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Recommendations for resuming elective spine surgery in the COVID-19 era

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Editor—As regions across the USA begin reopening after the initial surge of coronavirus disease 2019 (COVID-19), current guidelines recommend that in order to resume elective surgery facilities must have a sufficient number of ICU and non-ICU beds, and ventilators to treat all non-elective patients given the possibility of a second wave of COVID-19 patients.[1] Spine fusion surgeries are among the more resource-intensive elective procedures,[2] but delaying spine surgery can result in prolonged or worsening pain and discomfort. Thus, it is important for policymakers to consider average resource utilisation after common elective spine surgeries when strategising 'return-to-normal' operations.

Increasing patient access to care while maintaining availability of ICU beds and ventilators is not the only concern institutions face. As a consequence of social distancing and stay-at-home orders, there has been a major reduction in blood donations.[3] Given that certain spine surgeries are associated with high blood loss and need for transfusion, maintaining institutional blood supply is an additional concern.

We therefore sought to determine which spine procedures and surgical approaches are the least resource-intensive and which patient populations are the least likely to require these resources. This information could guide selection of procedures that might be considered earlier in a 'return-to-normal' plan. We evaluated ICU admission, use of mechanical ventilation, and blood transfusion in the context of elective spinal fusions, stratified by location, surgical approach, and number of levels fused.

After Institutional Review Board approval (IRB#2016-436), we conducted a retrospective analysis of patients who underwent elective inpatient spinal fusion surgery captured in the Premier Healthcare database (2006—2016; Premier Healthcare Solutions, Inc., Charlotte, NC). Surgeries were classified by level of the spine (cervical, thoracolumbar, or lumbar), surgical approach (anterior, posterior, or combined), and number of vertebrae fused (2—3 or 4+). For each distinct category we identified frequency of ICU admission, length of ICU and hospital stay, use and length of ventilation ($\geq$96 h or <96 h), and blood transfusion on or after the day of surgery. Separate multivariable logistic regression models were run for the three outcomes of ICU admission, any form of ventilation, and blood transfusion. Models were adjusted for patient age and comorbidity burden as measured by Charlson—Deyo index.[4] Odds ratios (OR) and 95% confidence intervals (CI) were reported. Analyses were performed with SAS version 9.4 (SAS Institute, Cary, NC, USA).

Table 1 Patterns in ICU, ventilation, and blood transfusion utilisation among cervical, thoracolumbar, and lumbar fusion cohorts. IQR, inter-quartile range.

	Cervical fusion						Thoracolumbar fusion						Lumbar fusion					
	Anterior approach		Posterior approach		Combined approach		Anterior approach		Posterior approach		Combined approach		Anterior approach		Posterior approach		Combined approach	
	2–3 vertebrae fused	4+ vertebrae fused	2–3 vertebrae fused	4+ vertebrae fused	2–3 vertebrae fused	4+ vertebrae fused	2–3 vertebrae fused	4+ vertebrae fused	2–3 vertebrae fused	4+ vertebrae fused	2–3 vertebrae fused	4+ vertebrae fused	2–3 vertebrae fused	4+ vertebrae Fused	2–3 vertebrae Fused	4+ vertebrae Fused	2–3 Vertebrae fused	4+ Vertebrae fused
Elective inpatient procedures, *n*	184 405	25 680	9520	12 694	1692	3720	1090	327	3649	12 140	205	884	28 581	1525	235 002	23 536	22 682	4249
Postoperative ICU admission, *n* (%)	11 257 (6.1)	3297 (12.8)	1488 (15.6)	2634 (20.8)	520 (30.7)	1652 (44.4)	597 (54.8)	218 (66.7)	1034 (28.3)	6791 (55.9)	108 (52.7)	639 (72.3)	1780 (6.2)	281 (18.4)	15 187 (6.5)	4365 (18.6)	2166 (9.6)	1172 (27.6)
ICU length of stay, day, median [IQR]	1 [1, 2]	1 [1, 2]	1 [1, 2]	1 [1, 3]	2 [1, 3]	2 [1,4]	2 [1, 4]	3 [1, 4]	2 [1, 3]	2 [1, 3]	2 [1, 5]	3 [2, 5]	1 [1, 3]	2 [1, 3]	1 [1, 3]	2 [1, 3]	2 [1, 3]	2 [1, 4]
Any ventilation, *n* (%)	1583 (0.9)	598 (2.3)	201 (2.1)	358 (2.8)	132 (7.8)	512 (13.8)	105 (9.6)	36 (11.0)	114 (3.1)	712 (5.9)	20 (9.8)	195 (22.1)	269 (0.9)	33 (2.2)	2455 (1.0)	603 (2.6)	302 (1.3)	219 (5.2)
Noninvasive	483 (30.5)	115 (19.2)	43 (20.9)	57 (15.9)	9 (6.8)	27 (5.3)	9 (8.6)	3 (8.3)	21 (18.4)	123 (17.3)	0 (0)	14 (7.2)	86 (32.0)	9 (27.3)	1097 (44.7)	133 (22.1)	78 (25.8)	33 (15.1)
Invasive	1058 (66.8)	466 (77.9)	148 (73.6)	289 (80.7)	116 (87.9)	462 (90.2)	88 (83.8)	31 (86.1)	87 (76.3)	564 (79.2)	17 (85.0)	170 (87.2)	178 (66.2)	22 (66.7)	1262 (51.4)	440 (73.0)	214 (70.9)	181 (82.7)
Both	42 (2.7)	17 (2.8)	11 (5.5)	12 (3.4)	7 (5.3)	23 (4.5)	8 (7.6)	2 (5.6)	6 (5.3)	25 (3.5)	3 (15.0)	11 (5.6)	5 (1.9)	2 (6.1)	96 (3.9)	30 (5.0)	10 (3.3)	5 (2.3)
Invasive ventilation duration, *n* (%)																		
Consecutive ≥96 h	218 (19.8)	98 (20.3)	29 (18.2)	58 (19.3)	23 (18.7)	74 (15.3)	18 (18.8)	8 (24.2)	21 (22.6)	126 (21.4)	3 (15.0)	34 (18.8)	32 (17.5)	8 (33.3)	199 (14.7)	71 (15.1)	34 (15.2)	25 (13.4)
Consecutive <96 h	882 (80.2)	385 (79.7)	130 (81.8)	243 (80.7)	100 (81.3)	410 (84.5)	78 (81.3)	25 (75.8)	72 (77.4)	463 (78.6)	17 (85.0)	147 (81.2)	151 (82.5)	16 (66.7)	1157 (85.2)	399 (64.9)	190 (84.8)	161 (86.6)
Blood transfusion, *n* (%)	1348 (0.7)	510 (2.0)	395 (4.2)	939 (7.4)	122 (7.2)	487 (13.1)	253 (23.2)	143 (43.7)	749 (20.5)	5420 (44.7)	75 (36.6)	547 (61.9)	1892 (6.6)	302 (19.8)	31 715 (13.5)	8725 (37.1)	3357 (14.8)	1703 (40.1)
Hospital length of stay, day, median [IQR]	1 [1, 2]	2 [1, 2]	3 [2, 4]	3 [2,5]	3 [2, 5]	4 [3, 7]	5 [3, 8]	6 [4, 8]	4 [3, 6]	5 [4, 6]	6 [4, 8]	8 [6, 12]	3 [2, 4]	4 [2, 5]	3 [2, 4]	4 [3, 5]	3 [2, 4]	5 [3, 7]
Patient age, yr, median [IQR]	53 [45, 62]	58 [51, 66]	59 [50, 69]	62 [54, 70]	58 [49, 67]	60 [53, 68]	53 [42, 64]	35 [15, 58]	59 [44, 69]	20 [14, 63]	55 [41, 63]	55 [28, 66]	51 [42, 63]	63 [53, 71]	60 [50, 69]	66 [57, 73]	56 [46, 66]	63 [54, 70]
Deyo index, *n* (%)																		
0	119 883 (65.0)	15 321 (59.3)	5272 (55.4)	6134 (48.3)	924 (54.6)	1792 (48.2)	589 (54.0)	204 (62.4)	1949 (53.4)	7795 (64.2)	112 (54.6)	422 (47.7)	19 359 (67.7)	901 (59.1)	140 377 (59.7)	12 177 (51.7)	14 325 (62.8)	2352 (55.4)
1	45 393 (24.6)	6949 (27.1)	2493 (26.2)	3596 (28.3)	459 (27.1)	1056 (28.4)	215 (19.7)	51 (15.6)	853 (23.4)	2036 (16.8)	37 (18.1)	179 (20.3)	6497 (22.7)	391 (25.6)	61 890 (26.3)	6725 (28.6)	5720 (25.2)	1174 (27.6)
2	12 742 (6.9)	2243 (8.7)	1019 (10.7)	1596 (12.6)	157 (9.3)	492 (13.2)	120 (11.0)	30 (9.2)	355 (9.7)	1189 (9.8)	28 (13.7)	135 (15.3)	1772 (6.2)	137 (9.0)	20 868 (8.8)	2738 (11.6)	1744 (7.7)	450 (10.6)
3+	6387 (3.5)	1257 (4.9)	736 (7.7)	1368 (10.8)	152 (9.0)	380 (10.2)	166 (15.2)	42 (12.8)	492 (13.5)	1120 (9.2)	28 (13.7)	148 (16.7)	953 (3.3)	96 (6.3)	12 049 (5.1)	1896 (8.1)	983 (4.3)	273 (6.4)

Thoracolumbar fusions had the greatest resource utilisation with more than half of patients requiring a postoperative ICU stay, which on average lasted >2 days. Thoracolumbar fusions with a combined anterior and posterior approach were particularly resource intensive, with 19.8% of patients requiring ventilation and 56.8% requiring blood transfusion. Anterior cervical discectomy and fusions were the least resource intensive with only 6.8% of patients admitted to the ICU postoperatively, 1% requiring ventilation, and < 1% requiring blood transfusion. This was followed closely by anterior or posterior lumbar fusions, which had relatively low resource utilisation compared with other procedures. Regardless of surgical approach, higher-level fusions were more resource intensive with more patients requiring ICU admission, ventilation, or blood transfusion relative to lower level fusions (Table 1). Across almost all surgical cohorts, older age and greater comorbidity burden were associated with significantly increased odds of ICU admission, any form of ventilation, and blood transfusion (Supplementary Fig. S1).

Although they represented the smallest cohort, thoracolumbar fusion procedures had the highest ICU, ventilation, and blood transfusion utilisation of all elective spine surgeries. Anterior cervical discectomy and fusions, and anterior or posterior lumbar fusions were the least resource intensive procedures, with relatively low rates of ICU admission, ventilation, or blood transfusions. Across all sections of the spine and surgical approaches, a higher number of levels fused was associated with high resource utilisation.

Based on these findings, elective thoracolumbar fusions, high-level fusions, or both should be greatly limited if not avoided entirely, whereas concerns regarding recurrent COVID-19 outbreaks persist requiring a renewed need for critical care and other resources. The frequency with which these procedures are performed should also be considered. Although highly resource intensive, thoracolumbar fusions are less common compared with cervical or lumbar fusions. Therefore, additional factors should be taken into account when scheduling more common yet less resource-intensive procedures such as anterior cervical discectomy and fusions or anterior or posterior lumbar fusions. In almost all surgical cohorts, older patients with a high comorbidity burden were more likely to require ICU admission, ventilation, and/or blood transfusion. Therefore, for all spinal fusion procedures, surgeries should be limited or at least prioritised to younger, healthier patients.

There are obvious ethical considerations in delaying elective spine surgery given that these procedures are commonly performed in order to relieve pain. Although thoracolumbar multilevel fusions may utilise the most resources, decision-making should not be based solely on cost, but also on what benefits are derived with that cost. Potential benefits for the patient must be weighed against potential shortages of resources or resource needs. Patients suffering from worsening pain and discomfort as a result of postponing surgery must be taken into account in each assessment; here, resource-intensive procedures should be scheduled further apart to maximise hospital capacity and resource availability.

Limitations of this study include its retrospective nature, but given that we evaluated 11 yr of data, it is likely that these patterns persist today. In addition, this study does not include urgent and emergent cases, which many spine surgeries are categorised as given concern for neurological involvement.

In conclusion, when resuming elective spine surgeries thoracolumbar and higher-level fusions should be limited if possible in favour of lower-level fusions of the cervical or lumbar spine. In addition, restricting these procedures to younger patients with fewer comorbidities could aid in further reducing resource utilisation.

Authors' contributions

Data analysis: LAW
Manuscript preparation: LAW, JP, SGM
All authors were involved in study design/planning, interpretation of results, and review of the manuscript

Declarations of interest

SGM 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. All other authors declare no conflicts of interest.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.bja.2020.06.022.

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