




The short-term impact of COVID-19 pandemic on spine surgeons: a cross-sectional global study

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Abstract

Purpose The outbreak of COVID-19 erupted in December 2019 in Wuhan, China. In a few weeks, it progressed rapidly into a global pandemic which resulted in an overwhelming burden on health care systems, medical resources and staff. Spine surgeons as health care providers are no exception. In this study, we try to highlight the impact of the crisis on spine surgeons in terms of knowledge, attitude, practice and socioeconomic burden.

Methods This was global, multicentric cross-sectional study on 781 spine surgeons that utilized an Internet-based validated questionnaire to evaluate knowledge about COVID-19, availability of personal protective equipment, future perceptions, effect of this crisis on practice and psychological distress. Univariate and multivariate ordinal logistic regression analyses were used to evaluate the predictors for the degree of COVID-19 effect on practice.

Results Overall, 20.2%, 52% and 27.8% of the participants were affected minimally, intermediately and hugely by COVID-19, respectively. Older ages ($\beta=0.33$, 95% CI 0.11–0.56), orthopedic spine surgeons ($\beta=0.30$, 95% CI 0.01–0.61) and those who work in the private sector ($\beta=0.05$, 95% CI 0.19–0.61) were the most affected by COVID-19. Those who work in university hospitals ($\beta=-0.36$, 95% CI 0.00 to –0.71) were affected the least. The availability of N95 masks (47%) and disposable eye protectors or face shields (39.4%) was significantly associated with lower psychological stress ($p=0.01$). Only 6.9%, 3.7% and 5% had mild, moderate and severe mental distress, respectively.

Conclusion While it is important to recognize the short-term impact of COVID-19 pandemic on the practice of spine surgery, predicting where we will be standing in 6–12 months remains difficult and unknown. The COVID-19 crisis will probably have an unexpected long-term impact on lives and economies.

Keywords COVID-19 · Spine surgeons · Mitigation · Quarantine · Economy

Introduction

On December 2019, an outbreak of severe lower respiratory tract infection of unknown etiology was identified in Wuhan City, China [1, 2]. The causative agent of the outbreak was found to be a betacoronavirus that was given the name of Severe Acute Respiratory Syndrome Coronavirus 2 (SARS-CoV2) [3]. It causes a syndrome called coronavirus disease 2019 (COVID-19), which has the symptomatology of fever, fatigue cough, dyspnea and sore throat [4, 5]. The virus spreads between individuals during close contact, often via droplets or through contact with contaminated surfaces and then hand-to-face contact [6].

To the date, there's no effective targeted medical treatment or vaccine for COVID-19 [7–9]. Therefore, preventive measures, in terms of social distancing, self-isolation and

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personal protective equipment (PPE), are the most effective methods to mitigate the effects of this infection [10]. The outbreak was declared as a global pandemic by the World Health Organization (WHO) on March 11, 2020 [4]. As a result, many countries applied home quarantine, entry bans or other restrictions for their citizens and recent travelers [11].

This resulted in an overwhelming burden on health care system, medical resources and staff. In addition, it created a global state of panic among populations, politicians and health care providers [12]. Spine surgeons, as other professional health care providers, were affected by the global pandemic and lockdowns [13, 14]. Most of them were forced to shut down their outpatient clinics, cancel appointments and limit their surgery to urgent/emergent cases [13]. Moreover, spine surgeries are lengthy procedures which can subsequently increase physical burden on surgeons with increased time interval in theaters. Instrumentations and the continuous need for intraoperative imaging mandate a higher than usual number of personnel in theater. Intraoperative use of high-speed drills and Bovie cautery may additionally help in the spread of the disease [14].

Health care workers are the frontline in the face of the virus, with higher chances of catching the latter. This study aimed first to estimate the impact of COVID-19 on spine surgeons globally. A secondary outcome of this study was to evaluate knowledge, attitude and experience of spine surgeons with COVID-19 crisis.

Methods

Study design and sampling

This is global, multicentric cross-sectional study that took part during COVID-19 pandemic (April 3–10, 2020). A self-administered, online-based questionnaire was sent to more than 3000 spine surgeons all over the world by e-mails and other Internet applications, resulting in a snowball sampling. Spine surgeon's contact details were provided by personal acquaintance or through national and international spine societies. Overall, 781 spine surgeons from 33 countries took part, filled and submitted the questionnaire.

Instrument development and validation

The survey included 31 questions addressing the spine surgeon's knowledge, attitude, practice, PPEs, psychological stress and the impact of COVID-19 on practice. The validity of the questionnaire content was determined after consensus among the authors.

The psychological distress was measured using the Kessler Psychological Distress Scale (K10), as it is shown to

have high reliability and validity among different populations from different cultural backgrounds. The effect of COVID-19 on practice was measured using four questions with five possible answers, yielding a total score from 20 points. It was then categorized into minimal (1–12), intermediate (13–16) and huge (17–20) effects, depending on the tertiles of the participants' responses. A pilot study was conducted on 40 participants, not included in the original study to assess the internal consistency of the questionnaire. The Cronbach's α value of the COVID-10 effect on practice subscale was 0.76.

Statistical analysis

Data analyses were done using STATA (Stata Statistical Software: Release 16. College Station, TX: Stata-Corp LLC). Overall, 780 surgeons agreed on filling the questionnaire; after removing incomplete and irrational responses, in addition to duplicates, the overall number of the participants became 739. The associations of baseline characteristics with the degree of COVID-19 effect on practice were analyzed using Kruskal–Wallis test for polychotomous variables and Mann–Whitney U test for dichotomous variables. A univariate and multivariate ordinal logistic regression analyses were used to assess the predictors of the degree of COVID-19 effect. A p value of less than 0.05 was considered statistically significant.

Ethical consideration

Ethical approval was granted from the Institutional Review Board (IRB). The study objectives, the nature of participation and the privacy of data handling were explained on the first page. An online consent form was obtained from all participants before accessing the questionnaire.

Results

Baseline characteristics

Table 1 shows the baseline characteristics of the participants. The mean age of the study participants was 44.5 years, ranging from 25 to 84 years. Most of the samples were from Middle East and Northern Africa (49%), orthopedic spine surgeons (59.1%), working in the private sector (55%) and having more than 15 years of experience (32.1%). The degree of psychological distress in the participants was as follows: mild 6.9%, moderate 3.7% and severe 5%.

Table 1 Baseline characteristics of 739 spine surgeons according to the effect of COVID-19 on their practice

Variable	Category	Total <i>n</i> (%)	COVID-19 effect on practice			<i>p</i> value
			Minimal <i>n</i> (%)	Intermediate <i>n</i> (%)	Huge <i>n</i> (%)	
Total			149 (20.2)	384 (52)	206 (27.8)	
Age (years)	≤ 30	33 (4.5)	10 (30.3)	20 (60.6)	3 (9.1)	< 0.01
	31–40	271 (36.7)	70 (25.8)	137 (50.6)	64 (23.6)	
	41–50	252 (34.1)	46 (18.3)	129 (51.2)	77 (30.6)	
	51–60	126 (17.1)	15 (11.9)	68 (54)	43 (34)	
	≥ 60	57 (7.7)	8 (14)	30 (52.6)	19 (33.3)	
	Total	739 (100)				
Region	Sub-Saharan Africa	18 (2.4)	10 (55.6)	6 (33.3)	2 (11.1)	< 0.01
	Middle East and North Africa	362 (49)	54 (14.9)	191 (52.8)	117 (32.3)	
	Europe	201 (27.2)	41 (20.4)	109 (54.2)	51 (25.4)	
	Far East and mid-Asia	77 (10.4)	19 (24.7)	32 (41.6)	26 (33.8)	
	Northern America	53 (7.2)	21 (39.6)	31 (52.5)	1 (1.9)	
	South America and Caribbean	18 (2.4)	2 (11)	11 (61.1)	5 (27.8)	
	Other	10 (1.4)	2 (20)	4 (40)	4 (40)	
	Total	739 (100)				
Health sector	Governmental Hospital (NHS)	280 (37.9)	48 (17.1)	157 (56.1)	75 (26.8)	0.6
	University Hospital	239 (32.3)	66 (27.6)	120 (50.2)	53 (22.2)	< 0.01
	Military medical services	30 (4.1)	6 (20)	15 (50)	9 (30)	0.8
	Private sector	406 (55)	60 (14.8)	210 (51.7)	136 (33.5)	< 0.01
Specialty	Neurosurgeons	302 (40.9)	67 (22.2)	164 (54.3)	71 (23.5)	0.03
	Orthopedics	437 (59.1)	82 (18.8)	220 (50.3)	135 (30.9)	
	Total	739 (100)				
Experience (years)	≤ 5	221 (29.9)	52 (23.5)	118 (53.4)	51 (23.1)	0.02
	5–10	149 (20.1)	40 (26.9)	71 (47.7)	38 (25.5)	
	10–15	132 (17.9)	22 (16.7)	64 (48.5)	46 (34.9)	
	≥ 15	237 (32.1)	35 (14.8)	131 (55.3)	71 (30)	
	Total	739 (100)				

Personal experience with COVID-19

Table 2 illustrates the frequency of participants' responses to the knowledge, attitudes and experience questions, as well as the source of knowledge, and PPE. Only few respondents knew spine surgeons who were directly involved in COVID-19 management (24.8%), or got trained to deal with COVID-19 pandemic (23.3%). Moreover, only 15.7% of them have already operated on COVID-19-positive patients. However, 69.2% of the surgeons were willing to operate on these patients if they were in need, and 62.2% of them were following protective measures when they returned back from their work.

Knowledge and attitudes

Improving general and personal hygiene (77.9%), increasing awareness to the importance of medical and scientific

research (77.7%) and increasing the number and usage of telemedicine (61.4%) were the most commonly reported positive effects of this pandemic on the society among the others. According to the participants' point of view, quarantine, mitigation measures (36.4%) and finding a vaccine for COVID-19 (35.1%) were the most reported solutions to end this pandemic.

Most of the participants knew that COVID-19 is transmitted by droplets (63.3%). Airborne (32.5%) and sexual transmission (8.8%), however, were the most frequent wrong answers. The most common sources of information were social media (73.2%) and scientific reports (68.2%).

Personal protective equipment (PPE)

Our results demonstrated that 37.5% of the respondents believed that they have enough ventilators in the country to deal with this crisis. Regarding the availability of

Table 2 Frequency of 739 participant's responses to general attitudes, knowledge and experience toward COVID-19

Variable	Statement	Answers Yes n (%)
<i>Knowledge, attitudes and experience</i>		
Personal experience with COVID-19	Do you know any spine surgeon in your country (including yourself) who is directly involved in COVID-19 management or rescue teams?	183 (24.8)
	Do you know any spine surgeon in your country (including yourself) who got trained to deal with COVID-19 pandemic?	172 (23.3)
	Have you already operated on patients positive with COVID-19?	116 (15.7)
	Do you believe that you have enough ventilators in your country to deal with this crisis?	277 (37.5)
General attitudes toward COVID-19	Do you isolate yourself at home when you return back from the hospital?	460 (62.2)
	Are you willing to operate on patients positive with COVID-19?	511 (69.2)
In your opinion, how do you think this pandemic has affected communities?	Improved general and personal hygiene	576 (77.9)
	Improved family bonds	393 (53.2)
	Increased awareness to the importance of medical and scientific research	574 (77.7)
	Increased the number and usage of telemedicine clinics	454 (61.4)
In your opinion, which is the best strategy to end this crisis?	Increased utility of online teaching	404 (54.7)
	Quarantine and mitigation strategies	269 (36.4)
	An efficient treatment	107 (14.5)
	Find a vaccine	259 (35.1)
In your opinion, how do you think COVID-19 spreads?	Herd immunity	110 (14.9)
	Droplets	468 (63.3)
	Airborne	240 (32.5)
	Sexually	65 (8.8)
<i>Source of knowledge</i>		
Which one of the following do you use as a source of your information?	Social media and TV	541 (73.2)
	Lectures and seminars	258 (34.9)
	Scientific papers	514 (68.2)
<i>Personal protective equipment</i>		
What is the medical protective equipment available at your institution?	Disposable gloves	626 (84.7)
	Long-sleeved cuffed gowns	251 (34)
	Disposable eye protection or face shields	291 (39.4)
	Surgical masks	687 (93)
	N95 masks	347 (47)
	Alcohol-based hand sanitizers	635 (85.9)

advanced PPE, only 47% and 39.4% reported that N95 masks and disposable eye protectors or face shields are currently available in their workplaces. In terms of basic PPE, participating surgeons reported that surgical masks (93%), alcohol-based hand sanitizers (85.9%) and disposable gloves (84.7%) were fairly available in their hospitals. Long-sleeve cuffed gowns, however, were available only in 34% of the responses.

Factors predicting the effect of COVID-19 on practice

Overall, 20.2%, 52% and 27.8% of the participants were affected minimally, intermediately and hugely by COVID-19, respectively. Table 3 shows the multivariate ordinal logistic regression model of the effect of COVID-19 on practice predictors. The results showed that older ages ($\beta=0.33$, 95% CI 0.11–0.56) and being orthopedic spine

Table 3 Multivariate ordinal regression analyses of the predictors of the degree of COVID-19 effect on practice in 739 participants

Variable	Categories	β coefficient	<i>p</i> value	95% Confidence interval	
Age (years)		0.33	<0.01	0.11	0.56
Region	Sub-Saharan Africa (Ref)				
	Middle East and North Africa	1.80	<0.01	0.80	2.79
	Europe	1.26	0.01	0.25	2.27
	Far East and mid-Asia	1.76	<0.01	0.70	2.82
	Northern America	0.09	0.9	-1.00	1.17
	South America and Caribbean	1.60	0.02	0.30	2.90
Health sector	Other	1.64	0.04	0.07	3.21
	Governmental Hospital (NHS)	-1.33	0.5	-0.49	0.22
	University Hospital	-0.36	0.05	-0.71	0.00
	Military medical services	0.020	0.6	-0.51	0.92
Specialty	Private sector	0.053	<0.01	0.19	0.87
	Neurosurgeons (Ref)				
Experience (years)	Orthopedics	0.30	0.05	0.01	0.61
	≤ 5 (Ref)				
	5–10	-0.10	0.6	-0.52	0.32
	10–15	0.26	0.3	-0.22	0.75
	≥ 15	-0.19	0.5	-0.76	0.37

surgeon ($\beta=0.30$, 95% CI 0.01–0.61) were predictors of higher effects of COVID-19 on practice. Those who work in the private sector were the most affected by COVID-19 ($\beta=0.05$, 95% CI 0.19–0.61), in contrast to those who work in university hospitals ($\beta=-0.36$, 95% CI 0.00 to -0.71) who were affected the least. Living in Middle East and North Africa ($\beta=1.80$, 95% CI 0.80–2.79); Europe ($\beta=1.26$, 95% CI 0.25–2.27); Far East and mid-Asia ($\beta=1.76$, 95% CI 0.70–2.82); or South America and Caribbean ($\beta=1.60$, 95% CI 0.30–2.90) was significantly associated with more drastic effects of COVID-19 on surgeons.

Discussion

This study was triggered in the first place by the ongoing global event of novel COVID-19 pandemic as it is most likely the first time in recent history that we know of, when a disease has spread so rapidly throughout most of the world in weeks of interval.

The impact of COVID-19 on spine surgeons was drastic as it was shown in this global multicentric cross-sectional study. In fact, most of them had to shut down their outpatient clinics, cancel appointments and limit their surgery to urgent/emergent cases. Older age of practice and being an orthopedic spine surgeon were predictors of higher effects of COVID-19 on practice; this may be explained by the fact that spine surgeons from the neurosurgery background may have had a higher rate of urgent/emergent cases such as intraspinal tumors or brain conditions usually considered

critical and that could not wait to undergo surgery later on. In addition, surgeons working in the private sector were more affected financially in contrast with their colleagues working in the university hospital. Such a finding can be explained by the fact that many surgeons in the private hospitals do not work on a salary basis, but are rather compensated for based on the number of treated patients and surgeries performed; therefore, any sudden drop in the number of patients would directly affect the surgeon's income.

Nevertheless, the study showed that the degree of psychological distress among the participants remained relatively moderate. This is logically due to the fact that the pandemic had a global planetary impact, which in a way may “reassure” people and let them accept the reality more easily by the fact that it affected billions of people all around the world at the same time, leading to the same negative consequences on everyone. Some positive effects of the pandemic were retrieved though, as the questionnaire showed that the majority of the participants expressed an improvement in general and personal hygiene, the awareness to the importance of medical and scientific research increased and the number and usage of telemedicine also increased.

Almost 70% of the surgeons expressed their will to operate on COVID-19 patients if they were in need. This finding clearly shows the motivation and dedication of the spine surgeons' community in order to help treating spine diseases whatever the status of the patient was; it illustrates how the health care providers are truly in the frontline of management during any pandemic, taking risks in order to help the patients as much as they can.

To the participants' point of view, quarantine, mitigation measures and finding a vaccine for COVID-19 were the most reported solutions to end this pandemic, which in fact goes in pair with the policies that were applied in the majority of the countries, where most outpatient clinics were shut down or the number of visiting patients was forced to drop down massively. Similarly, surgery for elective cases was suspended or dropped massively. The number of urgent surgeries had also dropped but not as massive as the elective cases.

It seems that few spine surgeons got directly involved or got trained to dealing with COVID-19 patients or volunteered on taking medical roles outside their practice. Quite a few have already operated on patients with COVID-19 and most are willing to take the proper precautions in case they have to operate on a positive patient. It was interesting to know that PPE are not standard and available to all spine surgeons or regions. More than two-thirds of surgeons believed that their country does not have enough ventilators. Nevertheless, most countries and hospitals had taken satisfactory measures in dealing with the pandemic.

Few papers have been so far published about COVID-19 and spine surgery [15–19]. In a narrative review by Jain [14], optimization and treatment of spine pathologies during the global pandemic were discussed, where appropriate triaging of the patients is advised in order to help preserve health care resources that can be reallocated to treat patients with COVID-19, and maximizing the use of telemedicine in the outpatient setting which would minimize viral transmission by community spread. Such recommendations were clearly demonstrated by the responses of the participants in the current study. This was also emphasized by Donnally [20] in an editorial paper where it was advised, in order to assess the risk of postponing a spine surgery, to follow up on the patient's quality of life and neurological status with telemedicine; in fact, the eventual surgery may occur in 3 months or more from the present. In another editorial paper by Ghogawala [20], it was stated how the magnitudes of the effects of lost revenues on medical personnel vary widely, depending on the institutional model for compensation. This was clearly demonstrated in our study with the clear discrepancy between surgeons working in private institutions and surgeons working in university hospitals.

Some limitations of the current study should nevertheless be acknowledged such as the relatively small sample size with limited number of participants from some countries, the non-random snowball sampling, the use of social media in order to reach out for the spine surgeons' community and being a cross-sectional study.

Conclusion

This study is one of the first studies, as far as we know, to highlight the diverting effects of the pandemic on spine surgery practice globally. It provided insight on what was going on through the minds of spine surgeons during that specific period. Although COVID-19 had a major impact on spine surgeons economically and professionally, the short-term psychological distress was nevertheless minor. The study showed the variability among countries and continents in knowledge, response and preparedness to handling the situation during the early phase of the pandemic. It also showed the variable deficiencies in health care systems. However, the crisis managed to reorganize priorities in terms of reconnection with the family, increasing awareness to scientific research and improving personal hygiene.

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Compliance with ethical standards

Conflict of interest The authors declare that they have no competing interests.

References

1. Zhu N, Zhang D, Wang W, Li X, Yang B, Song J, Zhao X, Huang B, Shi W, Lu R, Niu P, Zhan F, Ma X, Wang D, Xu W, Wu G, Gao GF, Tan W, China Novel Coronavirus Investigating, and Research Team (2020) A novel coronavirus from patients with pneumonia in China, 2019. *N Engl J Med* 382:727–733. <https://doi.org/10.1056/NEJMoa2001017>
2. Zhou P, Yang XL, Wang XG, Hu B, Zhang L, Zhang W, Si HR, Zhu Y, Li B, Huang CL, Chen HD, Chen J, Luo Y, Guo H, Jiang RD, Liu MQ, Chen Y, Shen XR, Wang X, Zheng XS, Zhao K, Chen QJ, Deng F, Liu LL, Yan B, Zhan FX, Wang YY, Xiao GF, Shi ZL (2020) A pneumonia outbreak associated with a new coronavirus of probable bat origin. *Nature* 579:270–273. <https://doi.org/10.1038/s41586-020-2012-7>
3. Coronaviridae Study Group of the International Committee on Taxonomy of V (2020) The species severe acute respiratory syndrome-related coronavirus: classifying 2019-nCoV and naming it SARS-CoV-2. *Nat Microbiol* 5:536–544. <https://doi.org/10.1038/s41564-020-0695-z>
4. Guo YR, Cao QD, Hong ZS, Tan YY, Chen SD, Jin HJ, Tan KS, Wang DY, Yan Y (2020) The origin, transmission and clinical therapies on coronavirus disease 2019 (COVID-19) outbreak—an

- update on the status. *Mil Med Res* 7:11. <https://doi.org/10.1186/s40779-020-00240-0>
5. Huang C, Wang Y, Li X, Ren L, Zhao J, Hu Y, Zhang L, Fan G, Xu J, Gu X, Cheng Z, Yu T, Xia J, Wei Y, Wu W, Xie X, Yin W, Li H, Liu M, Xiao Y, Gao H, Guo L, Xie J, Wang G, Jiang R, Gao Z, Jin Q, Wang J, Cao B (2020) Clinical features of patients infected with 2019 novel coronavirus in Wuhan, China. *Lancet* 395:497–506. [https://doi.org/10.1016/S0140-6736\(20\)30183-5](https://doi.org/10.1016/S0140-6736(20)30183-5)
 6. Cai J, Sun W, Huang J, Gamber M, Wu J, He G (2020) Indirect virus transmission in cluster of COVID-19 cases, Wenzhou, China, 2020. *Emerg Infect Dis*. <https://doi.org/10.3201/eid2606.200412>
 7. Zhai P, Ding Y, Wu X, Long J, Zhong Y, Li Y (2020) The epidemiology, diagnosis and treatment of COVID-19. *Int J Antimicrob Agents*. <https://doi.org/10.1016/j.ijantimicag.2020.105955>
 8. Gautret P, Lagier JC, Parola P, Hoang VT, Meddeb L, Mailhe M, Doudier B, Courjon J, Giordanengo V, Vieira VE, Dupont HT, Honore S, Colson P, Chabriere E, La Scola B, Rolain JM, Brouqui P, Raoult D (2020) Hydroxychloroquine and azithromycin as a treatment of COVID-19: results of an open-label non-randomized clinical trial. *Int J Antimicrob Agents*. <https://doi.org/10.1016/j.ijantimicag.2020.105949>
 9. Molina JM, Delaugerre C, Le Goff J, Mela-Lima B, Ponscarne D, Goldwirt L, de Castro N (2020) No evidence of rapid antiviral clearance or clinical benefit with the combination of hydroxychloroquine and azithromycin in patients with severe COVID-19 infection. *Med Mal Infect*. <https://doi.org/10.1016/j.medma.1.2020.03.006>
 10. Guan WJ, Ni ZY, Hu Y, Liang WH, Ou CQ, He JX, Liu L, Shan H, Lei CL, Hui DSC, Du B, Li LJ, Zeng G, Yuen KY, Chen RC, Tang CL, Wang T, Chen PY, Xiang J, Li SY, Wang JL, Liang ZJ, Peng YX, Wei L, Liu Y, Hu YH, Peng P, Wang JM, Liu JY, Chen Z, Li G, Zheng ZJ, Qiu SQ, Luo J, Ye CJ, Zhu SY, Zhong NS, China Medical Treatment Expert Group for C (2020) Clinical characteristics of coronavirus disease 2019 in China. *N Engl J Med* 382:1708–1720. <https://doi.org/10.1056/NEJMoa2002032>
 11. R Core Team (2020) Coronavirus: what measures are countries taking to stop it? *BBC News* <https://www.bbcom/news/world-51737226>. Accessed 4 Apr 2020
 12. Lai J, Ma S, Wang Y, Cai Z, Hu J, Wei N, Wu J, Du H, Chen T, Li R, Tan H, Kang L, Yao L, Huang M, Wang H, Wang G, Liu Z, Hu S (2020) Factors associated with mental health outcomes among health care workers exposed to coronavirus disease 2019. *JAMA Netw Open* 3:e203976. <https://doi.org/10.1001/jamanetworkopen.2020.3976>
 13. Ghogawala Z, Kurpad S, Falavigna A, Groff MW, Sciubba DM, Wu JC, Park P, Berven S, Hoh DJ, Bisson EF, Steinmetz MP, Wang MC, Chou D, Sansur CA, Smith JS, Tumialan LM (2020) Editorial. COVID-19 and spinal surgery. *J Neurosurg Spine*. <https://doi.org/10.3171/2020.4.SPINE20468>
 14. Jain NSAR, Schopler SS, Hah R, Wang JC (2020) COVID-19 and spine surgery: a review and evolving recommendations. *Glob Spine J*. <https://doi.org/10.1177/2192568220923655>
 15. Sornsara-Ard T, Niramitsantiphong A, Liawrungrueang W (2020) Management of traumatic spinal fracture in the coronavirus disease 2019 situation. *Asian Spine J*. <https://doi.org/10.31616/asj.2019.0183>
 16. Chang Liang Z, Wang W, Murphy D, Po Hui JH (2020) Novel coronavirus and orthopaedic surgery: early experiences from Singapore. *J Bone Joint Surg Am*. <https://doi.org/10.2106/JBJS.20.00236>
 17. North American Spine Society (2020) Coronavirus NASS guidance document. <https://www.spine.org/Portals/0/assets/downloads/Publications/NASSInsider/NASSGuidanceDocument040320.pdf>. Accessed 4 Apr 2020
 18. American Academy of Orthopaedic Surgeons. AAOS member alert on telemedicine coding. https://www.aaos.org/globalassets/about/covid-19/aaos-coding-guide_covid19.pdf. Accessed 4 Apr 2020
 19. Dowdell JE, Louie PK, Virk S, McCarthy MH, Sandhu HS, Qureshi SA, Albert TJ, Kim HJ (2020) Spine fellowship training reorganizing during a pandemic: perspectives from a tertiary orthopaedic specialty center in the epicenter of outbreak. *Spine J*. <https://doi.org/10.1016/j.spinee.2020.04.015>
 20. Donnally CJ 3rd, Shenoy K, Vaccaro AR, Schroeder GD, Kepler CK (2020) Triaging spine surgery in the COVID-19 era. *Clin Spine Surg* 33:129–130. <https://doi.org/10.1097/BSD.0000000000000988>

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