

## Work and Rest Cycles in Anesthesia Practice

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A questionnaire inquiring about existing and desirable work and rest patterns appeared in a newsletter mailed to about 22,000 anesthesiologists and anesthesiology residents and 24,000 nurse anesthetists (CRNA). Almost 3,000 anonymous replies were received and analyzed. Respondents reported mean work weeks of 47.5 h (CRNA) to 69.8 h (residents), longest continuous period of administering anesthesia without a break of 6.6 h (CRNA) to 7.7 h (residents), and longest period of administering anesthesia with or without breaks of 14.1 h (CRNA) to 20 h (resident). However, the respondents considered it safe to administer anesthesia without a break for 4.2 (CRNA) to 5.2 h (anesthesiologists) and with break for 12.8 h (CRNA) to 15 h (residents). A substantial number of respondents believed that they work at least occasionally beyond their perceived self-limitations. The majority of respondents recalled having made errors in the administration of anesthesia that they attributed to fatigue. These results may not be representative of work patterns or attitudes among American anesthesia providers because of the small sample size and the resultant potential for bias. Yet, the subject deserves attention and further study because fatigue can affect professional performance, ability to learn, and family life. (Key words: Anesthesiologists, nurse anesthetists, residents: fatigue; performance. Complications: accidents. Survey.)

CONCERN about the effects of fatigue on the performance of personnel engaged in hazardous activities has led to the establishment of rules regulating the work and rest patterns in several professions. Perhaps best known are the rules governing commercial airline pilots' work hours,<sup>§</sup> but other workers are also governed by such rules, for instance, truck drivers, maritime personnel, and railroad crews.<sup>¶\*\*††</sup> Rules promulgated by the state of New

York govern the work/rest patterns of house staff and emergency room physicians.<sup>‡‡</sup>

The literature offers little objective data relating work patterns to fatigue-induced errors of pilots, truck drivers, seamen, railroad crews, or physicians. Nevertheless, many intuitively suspect that fatigue of the kind produced by the workload and scheduling commonly experienced by anesthesia clinicians may adversely affect the quality of their performance.<sup>1,2</sup> When and under what circumstances fatigue has this effect remain to be established. Although many studies address the issues surrounding fatigue, sleep deprivation, and vigilance among medical personnel, there is little consensus.<sup>1-14</sup> §§ Two recent studies did not demonstrate decreased performance of physicians deprived of sleep by current on-call practices in American residency training programs.<sup>15,16</sup> The rules promulgated in New York and under consideration in California<sup>¶¶</sup> appear subjectively based. Given the public and professional interest in work/rest patterns of health care professionals, we wished to define the existing work patterns of American anesthesiologists, resident anesthesiologists (residents), and certified registered nurse anesthetists (CRNA).

### Methods

A ten-question survey was prepared (fig. 1) and reproduced in the June 1988 newsletter of the Anesthesia Patient Safety Foundation with a preaddressed, stamped mailer addressed to the Division of Biostatistics at the University of Florida. The quarterly newsletter is distributed to approximately 22,000 anesthesiologists and residents and 24,000 CRNA in the United States, which is approximately 90% of all such personnel. The newsletter included a brief statement of the objective of the survey with a request that the reader complete and mail the questionnaire, based on his or her practice during the first half of 1988. By September 13, 1988, 2,713 questionnaires had been returned and were subjected to analysis.<sup>\*\*\*</sup> After this arbitrary deadline, an additional 264

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§ Federal Aviation Administration, Department of Transportation, Code of Federal Regulation (CFR) Title 14, Parts 121.470-121.490 and 135.261-135.269

¶ Federal Highway Administration, Department of Transportation, CFR Part 395

\*\* Coast Guard, Department of Transportation, CFR Title 49, Subpart 157.20-10

†† Federal Railroad Administration, Department of Transportation, Title 49, Subpart B, 228.7, Appendix A

‡‡ State of New York, Official Compilation of Codes, Rules, and Regulations of the State of New York, Chapter 5 (Health), Subchapter A, Part 405.4, 1989

§§ Wallace-Barnhill GL, Florez G, Turndorf H, Craythorne NWB: The effect of 24 hour duty on the performance of residents on vigilance, mood and memory tasks (abstract). ANESTHESIOLOGY 59:A460, 1983

¶¶ Assembly Bill 4679, California Legislature, 1988

\*\*\* Rao PV, Linda SB: Survey on Fatigue and Work Practices of Anesthesia Practitioners: Statistical Analyses (Report to the University

SURVEY OF ANESTHESIA WORK/REST POLICIES

Instructions: Please answer the following questions as they apply to you personally. Return the completed survey by folding and sealing so that the printed address on the back is visible.

1. After how many continuous hours of administering anesthesia do you need a break or short rest in order to remain safe? \_\_\_\_\_ hours
2. Assuming you were able to take brief rest periods (breaks), for how many hours per day can you, personally, safely administer anesthesia? \_\_\_\_\_ hours
3. During the past 6 months, what is the longest continuous period that you have personally administered anesthesia without a break? \_\_\_\_\_ hours
4. During the past 6 months, what is the longest period (with or without breaks) that you have personally administered anesthesia? \_\_\_\_\_ hours
5. Does your department/institution have regulations or recommendations that limit how long you work without a long rest? (Check appropriate box) NO  YES   
 If you answer "Yes" to question 5 above please check the appropriate box below.  
 Day off after night on call  
 Work part-day after night on call  
 Other (please explain below) \_\_\_\_\_
6. Does your department/institution limit the total hours you may work per day or per week? (Check appropriate box) NO  YES   
 If you answer "Yes" to question 6 above please complete the appropriate space below.  
 \_\_\_\_\_ Maximum hours per day  
 \_\_\_\_\_ Maximum hours per week
7. Does your department/institution permit or encourage periodic breaks during work days? (Check appropriate box) NO  YES   
 If you answer "Yes" to question 7 above please check the appropriate box below  
 a. Are breaks permitted? NO  YES  Don't Know   
 b. Are breaks encouraged? NO  YES  Don't Know   
 c. Is there a limit on maximum time between breaks? NO  YES  Don't Know   
 If you answer "Yes" to (c) above please complete the appropriate spaces below  
 Limit on maximum time between breaks. \_\_\_\_\_ hours  
 Length of time of breaks. \_\_\_\_\_ minutes
8. Can you recall having made an error in clinical management which you attribute to fatigue? NO  YES
9. Please tell us about you and your practice:  
 a. My age \_\_\_\_\_ years  
 b. My gender MALE  FEMALE   
 c. Professional hours in my typical week \_\_\_\_\_ hours  
 d. ZIP code of principal place of practice \_\_\_\_\_  
 e. I am a(n): (Please check appropriate box)  
 Anesthesiologist  Anesthesiology Resident  Nurse Anesthetist  Nurse Anesthesia Student
10. Is your income directly related to the number of anesthetics you personally administer or supervise? NO  YES

FIG. 1. Through the Anesthesia Patient Safety Foundation Newsletter, this questionnaire was mailed to 90% of American anesthesiologists, anesthesiology residents, and certified registered nurse anesthetists.

questionnaires were received. These were compared with those that had already been analyzed and were found to be generally similar to the predeadline group. (We de-

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cided against including them in the analysis because they would not have altered the findings but would have added considerable expense.) Assuming that 22,000 anesthesiologists and residents and 24,000 CRNA did receive the questionnaire, the total response was about 6.5%.

Chi-square analysis tested the association among categorical variables, and logistic regression analyses modeled the probability that a response would be in a specific category as a function of explanatory variables. Quantitative

TABLE 1. Respondents Classified According to Gender and Job

Job Category	Gender	Frequency	Percent
Anesthesiologist	Female	230	9
	Male	1,156	43
Resident	Female	42	2
	Male	123	5
CRNA	Female	624	23
	Male	485	18

variables were analyzed by analysis of variance (ANOVA), the Wilcoxon rank-sum test, or the Kruskal-Wallis test. The assumptions for the ANOVA were checked, and where assumptions did not appear reasonable either a satisfactory transformation was found or nonparametric methods were used.  $P < 0.05$  was considered statistically significant.

### Results

#### DEMOGRAPHICS OF RESPONDENTS

The job category and gender of the respondents are shown in table 1. To examine possible bias in the sample, the age, gender, and geographical distribution of the respondents were compared with those of members of the American Society of Anesthesiologists (ASA). Although the gender distribution of respondents did not differ from that of the ASA, respondents underrepresented those younger than the age of 33 yr ( $P = 0.0005$ ) and overrepresented those older than the age of 48 yr ( $P = 0.0274$ ), with intermediate age grouping being similar to that of the ASA. Respondents underrepresented the Northeast and overrepresented the West ( $P < 0.0001$ ); however, distributions in other regions were similar to ASA distributions. Because we lacked data on the universe of CRNA, a comparable analysis of CRNA respondents was not performed.

#### REPORTED DURATION OF WORK

Residents reported substantially longer work weeks than anesthesiologists, who reported longer work weeks than CRNA (table 2). The longest continuous period that respondents had administered anesthesia without a break

during the study period was 4.5 h (25% quartile) to 8 h (75% quartile), 6 h being the median. Significant differences existed between job category and age. The period of uninterrupted administration of anesthesia was greater for anesthesiologists and residents than for CRNA ( $P < 0.03$ ) and for men than for women ( $P < 0.02$ ; table 3); also, the older the clinician, the shorter the period of uninterrupted administration ( $P < 0.05$ ).

During the study period, the longest periods of anesthesia administered with an occasional break by the respondents were 8 h (25% quartile) to 21 h (75% quartile), 14 h being the median. Residents reported significantly longer hours than anesthesiologists ( $P < 0.0001$ ) and CRNA ( $P < 0.0001$ ), and anesthesiologists reported longer hours than CRNA ( $P < 0.04$ ; table 4).

#### LIMITS TO WORK

The majority of respondents (59%) reported that their department or institution did not limit the length of work without a long rest. Anesthesiologists, residents, and CRNA reported overwhelmingly (94%) that there were no limits on the number of hours worked per day or per week. The respondents believed they could safely work without a break (rest) for 3 h (25% quartile) to 5.5 h (75% quartile), with a median of 4 h. Older men cited fewer hours than younger men ( $P < 0.0001$ ), but women's hours reported did not vary by age. Anesthesiologists cited longer hours than residents ( $P < 0.03$ ) and CRNA ( $P < 0.0001$ ), and residents reported longer hours than CRNA ( $P < 0.07$ ; table 5).

The respondents believed a safe workday including breaks would be 10 h (25% quartile) to 16 h (75% quartile) with a median of 12 h. CRNA suggested a shorter workday than either anesthesiologists ( $P < 0.0001$ ) or residents ( $P < 0.02$ ). The number of suggested hours decreased with age for both men and women ( $P < 0.006$ ), but the trend was more marked in men than women ( $P < 0.0001$ ; table 6).

Although 54% of the anesthesiologists and 9% of the CRNA reported that their income depended on the number of hours worked, only 1% of the residents reported such a relationship. The differences among the groups were significant ( $P < 0.0042$  to  $0.0001$ ).

TABLE 2. Professional Hours in a Typical Week, by Gender and Job

Job Category	Female	Male	Both Genders
Anesthesiologist	53.8 ± 1.03 (218)	56.5 ± 0.40 (1,106)	56.0 ± 0.38 (1,324)
Resident	67.3 ± 2.59 (38)	70.7 ± 1.38 (117)	69.8 ± 1.22 (155)
CRNA	46.2 ± 0.56 (597)	49.2 ± 0.68 (468)	47.5 ± 0.44 (1,065)
All categories	49.1 ± 0.52 (853)	55.5 ± 0.36 (1,691)	53.3 ± 0.30 (2,544)

Values are mean ± SEM; n values are given in parentheses.

TABLE 3. Summary Statistics for Longest Continuous Period of Administering Anesthesia Without Break, by Gender and Job

Job Category	Female	Male	Both Genders
Anesthesiologist	7.3 ± 0.37 (219)	7.7 ± 0.16 (1,128)	7.6 ± 0.15 (1,347)
Resident	8.1 ± 0.80 (40)	7.6 ± 0.38 (123)	7.7 ± 0.35 (163)
CRNA	6.4 ± 0.14 (612)	6.8 ± 0.17 (483)	6.6 ± 0.11 (1,095)
All categories	6.7 ± 0.14 (871)	7.4 ± 0.12 (1,734)	7.2 ± 0.09 (2,605)

Values in hours are mean ± SEM; n values are given in parentheses.

### FATIGUE-INDUCED ERRORS

In response to the question, "Were errors in anesthetic administration attributed to fatigue?" 61% said, "Yes" (table 7). There was no difference in the proportion of men answering "yes" among job classifications. However, among women, CRNA responded "yes" less frequently than did anesthesiologists ( $P < 0.0002$ ) or residents ( $P < 0.047$ ). Female CRNA responded "yes" less frequently than did their male counterparts ( $P < 0.0001$ ).

### Discussion

We cannot infer that this survey represents an accurate picture of work/rest patterns in anesthesia in the United States because of the low response rate (approximately 6.5% of distributed questionnaires). Given that the survey form had been stapled within a newsletter and many of those on the mailing list may not have opened the newsletter, the response rate is uncertain; the low response rate we report is the most conservative estimate. It is likely that those with a specific interest in this topic were more likely to respond. In addition, practice patterns may have influenced the response. For example, anesthesiologists and CRNA receiving fees for service may view long working hours differently than residents or others on fixed incomes. Because the survey was anonymous, we could not improve the response rate with a second mailing or verify the responses; nor do we have data to indicate how accurately the respondents reported their hours of work. Of 38 forms that contained unsolicited comments about the study, 25 expressed favor for the survey, reported a personal experience or problem with fatigue or relief, or indicated concern about this issue. Four expressed negative feelings toward the survey (*e.g.*, "You write as though you think we are shift workers.").

Despite the limited response and a potential bias, the results deserve attention because they reflect patterns and opinions of a section of the anesthesia community. We have no data on the actual frequency of errors made, regardless of whether attributed to fatigue. One narrow view would suggest that some errors were not recognized by the respondents.

Female CRNA reported making fatigue-related errors significantly less frequently than did the other five categories (50% *vs.* 63%). Female CRNA also experienced shorter time of continuous work without a break, *i.e.*, 6.35 h, compared with 6.8 h to 8.1 h reported by the other groups. Female CRNA reported working shorter periods with or without a break (13.9 h) than did male CRNA (14.4 h) and anesthesiologists (16 h). Whether these differences were the result of sampling bias or indicate that practitioners who work longer than their personal safe limit make more clinical errors is unknown.

We note several disturbing findings. A substantial number of respondents (73.6%) worked a greater stretch between breaks than they thought was safe at least once during the 6-month study period. Some individuals worked extremely long stretches: 61 of the 2,645 reported working for 36 h or more at least once. Eighteen per cent of respondents apparently work where breaks are not permitted.

There is no evidence from the literature to support the belief that adverse anesthesia-related outcomes are often linked to fatigue. There is a large body of literature on the effects of sleep deprivation and performance based on laboratory and field studies, but the reality of laboratory settings in which vigilance studies are typically conducted and that of actual work settings differ substantially. Controversy exists over how well vigilance experiments apply to real work situations.<sup>17</sup> Nevertheless, there appear

TABLE 4. Summary Statistics for Longest Period of Administering Anesthesia with or Without Break, by Gender and Job

Job Category	Females	Males	Both Genders
Anesthesiologist	15.5 ± 0.60 (220)	15.6 ± 0.27 (1,125)	15.6 ± 0.25 (1,345)
Resident	19.9 ± 1.25 (41)	20.1 ± 0.61 (122)	20.0 ± 0.55 (163)
CRNA	13.9 ± 0.28 (608)	14.4 ± 0.37 (482)	14.1 ± 0.23 (1,090)
All categories	14.6 ± 0.26 (869)	15.6 ± 0.21 (1,729)	15.3 ± 0.17 (2,598)

Values in hours are mean ± SEM; n values are given in parentheses.

TABLE 5. Hours a Practitioner Can Safely Work Without Rest (Self-Reported), by Gender and Job

Job Categories	Female	Male	Both Genders
Anesthesiologist	4.9 ± 0.17 (221)	5.2 ± 0.11 (1,131)	5.2 ± 0.09 (1,352)
Resident	4.8 ± 0.39 (41)	4.6 ± 0.20 (123)	4.6 ± 0.18 (164)
CRNA	4.1 ± 0.08 (609)	4.2 ± 0.10 (481)	4.2 ± 0.06 (1,090)
All categories	4.3 ± 0.08 (871)	4.9 ± 0.08 (1,735)	4.7 ± 0.06 (2,606)

Values are mean ± SEM; n values are given in parentheses.

to be some generally accepted beliefs that can be applied to anesthesia. We summarize some of the most applicable issues addressed in two pertinent reviews.<sup>2,18</sup>

On average, performance of some tasks begins to decrease after 18 h<sup>19</sup> and becomes substantially worse after 24 and 36 h. It is also affected by the circadian rhythm in which a trough of performance has been identified from approximately 4 A.M. to 6 A.M. In making decisions about work/rest policies, it is important to recognize that some people can withstand the rigors of long work hours better than others.

When performance is affected by sleep deprivation or fatigue, the greatest decrease is in the immediate recall of information, short-term and long-term memory, reasoning, and the time for completion of tasks requiring reasoning. Arousal is decreased with sleep deprivation, and short periods of "micro sleep" may occur. Thus, an unevenness in performance seems to result from sleep deprivation. The degree to which this occurs during a 24-h period of continuous work is not well established, however. Nor do we have information on the cumulative effect of repeated sleep deprivation, as occurs in some training programs with residents on duty every second or third night without compensatory rest periods.

The scientific evidence about the usefulness of periodic breaks in improving vigilance or reducing errors is unclear. Cooper recently reviewed the literature on the subject and applied evidence from critical incidents studies in anesthesia to conclude that a policy of periodic breaks for anesthesiologists and CRNA probably produces a safer work environment than a policy of prohibiting such rest periods.<sup>20</sup>

We have demonstrated that a substantial subset of American anesthesiologists and CRNA believe that, at least occasionally, they work beyond their perceived self-

limitations and they have made errors that they ascribe to fatigue. We cannot conceive of a study that would confirm or reject a hypothesis that links fatigue or sleep deprivation to serious adverse outcome. No sound scientific data exist that allow us to determine optimal work hours.

These preliminary findings could be enhanced by a similar survey of a randomized subset of all anesthesiologists and CRNA. A targeted critical incident study aimed at detailed accounts of fatigue-induced adverse outcomes might also be productive. Further studies of the effects of fatigue on performance, particularly those using realistic simulation environments, may better define which effects of anesthesia management are most jeopardized by fatigue or sleep deprivation. The clinical relevance of such laboratory studies will always be open to criticism though and still may not be useful for establishing work/rest policies or guidelines.

Despite the recent actions limiting continuous work hours of physicians in some jurisdictions, no evidence suggests that this will reduce the number of errors or adverse outcomes. Caution must be exercised before substituting one perceived hazardous situation for another that could be equally or more hazardous. Indeed, replacing long stretches of work with shift work has its own inherent dangers. Changing shift work patterns, *e.g.*, rotating from day to evening to night shifts, substantially affects mood, morale, and possibly performance.<sup>21</sup>

Anesthesia departments or groups of practitioners should examine the policies that govern their work patterns. We cannot offer specific recommendations based on the results of this survey. Other evidence encourages breaks according to individual needs. For instance, a 4-h work period is accepted in many industries. Establishing an upper limit on the number of continuous hours or work should be considered. A recuperative period fol-

TABLE 6. Hours of Administration of Anesthesia with Rest Periods Considered Safe, by Gender and Job

Job Categories	Female	Male	Both Genders
Anesthesiologist	13.8 ± 0.32 (222)	14.0 ± 0.14 (1,135)	13.9 ± 0.13 (1,357)
Resident	14.2 ± 0.77 (41)	15.2 ± 0.43 (123)	15.0 ± 0.37 (164)
CRNA	12.7 ± 0.18 (611)	12.8 ± 0.19 (481)	12.8 ± 0.13 (1,092)
All categories	13.0 ± 0.15 (874)	13.8 ± 0.11 (1,739)	13.5 ± 0.09 (2,613)

Values are mean ± SEM; n values are given in parentheses.

TABLE 7. Frequency with Which Respondents Attributed an Error in Anesthetic Administration to Fatigue, by Gender and Job

Job Categories	Gender	Frequency	Percent
Anesthesiologist	Female	141	64
	Male	739	65
Resident	Female	27	66
	Male	78	65
CRNA	Female	297	50
	Male	293	62

lowing a 24-h rotation seems sensible. In addition, based on his interpretation of the literature, Parker has made some specific suggestions (some of which may be overly restrictive and costly to implement): breaks following a 2-h stretch in cases lasting more than 3 h, at least 12 h of recovery time following a 16-h workday, and at least a 24-h recovery period following 24 h on call.<sup>2</sup> A nap during the late afternoon or early evening hours may also be useful for improving performance during the last 8-h stretch of a 24-h on-call period. No one will argue that extreme fatigue is bound to affect performance. The unique circumstances of medical practice, the physician-patient relationship, and the need to provide continuity of care make it inadvisable to establish rigid rules on work hours. Yet, we must recognize that we are all subject to influences that may impair our performance. One of these influences is fatigue.

Safe clinical practice is not the only issue when considering the implications of fatigue. In residency training programs, it is likely that learning suffers under conditions of sleep deprivation. The mood, morale, and family life of practitioners may also be adversely affected.

Given these considerations, attention to the problem of fatigue and sleep deprivation in anesthesia warrants further consideration and action to minimize its detrimental effects.

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