
| Coagulopathy                                   | 2.53 (2.42, 2.64)   | <.001   |
| Obesity                                        | 1.07 (1.04, 1.11)   | <.001   |
| Weight loss                                    | 1.4 (1.34, 1.46)    | <.001   |
| Fluid & electrolyte disorder                   | 2.3 (2.23, 2.37)    | <.001   |
| Blood loss anemia                              | 0.8 (0.73, 0.88)    | <.001   |
| Deficiency anemia                              | 0.95 (0.92, 0.99)   | 0.006   |
| Alcohol abuse                                  | 1.17 (1.12, 1.23)   | <.001   |
| Drug abuse                                      | 0.88 (0.81, 0.95)   | 0.001   |
| Psychoses                                      | 0.89 (0.84, 0.94)   | <.001   |
| Depression                                     | 0.84 (0.81, 0.87)   | <.001   |
| Procedure                                      |                     |         |
| AAA repair                                      | 18.59 (15.78, 21.9) | <.001   |
| Amputation                                      | 1.65 (1.52, 1.8)    | <.001   |
| Appendectomy                                   | 1.32 (1.16, 1.5)    | <.001   |
| Bile duct, liver or pancreas                   | 5.41 (4.86, 6.03)   | <.001   |
| Cardiac surgery                                | 10.8 (9.73, 11.99)  | <.001   |
| CABG                                           | 2.93 (2.62, 3.28)   | <.001   |
| CABG with IMA (no vein)                        | 3.51 (2.85, 4.34)   | <.001   |
| Carotid endarterectomy                         | 0.98 (0.81, 1.2)    | 0.878   |
| Cholecystectomy                                | reference           |         |
| Procedure                | Rate with 95% CI | p-value |
|-------------------------|-----------------|---------|
| Colon surgery           | 5.71 (5.28, 6.18) | <.001   |
| Craniotomy              | 12.07 (10.91, 13.34) | <.001   |
| Spinal fusion           | 1.62 (1.45, 1.82) | <.001   |
| Fracture surgery        | 0.93 (0.84, 1.02) | 0.122   |
| Gastric surgery         | 4.57 (4.15, 5.03) | <.001   |
| Hip arthroplasty        | 0.92 (0.83, 1.02) | 0.113   |
| Knee arthroplasty       | 0.40 (0.34, 0.47) | <.001   |
| Laminectomy             | 1.38 (1.2, 1.58) | <.001   |
| Peripheral vascular bypass | 4.19 (3.75, 4.68) | <.001   |
| Small bowel surgery     | 4.88 (4.47, 5.33) | <.001   |
| Thoracic surgery        | 5.57 (5.09, 6.1)  | <.001   |
| Exploratory laparotomy  | 4.49 (4.15, 4.86) | <.001   |