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The Prevalence of Burnout and Depression and Their Association with Adherence to Safety and Practice Standards: A Survey of United States Anesthesiology Trainees

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BACKGROUND: The prevalence of burnout and depression in anesthesiology residents has not been determined. It is also unknown whether anesthesiology resident burnout/depression may affect patient care and safety. The primary objective of this study was to determine the prevalence of burnout and depression in anesthesiology residents in the United States. We hypothesized that residents at high risk of burnout and/or depression would report more medical errors as well as a lower rate of following principles identified as the best practice of anesthesiology.
METHODS: A cross-sectional survey was sent to 2773 anesthesiology residents in the United States. The questionnaire was divided into 5 parts examining trainees' demographic factors, burnout (Maslach Burnout Inventory), depression (Harvard depression scale), 10 questions designed to evaluate best practice of anesthesiology, and 7 questions evaluating self-reported errors. Best practices and self-reported error rates were compared among subjects with a high risk of burnout only, high risk of depression only, high risk of burnout and depression, and low risk of burnout and depression. Pairwise comparisons were considered significant at $P < 0.004$ and confidence intervals (CIs) reported at 99.6%.
RESULTS: There were 1508 (54%) resident responds. High burnout risk was found in 41% (575 of 1417) of respondents. Working >70 hours per week, having >5 drinks per week, and female gender were associated with increased burnout risk. Twenty-two percent (298 of 1384) screened positive for depression. Working >70 hours of work per week, smoking, female gender, and having >5 drinks per week were associated with increased depression risk. Two hundred forty (17%) respondents scored at high risk of burnout and depression, 321 (23%) at high risk of burnout, 58 (4%) at high risk of depression only, and 764 (56%) at low risk of burnout or depression. Median best practice scores (maximum = 30) for residents at high risk of burnout (difference −2; 99.6% CI, −1 to −2; $P < 0.001$) or high risk of burnout and depression (difference −4; 99.6% CI, −3 to −6; $P < 0.001$) were lower than scores of residents at low risk for burnout or depression. Thirty-three percent of respondents with high burnout and depression risk reported multiple medication errors in the last year compared with 0.7% of the lower-risk responders ($P < 0.001$).
CONCLUSION: Burnout, depression, and suicidal ideation are very prevalent in anesthesiology residents. In addition to effects on the health of anesthesiology trainees, burnout and depression may also affect patient care and safety. (Anesth Analg 2013;117:182–93)

Health care workers are considered to be at high risk for the development of job burnout.[1] Among the stages of a physician career, residency training has been recognized as carrying the highest chance for the development of burnout.[2] Because burnout can impair the individual's cognitive function (more specifically visual attention),[3] it is of concern that anesthesiology residents at risk for burnout, who are constantly learning new skills and monitoring patients, may commit more medical errors than residents at lower burnout risk, and potentially jeopardize patient care and safety.

Depression has also been shown to be very common during medical training years.[4] Burnout primarily affects the life of the affected individual at work, whereas depression also affects personal life outside of work. When severe, depression can be a life-threatening disease, especially if unrecognized and untreated.[5] Depression also impairs cognitive ability; therefore, it is conceivable that residents with depression may negatively impact patient care and safety.

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The overall prevalence of depression and burnout risk in anesthesiology residents has not been quantified. It has also not been determined whether residents at risk of burnout and/or depression follow best practice standards to the same extent as residents at low risk of burnout or depression. The current survey was undertaken to determine the prevalence of and associated factors for burnout and depression among anesthesiology residents in the United States. We also hypothesized that residents at high risk of burnout and/or depression would report more medical errors as well as a lower rate of following principles identified as the best practice of anesthesiology compared with residents at lower risk of burnout and/or depression.

METHODS

The study was approved by the Northwestern University IRB. A cross-sectional nationwide survey was sent to 2773 residents in anesthesiology departments across the United States. The mailing list was obtained from the American Society of Anesthesiologists directory available to members. The survey was created using Survey Monkey software (SurveyMonkey Inc., Portland, OR). To assure confidentiality of the participants, the survey was set up to delink the responses to the respondents' e-mail address. The software created a unique identifier to prevent multiple responses from a single participant. The participants who did not respond to the electronic questionnaire were mailed a copy of the survey with self-addressed return envelope addressed to the primary investigator.

The questionnaire was divided into 5 parts and contained 53 questions. Multiple-choice questions were used. Likert scales were used to quantify respondents' level of agreement with a statement.

First Section

The first section of the questionnaire included 11 questions designed to capture demographic, social, and work characteristics about the residents: age, gender, marital and parenthood status, number of resident in their class, year of training, hours of work per week, overnight call frequency, smoking status, weekly alcohol consumption, and job satisfaction.

Second Section

The second section of the questionnaire included 12 questions from the Maslach Burnout Inventory—Human Services Survey (MBI-HSS).[6] The full MBI-HSS involves 22 questions: 5 assessing depersonalization, 9 for emotional exhaustion, and 8 for personal accomplishment. A score is given to each part of the MBI-HSS, based on a frequency scale of 0 "never" to 6 "every day." The questionnaire evaluates depersonalization using questions such as "I feel I have become more callous toward people"; emotional exhaustion with questions such as "I feel emotionally drained from my work" and "I feel used up at the end of the workday"; personal accomplishment with questions such as "I feel I am positively influencing people's life through my work." The Maslach was shortened to 12 questions to facilitate comparison with similar, previously published data on academic anesthesiology chairs and program directors and to reduce the questionnaire respondent for participants.[7,8] The 12 questions selected were identified by Gabbe et al.[9] using factor analysis of the subscales in the original Maslach questionnaire. These questions: 3 evaluating depersonalization, 5 examining emotional exhaustion, and 4 assessing personal accomplishment. From the subscale values the original MBI-HSS was calculated using proportional scoring. The risk ranges of the subgroup scoring are as follows: emotional exhaustion, 0 to 16 (low), 17 to 26 (moderate), and >26 (high); depersonalization, 0 to 6 (low), 7 to 12 (moderate), and >12 (high); and personal accomplishment, 0 to 31 (high), 32 to 38 (moderate), and >39 (low). A high risk of burnout was defined as a respondent with moderate high or high burnout subscales scores in 2 or more of the subscales.[9] In addition, recently, West et al.[10] have described internal consistency of single questions "I feel burned out from my work" and "I have become more callous toward people since I took this job" to evaluate emotional exhaustion and depersonalization dimensions of burnout, respectively. Single-item evaluation and conversion to the original Maslach by proportioning scores were uniformly consistent with those reported for models based on the full Maslach, with no changes in any of the reported associations.[10]

Third Section

The third section of the questionnaire included all the 10 questions from the Harvard National Depression Screening Day Scale (HANDS) to evaluate depression.[11] A score in the upper third (>9) has been found to be 94% specific and 95% sensitive for a major depressive episode, similar to the Beck Depression Inventory, which is twice as long. The questions are answered based on a 4-point frequency scale (none of the time, some of the time, most of the time, and all of the time). Examples of questions used by the instrument include "Over the past two weeks how often have you had poor appetite?" and "Over the past two weeks, how often have you thought about or wanted to commit suicide?"

Fourth Section

The fourth section of the questionnaire included 10 questions designed to evaluate behaviors commonly identified as best practice in anesthesiology, which were obtained from the work of previous investigators.[12] Questions were evaluated using a 5-point Likert scale (never, rarely, sometimes, often, and always).

Fifth Section

The fifth section of the questionnaire included 7 questions that evaluated frequency of self-reported errors using questions developed by previous investigators and used in other medical specialties, but with applicable relevance to anesthesiology.[13,14] Frequency was evaluated using a 5-point Likert scale (often, multiple times, a couple of times, once, never). Example of questions that were included are: "I make mistakes that have negative consequences to my patients," "I fall short in the quality of care I provide to my patients," and "I have made medication errors (dose or incorrect drug) in the last year." We modified 1 of the questions to reflect anesthesiology resident attentive behavior in the operating room: "I do not monitor the patient in the operating room as I should."

Statistical Analysis

A resampling of 300 nonresponders of the initial survey was performed 6 months after the completion of the initial survey to assess for a respondent bias in the initial sample. Comparison of the characteristics of the respondents of the initial sample with the validation cohort and the number of respondents assigned to the high burnout and depression risk groups in the initial and retest sample was made using Fisher exact test. Data obtained from resampling respondents were combined with that of initial respondents for the primary data analyses.

Respondents' characteristics are presented as *n* (%) of responses or median (interquartile range). Respondents whose scores indicated a high risk of burnout on the Maslach scale (moderate high or high) or a HANDS instrument screen (>9) for depression were compared with those with low-to-moderate risk for either burnout or depression using the Fisher exact test. Conditional inference trees were constructed from respondent characteristics to model a decision tree for association with high risk of burnout and depression. The conditional tree algorithm uses binary recursive splitting to classify applicants belonging to either the high or low risk of burnout and depression groups. Because 10 variables were evaluated for recursive splitting a $P < 0.005$ was selected as the minimal criterion for splitting of the groups. Stopping criteria for the analysis were based on multiplicity-adjusted *P* values with Bonferroni correction.

Binary logistic regression was used to develop a model for predicting burnout and depression risk based on respondent's characteristic. In addition to the 10 characteristics entered into the conditional tree analysis, interaction terms based on the terminal branches of the conditional tree were added to the model. Logistic regression analysis was performed using a forward/backward stepwise likelihood ratio elimination method. Criteria for entry and removal from the model at each step were set at 0.01 and 0.05, respectively. Odds ratios and 99% confidence intervals (CIs) were calculated for variables in the final equation. Sensitivity, specificity, positive and negative predictive values, positive and negative likelihood ratio, the diagnostic odds ratio, the accuracy, and the 99% CIs were calculated using standard formulae.

Although the 10 questions used to assess anesthesia practice were adapted from the study by White et al.[12] for the assessment of residents attitude's safety and the law, the use of these questions as a single construct based on the aggregate score of the individual questions has not been validated for assessment of best clinical practice. To establish a summary index of the measured variables assessing best practice, a factor analysis was performed. Component factors were determined using principal component analysis with varimax rotation and Kaiser normalization. Appropriateness of factor analysis was assessed using Barlett test of sphericity and adequacy of sampling for each question was assessed using a Kaiser-Meyer-Olkin measure of sampling adequacy >0.5. Factors were retained when the Eigen values exceeded 1 and through examination of the Scree plot. Individual questions were removed from subsequent analyses when the communality value for the question in the extracted matrix was <0.5. Generalizability of the result of the principle component analysis was performed using split-sample validation. Factor scores were calculated using the regression method and compared with summated Likert scale scores using Pearson correlation. Internal consistency of the items in the final analysis was determined using Cronbach α. The summary corrected interitem correlation was calculated to determine the influence of the overall score on the response to a single item. Because others have frequently used the reported medical errors as their primary outcome, we also examined the correlation of the best practice score with the frequency of errors reported in the 7 questions assessing self-reported errors.

On the basis of the risk of burnout and depression, respondents were assigned to 1 of 4 groups: high burnout and depression risk, high burnout risk only, high depression risk only, and low burnout and depression risk. Because we sampled the entire available population, a power analysis was performed to assess the ability of our sample to detect differences in the adherence to the factors identified as best practice among the different categories of burnout and/or depression. On the basis of the responses to the summated score used by White et al.[12] we estimated a score of 0.8 times the total possible points would be obtained at the 50th percentile of respondents. The summated scale identified by factor analysis contained 6 questions (30 possible points) and was compared among 4 groups (high burnout and depression risk, high burnout risk only, high depression risk only, and low depression and burnout risk). Assuming a standard deviation of 10 points, 85 respondents per group would be required to achieve 80% power to detect a median shift of 6 points between any 2 groups at an $\alpha = 0.004$ using Dunn post hoc test. This level of difference was deemed to be important as it represented a decrease of 1 level of adherence to each of the questions used in the summated score. Respondent self-report of adherence to anesthesiology best practice composite scores and self-reported errors were compared among subjects with a high risk of burnout only, high risk of depression only, high risk of burnout and depression, and low risk of burnout and depression, using the Kruskal–Wallis *H* test. Post hoc comparisons were made using Dunn test. The median shift and CIs were determined using the Wilcoxon exact procedure. Pairwise comparisons were considered significant at $P < 0.004$ (12 comparisons) and CIs reported at 99.6%.

Correlations among reported job satisfaction, Maslach subscale scores, best practice composite scores, and number of self-reported questions answered as having occurred often or multiple times were determined using Spearman ρ. Differences in proportions and CIs of the difference were determined using the Wald method. All other comparisons were considered significant at $P < 0.01$ and CI reported at 99%. Statistical analysis was performed using R version 2.14.1, release date December 22, 2011 (The R Foundation for Statistical Computing, Vienna, Austria).

RESULTS

The survey was sent to 2773 residents in the United States; 1430 anesthesiology trainees responded to the initial survey, 1007 via the electronic version and 423

through the mailed paper version. Seventy-eight of 300 nonresponders to the initial survey answered the resampling survey. The combined response rate was 54%. Respondents answered 62,615 of the 78,416 data elements (93%). There were insufficient responses for analysis of burnout in 91 and for assessment of depression risk in 124 surveys. It was not possible to assign 125 of the respondents to 1 of the 4 burnout and/or depression groups.

Characteristics of the respondents are shown in Table 1. Compared with the initial sample the resampled group was not different with the exception that it included more 1st and 2nd year residents (difference 19%; 99% CI, 5–33; $P < 0.001$), and more respondents reported working >70 hours per week (difference 19%; 99% CI, 4–34; $P < 0.001$). Thirty-seven percent of the resampled respondents and 25% of the initial respondents reported that they were dissatisfied to very dissatisfied with their current position (difference 12%; 99% CI, −3 to 26; $P = 0.04$); however, the prevalence of high burnout risk (difference −4%; 99% CI, −19 to 11; $P = 0.49$) and depression risk (difference −1%; 99% CI, −14 to 12; $P = 0.84$) was not different in the initial respondents compared with the resampled group.

Primary Analysis—Incidence of Anesthesiology Resident Burnout and Depression

Forty-one percent (575 of 1417) of the respondents met the criteria for high burnout risk. Median (interquartile range) subscale scores for emotional exhaustion, personal accomplishment, and depersonalization were 25 (16–36), 38 (30–40), and 8 (3–17), respectively. Seventy-one percent (371 of 569) of respondents at high risk of burnout were somewhat to very dissatisfied with their job compared with 29% of residents (149 of 838) with lower burnout risk ($P < 0.001$). Job satisfaction correlated with the subscale scores of the Maslach questionnaire: personal accomplishment $\rho = 0.51$ (99% CI, 0.46–0.57) $P < 0.001$, emotional exhaustion $\rho = -0.55$ (99% CI, −0.49 to −0.60) $P < 0.001$, and depersonalization $\rho = -0.46$ (99% CI, −0.40 to −0.52) $P < 0.001$.

Comparison of respondent characteristics in residents at high risk of burnout compared with lower burnout risk is presented in Table 1. Working hours per week, average

Table 1. Characteristics of Respondents by Burnout and Depression Risk

		Burnout risk			Depression risk		
	Overall	Low	High	*P*	Low	High	*P*
Age							
≤30	779 (54)	400 (54)	338 (46)	<0.0005	557 (77)	165 (23)	0.23
>30	668 (46)	422 (66)	220 (34)		499 (80)	125 (20)	
Gender							
Male	850 (57)	501 (63)	288 (37)	<0.0005	646 (84)	118 (16)	<0.0001
Female	641 (43)	335 (54)	285 (46)		433 (71)	179 (29)	
Marital status							
Married	884 (59)	557 (67)	268 (33)	<0.0005	701 (87)	102 (13)	<0.0001
Single	609 (41)	281 (48)	302 (52)		378 (66)	193 (44)	
Parenthood status							
Yes	452 (30)	293 (69)	131 (31)	<0.0005	365 (88)	49 (12)	<0.0001
No	1044 (70)	545 (55)	442 (45)		715 (74)	248 (26)	
Year of training							
First–second year	753 (51)	405 (56)	321 (44)	0.008	558 (77)	163 (23)	0.33
Third–fourth year	736 (49)	427 (63)	252 (37)		516 (79)	134 (21)	
Number of resident per class							
≤15	767 (52)	424 (59)	294 (41)	0.7	540 (77)	157 (23)	0.39
>15	695(48)	398 (60)	262 (40)		516 (79)	132 (21)	
Working hours							
≤70	1117 (76)	715 (69)	328 (31)	<0.0005	869 (86)	144 (14)	<0.0001
>70	346 (24)	108 (27)	228 (73)		186 (56)	146 (44)	
Call frequency (days between calls)							
≥5	648 (44)	425 (70)	181 (30)	<0.0005	511 (86)	80 (14)	<0.0001
<5	830 (56)	399 (51)	389 (49)		554 (72)	215 (28)	
Do you smoke							
Yes	102 (7)	21 (21)	80 (79)	<0.0005	35 (35)	66 (65)	<0.0001
No	1378 (93)	812 (63)	484 (37)		1036 (82)	226 (18)	
Average drinks per week							
<5	1067 (72)	693 (68)	319 (32)	<0.0005	823 (84)	160 (16)	<0.0001
≥5	413 (28)	145 (37)	249 (63)		254 (65)	136 (35)	

Data are presented as *n* (% of row). Univariate analysis using Fisher exact test.

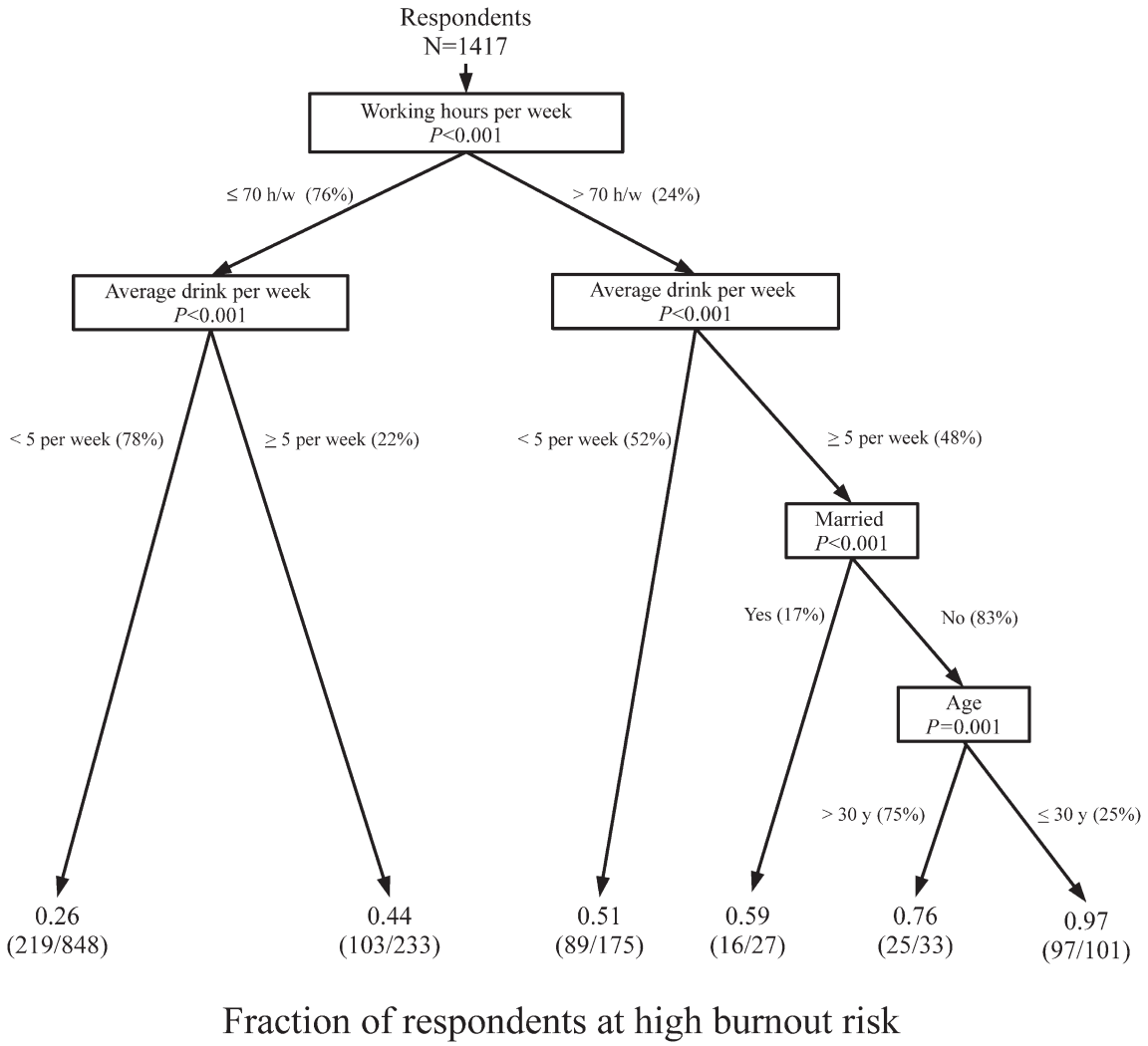

Figure 1. Classification tree for nonparametric recursive partitioning of respondents to high or low burnout risk based on demographic, social, and work characteristics of anesthesiology residents. Branches to the right classify respondents likely to be at high risk of burnout, and those to the left classify respondents unlikely to be at high risk. Fraction of subjects with high burnout risk (number of high burnout respondents/total number) listed for each terminal branch.

drinks per week, marital status, and age were identified by conditional inference tree analysis for classification of burnout risk (Fig. 1). The binary logistic model included gender, call frequency, the interaction of work hours per week with average drinks per week, and the interaction of work hours per week with average drinks per week with marital status (Table 2). The performance of these models in predicting burnout risk is shown in Table 3.

Twenty-two percent (298 of 1384) of respondents screened positive for depression (HANDS score >9). Respondent characteristics between high and lower risk of depression are presented in Table 1. Working hours per week, smoking, marital status, gender, and average drinks per week were identified by conditional inference tree analysis for classification of depression risk (Fig. 2). The binary logistic model included working hours per week, gender, marital status, call frequency, and the interaction of work hours per week with smoking with gender with average drinks per week (Table 2). The performance of these models in predicting depression risk is shown in Table 3. Twenty-three percent (68 of 298) of those who screened positive for depression reported that they thought about or wanted to commit suicide at least some of the time compared with 0.7% of respondents with a low depression risk ($P < 0.001$).

High burnout risk and high depression risk were coexistent in 240 of 1383 (17%) of the respondents. Three hundred twenty-one respondents (23%) demonstrated a high burnout risk without a concomitant increase in the HANDS score, consistent with an increased risk of a depressive episode. Fifty-eight residents (4%) screened positive for a depressive episode and 764 (56%) were classified as low risk of burnout and/or depression based on the survey responses.

Secondary Analysis—Association of Burnout and Depression Risk with Best Practice Characteristics and Self-Reported Error Rates

Distributions of the responses to the 10 questions evaluating the best practice of anesthesiology are shown in Table 4. A summated scale based on 6 of the 10 questions that accounted for 63% of the variance in the questions regarding

Table 2. Logistic Regression Models for Burnout and Depression Risk

	Value	β	Odds ratio (99% CI)	P
Burnout risk				
Gender	Female	0.38	1.47 (1.06–2.03)	0.002
Call frequency (days between calls)	>5 d	−0.49	0.62 (0.44–0.86)	<0.001
Work hours per week by	>70 h	0.95	2.58 (2.09–3.19)	<0.001
Average drinks per week	≥5 drinks			
Work hours per week by	>70 per week	−0.27	0.77 (0.63–0.93)	<0.001
Average drinks per week by	≥5 drinks			
Marital status	Married			
Constant		−1.56	0.21	
Depression risk				
Work hours per week	>70 per week	1.07	2.90 (1.87–4.50)	<0.001
Gender	Female	0.79	2.20 (1.47–3.28)	<0.001
Marital status	Married	−0.80	0.45 (0.29–0.67)	<0.001
Call frequency (days between calls)	>5 d	−0.49	0.61 (0.39–0.95)	0.004
Work hours per week by	>70 per week	0.29	1.34 (1.14–1.57)	<0.0001
Do you smoke by	No			
Gender by	Female			
Average drinks per week	≥5 drinks			
Constant		−2.93	0.05	

CI = confidence interval.

anesthesia best practice was identified by factor analysis (Table 5). Spearman correlation of the summated Likert scores with the regression-calculated factor scores for the questions in the model was 0.995 (99% CI, 0.993–0.996). The final model was validated by split-sample validation with similar communalities and factor loading for all variables in the model. Internal consistency of the items in the summated scale was demonstrated by Cronbach α = 0.88. The summary corrected interitem correlation coefficient was 0.55 (range, 0.41–0.74).

Summated best practice scores among the burnout and depression groups are shown in Figure 3. The median differences in safety scores for residents at high risk of burnout and depression was −5 points (99.6% CI, −3 to −6; $P < 0.001$) lower than that of residents at low risk for burnout or depression, −2 points (99.6% CI, −1 to −4; $P < 0.001$) lower than that of residents at high risk of burnout only, and −4 points (99.6% CI, −1 to −8; $P < 0.001$) lower than that of residents at high risk of depression only. The median differences in safety scores for residents at high risk of burnout only were −2 points (99.6% CI, −1 to −2; $P < 0.001$) lower than for residents at low risk for burnout or depression. The differences in summated safety scores did not achieve a difference hypothesized to represent a clinically important decrease in patient safety.

Responses to questions regarding frequency of self-reported errors are shown in Table 6. Residents exhibiting high burnout and depression risk reported more frequent medication errors, mistakes with negative consequences to patients, and less attention to patients compared with residents with high burnout or depression risk only or those at low risk of burnout and depression. Residents at high risk of burnout only also reported a higher frequency of errors and less attention to patients compared with respondents with low burnout and depression risk.

Figure 4 shows the distribution of the number of questions per respondent, to which the answers were that self-reported errors had occurred often or multiple times among the burnout and depression groups. The number of self-reported questions answered according to which errors had occurred often or multiple times was significantly associated with the HANDS total score (ρ = 0.33; 99% CI, 0.25–0.40; $P < 0.001$), as well as the emotional exhaustion (ρ = 0.39; 99% CI, 0.32–0.45; $P < 0.001$), personal accomplishment (ρ = −0.43; 99% CI, −0.49 to −0.35; $P < 0.001$), and depersonalization (ρ = 0.45; 99% CI, 0.39–0.51; $P < 0.001$) subscales of the Maslach inventory.

Summated best practice scores were inversely correlated with the number of self-reported questions answered according to which errors had occurred often or multiple times (ρ = −0.44; 99% CI, −0.51 to −0.37; $P < 0.001$), HANDS total score (ρ = −0.28; 99% CI, −0.34 to −0.21; $P < 0.001$), as well as the emotional exhaustion (ρ = −0.30; 99% CI, −0.37 to −0.22; $P < 0.001$), and depersonalization (ρ = −0.43; 99% CI, −0.49 to −0.37; $P < 0.001$) subscales of the Maslach inventory. Best practice scores were positively correlated with the personal accomplishment (ρ = 0.47; 99% CI, 0.40–0.53; $P < 0.001$) subscale of the Maslach inventory.

DISCUSSION

There are several important findings of this study. The risk of burnout in anesthesiology residents was substantial and was similar in prevalence to that of anesthesiology chairs and program directors.[7,8] The risk of burnout was lower in men, and was increased in residents who consumed more alcohol. Although individual characteristics can be

Table 3. Performance of Models Associating Respondent Characteristics with Burnout or Depression Risk

	Burnout		Depression	
	Conditional tree	Logistic regression	Conditional tree	Logistic regression
Sensitivity (%)	40 (34–45)	45 (40–51)	51 (44–58)	32 (26–40)
Specificity (%)	87 (84–90)	89 (85–91)	82 (79–85)	97 (95–98)
Positive likelihood ratio	3.1 (2.4–4.0)	3.9 (2.9–5.2)	2.8 (2.2–3.5)	9.8 (6–16)
Negative likelihood ratio	0.7 (0.6–0.8)	0.6 (0.5–0.7)	0.6 (0.5–0.7)	0.7 (0.6–0.8)
Diagnostic odds ratio	4.5 (3.1–6.3)	6.3 (4.4–9.1)	4.7 (3.3–6.7)	14.0 (8.0–24.4)
Accuracy (%)	68 (63–73)	71 (66–76)	75 (68–81)	83 (76–88)

Data presented as value (99% confidence interval).

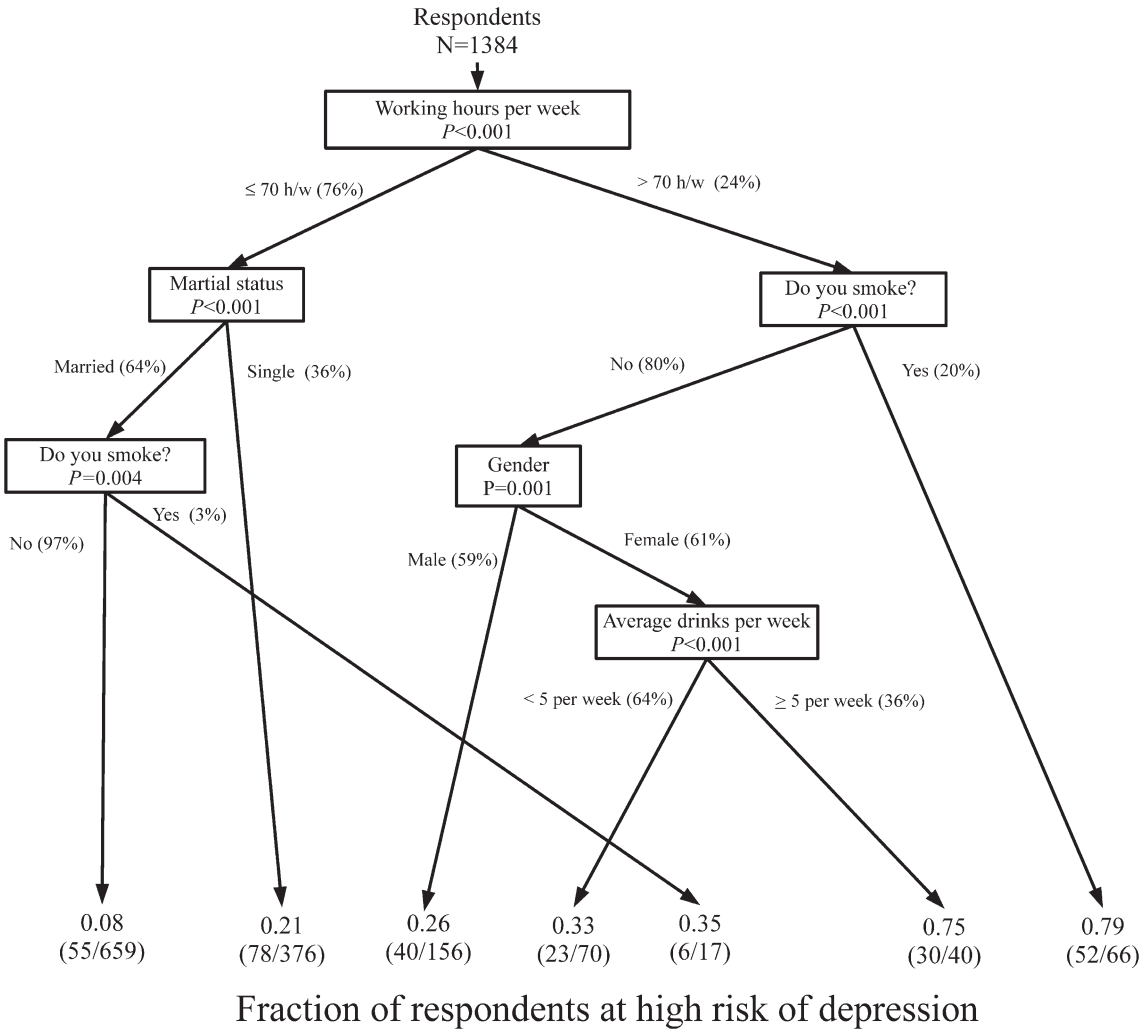

Figure 2. Classification tree for nonparametric recursive partitioning of respondents to high or low depression risk based on demographic, social, and work characteristics of anesthesiology residents. Branches to the right classify respondents likely to be at high depression risk, and those to the left classify respondents unlikely to be at high risk. Fraction of subjects with high depression risk (number of high burnout respondents/total number) listed for each terminal branch.

important to the development of burnout, work environment and job leadership are also determinant factors.[15] To protect participants' privacy, responses from our previous studies in different groups were set not to identify respondents, which restricted our ability to examine a possible association between leadership burnout (chairs and program directors) and resident burnout in anesthesiology. Nonetheless, because burnout in the workplace has been considered to be a contagious condition (it can spread to coworkers),[16] the goal to decrease the prevalence of resident burnout passes through decreasing the rates of burnout in anesthesiology chairs and program directors of academic departments.

In addition, we observed an association of burnout risk among residents with job-related pressures, including increased number of weekly working hours (>70) and a call frequency ≥1 call every 5 days. These results are supported by previous studies on burnout in other health care providers[17] who defined the syndrome as a result of increased workload leading to prolonged occupational stress.[18] It is conceivable that by reducing working hours and call frequency, the incidence of burnout among anesthesiology trainees may be reduced. Businger et al.[19] demonstrated an improvement in quality of life of surgical residents when their training was limited to a 50-hour workweek. However, the improvement in the residents' quality of life has been accompanied by a perceived negative effect on professional training. Therefore, it is important to achieve a balance between anesthesiology resident well-being and its effect on clinical training.

We also observed a high incidence of depression risk (22%) among anesthesiology residents. Our findings represent a 1.8-fold higher prevalence of a positive screen for a major depression episode among anesthesiology residents compared with the 12-month and only 8% lower than the lifetime screen positive rate that has been reported for the general US population.[20] Although younger physicians and medical students have been reported to have a higher incidence of suicidal ideation,[21] the rate of suicidal ideations observed in this study was more than twice the age-adjusted rate observed in developed countries 2.0% (99% CI, 1.7–2.2).[22] Our findings regarding the role of gender in the

Table 4. Response Distribution to Individual Questions Evaluating Resident's Practice of Anesthesiology

Individual positive items	Likert scale, *n* (% of row)				
	Never	Rarely	Sometimes	Often	Always
Visits patients preoperatively	18 (1)	109 (8)	189 (14)	320 (24)	720 (53)
Checks blood results preoperatively	10 (1)	93 (7)	98 (7)	323 (24)	832 (61)
Reads about the next day's surgery and patient's disease	18 (1)	168 (12)	303 (22)	387 (29)	480 (36)
Performs a complete machine check at beginning of the day	23 (2)	111 (8)	132 (10)	150 (11)	940 (69)
Checks airway equipment preoperatively	11 (1)	55 (4)	96 (7)	81 (6)	1113 (82)
Double checks medication vials for correct administration	18 (1)	93 (7)	166 (12)	350 (26)	729 (54)
Makes sure the monitor alarms are enabled	67 (5)	158 (12)	227 (17)	263 (19)	641 (47)
Confirms that surgery will be performed on correct side	28 (2)	80 (6)	168 (12)	307 (23)	773 (57)
Wears gown, gloves, and mask for spinals/ epidurals	119 (9)	90 (7)	123 (9)	104 (8)	920 (67)
Reviews postoperative chest radiography after central line placement	76 (5)	238 (18)	304 (22)	296 (22)	442 (33)

Items scored 1 = never, 2 = rarely, 3 = sometimes, 4 = often, and 5 = always.

development of depression in anesthesiology residents are in accordance with the literature examining the role of gender in the development of major depression.[23] Marital and parenthood status may be surrogates for an effective family support system, which can have protective effects against mood disorders.[24] Being single is a well-documented risk factor for suicide among depressed individuals.[25] Burnout was also an independent risk factor for suicidal ideation among American surgeons.[26] Work pressure and overnight work have also been shown to affect mood and depression in physicians.[27,28] The coexistence of mental illness or stress and substance abuse is well described.[29,30] We observed that residents who were at high risk of burnout or depression had a higher weekly alcohol consumption and were more frequently smokers than residents who were neither burned out nor depressed. Rates of substance abuse of anesthesiology residents have been reported to be higher than that of other health care providers.[31] Because substance abuse has been strongly associated with depression and burnout, it is likely that treating depression and reducing burnout in anesthesiology residents can have an important impact on reducing substance abuse among anesthesiology trainees.

An additional important finding of the current study was the association of decreased frequency of adherence to best practice principles in anesthesiology and greater prevalence of self-reported errors in residents at high risk of burnout and depression. Burnout alone was also associated with significant deviance from best practices of anesthesiology care practices compared with residents at low risk of burnout or depression. Residents who were at high risk of burnout and depression reported more medication errors, mistakes with negative consequences for patients, and less vigilance in patient monitoring than residents at lower risk of burnout or depression. Residents with high risk of burnout but not depression also reported more errors and lower quality of care than low-risk residents did.

Table 5. Principal Component Analysis of Questions Related to Best Practice of Anesthesia

Characteristics	Measure of sampling adequacy	Communality	Factor loading
Visit patient preoperatively	0.88	0.54	0.74
Check blood results preoperatively	0.85	0.74	0.86
Confirm that surgery will be performed on correct side	0.92	0.52	0.72
Double check medication vials for correct administration	0.92	0.56	0.75
Check airway equipment preoperatively	0.84	0.79	0.89
Perform a complete machine check at beginning of the day	0.88	0.62	0.79

Four questions were not retained in summated score: (1) Read about next day's surgery, (2) Make sure the monitor alarms are enabled, (3) Wear gown, gloves, and mask when performing a spinal or epidural, and (4) Review postoperative chest radiograph after central line placement. All factors demonstrated intercorrelation coefficients >0.4. The measure of sampling adequacy determined as the diagonal of the anti-image correlation matrix. Kaiser-Meyer-Olkin measure of sampling adequacy = 0.88. Bartlett test of sphericity ^{P} < 0.0005. Communalities represent the proportion of the variance in the variable explained by summated solution. Values range from 0 to 1, with value >0.5 required to remain in the model. Factor loading represents degree to which the factor contributes to the meaning of the component. Values range from 0 to 1.

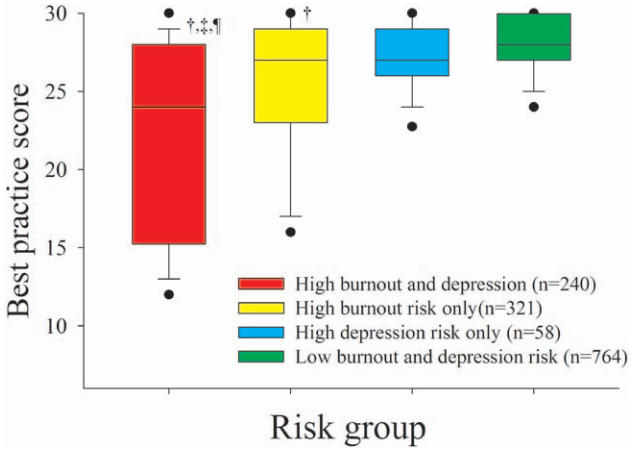

Figure 3. Box plot of best practice score among groups exhibiting burnout and depression risk. Median response is represented by the horizontal bar, and the interquartile range is depicted by the boxes. Whiskers represent the 10th and 90th percentile of the data, and circles the 5th and 95th percentile. Data were analyzed using Kruskal–Wallis *H* test. Post hoc pairwise comparisons were made using Dunn test corrected for 12 comparisons ($P < 0.004$). †Different from low burnout and depression risk group. ‡Different from high depression risk group. ¶Different from high burnout risk group.

Table 6. Anesthesiology Residents' Self-Reported Errors and Quality of Care by Risk of Burnout and/or Depression

Question	Group	Scores, median (IQR)	Distribution of responses, *n* (% of row)				
			Often	Multiple times	Sometimes	Once	Never
I make mistakes without negative consequences to patients	High burnout and depression risk	3 (2–3)[a,b,c]	17 (8)	94 (40)	100 (42)	19 (8)	5 (2)
	High burnout risk only	3 (3–3)[a]	3 (1)	68 (22)	185 (59)	46 (14)	13 (4)
	High depression risk only	3 (3–3)	0 (0)	5 (9)	36 (62)	16 (28)	1 (1)
	Low burnout and depression risk	3 (3–4)	7 (1)	42 (6)	400 (54)	183 (25)	105 (14)
I perform procedures without appropriate training	High burnout and depression risk	3 (2–4)[a,b,c]	27 (12)	70 (29)	45 (17)	24 (10)	71 (32)
	High burnout risk only	4 (3–5)[a]	3 (1)	43 (14)	79 (25)	38 (12)	152 (48)
	High depression risk only	4.5 (4–5)	0 (0)	2 (3)	15 (26)	8 (14)	33 (57)
	Low burnout and depression risk	5 (4–5)	2 (1)	9 (1)	105 (14)	95 (13)	526 (71)
I make mistakes with negative consequences to patients	High burnout and depression risk	3 (2–4)[a,b,c]	7 (3)	67 (29)	56 (24)	54 (23)	50 (21)
	High burnout risk only	5 (3–5)[a]	2 (1)	25 (8)	94 (30)	88 (28)	105 (33)
	High depression risk only	5 (3–5)	1 (2)	0 (0)	13 (22)	16 (28)	28 (48)
	Low burnout and depression risk	5 (4–5)	0 (0)	3 (1)	101 (13)	208 (28)	427 (58)
I fall short in the quality of care I provide to my patients	High burnout and depression risk	3 (2–4)[a,b,c]	17 (7)	67 (28)	78 (33)	32 (14)	43 (18)
	High burnout risk only	3 (3–5)[a,b]	4 (1)	43 (14)	110 (35)	73 (23)	83 (27)
	High depression risk only	4 (3–5)	1 (2)	1 (2)	17 (29)	15 (26)	24 (41)
	Low burnout and depression risk	5 (4–5)	1 (0)	8 (1)	148 (20)	151 (21)	425 (58)
I do not have enough time or attention for my patients	High burnout and depression risk	2 (2–3)[a,b,c]	35 (15)	91 (38)	68 (29)	16 (7)	26 (11)
	High burnout risk only	3 (2–4)[a]	17 (5)	73 (23)	116 (37)	37 (12)	72 (23)
	High depression risk only	3 (2.5–5)[a]	3 (5)	10 (18)	17 (30)	6 (10)	21 (37)
	Low burnout and depression risk	5 (3–5)	9 (1)	43 (6)	174 (24)	104 (14)	406 (55)
I do not monitor the patient in the operating room as closely as I should	High burnout and depression risk	3 (2–5)[a,b,c]	29 (12)	63 (27)	47 (20)	27 (12)	69 (29)
	High burnout risk only	4 (3–5)[a]	7 (2)	44 (14)	79 (25)	49 (16)	135 (43)
	High depression risk only	5 (3.5–5)	1 (2)	2 (4)	11 (19)	11 (19)	32 (56)
	Low burnout and depression risk	5 (4–5)	4 (1)	9 (1)	133 (18)	114 (16)	473 (64)
I have made medication errors involving the wrong drug or dose in the last year	High burnout and depression risk	3 (2–4)[a,b,c]	6 (2)	71 (30)	54 (23)	56 (24)	50 (21)
	High burnout risk only	4 (3–5)[a]	2 (1)	26 (8)	91 (29)	93 (29)	103 (33)
	High depression risk only	4 (3–5)	0 (0)	2 (3)	13 (22)	20 (35)	23 (40)
	Low burnout and depression risk	4 (4–5)	1 (0)	4 (1)	114 (15)	258 (35)	360 (49)

Data are presented as median (interquartile range [IQR]) and *n* (% of row). Data were analyzed using Kruskal–Wallis *H* test. Post hoc pair wise comparisons were made using Dunn test corrected for 12 comparisons ($P < 0.004$).

[a] Different from low burnout and depression risk group.

[b] Different from high depression risk only group.

[c] Different from high burnout risk only group.

Although the median difference in summated best practice scores in the high risk for burnout and depression or the burnout-only groups were less than we hypothesized would be clinically important, there were several patterns of practice reported by anesthesiology residents at risk for burnout with or without concomitant depression, which were raised concern for the safety of perioperative patients (Fig. 5). Residents at high burnout and depression risk reported a median value for visiting patients preoperatively, reading about the next day's surgery and disease, enabling monitor and alarms, and reviewing postoperative radiographs after central line placement only some of the time compared with median values of always or often by respondents at low risk of burnout and/or depression. In addition, respondents at high burnout risk with or without a high depression risk reported a median value for double checking medical vials for correct administration often compared with a median value of always for residents at low risk of burnout. As double checking of medication vials should ideally be performed before any drug administration, this behavior added to the propitious environment for medication errors created by current drug shortages might be a serious risk to patients undergoing surgical procedures.[32] Finally, residents at high risk of burnout and depression risk reported performing a complete anesthesia machine check only often which, in cases of machine failure, could cause serious consequences to anesthetized patients such as respiratory failure and awareness of the surgical procedure.

Resident burnout has been associated with problematic patient care in other medical specialties.[33] Shanafelt et al.[34] evaluating internal medicine residents demonstrated that burnout was associated with suboptimal patient care practices. Staff burnout has also been associated with lower patient satisfaction, which often reflects in suboptimal patient care.[35] There are also physiological consequences of burnout and depression. Stress and depression have been associated with cognitive dysfunction.[36,37] Burnout has been associated with impairment in visual attention.[38] The impact of burnout on visual attention might have an important role in anesthesia safety due to the significance of anesthesiologists' vigilance in preventing errors.[39,40] Although our findings are limited by the self-reported nature of the error evaluation, depression has been associated with an increase in observed errors in pediatric residents.[41] It has also been demonstrated that among internal medicine residents, higher levels of fatigue and distress are independently associated with self-perceived medical errors.[42] Nonetheless, it is possible that residents at high risk of burnout and depression may commit the same amount of errors as nonaffected residents but they are more likely to report them. Future prospective studies evaluating the effect of anesthesiology resident burnout and depression

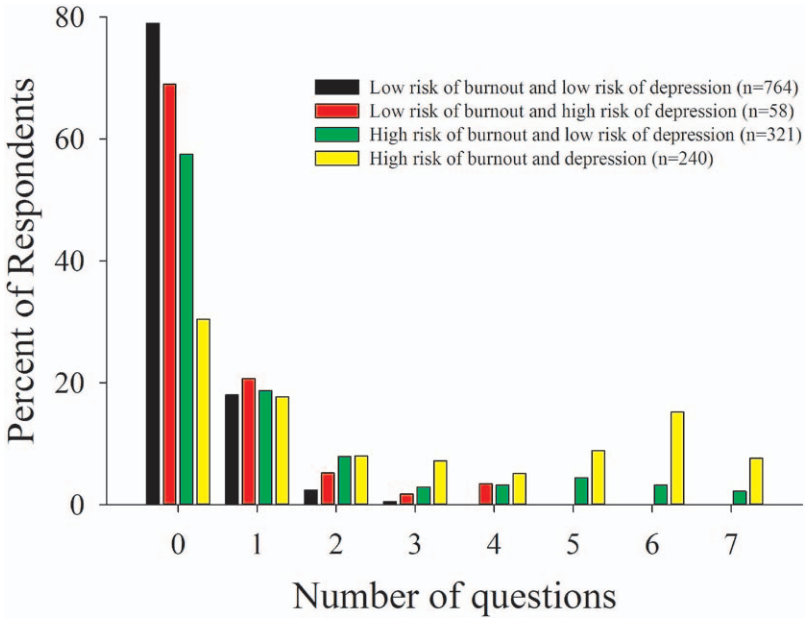

Figure 4. Histogram of the questions regarding the frequency of self-reported errors and quality of care answered as having occurred often or multiple times. Only 0.5% of respondents at low risk of burnout or depression reported errors multiple times or often on ≥3 of the 7 questions. In contrast, 16% of respondents exhibiting high burnout risk only reported errors on ≥3 questions, difference 15% (99% confidence interval [CI] of difference, 10%–21%; $P < 0.0001$). Forty-three percent of resident respondents at high risk of burnout and depression risk reported errors multiple times or often on ≥3 of 7 questions compared with 16% of respondents with high burnout risk only, difference 27% (99% CI of difference, 18%–37%; $P < 0.001$), and a difference of 43% (99% CI of the difference, 34%–52%; $P < 0.001$) compared with respondents at low burnout and depression risk.

on the incidence of medical errors to confirm our findings are needed.

Other specialties have examined the association between reported medical errors and job-related stress after medical training years. Williams et al.[43] reported more medical errors and suboptimal patient care among primary care physicians exhibiting burnout. Shanafelt et al.[44] also reported that major medical errors reported by surgeons are strongly related to a surgeon's degree of burnout and his or her quality of life. These studies suggest the need for future investigations evaluating the prevalence of burnout among practicing anesthesiologists who have completed medical training.

Although trainees seem to be the group most affected by burnout among clinicians, it is often difficult to identify the affected resident. Previous studies have found conflicting results between the association of residents' well-being and medical knowledge.[45,46] The first step to mitigate the current problem is to increase efforts by residency programs across the country to diagnose residents who are affected as well as those who are at risk. This might require confidential psychological or psychiatric professional screening interviews. The high suicidal ideation among anesthesiology residents observed in the current study as well as the possible negative consequences to patient care and safety suggests that this intervention is worthy with

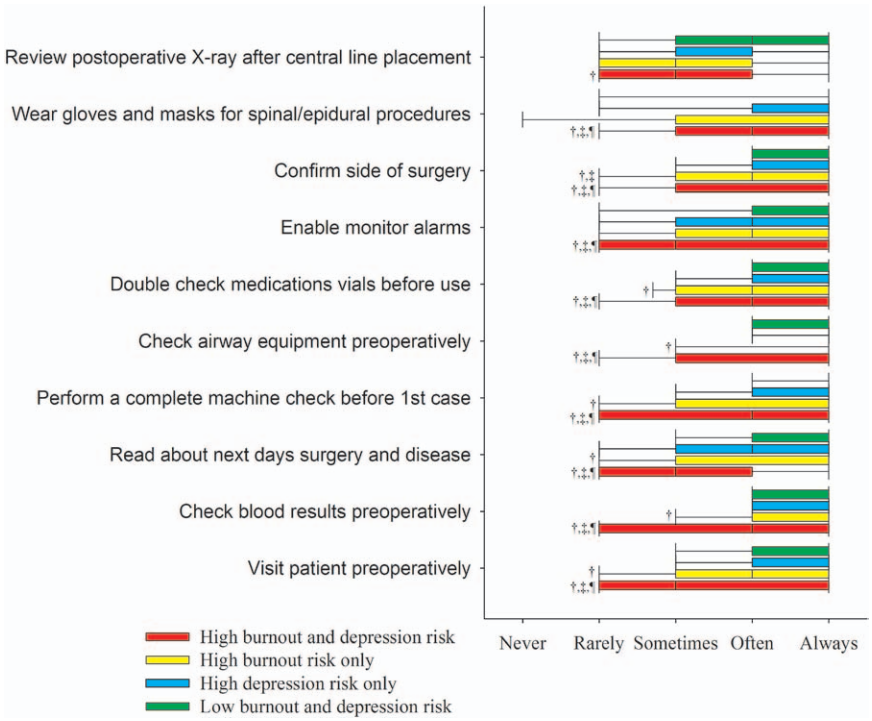

Figure 5. Box plots of response to questions evaluating best practice of anesthesiology. Median response is represented by the vertical bar, and the interquartile range is depicted by the boxes. Whiskers represent the 10th and 90th percentile of the data. Data were analyzed using Kruskal–Wallis *H* test. Post hoc pairwise comparisons were made using Dunn test corrected for 12 comparisons ($P < 0.004$). †Different from low burnout and depression risk group. ‡Different from high depression risk group. ¶Different from high burnout risk group.

regard to not only residents' health but also patients who are under the care of anesthesiology trainees.

Besides reducing residents' environmental stressors and workload, individual approaches can also be helpful in reducing burnout. McCue and Sachs[47] demonstrated that resident physicians who have learned stress-management techniques decreased their subscale score on depersonalization and emotional exhaustion. Promoting some degree of control over professional life has been demonstrated to be protective against burnout in other anesthesiologists groups,[7,8] and may be also effective for anesthesiology residents.

Our study is only valid when interpreted within the context of its limitations. The surveys were self-reported and might not represent actual behaviors. We evaluated a group of demographic, social, and work-related characteristics that have been examined in prior studies, but factors such as race, examination scores, birth order, perceived support structure, or other stressors that could affect the work–life balance, which were not considered in this study, may play a more important role than those examined. The study did not assess the frequency of errors performed by the respondents but rather their responses as stated. The questionnaires were also not completed in a controlled setting. Although response bias is always a concern in cross-sectional questionnaire studies attempting to determine the prevalence of morbidities, the size of the population we surveyed and the response rate we obtained allows us to attest a statistical precision of 99% ± 2.4%, suggesting the validity of our findings. In addition, the characteristics of a follow-up sample of initial nonrespondents did not significantly differ from characteristics of initial respondents, suggesting the absence of response bias.

In conclusion, burnout, depression, and suicidal ideation are very frequent among anesthesiology residents. Besides effects on trainees' health due to its association with high-risk behaviors (smoking and alcohol), burnout and depression may also affect patient care and safety. Anesthesiology residents are the future of our specialty; therefore, it is imperative that individual programs as well as anesthesiology societies recognize burnout and depression as a frequent problem in anesthesiology trainees and take prompt action to address them.

DISCLOSURES

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