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Factors associated with burnout among US neurosurgery residents: a nationwide survey

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OBJECTIVE Excessive dissatisfaction and stress among physicians can precipitate burnout, which results in diminished productivity, quality of care, and patient satisfaction and treatment adherence. Given the multiplicity of its harms and detriments to workforce retention and in light of the growing physician shortage, burnout has garnered much attention in recent years. Using a national survey, the authors formally evaluated burnout among neurosurgery trainees.

METHODS An 86-item questionnaire was disseminated to residents in the American Association of Neurological Surgeons database between June and November 2015. Questions evaluated personal and workplace stressors, mentorship, career satisfaction, and burnout. Burnout was assessed using the previously validated Maslach Burnout Inventory. Factors associated with burnout were determined using univariate and multivariate logistic regression.

RESULTS The response rate with completed surveys was 21% (346/1643). The majority of residents were male (78%), 26–35 years old (92%), in a stable relationship (70%), and without children (73%). Respondents were equally distributed across all residency years. Eighty-one percent of residents were satisfied with their career choice, although 41% had at some point given serious thought to quitting. The overall burnout rate was 67%. In the multivariate analysis, notable factors associated with burnout included inadequate operating room exposure (OR 7.57, p = 0.011), hostile faculty (OR 4.07, p = 0.008), and social stressors outside of work (OR 4.52, p = 0.008). Meaningful mentorship was protective against burnout in the multivariate regression models (OR 0.338, p = 0.031).

CONCLUSIONS Rates of burnout and career satisfaction are paradoxically high among neurosurgery trainees. While several factors were predictive of burnout, including inadequate operative exposure and social stressors, meaningful mentorship proved to be protective against burnout. The documented negative effects of burnout on patient care and health care economics necessitate further studies for potential solutions to curb its rise.

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KEY WORDS national survey; physician burnout; career satisfaction; neurosurgery; residency training

The practice of medicine has undergone a radical transformation whereby the doctor-patient relationship has been displaced by remuneration, patient satisfaction, and outcome-based metrics. Coincident with this paradigm shift is a dramatic rise in bureaucratic oversight, accountability, clinician workload, and reported rates of physician dissatisfaction. There is ever-growing concern for physician well-being in light of mounting evidence that more than half of American physicians, regardless of their career stage, exhibit signs of burnout.[20,56,58] Burnout dimin-

ABBREVIATIONS AANS = American Association of Neurological Surgeons; CSNS = Council of State Neurosurgical Societies; MBI = Maslach Burnout Inventory.

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ishes access to medical care as affected physicians show more absenteeism, are more likely to curtail hours, or, worse yet, shutter their practices altogether for retirement at a time when the US physician shortage is already in dire straits.[21,68] Furthermore, burnout and other measures of overall psychological health are directly linked not only to productivity, but also to quality of care and patient satisfaction and adherence to treatment regimens.[15,17,28,39,59,60,69]

Burnout is the by-product of unchecked professional and emotional distress in the context of workplace dissatisfaction.[37] In 1974 psychologist Herbert Freudenberger first described "staff burnout" as a state of vital exhaustion in the workplace that culminates in readily recognizable behavioral traits.[30] Christina Maslach later defined burnout as a syndrome characterized by the triad of emotional exhaustion, depersonalization, and a low sense of personal accomplishment.[40] It generally develops in individuals whose occupation brings them into perpetual human contact, with emotional exhaustion appearing first. Here, the subject lacks the mental fortitude to impart emotional support to others. Gradually, there is psychological isolation until cynicism and detachment in interpersonal relations emerge as a coping strategy. In its earliest stages, burnout can coexist with many necessary clinical merits, such as empathy and compassion. However, if left unattended, burnout erodes the foundation of these attributes and eventually supersedes them. Burnout can be accompanied by physical or psychological manifestations (for example, insomnia, appetite changes, headaches, and irritability, among others) in much the same way as depression.[34] However, unlike the latter's global impact on a person, burnout disrupts how an individual interfaces with their work environment. Thus, the two are distinct clinical entities, even though burnout can degenerate into depression.[25]

Nevertheless, burnout is not a normal eventuality in the course of daily occupational stress and personal sacrifice. Rather, it is an adverse consequence of discordance that ensues when a clinician's emotional distress is not sufficiently mitigated by the intrinsic reward system of practicing medicine or hobbies and physical exercise.[23] Ultimately, there is a loss of meaning and purpose in the role as health care provider. Factors that have often been implicated in burnout include excessive work hours or call requirements, loss of autonomy, and large amounts of work-home interference.[9,18] Nowhere is the stage more aptly set for burnout than in residency training, where these factors all hold true. Although there is considerable variation across specialties, residency burnout rates are reportedly twice as high for physicians in training than for their postgraduate counterparts.[22,57] In one series, 76% of surveyed residents exhibited signs of burnout.[34,57] Even more alarming, studies have suggested that burnout appears as early as in medical school.[13,19] These findings underscore the pervasiveness of burnout among health care professionals and would seem to suggest an epidemic is underway.

Few studies have addressed burnout in a field as technically and mentally onerous as neurosurgery. In a recent national survey of practicing neurosurgeons, 57% of respondents had documented signs of burnout, although 70% would choose the same career if given the choice, attesting to the immensely rewarding nature of the specialty.[41] Deeply concerning, however, is the fact that only 36% would ever recommend neurosurgery as a career to their offspring. This datum echoes a widespread sentiment across the profession of medicine, in which the majority would not recommend their career choice to others.[42] Such deterrence poses a considerable challenge to workforce recruitment and, ultimately, the viability and sustainability of health care. Studies on career satisfaction and burnout are therefore instrumental in identifying factors that precipitate psychological distress so that reforms can be instituted to stem the tide of disgruntled American physicians.

Here we present the results of a nationwide survey analyzing the extent of resident burnout, career satisfaction, and other quality of life variables related to physician well-being.

Methods

A modified version of the attending neurosurgeon burnout survey used by McAbee et al.[41] was provided electronically via the SurveyMonkey platform. While questions paralleled the format of the prior attending-based survey, the questions significantly differed to target the resident population (Appendix Table). We conducted the survey through a SurveyMonkey questionnaire linked to the American Association of Neurological Surgeons (AANS) listserv to ensure that each resident received a unique and confidential online survey link. Each individual link was de-identified with a unique 10-digit identification assigned with no capability of tracing results to a respondent. Importantly, once a survey was submitted from an individual link, the questionnaire link became inactive, ensuring that no individual response duplications occurred.

The survey consisted of 86 questions, including 4 free-text questions and 22 questions from the previously validated Maslach Burnout Inventory (MBI).[40] An electronic invitation was sent to all neurosurgical resident trainee members of the AANS on behalf of the Council of State Neurosurgical Societies (CSNS). The survey invitation was sent on 3 separate occasions between June and November 2015. Electronic communication with survey respondents consisted of a cover letter specifying study objectives and an individualized and de-identified link to the questionnaire. The introductory email invitation specified that each response would be coded in a de-identified fashion with no individual identifiers and strict confidentiality enforced. Critical email wording was as follows:

> Dear Resident:
>
> The Council of State Neurosurgical Societies (CSNS), the socioeconomic arm of the American Association of Neurological Surgeons (AANS) and Congress of Neurological Surgeons (CNS), is conducting a nationwide survey of current neurosurgical residents identifying predictors of job satisfaction, stress and burnout.
>
> This online survey should take less than five minutes to complete. This survey is strictly confidential with every response made anonymous.
>
> Neurosurgery is arguably one of the more mentally and physically demanding fields in medicine. A similar study conducted among practicing neurosurgeons was recently pub-

lished in the *Journal of Neurosurgery*. Though there are many studies on burnout and job satisfaction in almost all fields of medicine, few studies target residents. We hope to identify predictors of satisfaction/dissatisfaction not only among resident neurosurgeons as a whole, but within various subgroups, such as neurosurgeons of different age groups, geographic locations and training levels. Identities will remain anonymous and may be pooled in a de-identified cohort for survey again in two to three years to monitor changes in opinions over time.

Participation was encouraged by program coordinators but not mandatory. This national survey was promoted and funded by the CSNS.

Questionnaire Composition

The survey included questions on key demographics, including age, sex, relationship status, number of children, and postgraduate year of training. General questions were aimed to determine whether respondents would choose their specialty or residency program if presented with the choice again, goals after residency, and prior considerations of quitting training or leaving medicine entirely. Historical questions ascertained whether respondents had completed a subinternship in their program, felt they had an adequate perception of the field prior to applying, or had spent time away from education on research or other ventures before embarking on training. Program-related questions included the position of their program on the original rank list, size of resident complement, social atmosphere, leadership changes, and proximity of their training program to immediate family. Additional questions focused on mentorship and whether there was any perceived benefit to such a relationship, from the standpoint of both being a mentee and serving as a mentor to others. Specifically, mentorship was defined as "meaningful" if the trainee felt that they were benefiting from their relationship with their mentor. Finally, optional open-ended questions allowed trainees to report whether specific aspects of their training were associated with a worsened or improved training experience (Appendix Table).

Personal and professional stressors were gauged and graded along a 6-point Likert scale in terms of how residents felt they had been affected over the previous 12–24 months. Response categories were as follows: not at all or small, moderate, large, or extreme amounts. However, these categories were collapsed into a dichotomous scale for the purposes of statistical analysis, with large to extreme responses interpreted as having the variable of interest. Satisfaction in the workplace and home environments was also graded along a multipoint Likert scale from very satisfied to very dissatisfied and was similarly dichotomized for statistical interpretation. The method of converting the Likert score to a dichotomous variable, including the method of dividing groups, was based on the same methodology of conversion and group division employed by McAbee et al. in their analysis of burnout and career satisfaction in attending neurosurgeons.[41] This was intended to provide a basis for direct comparison between resident and attending results. Career satisfaction was determined as the responses of "very satisfied" or "somewhat satisfied" in relation to questions addressing this parameter. Variables collected in the survey included overall career satisfaction, intrinsic rewards of the profession (that is, appreciation from patients and staff), academic productivity, interpersonal relationships, and opportunities for work-life balance.

Burnout was determined according to the MBI, which uses a 7-point Likert scale from 0 through 6 to address 22 questions: 0 = never, 1 = a few times per year, 2 = once a month, 3 = a few times per month, 4 = once a week, 5 = a few times per week, and 6 = every day. Three subscales were used to evaluate a corresponding number of dimensions for burnout: emotional exhaustion (9 questions), depersonalization (5 questions), and low sense of personal accomplishment (8 questions). Responses were stratified into low, medium, and high categories. Consistent with previously published studies on health care workers,[49] burnout was defined by high scores for emotional exhaustion (≥ 27) and/or depersonalization (≥ 10).

Statistical Analysis

Demographic information was compiled from a series of descriptive statistics. As previously mentioned, select survey responses using multipoint Likert scales were converted into dichotomous variables for statistical analysis. For example, when addressing career satisfaction, respondents could choose one of the following responses: "very satisfied," "somewhat satisfied," "neutral," "somewhat dissatisfied," "very dissatisfied," or "not applicable." However, in the final analyses, responses were classified as either satisfied or not satisfied. As our primary objectives were directed at burnout and career satisfaction, we performed univariate analysis to look for associations between key demographic data and clinical measures of both of these outcomes by using logistic regression. Any item found to have a $p < 0.05$ on univariate testing was then placed in a multivariate analysis using a forward stepwise manner. To avoid collinearity among multiple "subjective" response collinear variables, we limited multivariate analysis to objective variables showing significance with univariate analysis and no more than 3 subjective variables. Two-tailed analysis with $p < 0.05$ was used as the cutoff for statistical significance. Results were reported with adjusted odds ratios and corresponding 95% confidence intervals. All data were analyzed using the SAS 9.4 statistical software (SAS Institute Inc.).

Results

Survey Results

Of the 1643 email addresses to which the survey invitation was sent, 395 responses (24%) were received. Of these, 346 (21%) were included in the final analysis since 49 were excluded on the basis of an incomplete survey. Most residents were male (78%), over 31 years old (52%), in a long-term relationship (70%), and had no children (73%). Respondents were equally distributed across all residency years. These demographic data are summarized in Table 1.

Forty-three percent of respondents made the decision to pursue neurosurgery during years 3 and 4 of medical school, and nearly one-fifth made their choice prior

TABLE 1. Demographic information on neurosurgery residency survey respondents

Characteristic	No. (%)
Age in yrs	
21–25	3 (1)
26–30	163 (47)
31–35	155 (45)
36–40	25 (7)
Sex	
Male	270 (78)
Female	76 (22)
Relationship status	
Stable partner/married	241 (70)
Divorced	7 (2)
Single	98 (28)
Children	
No	251 (73)
Yes	95 (27)
No. of children	
0	251 (73)
1	54 (16)
2	26 (8)
3+	10 (3)
Response missing*	5 (1)
PGY	
PGY1	47 (14)
PGY2	50 (14)
PGY3	62 (18)
PGY4	60 (17)
PGY5	56 (16)
PGY6	47 (14)
PGY7	24 (7)
Program location	
NE/NY	45 (13)
Midwest	87 (25)
Mid-Atlantic	39 (11)
South	90 (26)
Southwest	34 (10)
West	51 (15)

NE/NY = Northeast/New York; PGY = postgraduate year.
* Respondent indicated that they had children but did not specify how many.

TABLE 2. General perceptions among neurosurgery residents regarding their career

Perception	No. (%)
Satisfied w/ career as neurosurgeon*	280 (81)
Satisfied w/ academic productivity*	165 (47)
Satisfied w/ work-life balance*	111 (32)
Adequate time for personal growth/development*	121 (35)
Spouse understanding of work hrs*	241 (70)
Affected by control over one's schedule†	210 (61)
Would choose neurosurgery again	274 (79)
Would choose their residency program again	227 (66)
Would recommend neurosurgery to a prospective applicant	222 (64)
Has given serious thought to quitting	143 (41)
Concerned about health care reform & future of medicine	250 (72)

* Respondents answered "very satisfied" or "somewhat satisfied."
† Respondents answered "moderate amount," "large amount," or "extreme amount."

to medical school. Eighty-one percent of residents were satisfied with their career, of which 42% reported being very satisfied with their choice. Although 75% felt their professional and personal lives would improve following residency, 41% had given serious thought to quitting neurosurgery. If presented with the choice again, 79% said they would choose neurosurgery as a specialty, and 64% would recommend neurosurgery to a prospective medical school applicant. These and other perceptions are listed in Table 2.

A satisfactory work-life balance and sufficient time for personal development and didactics were reported by 32%, 35%, and 30%, respectively (Fig. 1). When asked to address factors that had appreciably affected their psyche in the previous 24 months, notable stressors with at least a moderate impact included poor control over one's schedule (61%), inadequate wages or burdensome debt (49%), hostile faculty (36%), hostile co-residents (31%), and co-resident attrition (31%; Fig. 2). The majority of residents (72%) were concerned about the direction of health care reform and how it might impact their future, with 42% describing feeling at least moderately burdened by future job prospects. When considering their quality of life as a resident, 59% were hopeful that things would improve. Conversely, when asked if life in residency would worsen, 45% believed that was the case (Fig. 3).

Despite having one of the most competitive careers, 43% of residents reported a low sense of personal accomplishment (Fig. 4). High emotional exhaustion and high depersonalization rates were calculated to be 36% and 60%, respectively. The overall burnout rate among neurosurgery trainees was 67%. Trends of the various MBI indices by postgraduate year are listed in Table 3 and depicted in Fig. 5.

Predictors of Burnout and Career Satisfaction

Several notable demographic factors with variable levels of burnout correlation in the literature, including age, sex, postgraduate year, relationship status, and having children,[34,35,43,55] were not correlated with burnout in our study. Variables with strong associations included occupational stressors, such as inadequate exposure to the operating room (OR 10.96, $p < 0.01$), hostile faculty (OR 9.02, $p < 0.0001$), hostile co-residents (OR 5.05, $p < 0.001$), feeling underappreciated by patients or staff (OR 5.59–7.73, $p < 0.0001$), poor control over one's schedule (OR 6.72, $p < 0.0001$), and co-resident attrition (OR 3.33, $p < 0.01$). Results of the univariate analysis are presented in Table 4.

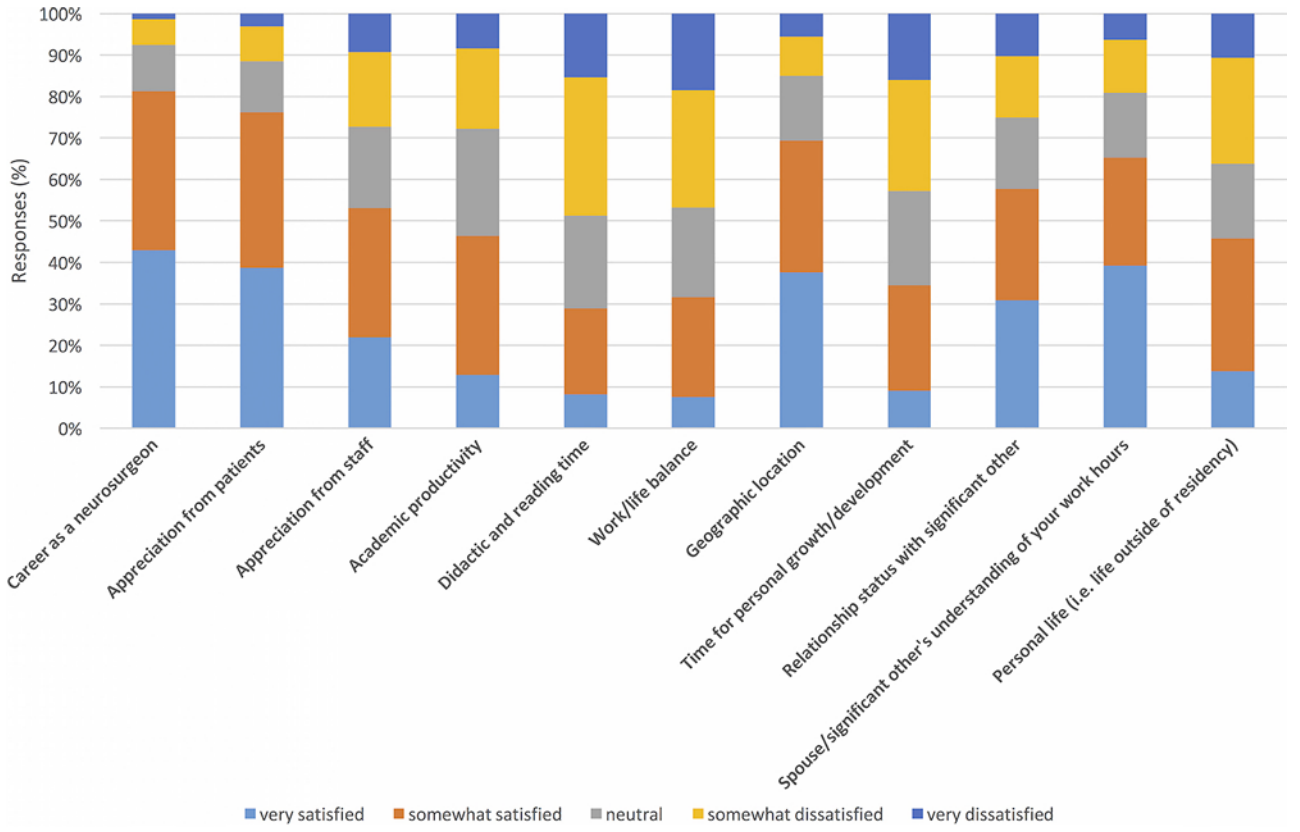

FIG. 1. Neurosurgery resident career and personal satisfaction. Figure is available in color online only.

In the multivariate analysis, notable factors associated with burnout included inadequate operating room exposure (OR 7.57, p = 0.011), hostile faculty (OR 4.07, p = 0.008), and social stressors outside of work (OR 4.52, p = 0.008). Moreover, residents who felt they were not benefiting from their interaction with their mentors were 3 times more likely to exhibit burnout in the multivariate models (OR 2.96, p = 0.031; Table 5).

Discussion

Undue stressors in the workplace can have adverse ef-

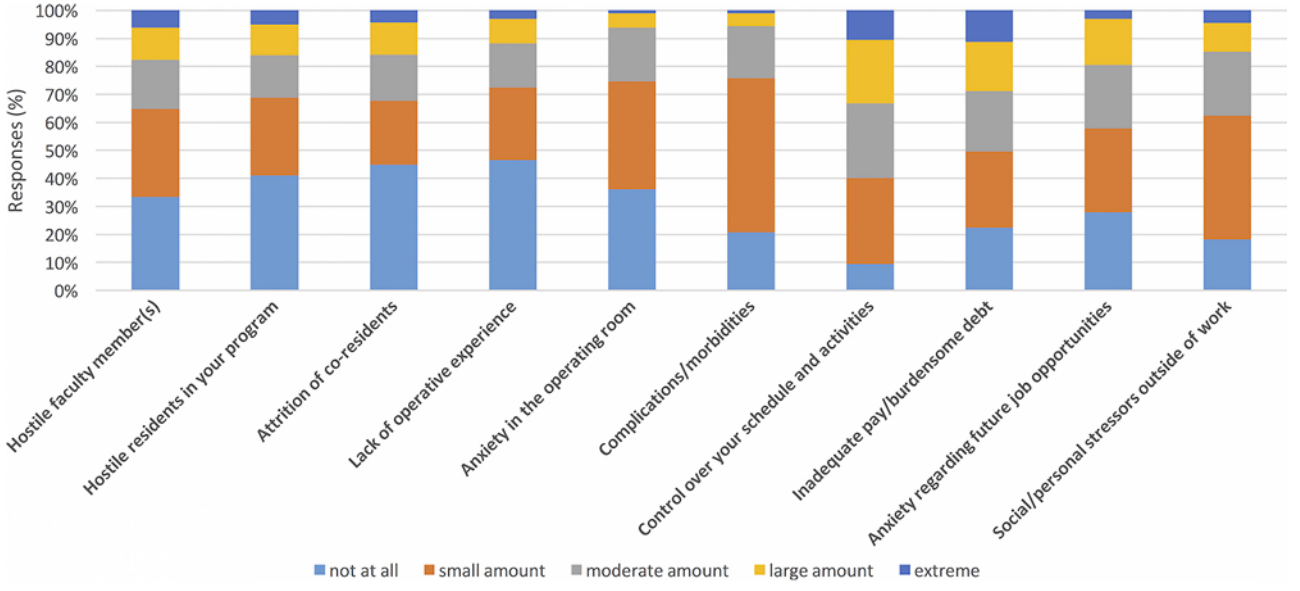

FIG. 2. Professional and personal stressors encountered by neurosurgery resident trainees. Figure is available in color online only.

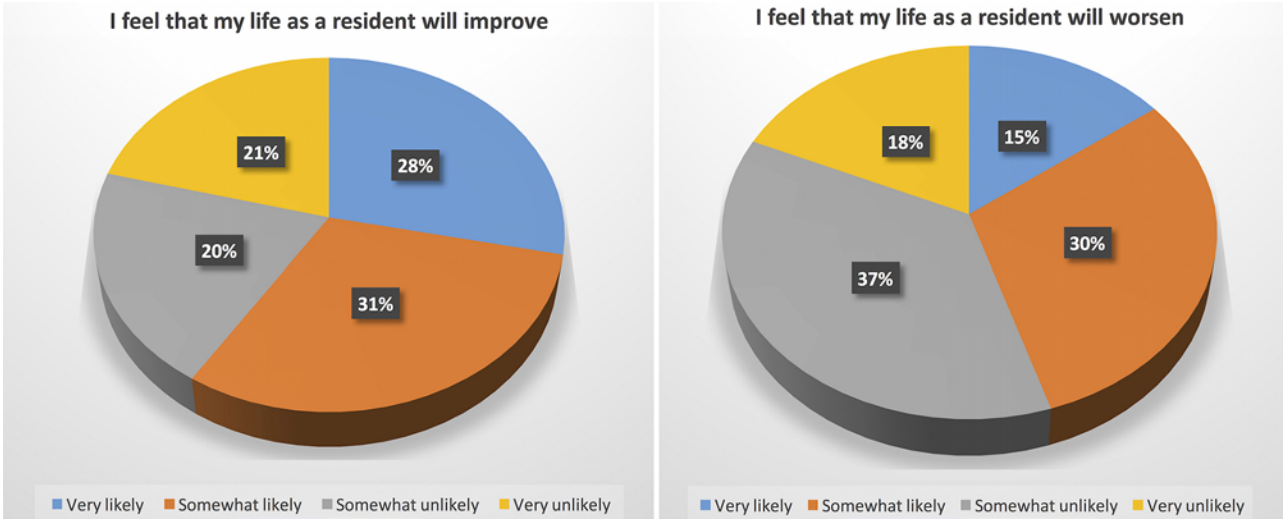

FIG. 3. Breakdown of perceptions among neurosurgery residents regarding the trajectory of their careers. Figure is available in color online only.

fects on a resident's emotional well-being with resultant detriment to patient care and health care economics. The extensive reach of burnout has prompted action because of its presumed role in medical errors and associations with higher rates of depression, substance abuse, relationship discord, and suicide.[8,11,27,28,57,66] Whereas the prevalence of burnout in US workers is estimated to be 28%, the number is closer to 40% for physicians and 57% for practicing neurosurgeons.[41,56] Burnout is also noted to be higher in trainees than in independent practitioners of the same specialty.[3] No previous studies have determined rates of burnout among neurosurgery residents. We have determined the overall rate of burnout to be 67% based on the results of a nationwide survey, one of the highest rates among residents (Table 6).

With advances in electronic communication, the line between work and home life has become increasingly blurred. Poor dissociation between work and personal life has long been recognized as a source of employee distress and burnout. Many organizations have thus devised policies limiting employee access to work matters when they walk out the door: Volkswagen turns off access to email, and Goldman Sachs and Credit Suisse have a "Saturday rule" stipulating that analysts must be away from the office for a designated period.[29] Medicine followed suit in 2003, curtailing the resident workweek to 80 hours. De-

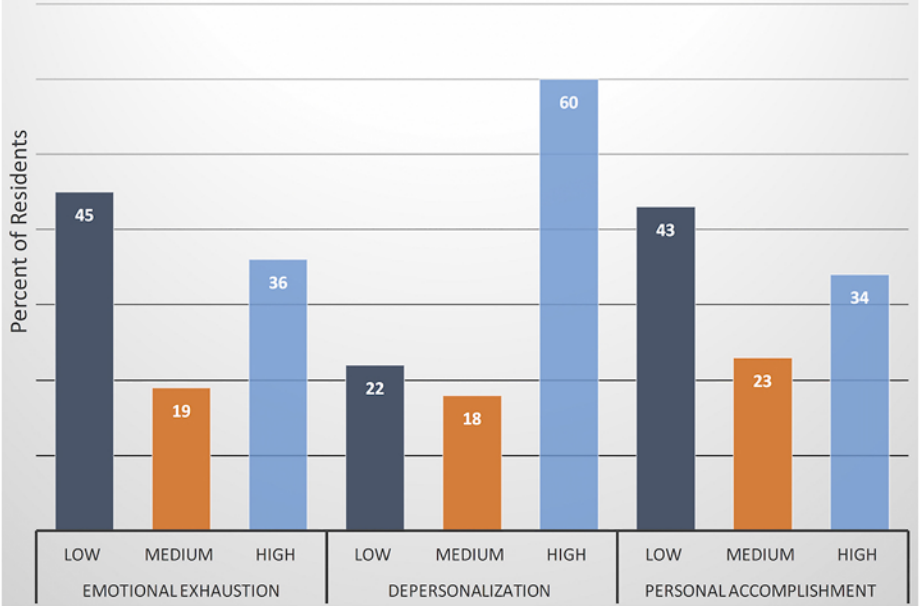

FIG. 4. Professional burnout indices among neurosurgery residents according to the MBI subscales. Figure is available in color online only.

TABLE 3. Burnout indices among neurosurgery residents

Variable	PGY						
	1	2	3	4	5	6	7
No. of residents	47	50	62	60	56	47	24
Emotional exhaustion							
Median	17	24	24	20	23	17	15.5
IQR	10–24	15–37	14–34	11–33	13–34	9–26	7.5–30
Low (no. [%])	26 (55)	19 (38)	22 (35)	28 (47)	19 (34)	26 (55)	15 (63)
Moderate (no. [%])	11 (23)	8 (16)	14 (23)	9 (15)	12 (21)	10 (21)	2 (8)
High (no. [%])	10 (21)	23 (46)	26 (42)	23 (38)	25 (45)	11 (23)	7 (29)
Depersonalization							
Median	10	13	12.5	12	11.5	8	10
IQR	4–15	7–19	8–17	7–17	7–15.5	4–14	3.5–14.5
Low (no. [%])	15 (32)	9 (18)	10 (16)	9 (15)	11 (20)	14 (30)	7 (29)
Moderate (no. [%])	6 (13)	8 (16)	9 (15)	12 (20)	11 (20)	13 (28)	5 (21)
High (no. [%])	26 (55)	33 (66)	43 (69)	39 (65)	34 (61)	20 (43)	12 (50)
Personal accomplishment							
Median	36	36	32.5	34.5	35	40	38
IQR	30–42	28–41	28–41	28.5–40	26.5–42	32–44	29.5–44
Low (no. [%])	21 (45)	22 (44)	33 (53)	27 (45)	24 (43)	13 (28)	9 (38)
Moderate (no. [%])	11 (23)	12 (24)	11 (18)	15 (25)	15 (27)	10 (21)	4 (17)
High (no. [%])	15 (32)	16 (32)	18 (29)	18 (30)	17 (30)	24 (51)	11 (46)

IQR = interquartile range.

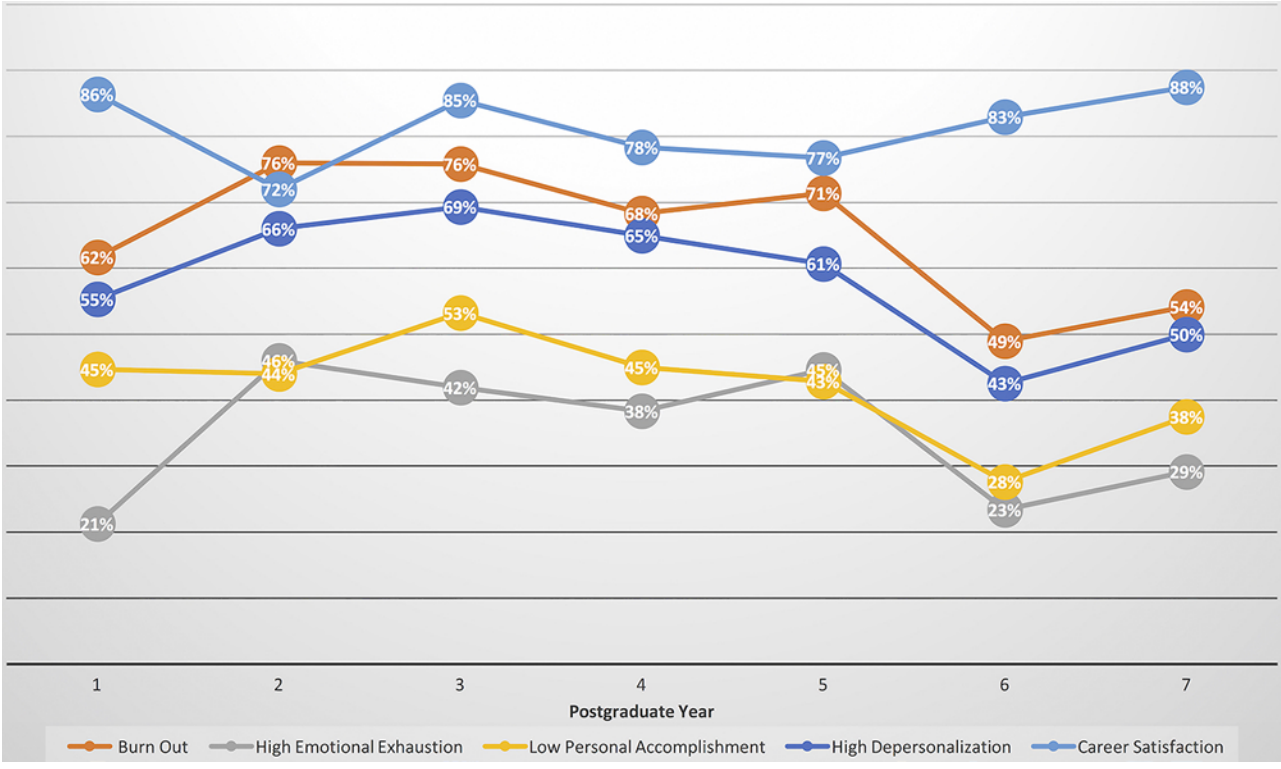

FIG. 5. Maslach Burnout Inventory and career satisfaction trends by postgraduate year. Figure is available in color online only.

TABLE 4. Univariate analysis of burnout and career satisfaction among neurosurgery residents

Variable	Burnout				Career Satisfaction			
	OR	95% CI		p Value	OR	95% CI		p Value
Sex								
Male	0.72	0.41	1.25	0.24	1.45	0.78	2.68	0.24
Female	Reference				Reference			
Relationship status								
Stable partner/married	Reference				Reference			
Divorced	3.39	0.40	28.61	0.26	0.28	0.06	1.28	0.10
Single	1.49	0.89	2.49	0.13	0.71	0.39	1.26	0.24
Children								
No	1.51	0.92	2.46	0.10	1.07	0.59	1.94	0.83
Yes	Reference				Reference			
PGY								
PGY1	Reference				Reference			
PGY2	1.97	0.82	4.72	0.13	0.41	0.14	1.17	0.10
PGY3	1.95	0.85	4.45	0.11	0.93	0.31	2.83	0.90
PGY4	1.34	0.60	2.98	0.47	0.57	0.20	1.64	0.30
PGY5	1.55	0.68	3.54	0.30	0.52	0.18	1.51	0.23
PGY6	0.60	0.26	1.35	0.21	0.77	0.24	2.43	0.66
PGY7	0.73	0.27	1.99	0.54	1.11	0.25	4.88	0.89
Would you choose neurosurgery again?								
No	5.31	2.42	11.64	<0.0001	0.05	0.02	0.11	<0.0001
Yes	Reference				Reference			
Don't know	2.80	1.37	5.72	<0.01	0.12	0.06	0.25	<0.0001
Would you choose your residency training program again?								
No	5.31	2.42	11.64	<0.0001	0.12	0.06	0.24	<0.0001
Yes	Reference				Reference			
Don't know	2.80	1.37	5.72	<0.0001	0.25	0.12	0.54	<0.0001
Would you recommend neurosurgery to a medical student?								
No	10.65	3.74	30.35	<0.0001	0.13	0.07	0.25	<0.0001
Yes	Reference				Reference			
Don't know	1.94	1.05	3.61	0.04	0.35	0.17	0.73	<0.0001
How likely do you feel that your life as a resident will improve?								
Unlikely	1.93	1.20	3.09	<0.01	0.29	0.17	0.51	<0.0001
Likely	Reference				Reference			
How likely do you feel your life as a resident will worsen?								
Unlikely	0.39	0.24	0.62	<0.0001	3.06	1.75	5.37	<0.0001
Likely	Reference				Reference			
At some point during residency, have you given serious thought to quitting?								
No	0.22	0.13	0.37	<0.0001	5.61	3.06	10.28	<0.0001
Yes	Reference				Reference			
Are you or do you intend to get significantly involved w/ one of the national neurosurgical societies, such as AANS or CNS?								
No	1.75	1.04	2.92	0.03	0.35	0.20	0.60	<0.001
Yes	Reference				Reference			
Do you feel you had an accurate perception of neurosurgery as a medical student?								
No	3.15	1.82	5.45	<0.0001	0.37	0.21	0.66	<0.001
Yes	Reference				Reference			

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TABLE 4. Univariate analysis of burnout and career satisfaction among neurosurgery residents

Variable	Burnout				Career Satisfaction			
	OR	95% CI		p Value	OR	95% CI		p Value
Do you socialize w/ your co-residents outside of work?								
No	2.75	1.34	5.67	<0.01	0.41	0.22	0.76	<0.01
Yes	Reference				Reference			
Do you feel you are performing adequately for your stage of training?								
No	4.63	1.60	13.40	<0.01	0.22	0.11	0.46	<0.0001
Yes	Reference				Reference			
Do you think your professional & personal life will significantly improve AFTER residency?								
No	1.60	0.62	4.15	0.33	0.21	0.09	0.51	<0.001
Yes	Reference				Reference			
Do you have a mentor (informal or formally assigned)?								
No	1.51	0.92	2.50	0.11	0.67	0.38	1.17	0.16
Yes	Reference				Reference			
Do you feel you are benefiting from your relationship w/ your mentor?								
No	4.12	1.85	9.19	<0.001	0.23	0.11	0.45	<0.0001
Yes	Reference				Reference			
Not applicable	2.33	1.34	4.06	<0.01	0.42	0.22	0.80	<0.01
Do you act as a mentor for other residents or students?								
No	1.63	0.97	2.75	0.07	0.43	0.25	0.76	<0.01
Yes	Reference				Reference			
In the past 12–24 mos, have you felt the following?								
Hostile faculty member(s)								
Large to extreme	9.02	3.18	25.56	<0.0001	0.23	0.13	0.43	<0.0001
None to moderate	Reference				Reference			
Hostile residents in your program								
Large to extreme	5.05	2.10	12.17	<0.001	0.49	0.26	0.93	0.03
None to moderate	Reference				Reference			
Attrition of co-residents								
Large to extreme	3.33	1.51	7.34	<0.01	0.49	0.25	0.95	0.03
None to moderate	Reference				Reference			
Lack of op experience								
Large to extreme	10.96	2.59	46.36	<0.01	0.37	0.18	0.76	<0.01
None to moderate	Reference				Reference			
Lack of control over your schedule & activities								
Large to extreme	6.72	3.50	12.90	<0.0001	0.28	0.16	0.49	<0.0001
None to moderate	Reference				Reference			
Inadequate pay/burdensome debt								
Large to extreme	1.78	1.05	3.02	0.03	0.45	0.26	0.78	<0.01
None to moderate	Reference				Reference			
Anxiety regarding future job opportunities								
Large to extreme	1.81	0.98	3.34	0.06	0.22	0.12	0.40	<0.0001
None to moderate	Reference				Reference			
Social/personal stressors outside of work								
Large to extreme	4.32	1.78	10.45	<0.01	0.29	0.15	0.55	<0.001
None to moderate	Reference				Reference			

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TABLE 4. Univariate analysis of burnout and career satisfaction among neurosurgery residents

Variable	Burnout				Career Satisfaction			
	OR	95% CI		p Value	OR	95% CI		p Value
In relation to your residency, how satisfied are you w/ the following factors?								
Career as a neurosurgeon								
Not satisfied	13.63	4.17	44.48	<0.0001				
Satisfied	Reference							
Appreciation from patients								
Not satisfied	5.59	2.68	11.66	<0.0001	0.15	0.08	0.26	<0.0001
Satisfied	Reference				Reference			
Appreciation from staff								
Not satisfied	7.73	4.45	13.43	<0.0001	0.19	0.10	0.36	<0.0001
Satisfied	Reference				Reference			
Academic productivity								
Not satisfied	3.08	1.92	4.93	<0.0001	0.13	0.06	0.27	<0.0001
Satisfied	Reference				Reference			
Didactic & reading time								
Not satisfied	3.04	1.87	4.94	<0.0001	0.12	0.04	0.35	<0.0001
Satisfied	Reference				Reference			
Work-life balance								
Not satisfied	3.94	2.43	6.40	<0.0001	0.11	0.04	0.31	<0.0001
Satisfied	Reference				Reference			
Geographic location								
Not satisfied	2.26	1.33	3.84	<0.01	0.31	0.18	0.54	<0.0001
Satisfied	Reference				Reference			
Time for personal growth/development								
Not satisfied	4.37	2.70	7.08	<0.0001	0.18	0.08	0.41	<0.0001
Satisfied	Reference				Reference			
Relationship status w/ significant other								
Not satisfied	2.10	1.28	3.44	<0.01	0.32	0.18	0.57	<0.0001
Satisfied	Reference				Reference			
Spouse/significant other's understanding of your work hrs								
Not satisfied	1.79	1.05	3.04	0.03	0.33	0.19	0.60	<0.0001
Satisfied	Reference				Reference			
Personal life (i.e., life outside of residency)								
Not satisfied	2.80	1.76	4.45	<0.0001	0.28	0.15	0.53	<0.0001
Satisfied	Reference				Reference			
Exercise								
No	Reference				Reference			
Yes	0.57	0.34	0.94	0.03	1.59	0.91	2.78	0.10

spite this change, 65% of neurosurgery residents reported insufficient time for personal growth and development and 68% had not achieved a satisfactory work-life balance. These individuals were, in turn, 4 times more likely to suffer burnout (OR 4.37, $p < 0.0001$), according to univariate analysis. This is not surprising, as time outside the hospital is often filled with scholarly pursuits, including independent study, operative planning, and research. Therefore, successfully combating burnout and improving resident quality of life extends beyond work hours. A recent pilot study addressed neurosurgery departmental wellness through a physical education and nutrition program, promising steps in managing stress.[61]

Central to physician wellness is the intrinsic reward and career satisfaction offered by the specialty. While neurosurgery is renowned for arduous training, its tremendous impact makes for thankful patients and a rewarding profession. This may, in part, explain why traditionally challenging fields with high susceptibility to burnout can also have high satisfaction rates. However, a decrease in intrin-

TABLE 5. Multivariable logistic regression analysis of burnout

Variable	Burnout		
	OR	95% CI	p Value
Would you recommend neurosurgery to a medical student?			
No	6.40	1.85, 22.08	0.003
Yes		Reference	
When considering quitting, would you have left the medical field?			
No	3.63	0.69, 19.20	0.129
Yes		Reference	
Do you feel you are benefiting from your relationship w/ your mentor?			
No	2.96	1.11, 7.90	0.031
Yes		Reference	
Not applicable	1.51	0.75, 3.06	0.251
No. of children			
0		Reference	
1	0.55	0.24, 1.22	0.14
2	0.35	0.13, 0.98	0.046
3	8.47	0.91, 78.98	0.061
4+		NA	
Lack of op experience			
None to moderate		Reference	
Large to extreme	7.57	1.59, 35.95	0.011
Social/personal stressors outside of work			
None to moderate		Reference	
Large to extreme	4.52	1.47, 13.84	0.008
Difficult/hostile faculty member			
None to moderate		Reference	
Large to extreme	4.07	1.44, 11.47	0.008

NA = not applicable.

sic reward is often followed by a corresponding decrease in satisfaction. Residents who felt underappreciated by patients or staff had a nearly 7-fold reduction in career satisfaction (OR 0.15 and 0.19, respectively, $p < 0.0001$) and an 8-fold increase in burnout (OR 5.59 and 7.73, respectively, $p < 0.0001$). Despite the high burnout rates, 81% described being satisfied with their career, and 79% would pursue neurosurgery as a specialty again if given the choice. This paradoxical relationship between burnout and career satisfaction has been noted in the literature and is often attributed to the subjectivity inherent to burnout surveys and the episodic nature of burnout over the course of training.[5,38,41]

A review of the outcome trends revealed that a high degree of career satisfaction was maintained throughout all 7 years of training (Fig. 5). However, burnout rates spiked in postgraduate years 2 and 3 (76%), trending downward thereafter. These findings are possibly attributable to the change in clinical responsibility and shared decision making, which is greatest across these years when one stands on the front lines as the "consultant" resident. While one cannot generalize the natural course of burnout between specialties, it is curious that an analogous upswing in burnout occurs in internal medicine and pediatrics, with the trend reversing 2 years into training.[7,46,65] This reversal may result from the proverbial "light at the end of the tunnel" as residency nears completion. Nonetheless, these patterns may offer insight into the timing of any intervention targeting burnout, as well as those persons most likely to benefit from therapy.

In recent years, pursuing a career in medicine has become synonymous with being saddled with high financial debt. The median indebtedness of medical school graduates in 1992 stood at just around $50,000.[53] By 2016, this figure approached $190,000.[4] And yet, resident wages have remained relatively stagnant over this period. While the decision to pursue a specific specialty is likely multifactorial, a growing body of evidence implicates debt and lifestyle as major determinants of career choice.[16] Some studies indicate, intuitively so, that graduates with higher debt are more likely to pursue higher-paid specialties.[32,63] In a longitudinal study of students from 2 prominent medical schools over an 8-year period, Grayson et al. discovered that higher debt loads were predictive of a student's likelihood to switch career trajectories from primary care to a higher-paying alternative.[32] Because debt influences the timing of major life events, such as the decision to start a family or buy a home,[53] it may ultimately serve as a source of stress and burnout in those who may be forced to postpone or forego these milestones. Indeed, neurosurgery residents from our survey with burdensome debt were twice

TABLE 6. Published burnout rates for various residency specialties

Authors & Year	Residency	No. of Respondents (completion rate)	Burnout Rate*	Comment
West et al., 2011	IM	16,394 (74%)	51.5%	MBI; national survey of all IM residents in US w/ data collected at time of annual in-training exam
Shanafelt et al., 2002	IM	115 (76%)	76%	MBI; single-institution study in US
Fahrenkopf et al., 2008	Pediatrics	123 (100%)†	74%	MBI; multicenter prospective study in US
Pantaleoni et al., 2014	Pediatrics	Varied throughout study from 54% to 100%; largest cohort 80 residents	17% (intern yr), 40% (junior yr), 42% (senior yr)	MBI; longitudinal cohort study across multiple centers
Kimo Takayesu et al., 2014	EM	218 (67%)	65%	MBI; multi-institutional study across 8 EM programs in US
Nyssen et al., 2003	Anesthesiology	151 (48%)	40.4%	MBI; anesthetists in training & independent practitioners surveyed w/in Belgium university network
Elmore et al., 2016	General surgery	753 (NK)	69%	MBI; national survey in US
Golub et al., 2007	ENT	684 (50%)	86%	MBI; burnout subdivided into moderate & high subscores; 76% exhibited the former & 10% the latter; national survey of ENT residents in US
Aldrees et al., 2015	ENT	85 (69%)	45%	MBI; multicenter study across Saudi Arabia
Chaput et al., 2015	Plastic surgery	52 (61%)	29%	MBI; national survey of residents in France
Arora et al., 2014	Orthopedic surgery	236 (22%)	53%	MBI; national survey of Australian trainees
Becker et al., 2006	Ob/gyn	125 (29%)	83%	MBI; moderate burnout reported; multicenter study across US
Castelo-Branco et al., 2007	Ob/gyn	109 (67%)	58%	MBI; multicenter study across Spain

EM = emergency medicine; ENT = ear, nose, and throat; IM = internal medicine; NK = not known; ob/gyn = obstetrics and gynecology.
* Definitions of burnout were not consistent across studies.
† Prospective cohort study.

as likely to exhibit burnout (OR 1.78, $p = 0.03$) with a corresponding reduction in career satisfaction (OR 0.45, $p < 0.01$), according to univariate analysis.

Medical school graduates have regarded mentorship as the single most influential factor on specialty choice.[44] It has also been viewed as an important catalyst for success in residency training and beyond. For instance, increased academic productivity based on higher numbers of publications and grants,[51,52,62] a greater likelihood for promotion,[70] and higher rates of career satisfaction[45,54] have all been directly linked to mentorship. Despite these benefits, less than 50% of medical students, residents, and junior faculty report having mentors.[1,33,50] The problem seems less to do with the desire for mentorship and more to do with excessive clinical, administrative, and scholarly demands on faculty that preclude time for meaningful mentor-mentee relationships.[14,47] Sixty-eight percent of respondents in our survey claimed to have a mentor of some sort, which is higher than rates in the literature. Among those with a mentor, approximately 20% described feeling that they were not significantly benefiting from the interaction, and they, in turn, exhibited 3-fold more burnout (OR 2.96, $p = 0.03$), according to multivariable analysis. Respondents were further offered the opportunity to expand on their mentor relationships, with common responses that they valued "career guidance," "encouragement from staff," and "faculty research guidance/productivity." This suggests that, ultimately, it is the quality rather than the nominal nature of the mentoring relationship that matters. For mentoring to be effective, mentors may need to undergo development training. In one survey, even those with significant mentorship experience expressed a desire for training workshops that addressed complex issues such as race and culture in the workplace.[64] Increased availability of career development sessions in which prospective mentors could be formally trained in the art of mentorship may be a potentially useful adjunct for faculty at training hospitals. Such an addition would also likely be self-perpetuating since those with effective mentors are generally more likely to offer mentorship to others.[62]

Graded responsibility and supervision through a hierarchical structure is a cornerstone of surgical education.[47] Much has changed since the inception of this Halstedian tradition in 1889—notably, a cap on excessive hours and an erosion of the supervised independence residents once enjoyed. However, many traditions persist within the hierarchy, including a carryover of the mentality to "do unto others as you would have others do unto you." Almost a third of residents surveyed in our study noted that their lives entailed dealing with hostile faculty or residents within the past 2 years. The presence of difficult interactions with faculty increased burnout more than 4-fold (OR 4.07, $p = 0.008$), according to multivariate analysis. While the true nature of these interactions cannot be further investigated, relationships between trainees and their senior residents and faculty can often be strained. Hostile encounters and other negative experiences are known deterrents to pursuing surgery.[33] In light of the precipitous decline in medi-

cal students' interest in surgery compared with that in the 1980s,[48] hostile practices must be further addressed by programs to successfully combat burnout and preserve surgical pedigree.

Meaningful mentorship and personal stressors were significant predictors of burnout and career satisfaction in a multivariable regression model. However, high degrees of correlation between individual subjective predictor variables, such as positive responses to multiple stressors occurring together, limited the ability to include all answers to purely subjective questions in the multivariate analysis. The use of subjective rating scales in our questionnaire and data analysis limits objective interpretation of the impact of individual subjective factors, though we did attempt to mitigate this through limited incorporation of subjective variables in our multivariate model and by modeling our survey off of prior neurosurgical burnout studies in the attending population. Current limitations of this work are those typical of surveys, such as inaccurate reporting by respondents due to recall bias. Our response rate was only 21%, which is on the lower end of the spectrum compared with rates in other published studies on trainees. Thus, one possible scenario is a skewing of data trends secondary to disproportionate completion by a particular subgroup (that is, so-called response bias). This may be due to the fact that those who suffer burnout are either less likely to complete the survey because of apathy or more likely to do so because of interest in the subject matter. In addition, despite a rigorous de-identification process for respondents, it is unclear whether our response rate was affected by potential concerns regarding confidentiality of responses. Despite the relatively low response rate, our data showed a relatively homogeneous distribution of responses, with approximately one-quarter of the responses corresponding to the East Coast, the West Coast, the South, and the Midwest. In addition, responses were similarly distributed at 14%–18% per year among the postgraduate years. As the direction of influence cannot be ascertained, there may be some degree of response bias that remains unaccounted for. Future studies could include a repeat of the above with greater incentives to enhance completion rates. Additionally, because each respondent was linked to a unique identifier, it would be informative to track resident responses over the course of their residency to more accurately delineate burnout trends and identify causal factors.

Conclusions

Burnout is a pervasive problem among both physicians in practice and residents in training. Several factors were independently identified as predictors of burnout, including personal and occupational stressors, which impact resident education and probably patient-related outcomes. Analysis of burnout trends revealed a spike between postgraduate years 1 and 2, suggesting the best timing for any intervention. Mentorship was identified for its putative benefit in combating burnout and may be one systematic approach that programs can formally adopt. Despite work-hour restrictions, both poor work-life dissociation and limited time for personal growth and development remain central issues. Nonetheless, the majority of residents were satisfied with their professional careers, were hopeful about the future of health care, and would choose neurosurgery as a profession again if given the choice.

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Supplemental Information

Online-Only Content

Supplemental material is available with the online version of the article.

Appendix Table. https://thejns.org/doi/suppl/10.3171/2017.9.JNS17996.

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