SPECIAL ARTICLE

Anesthesiology
81:488–500, 1994

Production Pressure in the Work Environment

California Anesthesiologists' Attitudes and Experiences

David M. Gaba, M.D., Steven K. Howard, M.D.,† Belinda Jump, B.A.‡*

Background: **Pressure to put efficiency, output, or continued production ahead of safety has caused catastrophic accidents in various industries. The authors assessed the attitudes and experiences of anesthesiologists concerning production pressure.**

Methods: **A random, repeated-mailing survey was conducted among 647 members of the American Society of Anesthesiologists residing in California. Questions were asked about attitudes toward production pressure and other patient safety issues, frequency of occurrence of various operating room events, encounters with situations involving unsafe actions, and ratings of sources of production pressure.**

Results: **Forty-seven percent of those sampled returned surveys. The demographics of the respondent population were largely similar to those of the population of anesthesiologists in California. There was no systematic difference between the respondents to the first *versus* the second mailing, reducing (but not eliminating) the possibility of self-selection bias. Nearly half (49%) of respondents had witnessed production pressure result in what they believed to be unsafe actions by an anesthesiologist. Such events included elective surgery in patients without adequate evaluation or with significant contraindications to surgery. Anesthesiologists felt pressures within themselves to work agreeably with surgeons, avoid delaying cases, and avoid litigation. They also reported overt pressure by surgeons to proceed with cases instead of canceling them, and to hasten anesthetic procedures. Some aspects of production pressure were perceived differently by those reimbursed by fee-for-service *versus* those paid by salary.**

Conclusions: **Production pressure from internal and external sources is a reality for many anesthesiologists and is perceived in some cases to have resulted in unsafe actions being performed. (Key words: Practice: medical economics; production pressure. Organizational theory.)**

EVERY modern industrial activity involves a balance between production efficiency and safety. The term "production pressure" refers to overt or covert pressures and incentives on personnel to place production, not safety, as their primary priority. These pressures exist in all industries and have been identified as important causes of catastrophic accidents in aviation,[1] space flight, nuclear power production, long-haul trucking, chemical production, and shipping.[2]

Production pressure can have at least two effects that can reduce safety. First, and perhaps most importantly, production pressure can induce personnel to commit "violations," which are defined as "deliberate—but not necessarily reprehensible—deviations from those practices deemed necessary (by designers, managers, and regulatory agencies) to maintain the safe operation of a potentially hazardous system."[3] Second, production pressure can induce haste, which may increase the likelihood of unintentional errors in judgment and performance. The error-inducing aspects of haste can interact with other performance shaping factors such as fatigue.

Both of these aspects of production pressure were documented in the analysis of the explosion of the space shuttle Challenger[3–5] and the nuclear disaster at Chernobyl.[3] In these accidents, production pressure was compounded by other features of the organizational and work environment including poorly defined channels of communication and acute and chronic fatigue of responsible individuals.

Although health care shares many features with the complex high-risk industries mentioned above, the organizational environment is different. Commercial aviation is decentralized but highly regulated both by the government and the air carriers. Nuclear power is moderately centralized and very highly regulated. Even

* Associate Professor of Anesthesia (Tenured).

† Assistant Professor of Anesthesia.

‡ Medical Student.

Received from the Department of Anesthesia, Stanford University School of Medicine, Stanford, and Anesthesiology Service, Palo Alto Department of Veterans Affairs Medical Center, Palo Alto, California. Accepted for publication April 26, 1994. Supported by the Department of Veterans Affairs. Presented in part at the annual meeting of the Society for Technology in Anesthesia, New Orleans, Louisiana, February 17–19, 1993, and at the annual meeting of the American Society of Anesthesiologists, Washington, DC, October 9–13, 1993.

Address reprint requests to Dr. Gaba: Anesthesiology Service, 112A, Palo Alto VAMC, 3801 Miranda Avenue, Palo Alto, California 94304.

long-haul trucking, which is extremely decentralized, has considerable governmental regulation of operations. Medicine is extremely decentralized, and despite the extensive bureaucracy concerning reimbursement for medical care, there is very little regulation concerning the delivery of care itself. Individual medical institutions and practitioners adapt their practices to the perceived risks and benefits of each case and to the prevailing economic conditions of medical care. Situations involving direct and indirect production pressures to alter standard anesthetic practices appear to be common.§ Anesthesiologists frequently are heard to comment about impatient surgeons or administrators interested predominantly in the "bottom line." In addition, anesthesiologists may "cut corners" to maximize their own income. Finally, anesthesiologists often discuss fatigue as an issue in their work environment.

If production pressures do exist in anesthesiology they may adversely influence clinical decisions, perhaps resulting in avoidable adverse outcomes for patients. However, the extent (if any) to which anesthesiologists encounter production pressure in various work settings is unknown because there has been no research on the work environment and production pressure related to any domain in medicine. We therefore decided to investigate anesthesiologists' attitudes and first-hand experiences concerning the environments in which they work and the production pressures they encounter. Documenting their attitudes and experiences is the first step to understanding the role of the work environment and production pressure in influencing anesthesia safety. However, such a survey cannot determine the extent to which these issues actually affect patient outcome.

Materials and Methods

We conducted an anonymous survey of a random sample of anesthesiologists in California. Anonymity was a critical feature of the survey because it dealt with highly sensitive topics. The study was limited to a single region of the United States for logistic simplicity. However, California has a large and diverse economy and encompasses a wide variety of urban, suburban, and rural areas.

Survey Questions

We developed a questionnaire based on our review of literature concerning production pressures in other industries.[1,6,‖] In particular we drew on "Human Error in Merchant Marine Safety," a study prepared by the Maritime Transportation Research Board Commission on Sociotechnical Systems under the auspices of the National Research Council.# Although we asked many questions directly relating to production pressure, we also included questions relating to other aspects of the work environment and to patient safety (such as "capnography will enhance patient safety") to balance the target questions. The questionnaire included sections on:

1. Demographics of the respondent
2. The objective characteristics of the respondent's work environment
3. Attitudes of the respondent concerning patient safety, production pressure, and the work environment
4. The frequency of occurrence of various situations in the respondent's work environment
5. The respondent's ratings of the intensity of potential sources of production pressure

The questionnaire is too long to reproduce here but is available in its entirety from the National Auxiliary Publication Service (NAPS).**

Three types of scales were used in the study, all of which are commonly used in survey research.[7] Attitudes were assessed on a series of statements to which the respondent was asked to agree or disagree on a five-element Likert scale.[7] The frequency of occurrence of specific situations in the work environment was as-

§ Blitt CD: 'Practice pressure': A constant threat to patient safety. Anesthesia Patient Safety Foundation Newsletter 7:14, 1992.

‖ The Presidential Commission on the Space Shuttle Challenger Accident: Report to the President. Washington, DC, United States Government Printing Office, 1986, pp 82–177. Feynman RP: Appendix F—Personal Observations on Reliability of Shuttle, pp F1–F5.

Maritime Transportation Research Board Commission on Sociotechnical Systems: Human Error in Merchant Marine Safety. Washington, DC, Maritime Transportation Research Board, 1976.

** See NAPS document no. 05125 for 90 pages of supplementary material. This is not a multi-article document. Order from NAPS % Microfiche Publications, P.O. Box 3513, Grand Central Station, New York, New York 10163-3513. Remit in advance in U.S. funds only $28.75 for photocopies or $5.00 for microfiche. There is a $15.00 invoicing charge on all orders filled before payment. Outside U.S. and Canada, add postage of $4.50 for the first 20 pages and $1.00 for each 10 pages of material thereafter, or $1.75 for the first microfiche and $0.50 for each fiche thereafter.

sessed by presenting a series of statements to which the respondent was asked to rate frequency on a verbal frequency scale.[7] Respondents were asked to reply yes or no as to whether they had ever witnessed unsafe events or to place a check mark to indicate whether they had witnessed specific types of events in their clinical practices in the preceding 3 yr. A horizontal numerical scale[7] was used for ratings of sources of production pressure and for rating proposals aimed at enhancing anesthesia safety.

Because of the potential for individuals to unconsciously list the same numerical response for each question we constructed roughly half of the attitude questions to require a "negative" answer, and the other half to require a "positive" answer. The survey questions were not placed in any specific order in each section, but they were not strictly randomized. For ease of comprehension in this paper only those questions specifically related to the main topics of interest are included in the tables of results, and the questions are grouped by subject area (the unabridged tables are available from NAPS).

Mailings and Responses

A pseudo-random sampling of California anesthesiologists was created by choosing every fifth name in consecutive order from the California section of the 1992 Geographical List of Members of the American Society of Anesthesiologists (Park Ridge, IL). This list is organized in alphabetical order of the cities of the members' mailing address, and within each city by alphabetical order of last names. Although a table of random numbers was not used, the dual organization of the listing makes this procedure essentially equivalent to a truly random sample. There were 647 names selected for entry into the study database. Under a protocol approved by the Stanford University Institutional Review Board a survey packet was sent to each individual in the database. The packet included two postage-free return envelopes, one for a signed and dated consent form, the other for the anonymous survey form itself. This allowed us to maintain the anonymity of the survey while determining which individuals had responded to each mailing.

Of 647 packets sent in the first mailing (September 1992), 15 were undeliverable. Forty-three individuals returned a statement declining to participate, most of them because they were retired and did not believe that they could answer the questions properly. Thus, 589 eligible individuals to whom the survey was deliverable were included in the study population. Completed forms were returned in response to the first mailing from 195 individuals. Three months later a repeat mailing of the entire packet was sent to all individuals who could not be identified as having returned a signed consent form. By definition, this mailing also included some individuals whose name on a returned consent form was illegible. All participants were instructed not to return an additional survey form if they had in fact responded to the first mailing. Completed forms were returned by 84 individuals in response to the second mailing. Therefore, the overall response rate was 279 (47%) of 589 eligible and participants to whom the mailing was deliverable. Data from the completed forms were entered into the database along with the mailing number to which they responded. Inclusion of the mailing number allowed an analysis of any differences between the mailings, which could suggest a selection bias in the study.

Statistical Methods

The statistical database was maintained and analyses performed with Statview 512 and Statview 4.01 statistical packages (Abacus Concepts, Berkeley, CA). We have made the entire study data file available (in hard copy) through the NAPS. (Interested investigators who wish to have the data file in computer readable form can contact the authors). Demographic data are summarized as the mean and standard deviation for interval data, and by cross tabulation for nominal data. The data from Likert scales, verbal frequency scales, and yes–no questions are presented as tabulations. The horizontal numerical-scale data are summarized as the mean and the 95% confidence intervals of the mean. For selected horizontal numerical-scale questions the tabulation of answers is also provided.

Based in part on literature concerning other industries,[1,2] we chose to conduct hypothesis testing according to the source of reimbursement of the anesthesiologist and the number of years in anesthesia as predictor variables. We hypothesized that individuals being reimbursed on a fee-for-service basis might be expected to be more sensitive to the economic considerations of their work environment and of individual cases than would individuals who receive a fixed salary. We further hypothesized that individuals new to the specialty might have different attitudes toward production pressures than do their more senior colleagues, and that attitudes and practices that were acquired during initial training might be different for practitioners

Table 1. Demographics of Survey Respondents Compared with Other Populations

	Survey Respondents	CSA Members	ASA Members Residing in California
Age (years)	45 ± 12	47*	44 ± 9.8
Years since beginning training	16 ± 11		
Gender			
Male	85%	83%	81%
Female	15%	17%	19%
Board certification status			
Resident	5%		17%†
No examination taken	3%		
Written examination passed	12%		
Board certified	80%		65%†
Reimbursement source of anesthesiologist			
Fee for service	65%		73%‡
Salary	28%		27%‡
Both fee for service and salary	7%		

CSA = California Society of Anesthesiologists; ASA = American Society of Anesthesiologists.

* Estimated mean age—CSA data were reported as number of members in each of six age groups.

† The ASA maintains data on board certified members and residents, but the board certification status of other non-resident members is not recorded.

‡ ASA classifications are somewhat different from those used in the survey, but we considered all private practice and self-employed classifications as fee for service, and all university, hospital, and government classifications as salary.

trained at different times over the last few decades. We recoded the years in anesthesia into five categories (≤ 3, 4–8, 9–13, 14–18, and ≥ 19) for use in hypothesis testing. Where they were statistically significant (see below) we have included the analyses involving these predictor variables in the tables of results or in the text. In all other cases they were not significant. We also conducted hypothesis testing to determine whether there was a difference between respondents to the two mailings.

Hypothesis testing used the following statistical techniques.[7] The chi-squared statistic was used for the yes–no questions and for the Likert-scale data. Because the verbal frequency scale is clearly ordinal, the nonparametric Mann–Whitney U test was used. For demographic interval scale data and for the horizontal numerical-scale data one-way analysis of variance was utilized. We used the Kendall τ nonparametric correlation coefficient to analyze the correlation between objective self-reports of work hours and on-call work load and several questions relating to attitudes and experience with fatigue.

Because of the large number of questions (96) asked in this exploratory investigation there was a high probability of type I error (differences between subgroups attributable to chance alone). Thus, when examining the effect of predictor variables or for correlations, the level of statistical significance was reduced to 0.001, essentially partitioning the typical level of type I error ($P < 0.05$) across 50 questions. When examining the results of the two different mailings for potential bias we set the level of significance at 0.05, with the caveat that any differences detected between the mailing groups could be attributable to chance alone, and thus would require careful interpretation.

Results

Demographics of the Sample Population

The demographic makeup of the survey respondents is shown in table 1 and figure 1. These data are compared with data about members (active and retired) of the California Society of Anesthesiologists (CSA) and to data about active members (excluding retired) of the American Society of Anesthesiologists (ASA) residing in California. The respondents were mostly middle aged males. The vast majority (80%) of the respondents were board certified anesthesiologists. Table 2 shows objective data concerning the work environment of the respondents. Most practice in medium to large OR settings with fee-for-service reimbursement. Respondents reported that roughly half of their patients were outpatients. They worked 52 ± 16 h per week and were on call approximately 5 nights and 2 weekend days per month. They reported significantly less sleep than nor-

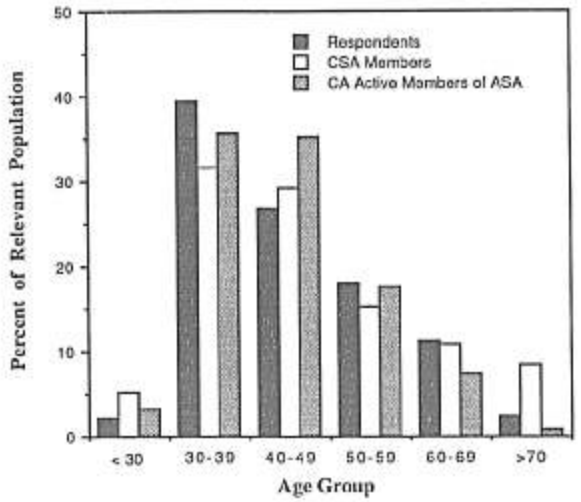

Fig. 1. The age distribution (1993–1994) of survey respondents, members of the California Society of Anesthesiologists, and members of the American Society of Anesthesiologists residing in California.

mal when they were on call. ASA members reported working an average of 62 ± 17 hours per week.

Attitudes and the Frequency of Occurrence of Specific Situations

As shown in table 3 over half of respondents agreed that they had made an error attributable to fatigue, even more (63%) suggested that they had made errors because of the work load within a case. In terms of attitudes toward production pressure, most respondents believed that they had a duty to cancel cases from the surgical schedule if necessary. However, there were limits to this belief, as 35% indicated that it was possible they could lose their job if they canceled too many cases. Although 96% of respondents indicated that they often or always had a good working relationship with surgeons, 12% believed that their opinions on medical care often differed from those of surgeons. Slightly over half did not believe that surgeons understand the risks of anesthesia. Inadequate preoperative evaluation was the major reason for case cancellations (77% of respondents had canceled a case for this reason sometimes or more often), with risk–benefit issues and ethical reasons for cancellation being less common. Litigation and family pressure were rare factors in case cancellations.

As shown in table 4 some respondents (39%) agreed that hospital administrators insisted on minimizing case turnover time, and 71% agreed that doing so was within their scope of responsibility. But most respondents seemed relatively resistant to pressures to inappropriately speed the start of surgery or to leave unstable patients in the postanesthesia care unit to begin the next case. Fatigue was an important issue for a minority of respondents. Twelve percent reported feeling fatigued at work often and 21% reported being expected to do cases after being awake most of the preceding night often or always. The respondents indicated good ability to prepare for cases and a uniformly good ability to conduct preoperative evaluation of inpatients. However, 14% said that they seldom or never had ample time to evaluate outpatients before surgery.

Unsafe Actions

The number of anesthesiologists who had witnessed what they believed to be unsafe activities was surprisingly large. Ten percent stated that they often or always witnessed a surgeon or colleague do something unsafe, and an additional 43% had seen this occur occasionally. Nearly half (49%) of respondents had actually observed an anesthesiologist pressured to conduct anesthesia in an unsafe fashion (in their opinion) given the level of urgency of the situation (table 5). Some respondents had seen, in the preceding 3 yr, patients undergoing elective surgery with inadequate evaluations (54%) or with significant contraindications to surgery or anesthesia (31%). They had observed nonemergent cases started without adequate monitoring (28%). Approximately one third of respondents (34%) in the preceding 3 yr had

Table 2. Characteristics of the Survey Respondents' Work Environment

Size of operating room suite	
1–3 rooms	8%
4–6 rooms	24%
7–10 rooms	29%
10–20 rooms	25%
More than 20 rooms	14%
Number of cases per day	4.1 ± 2.0
Fraction of cases that involve outpatients	53 ± 24%
Hours in typical work week	52 ± 16
Average call per month	
Nights	5.5 ± 3.5
Weekend days	2.1 ± 1.3
Average daily hours of sleep	
On call	4.8 ± 1.6
Not on call	7.2 ± 0.83

Table 3. Respondents' Attitudes about the Work Environment (%)

	Scale				
	1 Strongly Disagree	2 Disagree	3 Neutral	4 Agree	5 Strongly Agree
I have made an error in clinical management that I attribute to fatigue	9	24	12	41	13
My call workload is heavy	4	18	30	39	9
I have never made any errors in clinical management that I attribute to excess workload during a case	15	48	14	20	3
Hospital administrators do provide me with adequate technical support staff	6	23	16	46	9
Surgeons understand the risks of anesthesia	11	43	18	25	3
There is never a reason to cancel a case from the surgical schedule	78	18	1	1	3
Hospital administrators insist on minimizing time between cases	5	18	28	24	15
I don't make money if I don't do cases	14	10	8	20	48
It is not my responsibility to keep time between cases to a minimum	17	54	16	9	4
I would not lose my job no matter how many cases I decided to cancel	8	27	19	33	13
The amount of money I make does not directly depend on the number of cases I do	39	25	2	18	16
If I cancel a case I might jeopardize working with that surgeon at a later date	25	42	12	17	3
I try to finish my list of cases quickly so that I can leave the hospital	14	33	27	20	6
My practice income has been increasing over the last 3 yr	33	30	16	18	3

observed a colleague perform anesthesia on a patient for whom anesthesia had just been refused or canceled by another anesthesiologist for safety reasons. The true incidence of these occurrences cannot be determined from this study.

Sources and Types of Pressure

The anesthesiologists were asked to rate 26 possible sources and types of production pressure ranging from those they put on themselves (internal pressures) to external pressures from surgeons, family, colleagues, or administrators (fig. 2). Only a few sources of pressure had a mean rating of pressure of 2.5 or greater (on a 1–5 scale from "no pressure" to "intense pressure"). The distribution of the numerical ratings of the more highly rated sources is tabulated in table 6. Respondents reported substantial internal pressure to work agreeably with surgeons, to avoid delaying cases, and to avoid litigation. Explicit external pressure from surgeons was also felt. This was primarily pressure to proceed with cases rather than canceling them, although some pressure to hasten anesthetic procedures was reported. Little pressure was reported from colleagues, patients or families, and administrators, except that administrators were cited as a source of pressure to reduce time between cases.

Correlations between Attitudes toward Fatigue and Characteristics of the Work Environment

Table 7 shows that there were weak but strongly significant correlations between self-reported weekly or on-call work load and several measures of attitudes and experiences concerning fatigue and case work load. However there was no correlation between work hours or case load and the self-perceived incidence of having made errors because of fatigue.

Analysis by Reimbursement Source

Call nights per month was significantly greater for fee-for-service practitioners (6.4 ± 3.5) *versus* salaried practitioners (3.6 ± 2.7). Not surprisingly there were significant differences by reimbursement source in attitudes concerning the nature of practice income. Fee-for-service respondents believe that their income is linked to the number of cases done and is decreasing, whereas salaried physicians did not indicate this (table 8, $P = 0.0001$). Fee-for-service practitioners reported having to work after being awake most of the night more frequently than did salaried practitioners ($P = 0.0001$). Fee-for-service respondents reported more internal pressure than did salaried practitioners to maximize cases (mean rating 2.4 *vs.* 1.8, $P = 0.0007$), to accrue income from high paying cases (2.0 *vs.* 1.1,

Table 4. Respondents' Reports of the Frequency of Occurrence of Work Situations (%)

	Scale				
	1 Never	2 Seldom	3 Sometimes	4 Often	5 Always
My opinions concerning medical care differ from those of the surgeons	2	31	55	12	0
I have a good working relationship with surgeons	0	1	3	74	22
I have witnessed a surgeon or colleague do something that appeared to me to be unsafe	3	44	43	8	2
I have altered my normal practices in order to speed the start of surgery	22	52	20	5	1
I feel fatigued at work	2	29	57	12	0
I am expected to do cases the day after being awake most of the night on call	21	38	20	14	7
I have cancelled a case(s) because of ethical reasons	34	42	19	3	2
I have cancelled a case because the patient had not undergone adequate preoperative evaluation	1	22	52	21	4
I have refused to do a case because I thought the risks exceeded the likely benefits	21	40	31	6	1
I have performed anesthetics that I would have cancelled except that the patient or the patient's family pleaded with me to go ahead	65	28	6	2	0
I have cancelled a case because I feared litigation if I proceeded	66	26	5	2	0
The ambulatory surgery system in my hospital allows me ample time to evaluate my patients preoperatively	3	11	18	41	27
The inpatient surgery system in my hospital allows me ample time to evaluate my patients preoperatively	0	3	11	53	32

$P = 0.0001$), and to avoid litigation (3.4 *vs.* 2.5, $P = 0.0002$).

Analysis by Years of Anesthesia Practice

As expected, the distribution of respondents' years of practice mirrored that of the respondents' ages. Of the 96 questions, 3 showed differences beyond the $P = 0.001$ level of significance when analyzed by years of anesthesia practice. These were:

- "I don't make money if I don't do cases" ($P = 0.0006$)
- "The amount of money I make does not directly depend on the number of cases I do" ($P = 0.0001$)
- "Accrue income from specific high-paying cases" [Rating of source of pressure] ($P = 0.0009$)

In each case the question relates to the relationship between earning money and performing anesthetics and were similar to the analysis by source of reimbursement

Testing for Bias

We tested for two different types of sample selection bias. We first tested to see if the respondent population

Table 5. Respondents' Observations of Activities Perceived to be Unsafe (%)

	Yes %	No %
Have you *ever* observed an anesthetist pressured to conduct anesthesia in a fashion you considered unsafe given the level of urgency of the situation?	49	51
In the past 3 yr have you ever observed any of the following events to occur?		
Patient anesthetized for elective surgery without sufficient medical or surgical evaluation	54	46
Patient anesthetized for elective surgery with significant contraindications to surgery/anesthesia	31	69
Nonemergent case begun without adequate monitoring or lines	28	72
Nonemergent cases not aborted after major event (*e.g.*, cardiac arrest)	13	87
Help not called for during a major crisis to avoid "looking bad" or delaying procedure	15	85
Other anesthetist called to do case refused or cancelled by a colleague for patient safety concerns	34	66

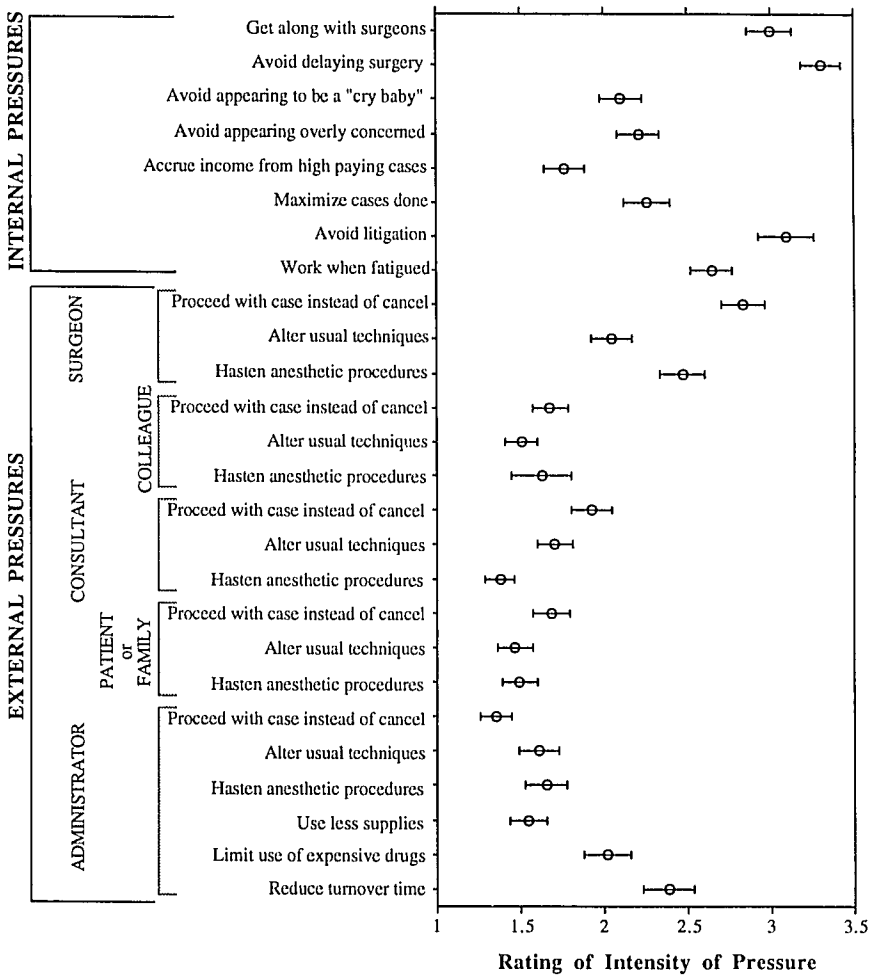

Fig. 2. Respondents' ratings (mean and 95% confidence interval of the mean) of the intensity of production pressure of 26 sources and types. Ratings were made on a scale from 1 (no pressure) to 5 (intense pressure). Vertical axis shows the source and type of pressure; horizontal axis shows the rating of intensity of pressure, which for clarity is displayed only in the range of 1–3.5.

was demographically similar to the underlying population receiving surveys. Comparison of demographic data about the survey respondents with data from the CSA and ASA are shown in table 1 and figure 1. For the most part the respondents appeared similar to the CSA and ASA (California) populations. The average age of respondents did not differ between these groups. There were differences in the age distribution (fig. 1) but the overall pattern was similar. The CSA data included retired members, whereas the ASA data did not, and many retired anesthesiologists declined to participate in our survey. The gender distributions (table 1) were similar, although the small differences did reach statistical significance ($P < 0.03$). Survey respondents were more likely to be board certified than are ASA members (table 1). The reimbursement source of respondents was similar to our estimates of the reimbursement source of California members of the ASA (table 1).

The second type of sample selection bias is called "nonresponse bias" or "self-selection bias," referring to the inherent difference of those who chose to respond to the survey, purely on the basis of having made that choice, in contrast to those who did not respond. One aspect of possible nonresponse bias could be tested. We compared the population who responded immediately to those who responded only after the additional stimulus of receiving a second mailing. If there were large differences between these populations it would suggest (but would not prove) that large differences might exist between the respondent population as a whole and the nonresponder population. If true, this would limit the applicability of the survey results.

Table 6. Tabulation of Responses to the Most Highly Rated Sources of Production Pressure (%)

	Scale				
	1	2	3	4	5
Internal pressure that you put on yourself to					
Get along with surgeons	12	21	28	29	9
Avoid delaying surgery	6	16	31	39	9
Accrue income from specific high-paying cases (ALL)	56	19	16	6	1
Fee for service	45	23	22	8	2
Salary	88	10	1	0	0
Both	43	19	19	19	0
Avoid litigation (ALL)	18	20	18	24	20
Fee for service	12	17	17	26	27
Salary	30	25	21	18	6
Both	18	23	18	27	14
Work when fatigued	12	37	32	13	6
External pressures someone else explictly exerts					
Surgeon's explicit pressure to					
Proceed case rather than cancelling	12	28	29	24	6
Hasten your anesthetic preparation or induction	21	36	23	16	4
Administrator's or institution's explicit pressure to					
Reduce turnover time between cases	33	24	21	14	7

Scale: 1 = no pressure to 5 = intense pressure.

For 7 questions, there was a difference between mailings that was significant beyond the $P = 0.05$ level. Given that 96 questions were asked it is not surprising that there were a few differences. Using the binomial theorem we calculated the likelihood that 7 of 96 questions would show such a difference resulting from chance alone by assuming that each of the questions had a 5% of showing a difference when none existed. There is a 9.6% probability of this occurring by chance. Interestingly, however, 2 of the 7 questions showed a strong difference between mailings ($P = 0.0001$): "I would not lose my job no matter how many cases I decided to cancel," and "I have canceled a case because I feared litigation if I proceeded." These differences did not appear to result from an interaction with source of reimbursement (chi-squared analysis, $P = 0.12$), and we have no explanation for such significant differences.

Discussion

Although anesthesiologists are frequently heard to comment about their practice environment this study presents the first systematic evaluation of their attitudes and experiences regarding these issues. Despite the limitations of the study as described below we believe that it gives a clear indication that a substantial fraction of anesthesiologists experience moderate to strong production pressures in their work environment. These pressures include avoiding case cancellations, eliminating delay in starting cases, and providing quick turnaround between cases in all situations. Although these practice goals can be consistent with patient care that is both safe and efficient, the pressure to achieve them has caused the occurrence of unsafe actions in the opinion of many of the respondents. The degree to which such actions resulted in preventable harm to patients is unknown. Investigating adverse outcomes resulting from production pressure will be particularly difficult because of the intense medicolegal concerns likely to be involved in any such case. Also practitioners are likely to be extremely sensitive to any suggestion that they succumbed to, or were the source of, pressures to act in an unsafe manner.

Limitations of the Study

This survey targeted anesthesiologists who are members of the ASA. It is possible that this group is not representative of anesthesiologists as a whole, although it is estimated that 90% of anesthesiologists are members.†† The respondent population had similar demo-

†† Orkin F: Personal communication.

Table 7. Correlations between Work Hours and Attitudes or Experiences with Fatigue

	"I Feel Fatigued at Work"	"I Have Made an Error Due to Fatigue"	"I am Expected to Do Cases the Day after Call"	"My Call Workload is Heavy"	"I Try to Finish Cases Quickly So I Can Leave the Hospital"	Rating of Intensity of Internal Pressure to Do Cases When Fatigued
Hours in work week	$\tau = 0.12$, $P < 0.0001$	Not significant	$\tau = 0.10$, $P < 0.001$	$\tau = 0.22$, $P < 0.0001$	$\tau = 0.10$, $P < 0.001$	$\tau = 0.11$, $P < 0.0005$
Hours of sleep on call	Not significant	Not significant	Not significant	$\tau = -0.30$, $P < 0.0001$	Not significant	$\tau = -0.11$, $P < 0.003$
Call nights per month	Not significant	Not significant	$\tau = 0.25$, $P < 0.0001$	Not significant	Not significant	$\tau = 0.14$, $P < 0.0001$

τ = Kendall Tau Nonparametric correlation coefficient.

Statistical significance was considered with $P < 0.001$.

The exact wording of each question can be found in the verbatim questionnaire available through the NAPS.

graphic characteristics to those of CSA members and ASA members in California, although the respondents were more likely than expected to be board certified anesthesiologists, and residents were underrepresented. The survey was limited to a single region of the United States. We do not know if the results would differ among regions or countries as a result of factors such as the relative proportion of anesthesiologists practicing in anesthesia care teams, the proportion of practitioners in health maintenance organizations, or cultural differences. The response rate of 47% combining the two mailings was surprisingly good, considering the length, complexity, and sensitivity of the questionnaire. For comparison, the National Research Council's study on Human Error in Merchant Marine Safety had only a 25% response rate.#

Comparison with Other Data

There have been few similar studies. Holzman *et al.* (including one of the current authors) recently reported on responses to questions about production pressure that were embedded within a questionnaire evaluating a simulator-based training course on anesthesia crisis management.[8] All participants in the training course were volunteers, but the questions about production pressure were incidental to the course. Ap-

Table 8. Tabulation of Responses to Questions That Differed Significantly by Source of Reimbursement

	Scale (%)				
	1 Strongly Disagree	2 Disagree	3 Neutral	4 Agree	5 Strongly Agree
I don't make money if I don't do cases (ALL)	15	10	8	19	48
Fee for service	1	2	4	25	68
Salary	48	26	13	6	6
Both	9	18	18	23	32
The amount of money I make does not directly depend on the number of cases I do (ALL)	39	25	2	17	17
Fee for service	60	30	1	7	2
Salary	0	10	1	35	53
Both	9	27	14	41	9
My practice income has been increasing over the last 3 yr (ALL)	32	30	16	18	3
Fee for service	40	33	11	13	3
Salary	18	26	28	26	1
Both	15	20	25	30	10

proximately half the participants were residents in the CA2–CA4 (CA = Clinical Anesthesia) years of training; the other half were faculty anesthesiologists. Holzman *et al.* found that 84% of respondents answered that they had been pressured to conduct anesthesia in an unsafe fashion.[8] For those answering yes, three of the five listed sources of pressure were cited frequently, including "surgeon" (66%), "colleague/attending" (73%), and "own fatigue" (38%). "The hospital" and "internal economic pressure" were cited very infrequently. In the written comments residents frequently stated that pressure to act in ways that they believed to be unsafe had been exerted by their supervising attending staff.

Previous discussions of production pressure have often cited direct economic pressure or managerial influence as a major reason for individuals to cut corners or take unsafe actions.[1–3,#] For example, Orasanu and Salas[9] cited a case in which an airline paid each passenger if a flight was late (the "Fast Buck" program). They stated that "this policy was implicated in one crash when the pilot tried to fly through instead of around a line of thunderstorms near his destination airport." They also cited a study suggesting that 15 of 23 fatal jet accidents studied showed "policy factors" to be an influence. The Maritime Safety study# found "high level of calculated risk," defined as the "knowing acceptance of risk in operational situations to meet personal or corporate priorities," to be a significant causal factor in merchant marine casualties [accidents]." Forty percent of respondents listed "making schedule" as the prime criterion for grading a captain's performance, and 50% cited strong pressures to meet schedules.

Practicing medicine in dynamic environments is a complex and stressful task in which errors can occur.[10,11] It is not clear from our data the degree to which the unsafe actions witnessed by anesthesiologists resulted from inadvertent errors as compared with intentional violations of standard safety practices, but both of these mechanisms would be likely to be exacerbated by the existence of production pressure.

Surgeons and Anesthesiologists

Surgeons, like anesthesiologists, want good outcomes for their patients. Why then do anesthesiologists sometimes feel pressured by surgeons to proceed when the anesthesiologist believes it would be unsafe? One hypothesis is that surgeons differ from anesthesiologists in their calculation of risk *versus* benefit. If true, one explanation could be that surgeons are unaware of the risks involved in conducting anesthesia and are making incorrect risk–benefit assessments. Many respondents agreed with this assertion. Another explanation could be that the fields of surgery and anesthesiology attract and select individuals for residency training who have different personality and attitude profiles, and that the two specialties teach and reinforce different approaches to risk. Thus, surgeons might be characteristically optimistic and risk taking, whereas anesthesiologists may be characteristically risk averse. This hypothesis and its underlying explanations remain to be investigated. Gild has recently described an ethnographic (anthropologic) methodology to study these issues and the procedures by which anesthesiologists, surgeons, and consultants resolve their differences.‡‡

Internal versus *External Production Pressure*

Anesthesiologists rated "internal pressures" they put on themselves to work agreeably with surgeons and avoid delaying cases as the most intense sources of pressure. Perhaps this explains why overall production pressure appeared to be equally perceived by salaried anesthesiologists (whose income is not related to the number of cases performed) as by fee-for-service anesthesiologists. After previous exposure to overt external pressure by surgeons, and with the premium on production efficiency inherent in the use of the scarce OR resource, the production pressures become internalized so that they continue to operate even in the absence of overt pressure. Internal desires to practice efficiently are appropriate, but some respondents believed that these desires sometimes altered decisions in ways that were not in the patient's best interest.

Fatigue

Although it is now quite common in many institutions (especially teaching programs) to prevent anesthesiologists from working more than 24 h without sufficient sleep, a significant number of anesthesiologists in this study frequently were called on to do so. This was more common in the fee-for-service subgroup. Some respondents reported that to compete for surgeons' business, institutions are allowing

‡‡ Gild WM: Ethnography in the operating room (presentation). Annual meeting of the Society for Technology in Anesthesia, New Orleans, Louisiana, February 1993.

elective surgery well into the night and on weekends. Some respondents reported feeling fatigued at work often, and there were a number of written comments complaining of increasing fatigue. It is known that subjective self-assessment of fatigue generally underestimates the true level of fatigue.[12,13] Although a consensus has not yet been reached concerning the effects of fatigue and sleep deprivation on the performance of medical personnel,[14] there is reason to believe that fatigue is frequently a factor in accident situations in many industries, including medicine.[15]

In our study, respondents with heavier work schedules and on-call work loads were more likely to report fatigue and pressure to work while fatigued. However, work load did not correlate with self-ratings of experience of errors attributed to fatigue. These data suggest that work hours do affect mood and internal production pressures of anesthesiologist, but the data cannot be used directly to determine safety limits for their work hours or sleep habits.

Conclusions

No one sets out to create a system that poses undue risks. Production speed, efficiency, and output are important goals of every industry, as is safety. Safety and production efficiency can coexist. Airlines manage impressive passenger loads over a wide variety of weather conditions, with an admirable safety record. The Navy's aircraft carriers launch and recover aircraft at an amazing rate, with very rare losses of aircraft. The organizational means to achieve these goals have been described as the "high-reliability organization."§§ This is achieved only by constant commitment to safety as well as production in the organizational culture; the presence of redundant safety systems; constant training; and dedication to learning from mistakes. When specific efforts have been made in the OR to utilize principles of total quality management and continuous quality improvement, these features can be harnessed to simultaneously improve efficiency and safety.‖‖

Nonetheless, in the absence of frequent overt negative outcomes, safety concerns may be eroded by the other increasing pressures. We are concerned that to appear competitive, to attract patients, or to negotiate agreements with surgeons and managed care organizations, both hospitals and anesthesiologists may be tempted to make excessive claims of productivity, cost efficiency, and safety that cannot be met realistically. In an era of progressively greater constraints on costs of care and growing intensity of competition, there will be increased pressure to increase production at the expense of safety. The Nobel laureate physicist Richard Feynman warned in his addendum to the report of the presidential commission investigating the Challenger explosion: "For a successful technology, reality must take precedence over public relations, for nature cannot be fooled."‖ It took a highly public disaster to produce changes in the corporate culture and operational procedures of the space shuttle program. We believe that the anesthesia profession should address the issue of production pressure directly without waiting for such unfavorable publicity.

The authors thank the California Society of Anesthesiologists and the American Society of Anesthesiologists for providing demographic data about their members for comparison with the current results. The authors also thank Fred Orkin, M.D., for assistance in obtaining the data.

References

1. Nance JJ: Blind Trust. New York, William Morrow, 1986
2. Perrow C: Normal Accidents. New York, Basic Books, 1984
3. Reason JT: Human Error. Cambridge, Cambridge University Press, 1990
4. Lewis RS: Challenger: The Final Voyage. New York, Columbia University Press, 1988
5. Rasmussen J: Cognitive control and human error mechanisms, New Technology and Human Error. Edited by Rasmussen J, Duncan K, Leplat J. Chichester, John Wiley & Sons, 1987, pp 53–61
6. Reason J: The contribution of latent human failures to the breakdown of complex systems. Philos Trans R Soc Lond [Biol] 327: 475–484, 1990
7. Alreck PL, Settle RB: The Survey Research Handbook. Homewood, Richard D. Irwin, 1985
8. Holzman RS, Cooper JB, Gaba DM, Philip JH, Small S, Feinstein D: Participant responses to realistic simulation training in anesthesia crisis resource management (ACRM) (abstract). ANESTHESIOLOGY 79: A1112, 1993
9. Orasanu J, Salas E: Team decision making in complex environments, Decision Making in Action: Models and Methods. Edited by Klein G, Orasanu J, Calderwood R, Zsambok CE. Norwood, New Jersey, Ablex Publishing, 1993, pp 327–345

§§ Rochlin GI, La Porte TR, Roberts KH: The self-designing high reliability organization: Aircraft carrier flight operations at sea. Naval War College Review 42:76–90, 1987.

‖‖ Gulczynski D: 'Production pressure' danger avoided by CQI effort. Anesthesia Patient Safety Foundation Newsletter 8:28–29, 1993.

10. Eisendrath SJ, Matthay M: Intensive care unit: How stressful for physicians? Crit Care Med 14:95–98, 1986

11. Wu AW, Folkman S, McPhee SJ, Lo B: Do house officers learn from their mistakes? JAMA 265:2089–2094, 1991

12. Hoddes E, Zarcone V, Smythe H, Phillips R, Dement WC: Quantification of sleepiness: A new approach. Psychophysiology 10: 431–436, 1973

13. Monk TH: Subjective ratings of sleepiness: The underlying circadian mechanisms. Sleep 10:343–353, 1987

14. Samkoff JS, Jacques CHM: A review of studies concerning effects of sleep deprivation and fatigue on residents' performance. Acad Med 66:687–693, 1991

15. Mitler MM, Carskadon MA, Czeisler CA, Dement WC, Dinges DF, Graeber RC: Catastrophes, sleep, and public policy: Consensus report. Sleep 11:100–109, 1988