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Recommended Citation

Khalafallah, Adham M; Lam, Shravika; Gami, Abhishek; Dornbos, David L; Sivakumar, Walavan; Johnson, Jeremiah N; and Mukherjee, Debraj, "A national survey on the impact of the COVID-19 pandemic upon burnout and career satisfaction among neurosurgery residents." (2020). *Articles, Abstracts, and Reports*. 3768.

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Clinical study

A national survey on the impact of the COVID-19 pandemic upon burnout and career satisfaction among neurosurgery residents



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ARTICLE INFO

Article history:

Received 13 July 2020

Accepted 9 August 2020

Keywords:

Burnout

Career satisfaction

COVID-19

Neurosurgery

Pandemic

Residents

ABSTRACT

The coronavirus disease 2019 (COVID-19) pandemic has posed significant changes to resident education and workflow. However, the impact of the pandemic on U.S. neurosurgery residents has not been well characterized. We investigated the impact of the COVID-19 pandemic on U.S. neurosurgery resident workflow, burnout, and career satisfaction. In 2020, a survey evaluating factors related to career satisfaction and burnout was emailed to 1,374 American Association of Neurological Surgeons (AANS) residents. Bivariate and multivariate (logistic) analyses were performed to characterize predictors of burnout and career satisfaction. 167 survey responses were received, with a response rate (12.2%) comparable to that of similar studies. Exclusion of incomplete responses yielded 111 complete responses. Most respondents were male (65.8%) and White (75.7%). Residents reported fewer work hours (67.6%) and concern that COVID-19 would impair their achievement of surgical milestones (65.8%). Burnout was identified in 29 (26.1%) respondents and career satisfaction in 82 (73.9%) respondents. In multivariate analysis, burnout was significantly associated with alterations in elective rotation/vacation schedules ($p = .013$) and the decision to not pursue neurosurgery again if given the choice ($p < .001$). Higher post-graduate year was associated with less burnout ($p = .011$). Residents displayed greater career satisfaction when focusing their clinical work upon neurosurgical care ($p = .065$). Factors related to COVID-19 have contributed to workflow changes among U.S. neurosurgery residents. We report a moderate burnout rate and a paradoxically high career satisfaction rate among neurosurgery residents. Understanding modifiable stressors during the COVID-19 pandemic may help to formulate interventions to mitigate burnout and improve career satisfaction among residents.

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1. Introduction

The novel coronavirus 2019 (COVID-19) pandemic has disrupted graduate medical education (GME) globally. Neurosurgical

resident education has been particularly impacted, with many centers reporting significant decreases in surgical case volumes, alterations in call schedules, and redeployment of resident staffing to non-neurosurgical units [1–3]. In addition to the mental and emotional distress it has inflicted upon healthcare workers [4,5], the COVID-19 pandemic may also contribute to resident burnout, which has been previously reported to occur at high levels among neurosurgical residents [6–9].

Burnout has been defined as a syndrome of emotional exhaustion and cynicism experienced in individuals who must sacrifice emotional resources as part of their work [10]. Previous studies have linked burnout in healthcare workers to increased medical errors, substance abuse, and suicide [11–14]. Because of the immense stresses the pandemic has placed upon neurosurgical

Abbreviations: AANS, American Academy of Neurological Surgeons; ACGME, Accreditation Council for Graduate Medical Education; aMBI, abbreviated Maslach Burnout Inventory; AUC, area under the Receiver Operating Characteristics curve; CI, confidence interval; CNS, Congress of Neurological Surgeons; COVID-19, Coronavirus Disease 2019; DP, depersonalization; EE, emotional exhaustion; OR, odds ratio; PA, personal accomplishment; PGY, post-graduate year; PUI, patient under investigation; ROC, Receiver Operating Characteristics; SD, standard deviation.

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<https://doi.org/10.1016/j.jocn.2020.08.012>

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residents and the significant changes COVID-19 has imposed on resident education, it is important to evaluate how the burnout rate among neurosurgical residents has changed during this unique time. This study aims to evaluate the prevalence of burnout among neurosurgical residents related to the COVID-19 pandemic and identify risk factors that may place residents at higher risk for burnout.

2. Methods

2.1. Study population

An anonymous electronic survey assessing burnout and career satisfaction among neurosurgery residents was created using the Qualtrics online platform (Qualtrics, Provo, UT). In May 2020, a cover letter describing the study and containing a hyperlink to the survey was emailed to all current resident members of the American Association of Neurological Surgeons (AANS) on behalf of the AANS Young Neurosurgeons Committee. Resident neurosurgeons were encouraged to complete the survey within 2 weeks of receiving the link, and a follow-up email was sent after 1 week to improve response rate. Data collection was ceased 2 weeks after the initial recruitment email was distributed. This study was exempt from institutional review board approval due to a lack of identifiable participant information. The survey was piloted with 4 independent faculty neurosurgeons (D.D., W.S., J.J., D.M.) to ensure content validity prior to distribution.

2.2. Survey design

The survey consisted of 26 questions regarding demographics, personal and professional stressors related to COVID-19, career satisfaction, and burnout (see Supplemental Content 1). Questions assessed changes in various aspects of residents' lives as a result of the pandemic, including workload and uncertainty regarding future earnings. An optional write-in question allowed respondents to state what they found to be the most challenging aspect of their role in the pandemic response.

The effect of COVID-19 on residents' work hours, achievement of surgical milestones, uncertainty regarding future earnings and healthcare reform, personal life, and professional life were scored along a 5-point Likert scale. Responses were collapsed into three categories (e.g. "improved," "no change," "worsened") for the purposes of statistical interpretation. Impact of COVID-19 on residents' ability to meet ACGME operative case minimums was scored along a 3-point Likert scale ("improved," "no change," "worsened"). Responses regarding alterations in elective rotation or vacation schedules due to COVID-19, whether respondents had cared for a patient with or under investigation for COVID-19, whether respondents' colleagues had contracted COVID-19, and whether respondents would pursue neurosurgery again if given the choice were converted to dichotomous outcomes ("yes" or "no").

Burnout was assessed using the abbreviated Maslach Burnout Inventory (aMBI) [15,16], a previously-validated 9-item questionnaire which assess three indices related to burnout: emotional exhaustion (EE; 3 questions), depersonalization (DP; 3 questions), and personal accomplishment (PA; 3 questions). Each question was scored on a 7-point Likert scale, and the total score for each aMBI index was categorized as low (0–6 points), intermediate (7–12 points), or high (13–18 points). Burnout was defined as a high score in either EE or DP as consistent with previous studies reporting physician burnout [8,17,18]. Residents were classified as being satisfied with their career if they selected "Every day" or

"A few times a week" in response to Question 6 of the aMBI ("I feel I'm positively influencing other people's lives through my work").

2.3. Statistical analysis

Resident demographics and information assessing various stressors related to COVID-19 was summarized using standard descriptive statistics. Descriptive statistics were used to categorize the proportion of residents receiving low, intermediate, and high scores for each of the 3 aMBI indices (EE, DP, PA) and to assess the proportion of residents that reached aforementioned thresholds for burnout and career satisfaction. Average scores for each aMBI index were reported as mean \pm standard deviation (SD).

Bivariate analysis using chi-squared and Fisher's exact tests was performed to identify factors associated with burnout and career satisfaction. All factors with a p-value \leq 0.10 in bivariate analysis were placed in a multivariate binary logistic regression analysis using a forward stepwise approach to investigate predictors of burnout and career satisfaction. The regression models generated in multivariate analysis were internally validated using bias-corrected bootstrapping with 1000 samples, and model performance was assessed by measuring the area under the receiver operating characteristic (ROC) curve (AUC) for each model. P-values \leq 0.05 were considered statistically significant. All data analysis was conducted using IBM SPSS Statistics software (Version 25.0; IBM Corp., Armonk, NY).

3. Results

Of the 1,374 resident neurosurgeons invited to complete the survey, 225 neurosurgeons accessed the survey link and 167 survey responses were received. The overall response rate was 12.2% among all AANS resident neurosurgeons and 74.2% among those who viewed the survey. Notably, this rate is comparable to that of a similar survey of resident neurosurgeons conducted amid the COVID-19 pandemic [19]. 56 incomplete responses were excluded, yielding 111 complete responses to be included in the final analysis. The majority who responded were male (65.8%), White (75.7%), age 30–40 (74.8%), in a stable relationship (82.9%), and between post-graduate year (PGY) 3 and PGY-6 (63.9%). A summary of respondent demographic data and training program characteristics can be found in Table 1, and a heat map visualization of respondents by U.S. state has been also been provided (see Supplemental Content 2).

Among surveyed residents, the majority indicated that they had personally cared for a patient under investigation (PUI) for COVID-19 (91.9%). A large proportion also expressed uncertainty about future healthcare reform (79.3%) and earnings (45.9%) due to the pandemic. Most residents reported experiencing fewer weekly work hours (74.8%), decreased ability to meet ACGME operative case minimums (67.6%), and alteration of their elective rotation/vacation schedules (66.7%), and expressed concern that COVID-19 would hinder their achievement of surgical milestones (65.8%). Since the rise of COVID-19, the majority of residents surveyed spent increased time participating in remote didactic lectures held by their training program or national organizations (e.g. AANS, CNS) (82.0%) and increased time working on clinical research studies (66.7%). A notable proportion also spent increased time interacting with family members (45.0%). These and other specific responses related to COVID-19 have been summarized in Table 2.

3.1. Burnout and career satisfaction among resident neurosurgeons

The overall burnout rate among neurosurgery residents was 26.1%, whereas the overall rate of career satisfaction was 73.9%

Table 1
Demographic Information and Training Program Characteristics of Neurosurgery Residents (N = 111).

Characteristic	No. (%)
Age	
<30	28 (25.2)
30–40	83 (74.8)
Gender	
Male	73 (65.8)
Female	37 (33.3)
Other	1 (0.9)
Race	
White	84 (75.7)
Asian	16 (14.4)
Black or African American	4 (3.6)
American Indian or Alaska Native	2 (1.8)
Other	5 (4.5)
Ethnicity	
Not of Hispanic, Latino, or Spanish Origin	98 (88.3)
Hispanic, Latino, or Spanish Origin	13 (11.7)
Relationship Status	
Stable Partner	92 (82.9)
Single	19 (17.1)
Have Children	
Yes	36 (32.4)
No	75 (67.6)
Region	
Northeast	24 (21.6)
Northwest	38 (34.2)
Southeast	28 (25.2)
Southwest	21 (18.9)
Post-graduate Year	
1	15 (13.5)
2	7 (6.3)
3	19 (17.1)
4	12 (10.8)
5	17 (15.3)
6	23 (20.7)
7	17 (15.3)
>7	1 (0.9)
Average Number of Residents in Training Program	
1	20 (18.0)
2	55 (49.5)
3	30 (27.0)
4	6 (5.4)

Table 2
Neurosurgery residents' perceptions and stressors related to Coronavirus disease 2019.

Perception	N (%)
Personally cared for a patient under investigation (PUI) for COVID-19	102 (91.9)
Uncertain about future changes in healthcare due to COVID-19	88 (79.3)
Decreased weekly work hours due to COVID-19	83 (74.8)
Decreased ability to meet ACGME operative case minimums due to COVID-19	75 (67.6)
Altered elective rotation or vacation schedules due to COVID-19	74 (66.7)
Concerned that COVID-19 may affect achievement of technical or operative milestones	73 (65.8)
Disagree that professional life will improve due to COVID-19	69 (62.2)
Personally cared for patient with COVID-19	60 (54.1)
Uncertain about future earnings due to COVID-19	51 (45.9)
Disagree that personal life will improve due to COVID-19	47 (42.3)
Colleague in training program contracted COVID-19	27 (24.3)
Redeployed to a COVID-related neurosurgery service	17 (15.3)
Would not pursue neurosurgery again	16 (14.4)
Since rise of COVID-19, spent increased time:	
Participating in remote didactic lectures	91 (82.0)
Working on clinical research studies	74 (66.7)
Interacting with my family members	50 (45.0)
Partaking in board preparation	35 (31.5)
Conducting non-neurosurgical medical care	28 (25.2)
Engaging with other residents or faculty	18 (16.2)
Conducting neurosurgical medical care	11 (9.9)
In the cadaver/anatomy lab	4 (3.6)
None of the above	4 (3.6)

^aAbbreviations: COVID-19 (Coronavirus Disease 2019); PUI (patient under investigation); ACGME (American Council for Graduate Medical Education).

(Table 3). The majority of respondents reported low levels of emotional exhaustion (51.4%), low levels of depersonalization (67.6%), and high levels of personal accomplishment (78.4%).

In multivariate analysis, burnout was significantly associated with alterations in elective rotation or vacation schedules due to COVID-19 ($p = .013$) and the decision to not pursue neurosurgery again if given the choice ($p < .001$). PGY was negatively associated with burnout such that with every 1-year increase in PGY level, there was a 33.2% reduction in burnout rate ($p = .011$). 93.1% of respondents who indicated that COVID-19 had not affected their professional life screened positive for career satisfaction ($p = .020$). Neurosurgery residents displayed greater career satisfaction when focusing their clinical work on neurosurgical patient care ($p = .065$); however, this association was not significant. The results of the multivariate analysis are provided in Table 4.

An optional, open-ended survey question allowed residents to describe aspects of their role they found to be most challenging during the pandemic. This question received 32 total responses. Common themes included difficulty treating patients effectively while navigating changing hospital policies regarding the pandemic (18.8%), inconsistency in daily routines (18.8%), the challenge of improving or maintaining one's surgical skills in light of decreased operative time (18.8%), fear of spreading COVID-19 to family members (9.4%), and feelings of underutilization (9.4%). Despite these challenges, one resident commented that the ability to continue research and connect with medical students during this time was appreciated, while another stated that "it is still one of the best jobs to be a neurosurgeon in the United States" in spite of the epidemic.

4. Discussion

In this study of burnout among neurosurgery residents during the COVID-19 pandemic, we measured a burnout rate of 26.1%, a career satisfaction rate of 73.9%, and discovered that the majority of surveyed residents reported fewer work hours, decreased ability to meet ACGME case minimums, uncertainty about healthcare reform, and concern that COVID-19 may affect achievement of surgical milestones. Our optimal model predicting burnout among residents includes the alteration of residents' elective rotation/vacation schedules, residents' post-graduate year, and residents' decision regarding whether to pursue neurosurgery residency again if given the choice. The full impact of the pandemic has yet to be realized, but it will be important to evaluate these stressors and their impact on neurosurgical resident wellness and burnout.

Neurosurgery residency is among the most rigorous of medical training programs, and previous studies have evaluated the prevalence of burnout within this unique training environment [20]. Attenello et al. discovered that 67% of neurosurgery residents experienced burnout, whereas Shakir et al. discovered a lower burnout rate of 37% [7,8]. Attenello et al. utilized the 22-question Maslach Burnout Inventory, whereas Shakir et al. used the 9-question aMBI, potentially explaining the differing rates of burnout recorded in these studies [7,8]. We measured a lower rate of burnout using the aMBI than previously reported in the neurosurgical literature. This may be indicative of a high level of resilience among neurosurgery residents during times of increased stress [9].

The factors we discovered related to resident stress and burnout have been corroborated by reports published by neurosurgical res-

Table 3
Burnout and career satisfaction indices among 111 neurosurgery residents.

Burnout Index	Score (Mean \pm SD)	N (%)
Burnout	7.86 \pm 5.18	29 (26.1)
Emotional Exhaustion		
Low score (0–6)		57 (51.4)
Intermediate score (7–12)		28 (25.2)
High score (13–18)		26 (23.4)
Depersonalization	5.22 \pm 4.65	
Low score (0–6)		75 (67.6)
Intermediate score (7–12)		27 (24.3)
High score (13–18)		9 (8.1)
Career Satisfaction Index	Score (Mean \pm SD)	N (%)
Career Satisfaction	14.62 \pm 3.07	82 (73.9)
Personal Accomplishment		
Low score (0–6)		1 (0.9)
Intermediate score (7–12)		23 (20.7)
High score (13–18)		87 (78.4)

^aAbbreviations: SD (standard deviation).

Table 4
Multivariate Binary Logistic Regression Analysis of Burnout and Career Satisfaction in 111 Neurosurgery Residents.

Characteristic	Factor	p-value	Bootstrap p-value
Increased Burnout*	Would not choose to pursue neurosurgery again	<0.001	0.001
	Lower PGY	0.011	0.001
	Altered elective rotation or vacation schedules due to COVID-19	0.013	0.016
Increased Career Satisfaction**	No change in professional life as a result of COVID-19 pandemic	0.020	0.009
	Did not personally care for a patient with COVID-19 ^a	0.065	0.079

*The AUC = 0.899 (95% CI 0.833–0.966). All significant predictors of burnout maintained statistical significance after bias-corrected bootstrapping with 1000 samples.

**The AUC = 0.800 (95% CI 0.710–0.890). All significant predictors of career satisfaction maintained statistical significance after bias-corrected bootstrapping with 1000 samples.

^aApproached but did not reach significance.

^bAbbreviations: COVID-19 (Coronavirus disease 2019); AUC (area under the Receiver Operating Characteristic curve); CI (confidence interval); COVID-19 (Coronavirus disease 2019); PGY (post-graduate year).

idency programs nationwide. Due to COVID-19, many programs temporarily halted elective cases in order to conserve equipment and maintain social distancing guidelines [21–23]. Residents also experienced significant changes in scheduling, with some programs allowing only the minimum number of trainees required for patient care to enter the hospital in order to reduce exposure to COVID-19 [24,25]. Other centers have also furloughed ancillary staff, limited participation in operative cases to only one resident, and minimized daily inpatient rounds to include only necessary personnel [23,26]. A recent survey of neurosurgical program directors matches our findings, with 65% of program directors reporting a reduction in resident work hours and 95% reporting a decrease in inpatient census. Notably, despite these decreases in volume, the majority of program directors were not concerned that their graduating or incoming chief residents would fail to meet ACGME case minimums [26]. It will be important to reconcile residents' concerns regarding possible inability to achieve operative case minimums or reach operative milestones with the relatively lower level of concern from program directors; if low operative volumes continue through a prolonged pandemic, it may be necessary to employ surgical simulation and other virtual modalities of teaching operative skills. Despite decreases in overall operative time, nearly all residency programs have begun to conduct grand rounds and minor conferences using teleconferencing, with many reporting increased attendance by residents and faculty compared to before the pandemic [26,27]. This is consistent with our findings that residents have spent more time participating in virtual didactic lectures.

We can use our model predicting burnout, combined with other factors previously associated with burnout, to identify those residents who may be at particular risk during the pandemic. Our finding that residents earlier in their training are at higher risk for burnout is consistent with the literature, with some reports identifying PGY-2 as the most vulnerable stage of training [6]. In particular, one study discovered an attrition rate of 11% among neurosurgical residents, with attrition more likely occurring among junior residents (PGY-1 or PGY-2) [28]. Notably, PGY-2s in our survey had the lowest response rate of any PGY (6.3%), which may be reflective of a lack of time among PGY-2 neurosurgery residents to complete the survey. This relative dearth of responses from PGY-2s may have led to an under-reporting of burnout within this cohort. In addition, our finding that residents who focused their clinical work on patient care within their specialty reported greater career satisfaction is corroborated by recent literature demonstrating that resident redeployment was associated with greater anxiety at work [29]. As residents nationwide have faced both increased stress and decreased operative exposure during the pandemic, it will likely be essential to increase mentorship of both junior and redeployed residents. Despite a moderate burnout rate among neurosurgical trainees, we also report an overall career satisfaction rate of 73.9%. McAbee et al. previously described a similar paradoxical relationship between burnout and career satisfaction among attending neurosurgeons and posited that burnout may occur episodically during periods of stress throughout one's career, whereas career satisfaction is more resistant to these periods [30].

In a study of neurosurgery program directors during the pandemic, 37% of programs reported providing additional benefits to their residents since the onset of the pandemic, including wellness initiatives, hotel vouchers, and childcare support [26]. One center began holding daily video conferences to ensure the general well-being of all residents and attendings and encourage utilization of mental health support during the pandemic [31]. Prior to the pandemic, several models of resident wellness have been studied, including workout sessions, team-building exercises, and mindfulness-based initiatives [6,32]. Resilience coach-

ing has also shown to be effective in improving resilience and decreasing burnout among surgical interns [33]. Though it may be difficult to implement these types of initiatives while also maintaining social distancing, communication-based wellness initiatives may still be translatable to a virtual environment during the pandemic.

Our study has several limitations. We reported a response rate of 12%, which is lower than previous studies; this relatively low response rate may have underpowered our study. However, this response rate is similar to that reported in a recently-published study surveying neurosurgery residents during the COVID-19 pandemic [19]. Secondly, our study may also suffer from selection bias, as only those residents with increased spare time during the pandemic may have responded to our online survey, potentially leading to under-reporting of burnout due to a failure to capture residents with less spare time. Future studies should evaluate the impact of wellness initiatives implemented during the COVID-19 pandemic and their effect on resident burnout. Studies should also evaluate the impact of the pandemic on the achievement of resident education milestones, such as surgical case volumes and achievement of operative skills.

5. Conclusion

Changes related to the COVID-19 pandemic have led to an unprecedented impact on neurosurgical resident education and may contribute to resident burnout. Residents are particularly concerned about the achievement of surgical milestones, as well as the future uncertainty the pandemic has brought to neurosurgical practice. Residents who are more likely to experience burnout include those who are earlier in their training, those who would elect to not pursue neurosurgery again, and those who have experienced altered rotation/vacation scheduling. As we continue to treat patients in the COVID era and beyond, it will be essential to ensure that resident wellbeing is an ongoing priority.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Acknowledgements

We thank the AANS Young Neurosurgeons Committee and the AANS administration for their collaboration in developing and distributing the survey. We would also like to thank the AANS resident physician participants for taking the time to complete the surveys, as well as for their thoughtful free text survey responses.

Disclosures

The authors have no disclosures and declare no competing interests with respect to this work.

Sources of Support

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.jocn.2020.08.012>.

References

- [1] Amin-Hanjani S, Bambakidis NC, Barker FG, et al. COVID-19 and neurosurgical practice: an interim report. *J Neurosurg* April 2020;1–2. doi:10.3171/2020.4.JNS201099.
- [2] Khalafallah AM, Jimenez AE, Lee RP, Weingart JD, Theodore N, Cohen AR, Tamargo RJ, Huang J, Brem H, Mukherjee D. Impact of COVID-19 on an academic neurosurgery department: the Johns Hopkins experience. *World Neurosurg* 2020;139:e877–84.
- [3] Theofanis TN, Khanna O, Stefanelli A, et al. Letter: Neurosurgery residency in the COVID-19 era: experiences and insights from Thomas Jefferson University Hospital, Philadelphia, Pennsylvania. *Neurosurgery* 2020;0(0):2020. doi:10.1093/neuros/nyaa211.
- [4] 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. Factors associated with mental health outcomes among health care workers exposed to coronavirus disease 2019. *JAMA Netw Open* 2020;3(3):e203976. <https://doi.org/10.1001/jamanetworkopen.2020.3976>.
- [5] Rossi R, Succi V, Pacitti F, Di Lorenzo G, Di Marco A, Siracusano A, Rossi A. Mental health outcomes among frontline and second-line health care workers during the coronavirus disease 2019 (COVID-19) pandemic in Italy. *JAMA Netw Open* 2020;3(5):e2010185. <https://doi.org/10.1001/jamanetworkopen.2020.10185>.
- [6] Tang OY, Dunn KA, Yoon JS, Ponce FA, Sonntag VKH, Lawton MT. Neurosurgery resident wellness and recovery from burnout: a 39-year single-institution experience. *World Neurosurg* 2020;138:e72–81.
- [7] Attenello FJ, Buchanan IA, Wen T, et al. Factors associated with burnout among US neurosurgery residents: a nationwide survey. *J Neurosurg* 2018;129(5):1349–1363. doi:10.3171/2017.9.JNS17996.
- [8] Shakir HJ, McPheeters MJ, Shallwani H, Pittari JE, Reynolds RM. The prevalence of burnout among US neurosurgery residents. *Clin Neurosurg* 2018;83(3):582–590. doi:10.1093/neuros/nyx494.
- [9] Shakir HJ, Cappuzzo JM, Shallwani H, Kwasnicki A, Bullis C, Wang J, Hess RM, Levy EI. Relationship of grit and resilience to burnout among U.S. neurosurgery residents. *World Neurosurg* 2020;134:e224–36.
- [10] Maslach C, Jackson SE. The measurement of experienced burnout. *J Organ Behav* 1981;2(2):99–113. doi:10.1002/job.4030020205.
- [11] Dimou FM, Eckelbarger D, Riall TS. Surgeon burnout: a systematic review. *J Am Coll Surg* 2016;222(6):1230–9.
- [12] Dyrbye L, Shanafelt T. A narrative review on burnout experienced by medical students and residents. *Med Educ* 2016;50(1):132–49.
- [13] Dyrbye LN, Varkey P, Boone SL, Satele DV, Sloan JA, Shanafelt TD. Physician satisfaction and burnout at different career stages. *Mayo Clin Proc* 2013;88(12):1358–67.
- [14] Shanafelt TD, Balch CM, Bechamps G, Russell T, Dyrbye L, Satele D, Collicott P, Novotny PJ, Sloan J, Freischlag J. Burnout and medical errors among American surgeons. *Ann Surg* 2010;251(6):995–1000.
- [15] McManus IC, Winder BC, Gordon D. The causal links between stress and burnout in a longitudinal study of UK doctors. *Lancet* 2002;359(9323):2089–90.
- [16] McManus IC, Keeling A, Paice E. Stress, burnout and doctors' attitudes to work are determined by personality and learning style: a twelve year longitudinal study of UK medical graduates. *BMC Med* 2004;2(1):29. <https://doi.org/10.1186/1741-7015-2-29>.
- [17] Lebares CC, Guvva EV, Ascher NL, O'Sullivan PS, Harris HW, Epel ES. Burnout and stress among US surgery residents: psychological distress and resilience. *J Am Coll Surg* 2018;226(1):80–90.
- [18] Dyrbye LN, West CP, Satele D, Boone S, Tan L, Sloan J, Shanafelt TD. Burnout among U.S. medical students, residents, and early career physicians relative to the general U.S. population. *Acad Med* 2014;89(3):443–51.
- [19] Pelargos PE, Chakraborty A, Zhao YD, Smith ZA, Dunn IF, An BAM, et al. Pandemic: a North American survey. *World Neurosurg* 2019;2020. <https://doi.org/10.1016/j.wneu.2020.05.263>.
- [20] Pan J, Mocco J. Are neurosurgery residents burned out?. *World Neurosurg* 2018;116:394. <https://doi.org/10.1016/j.wneu.2018.06.131>.
- [21] Weber AC, Henderson F, Santos JM, Spiotta AM. Letter: for whom the bell tolls: overcoming the challenges of the COVID pandemic as a residency program. *Neurosurgery* 2020;0(0):2020. doi:10.1093/neuros/nyaa166.
- [22] Arnaout O, Patel A, Carter B, Chiocca EA. Letter: adaptation under fire: two harvard neurosurgical services during the COVID-19 pandemic. *Neurosurgery* 2020;0(0):1–5. doi:10.1093/neuros/nyaa146.
- [23] Bray DP, Stricsek GP, Malcolm J, et al. Letter: maintaining neurosurgical resident education and safety during the COVID-19 pandemic. *Neurosurgery* 2020;0(0):1–3. doi:10.1093/neuros/nyaa164.
- [24] Bambakidis NC, Tomei KL. Editorial. Impact of COVID-19 on neurosurgery resident training and education. *J Neurosurg* 2020;1–2. doi:10.3171/2020.3.jns20965.
- [25] Eichberg DG, Shah AH, Luther EM, et al. Letter: academic neurosurgery department response to COVID-19 pandemic: The University of Miami/Jackson Memorial Hospital model. *Neurosurgery* 2020;0(0):1–3. doi:10.1093/neuros/nyaa118.
- [26] Pennington Z, Lubelski D, Khalafallah AM, et al. Changes to neurosurgery resident education since onset of the COVID-19 pandemic. *World Neurosurg* 2020 May. <https://doi.org/10.1016/j.wneu.2020.05.139>.
- [27] Planchard R, Lubelski D, Ehresman J, Sciubba D. Telemedicine and remote medical education within neurosurgery. *J Neurosurg Spine* 2020;1–4. doi:10.3171/2020.5.SPINE20786.
- [28] Agarwal N, White MD, Pannullo SC, Chambless LB. Analysis of national trends in neurosurgical resident attrition. *J Neurosurg* 2019;131(5):1668–73. <https://doi.org/10.3171/2018.5.JNS18519>.
- [29] Khusid JA, Weinstein CS, Becerra AZ, et al. Well-being and education of urology residents during the COVID-19 pandemic: results of an American National Survey. *Int J Clin Pract* May 2020;ijcp.13559. doi:10.1111/ijcp.13559.
- [30] McAbee JH, Ragel BT, McCartney S, et al. Factors associated with career satisfaction and burnout among US neurosurgeons: results of a nationwide survey. *J Neurosurg* 2015;123(1):161–173. doi:10.3171/2014.12.JNS141348.
- [31] Ammar A, Stock AD, Holland R, Gelfand Y, Altschul D. Managing a specialty service during the COVID-19 crisis: lessons from a New York City health system. *Acad Med* 2020;XX(X):1–4. doi:10.1097/ACM.0000000000003440
- [32] Wolfe SQ, West JL, Hunt MA, et al. A comparison of the existing wellness programs in neurosurgery and institution champion's perspectives. *Neurosurgery* 2019;84(5):1149–1155. doi:10.1093/neuros/nyy418.
- [33] Song Y, Swendiman RA, Shannon AB, Torres-Landa S, Khan FN, Williams NN, Dumon KR, Brooks AD, DeMatteo RP, Aarons CB. Can we coach resilience? An evaluation of professional resilience coaching as a well-being initiative for surgical interns. *J Surg Educ* 2020. <https://doi.org/10.1016/j.jsurg.2020.04.014>.