Acute Care Resource Use After Elective Surgery in the United States: Implications During the COVID-19 Pandemic

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Background The COVID-19 pandemic created pressure to delay inpatient elective surgery to increase US health care capacity. This study examined the extent to which common inpatient elective operations consume acute care resources.
Methods This cross-sectional study used the Premier Healthcare Database to examine the distribution of inpatient elective operations in the United States from the fourth quarter of 2015 through the second quarter of 2018. Primary outcomes were measures of acute care use after 4 common elective operations: joint replacement, spinal fusion, bariatric surgery, and coronary artery bypass grafting. A framework for matching changing demand with changes in supply was created by overlaying acute care data with publicly available outbreak capacity data.
Results Elective coronary artery bypass grafting (n=117 423) had the highest acute care use: 92.8% of patients used intensive care unit beds, 89.1% required postoperative mechanical ventilation, 41.0% required red blood cell transfusions, and 13.3% were readmitted within 90 days of surgery. Acute care use was also substantial after spinal fusion (n=203 789): 8.3% of patients used intensive care unit beds, 2.2% required postoperative mechanical ventilation, 9.2% required red blood cell transfusions, and 9.3% were readmitted within 90 days of surgery. An example of a framework for matching hospital demand with elective surgery supply is provided.
Conclusions Acute care needs after elective surgery in the United States are consistent and predictable. When these data are overlaid with national hospital capacity models, rational decisions regarding matching supply to demand can be achieved to meet changing needs.
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The COVID-19 pandemic has tested health care capacity worldwide.[1] According to initial reports in the United States, as many as 12% of patients with COVID-19 require acute care hospitalization. Of these, approximately 25% require admission to an intensive care unit (ICU).[2] One way that this demand for acute care capacity is being met is through the perioperative infrastructure with delays in elective surgery.

Our study objective was to describe the extent to which common inpatient elective surgical procedures consume acute and critical care resources. We also sought to provide an example of an initial framework for matching changing demand with corresponding changes in supply created by rational delays in elective surgery.

Methods

We conducted a cross-sectional study of inpatient surgical procedures performed in the United States by using the Premier Healthcare Database (Premier, Inc) from the fourth quarter of 2015 (following the conversion to *International Statistical Classification of Diseases, Tenth Revision* coding) through the second quarter of 2018. Details of the database are available elsewhere.[3] We examined all inpatient surgical procedures and ascertained their classification (elective, urgent, or emergency). Our primary outcomes were measures of acute and critical care resource use after the 4 most common elective operations during the study period: joint replacement surgery, spinal fusion, bariatric surgery, and coronary artery bypass grafting. Our study was exempt from informed consent requirements by the Duke University Health System institutional review board because the study used deidentified administrative data.

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We divided our cohort among the 4 common surgical procedures. Outcomes included markers of acute care and critical care use: hospital length of stay, need for postoperative ICU admission, need for postoperative invasive mechanical ventilation, need for red blood cell transfusion, 30-day hospital readmission, and 90-day hospital readmission. Covariates included age, sex, race/ethnicity, facility characteristics (teaching status, urban or rural setting, region, and hospital size), and comorbidities (cardiovascular disease, pulmonary disease, peripheral vascular disease, neurological disorders, diabetes mellitus, endocrine disease, cancer, HIV/AIDS, autoimmune disease, coagulation disorders, obesity, anemia, psychiatric disease, and drug/alcohol use disorders).

Our objective was to describe the extent to which common inpatient elective surgical procedures consume acute and critical care resources.

We used descriptive statistics to describe demographic and clinical characteristics of the sample. To explore a simple hypothetical framework for matching supply and demand during the pandemic, we overlaid hospital bed-day use data derived from our analyses with data from publicly available sources, including COVID-19 outbreak data from the Institute for Health Metrics and Evaluation (acquired April 8, 2020)[4] and Fast Stats by the Healthcare Cost and Utilization Project[5] (to estimate national acute care use), using total joint replacement surgery as an example. All analyses were performed with SAS statistical software (SAS Institute Inc).

Results

The type and burden of inpatient elective operations (as a proportion of all inpatient operations) remained relatively constant over time (Figure 1). Patient characteristics and postoperative acute care use are displayed in the Table. As expected, acute care use was highest for elective coronary artery bypass grafting (n = 117 423): 92.8% of patients used ICU beds, 89.1% required postoperative

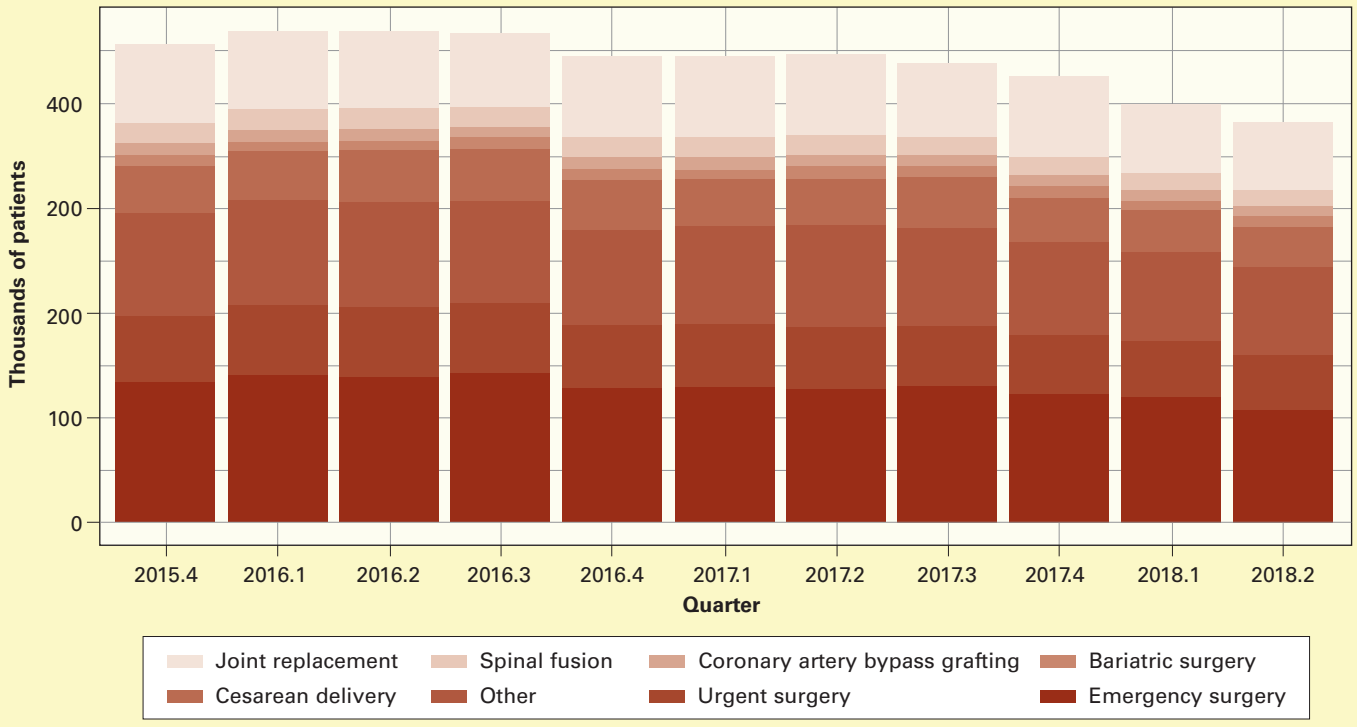

Figure 1 Numbers of patients having inpatient surgical procedures in the United States per quarter from 2015 to 2018.

mechanical ventilation, 41.0% required red blood cell transfusions, and 13.3% were readmitted within 90 days of surgery. Acute care use was also substantial after spinal fusion (n = 203 789), second only to coronary artery bypass grafting: 8.3% of patients used ICU beds, 2.2% required postoperative mechanical ventilation, 9.2% required red blood cell transfusions, and 9.3% were readmitted within 90 days of surgery.

The framework for matching hospital demand with elective surgery supply, using total joint replacement surgery in the United States as an example, is shown in Figure 2. By overlaying joint replacement hospital bed-day use data (derived from our analysis) with April 2020 COVID-19 hospital capacity needs data (hospital bed-days) from the Institute for Health Metrics and Evaluation and an estimate of national hospital bed-day use for joint replacement surgery from Healthcare Cost and Utilization Project data, we show an example of matching supply and demand for hospital beds in the United States in April 2020 by delaying elective joint replacement surgery (Figure 2).

Acute and critical care needs after elective surgery in the United States are consistent and predictable.

Discussion

Blanket cancellation of nonessential surgery to enhance acute and critical care hospital capacity (as a response to broad calls from multiple societies, including the Centers for Medicare & Medicaid Services[6]) represents an important public health effort to bolster hospital capacity during a pandemic. Nonessential surgery cancellation, however, needs to be balanced with potential undue harm, including development of chronic pain and severe functional limitations, exacerbation of underlying disease processes, and revenue losses to health care facilities, caused by prolonged delays in surgical care. Our data suggest that elective surgical procedures are consistent over time, making needs for postoperative acute care use relatively predictable.

Our analysis has several limitations. First, the Premier database is not nationally weighted; nonetheless, it represents the health care experience in more than 25% of hospitals in the United States, covering a wide range of US census regions and facility types. Second, inferences drawn from administrative data are at risk for residual confounding. Third, translating national data to inform local policy is a significant challenge. Fourth, our supply-demand framework is crude and requires continuous updates with contemporary outbreak data and local health system capacity data.

Table
Characteristics of patients undergoing inpatient elective surgical procedures in the United States from the fourth quarter of 2015 to the second quarter of 2018

Characteristic	Bariatric surgery (n = 113 638)	CABG (n = 117 423)	Joint replacement (n = 788 948)	Spinal fusion (n = 203 789)
Demographics				
Age, median (range), y	44 (36-53)	67 (59-74)	66 (59-73)	62 (52-70)
Sex, No. (%)				
Female	90 820 (79.9)	35 697 (30.4)	466 290 (59.1)	111 864 (54.9)
Male	22 818 (20.1)	81 716 (69.6)	322 558 (40.9)	91 892 (45.1)
Unknown	0 (0.0)	10 (0.0)	100 (0.0)	33 (0.0)
Race, No. (%)				
Black	19 835 (17.5)	6824 (5.8)	64 181 (8.1)	17 764 (8.7)
White	80 222 (70.6)	98 792 (84.1)	665 825 (84.4)	166 984 (81.9)
Other	11 444 (10.1)	9695 (8.3)	49 040 (6.2)	15 022 (7.4)
Unknown	2137 (1.9)	2112 (1.8)	9902 (1.3)	4019 (2.0)
Ethnicity, No. (%)				
Hispanic	9440 (8.3)	5993 (5.1)	22 841 (2.9)	7888 (3.9)
Non-Hispanic	79 443 (69.9)	87 308 (74.4)	618 225 (78.4)	153 722 (75.4)
Unknown	24 755 (21.8)	24 122 (20.5)	147 882 (18.7)	42 179 (20.7)
Hospital characteristics, No. (%)				
Teaching status				
No	56 292 (49.5)	48 684 (41.5)	451 388 (57.2)	106 410 (52.2)
Yes	57 346 (50.5)	68 739 (58.5)	337 560 (42.8)	97 379 (47.8)
Setting				
Urban	103 296 (90.9)	107 974 (92.0)	701 440 (88.9)	186 578 (91.6)
Rural	10 342 (9.1)	9449 (8.0)	87 508 (11.1)	17 211 (8.4)
Region				
Midwest	25 362 (22.3)	25 880 (22.0)	194 728 (24.7)	45 959 (22.6)
Northeast	30 176 (26.6)	18 243 (15.5)	132 340 (16.8)	28 110 (13.8)
South	44 671 (39.3)	54 262 (46.2)	334 371 (42.4)	98 847 (48.5)
West	13 429 (11.8)	19 038 (16.2)	127 509 (16.2)	30 873 (15.1)
Outcomes				
Days in hospital				
Mean (SD)	1.7 (1.3)	7.3 (4.7)	2.3 (1.4)	3.3 (2.7)
Median (range)	2 (1-2)	6 (5-8)	2 (1-3)	3 (2-4)
Postoperative ICU admission, No. (%)	1825 (1.6)	108 967 (92.8)	6572 (0.8)	16 885 (8.3)
Postoperative invasive mechanical ventilation, No. (%)	1294 (1.1)	104 582 (89.1)	2279 (0.3)	4519 (2.2)
Red blood cell transfusion, No. (%)	1258 (1.1)	48 149 (41.0)	34 650 (4.4)	18 686 (9.2)
30-Day readmission, No. (%)	3349 (2.9)	11 585 (9.9)	32 880 (4.2)	14 419 (7.1)
90-Day readmission, No. (%)	4678 (4.1)	15 624 (13.3)	57 157 (7.2)	18 868 (9.3)

Abbreviations: CABG, coronary artery bypass grafting; ICU, intensive care unit.

Conclusions

Acute and critical care needs following elective surgery in the United States are consistent and predictable. When these data are overlaid with national hospital capacity models, rational decisions regarding matching supply to demand can be achieved to meet the changing needs throughout the COVID-19 pandemic.

FINANCIAL DISCLOSURES
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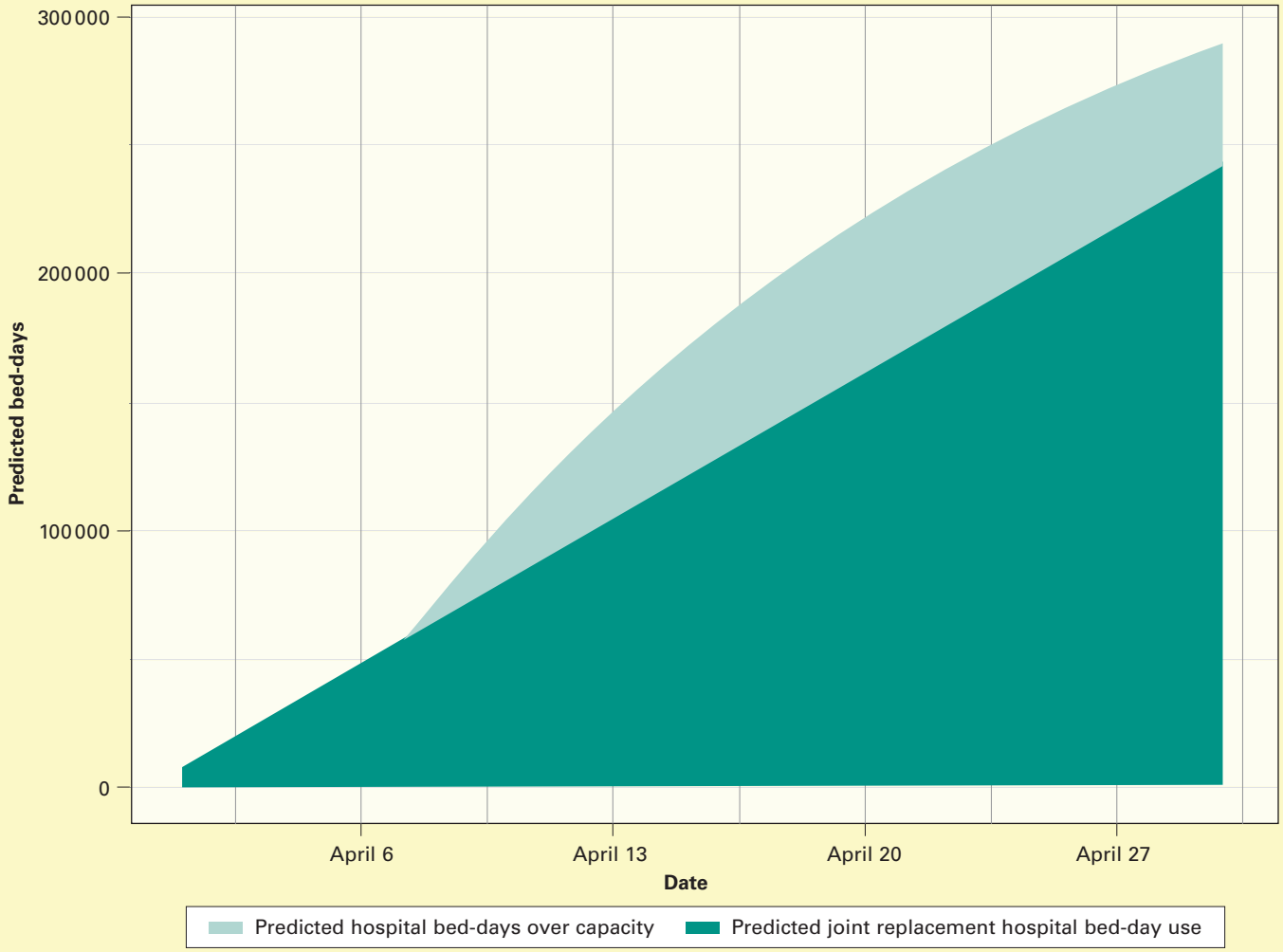

Figure 2 Framework for supply-demand matching for joint replacement surgery during April 2020.

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