# Return to Normal: Prioritizing Elective Surgeries With Low Resource Utilization

#### **To the Editor**

Supervised to determine the optimal strategy to safely return to "normal" operations while remaining vigilant and prepared for future recurrent outbreaks.

We therefore evaluated intensive care unit (ICU) utilization and mechanical ventilation following common elective surgical procedures to (1) determine which procedures are the least resource intensive and (2) which patient populations are less likely to require postoperative ICU admission or ventilation.

After Institutional Review Board approval (IRB no. 2016-436), we conducted a retrospective analysis of patients captured in the Premier Healthcare database (2006–2016) who underwent common elective inpatient procedures (Supplemental Digital Content, Appendix, http://links.lww.com/AA/D93).<sup>2</sup> For each surgical cohort, we identified ICU admission, length of ICU (and hospital) stay, and use and length of (non-) invasive ventilation (≥96 or <96 hours). Multivariable logistic regression models measured the association between patient age/comorbidity burden as measured by Charlson-Deyo index,<sup>3</sup> and the outcomes of ICU admission and ventilation, to validate the perception that younger and healthier patients are less likely to require these resources.

Of the 15 elective surgeries evaluated, cardiac procedures were the most resource intensive with 83.9% of patients admitted to the ICU and 27.9% requiring ventilation, followed by abdominal procedures that had an average ICU admission rate of 20.3%. Gynecological surgeries and joint arthroplasties appeared to be the least resource intensive with

fewer than 5.5% of patients admitted to the ICU and <2% requiring postoperative ventilation (Table). In regression models, greater comorbidity burden was associated with significantly increased odds of ICU admission or any form of ventilation in almost all procedure cohorts; this association was more subdued and sometimes reversed for older age (Figure).

The highest ICU utilization was seen in cardiac, abdominal, and spine surgeries. Outside of cardiac procedures, postoperative ventilation was relatively uncommon, indicating that limiting elective procedures is primarily beneficial in maximizing ICU capacity rather than freeing up ventilators.

In almost all procedure cohorts, younger patients with a low comorbidity burden were less likely to require ICU admission and/or ventilation. Comorbidity burden was a stronger risk factor and thus should be prioritized over age for optimal patient selection. There is a 2-fold impact of restricting these surgeries to younger patients with a low comorbidity burden. These patients are not only less likely to require ICU or ventilation, but they are also at lower risk of developing severe COVID-19 symptoms were they to contact the virus during their hospital stay.<sup>4</sup> However, if patients do not meet these criteria and their health could worsen from delaying surgery, it may be advisable to instead space out surgeries of older patients with underlying conditions to optimize resource utilization.

Limitations of this study include our simplified analysis that only considered patient age and comorbidity burden. While there are a number of other factors associated with ICU admission and ventilation, our findings should provide a useful starting point in strategizing to return to normal operations. Additionally, some procedures classified as elective in this database may not truly be elective; however, given that they will still be performed during the COVID-19 pandemic, we felt valuable information could still be gained from retaining them in our analyses.

These data suggest that, in the transition back to elective surgery, cardiac and abdominal procedures should be limited if possible in favor of "safer" and less resource-intensive surgeries such as gynecological and nontraumatic orthopedic procedures. Across all procedure cohorts, it would be ideal to restrict or at least prioritize younger patients with fewer comorbidities.

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Conflicts of Interest: Stavros G. Memtsoudis is a director on the boards of the American Society of Regional Anesthesia and Pain Medicine (ASRA) and the Society of Anesthesia and Sleep Medicine (SASM). He is a one-time consultant for Sandoz Inc and Teikoku and is currently on the medical advisory board of HATH. He has a pending US Patent application for a Multicatheter Infusion System. US-2017-0361063. He is the owner of SGM Consulting, LLC, and co-owner of FC Monmouth, LLC. None of the above relations influenced the conduct of the present study.

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e         2287         68.545         23.116         292.61         10,625         52.4         83         3804         463         1620         3013           117         260.8         105.4         (6.1)         (6.1)         (6.1)         (6.1)         (6.1)         (6.1)         (3.3)         (4.1)         (2.7)         (3.3)         (3.4)           ation         0n, n(%)         (5.5)         (4.2)         (6.4)         (6.5)         (3.9)         (3.3)         (4.1)         (2.7)         (3.3)         (3.4)           ation         0n, n(%)         (5.3)         (4.1)         (5.6)         (4.1)         (2.7)         (3.3)         (3.4)           non, n(%)         613         (6.1)         (6.5)         (3.4)         (6.5)         (4.1)         (2.7)         (3.4)         (3.4)           non, n(%)         613         (6.2)         37.42         15.8         (4.1)         (2.7)         (3.4)         (3.4)           non, n(%)         613         (6.3)         (672)         71.5         (4.2)         (7.4)         (14.4)         (13.4)           non, n(%)         66.9         71.5         (6.4)         (672)         (71.5)         (6.7) <t< td=""><td><ul> <li>Le 2287 68,545</li> <li>(84.5) (92.6)</li> <li>117 2608</li> <li>(4.3) (3.5)</li> <li>ation</li> <li>on, n (%) 613 6891</li> <li>cutive 1790 64,250</li> <li>h (74.5) (90.3)</li> <li>length 1 (1-3) 6 (5-9)</li> <li>y, in (IQR) 68</li> <li>67</li> <li>in (IQR) 68</li> <li>67</li> <li>in (IQR) (60-75) (60-74)</li> <li>ex, n (%) 22,846 64,264</li> <li>(25.93 45,646</li> <li>(21.2) (20.4)</li> </ul></td><td></td><td></td><td>83</td><td>(1.01)</td><td>463</td><td>(55.8)</td><td>(65.5)</td><td>(25.5)</td><td>(15.3)</td><td>(21.1)</td><td>(34.6)</td></t<>	<ul> <li>Le 2287 68,545</li> <li>(84.5) (92.6)</li> <li>117 2608</li> <li>(4.3) (3.5)</li> <li>ation</li> <li>on, n (%) 613 6891</li> <li>cutive 1790 64,250</li> <li>h (74.5) (90.3)</li> <li>length 1 (1-3) 6 (5-9)</li> <li>y, in (IQR) 68</li> <li>67</li> <li>in (IQR) 68</li> <li>67</li> <li>in (IQR) (60-75) (60-74)</li> <li>ex, n (%) 22,846 64,264</li> <li>(25.93 45,646</li> <li>(21.2) (20.4)</li> </ul>			83	(1.01)	463	(55.8)	(65.5)	(25.5)	(15.3)	(21.1)	(34.6)		
	(84.5) (92.6) (4.3) (3.5) (4.3) (3.5) (4.3) (3.5) (4.3) (3.5) (4.3) (3.5) (9.7) (1) (25.5) (9.7) (1) (25.5) (9.7) (1) (2.5.5) (9.7) (1) (1) (1) (3.1) (1) (1) (1) (1) (1) (1) (1) (1) (1) (1)				3804		1620	3013	7830	117	566	120		
$ \begin{array}{cccccccccccccccccccccccccccccccccccc$	117 2608 ation (4.3) (3.5) (4.3) (3.5) (4.3) (3.5) (3.5) (3.5) (3.7) (3.7) (3.7) (3.5) (3.5) (3.5) (3.7) (3.7) (3.5) (3.7) (3.5) (3.7) (3.7) (3.5) (3.7) (3.5) (3.5) (3.5) (3.5) (5.9) (60-74) (60-74) (60-74) (25.9) (60-74) (20,		Ū	(90.2)	(75.8)	(79.4)	(40.9)	(31.1)	(70.7)	(81.3)	(72.4)	(57.7)		
(4.3)         (5.5)         (4.2)         (0.4)         (0.5)         (3.3)         (4.1)         (0.5)         (3.3)         (3.4)         (3.5)         (4.1)         (3.5)         (4.1)         (3.5)         (4.1)         (3.5)         (4.1)         (3.5)         (3.4)         (3.3)         (3.4) <t< td=""><td>(4.3)       (3.5)         ation       (4.3)       (3.5)         ation       613       6891         cutive       1790       64,250         h       (74.5)       (90.3)         cutive       1790       64,250         h       (74.5)       (90.3)         length       1 (1-3)       6 (5-9)         y.       nn (IQR)       68         ge,       68       67         nn (IQR)       68       67         ex, n (%)       22,846       64,264         19,023       45,646       (20.4)         22,846       64,264       (31.2)         (31.2)       (28.7)       (28.7)</td><td></td><td></td><td>ი ე</td><td>204</td><td>16 0 J</td><td>132</td><td>332</td><td>420</td><td>نہ ت و</td><td>51 21</td><td>) 16 ا</td></t<>	(4.3)       (3.5)         ation       (4.3)       (3.5)         ation       613       6891         cutive       1790       64,250         h       (74.5)       (90.3)         cutive       1790       64,250         h       (74.5)       (90.3)         length       1 (1-3)       6 (5-9)         y.       nn (IQR)       68         ge,       68       67         nn (IQR)       68       67         ex, n (%)       22,846       64,264         19,023       45,646       (20.4)         22,846       64,264       (31.2)         (31.2)       (28.7)       (28.7)			ი ე	204	16 0 J	132	332	420	نہ ت و	51 21	) 16 ا		
tion $(\%)$ 613 6891 4020 1057 3742 155 5 576 71 253 448 cuive 1790 64,250 20,144 2141 7709 392 81 3428 407 143,81 (13,4) (13,4) (17,45) (90,3) (83,3) (32,6) (28,3) (5,8) (14,4) (14,8) (13,4) (13,4) (17,45) (90,3) (83,3) (65,9) (67,2) (71,5) (94,2) (85,5) (84,5) (86,5) (86,5) (14,1) (17,3) (6,5-9) 7(5-11) 4(2-7) 6(4-8) 4(2-7) 3(2-3) 2(3	ation on. n (%) cutive 613 6891 h (25.5) (9.7) cutive 1790 64.250 h (74.5) (90.3) length 1 (1–3) 6 (5–9) y in (10R) 68 67 w (10R) 68 67 ex, n (%) ex, n (%) 22.846 64.264 (25.9) (20.4) 22.846 64.264 (31.2) (28.7)			(3.3)	(4.1)	(2.1)	(3.3)	(3.4)	(3.8)	(3.5)	(6.9)	(I, I)		
	<ul> <li>()</li> <li>(13)</li> <li>(25.5)</li> <li>(9.7)</li> <li>(9.7)</li> <li>1790</li> <li>64,250</li> <li>(74.5)</li> <li>(90.3)</li> <li>1(1-3)</li> <li>6(5-9)</li> <li>(74.5)</li> <li>(60-75)</li> <li>(60-74)</li> <li>(60-75)</li> <li>(60-74)</li> <li>(60-75)</li> <li>(60-74)</li> <li>(25.9)</li> <li>(20.4)</li> <li>(25.9)</li> <li>(20.4)</li> <li>(22.846</li> <li>64,264</li> <li>(31.2)</li> <li>(28.7)</li> </ul>													
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$ \begin{array}{cccccccccccccccccccccccccccccccccccc$	1790 64,250 (74.5) (90.3) 1 (1–3) 6 (5–9) . 68 67 68 67 (60–75) (60–74) 6) 19,023 45,646 (25.9) (20.4) 22,846 64,264 (31.2) (28.7)		-	(5.8)	(14.4)	(14.8)	(14.4)	(13.4)	(17.5)	(22.1)	(21.9)	(27.9)		
	(74.5) (90.3) 1 (1–3) 6 (5–9) 7 68 67 68 67 (60–75) (60–74) 6) 19,023 45,646 (25.9) (20.4) 22,846 64,264 (31.2) (28.7)			81	3428	407	1498	2894	6805	95	481	98		
$ \begin{array}{c ccccccccccccccccccccccccccccccccccc$	1 (1-3) 6 (5-9) 68 67 68 67 (60-75) (60-74) 6) 19,023 45,646 (25.9) (20.4) 22,846 64,264 (31.2) (28.7)			(94.2)	(85.5)	(84.5)	(85.5)	(86.5)	(82.5)	(6.77)	(78.0)	(72.1)		
QR         68         67         72         62         64         54         32         46         50         (2-3)<	QR) 68 67 QR) (60–75) (60–74) n (%) 19,023 45,646 (25.9) (20.4) 22,846 64,264 (31.2) (28.7)			3 (2–3)	2 (1–3)	7	ო	ო	2	4	4	ო		
QR         68         67         72         62         64         54         32         46         50         65         66           QR         (60-75)         (60-74)         (64-79)         (50-73)         (53-73)         (43-65)         (28-36)         (40-53)         (43-61)         (57-73)         (59-73)           n (%)         19,023         45,646         12,062         21,452         81,108         7771         19,044         453,264         20,379         352,137         (537)944           19,023         45,646         17,365         13,321         31,607         2098         1667         81,038         4826         136,237         320,324           (25:9)         (20.4)         (17.8)         (32.7)         (49.0)         (90.9)         (72.0)         (57.6)         (62.4)         (56.4)           (25:9)         (20.4)         (17.8)         (32.7)         (32.7)         (49.0)         (90.9)         (72.0)         (57.6)         (62.4)         (56.4)           (25:9)         (20.4)         (17.8)         (32.7)         (13.2)         (8.0)         (12.9)         (13.6,7)         (56.4)         (56.4)         (56.4)         (56.4)         (56.4)         (56.4) </td <td>QR) 68 67 QR) (60–75) (60–74) n (%) 19,023 45,646 (25.9) (20.4) 22,846 64,264 (31.2) (28.7)</td> <td></td> <td></td> <td></td> <td></td> <td>(2–3)</td> <td>(2–3)</td> <td>(2–3)</td> <td>(1-4)</td> <td>(2–7)</td> <td>(3–6)</td> <td>(2-4)</td>	QR) 68 67 QR) (60–75) (60–74) n (%) 19,023 45,646 (25.9) (20.4) 22,846 64,264 (31.2) (28.7)					(2–3)	(2–3)	(2–3)	(1-4)	(2–7)	(3–6)	(2-4)		
QR)         (60-75)         (60-74)         (54-79)         (50-73)         (53-73)         (43-65)         (28-36)         (40-53)         (43-61)         (57-73)         (53-73)         (59-73)           n (%)         19,023         45,646         12,062         21,452         81,108         7771         19,044         453,264         20,379         352,137         (53-74)         (56-4)           (25,9)         (20.4)         (17.8)         (35.7)         (32.7)         (49.0)         (90.9)         (72.0)         (57.6)         (62.4)         (56.4)           (25,9)         (20.4)         (17.8)         (35.7)         (32.7)         (49.0)         (90.9)         (72.0)         (57.6)         (62.4)         (56.4)           (25.9)         (20.4)         (17.8)         (32.7)         (13.2)         (8.0)         (12.9)         (13.6)         (24.1)         (28.3)           (31.2)         (28.7)         (25.6)         (22.2)         (12.7)         (13.2)         (8.0)         (12.9)         (13.6)         (24.1)         (28.3)         (9.6)           (31.2)         (21.4)         (25.6)         (22.2)         (12.7)         (13.2)         (12.9)         (10,9)         (12.9)         (10,9)<	QR) (60–75) (60–74) n (%) 19,023 45,646 (25.9) (20.4) 22,846 64,264 (31.2) (28.7)	67		37	46	۲ ا	ц С	99	57	60	75	ц		
	19,023 45,646 (25,9) (20.4) 22,846 64,264 (31.2) (28.7)			-	(40-53)	(43–61)	(57-73)	(59–73)	(47-67)	(49–69)	(63–84)	(46–68)		
19,02345,64612,06221,45281,108777119,044453,26420,379352,137637,944 $(25.9)$ $(20.4)$ $(17.8)$ $(35.7)$ $(32.7)$ $(49.0)$ $(90.9)$ $(72.0)$ $(57.6)$ $(62.4)$ $(56.4)$ $(25,9)$ $(20.4)$ $(17.8)$ $(33.7)$ $(32.7)$ $(49.0)$ $(90.9)$ $(72.0)$ $(57.6)$ $(62.4)$ $(56.4)$ $(21.2)$ $(28.7)$ $(23.7)$ $(32.2)$ $(12.7)$ $(13.2)$ $(8.0)$ $(12.9)$ $(13.6)$ $(24.1)$ $(28.3)$ $(31.2)$ $(28.7)$ $(22.2)$ $(12.7)$ $(13.2)$ $(8.0)$ $(12.9)$ $(13.6)$ $(24.1)$ $(28.3)$ $(31.2)$ $(28.7)$ $(27.2)$ $(12.7)$ $(13.2)$ $(8.0)$ $(12.9)$ $(13.6)$ $(24.1)$ $(28.3)$ $(31.2)$ $(28.7)$ $(27.2)$ $(12.7)$ $(13.2)$ $(29.6)$ $(27.3)$ $(28.3)$ $(18.9)$ $(21.4)$ $(21.5)$ $(12.9)$ $(12.9)$ $(12.9)$ $(13.6)$ $(24.1)$ $(28.3)$ $(18.9)$ $(21.4)$ $(21.5)$ $(12.9)$ $(0.9)$ $(8.1)$ $(13.6)$ $(8.3)$ $(9.6)$ $17,634$ $66,341$ $23,800$ $15,975$ $82,038$ $3933$ $57$ $44,317$ $5369$ $29,569$ $64,273$	19,023 45,646 (25,9) (20.4) 22,846 64,264 (31.2) (28.7)					Ì	Ì							
	(25.9) (20.4) 22,846 64,264 (31.2) (28.7)			19,044	453,264	20,379	352,137	637,944	407,117	1554	14,095	8329		
22,846         64,264         17,365         13,321         31,607         2098         1667         81,038         4826         136,237         320,324           (31.2)         (28.7)         (25.6)         (22.2)         (12.7)         (13.2)         (8.0)         (12.9)         (13.6)         (24.1)         (28.3)           13,824         47,964         14,609         9276         53,368         2045         194         51,276         4804         46,739         10,8975           (18.9)         (21.4)         (21.5)         (12.9)         (0.9)         (8.1)         (13.6)         (8.3)         (9.6)           17,634         66,341         23,800         15,975         82,038         3933         57         44,317         5369         29,569         64,273	22,846 64,264 (31.2) (28.7)		-	(6.06)	(72.0)	(57.6)	(62.4)	(56.4)	(60.8)	(53.1)	(40.6)	(56.3)		
(31.2)         (28.7)         (25.6)         (22.2)         (12.7)         (13.2)         (8.0)         (12.9)         (13.6)         (24.1)         (28.3)           13,824         47,964         14,609         9276         53,368         2045         194         51,276         4804         46,739         10,8975           (18.9)         (21.4)         (21.5)         (12.5)         (12.9)         (0.9)         (8.1)         (13.6)         (8.3)         (9.6)           17,634         66,341         23,800         15,975         82,038         3933         57         44,317         5369         29,569         64,273	(31.2) (28.7)			1667	81,038	4826	136,237	320,324	171,168	720	8965	3367		
13,824 47,964 14,609 9276 53,368 2045 194 51,276 4804 46,739 10,8975 (18.9) (21.4) (21.5) (15.5) (21.5) (12.9) (0.9) (8.1) (13.6) (8.3) (9.6) 17,634 66,341 23,800 15,975 82,038 3933 57 44,317 5369 29,569 64,273				(8.0)	(12.9)	(13.6)	(24.1)	(28.3)	(25.5)	(24.6)	(25.8)	(22.8)		
(18.9) (21.4) (21.5) (15.5) (21.5) (12.9) (0.9) (8.1) (13.6) (8.5) (9.5) (1.6)	13,824 47,964			194	51,276	4804	46,739	10,8975	57,018	354	5145	1496		
1, 034 00, 341 23, 8UU 13, 970 82, 038 3933 37 44, 317 3369 24, 29, 309 04, 273	(18.9) (21.4)			(0.9) 13	(8.1) 11011	(13.6)	(8.3) 00 F00	(9.6)	(6.5)	(12.1)	(14.8) CF2C	(10.1)		
(20 6) (35 1) (26 6) (33 1) (24 8) (0 3) (7 0) (15 0) (5 2)	L1,034 00,34L (24.1) (29.6)			/C	44,317 (7 0)	0309 (15 2)	29,209 (5.2)	04,213 (57)	34,032 (5.2)	(10.2)	0220 (18.8)	(0 UL)		

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### **LETTERS TO THE EDITOR**

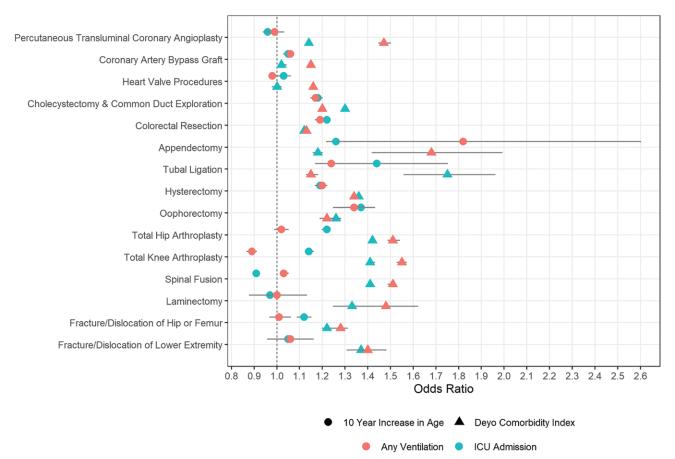


Figure. Plot of adjusted odds ratios and 95% confidence intervals for the association between patient age/Deyo comorbidity index and the 2 outcomes of postoperative ICU admission and any ventilation, stratified by surgical cohort. ICU indicates intensive care unit.

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