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## The Health of Operating Room Personnel

BECAUSE OF DISAGREEMENT among knowledgeable investigators regarding the validity and interpretation of published reports, the American Society of Anesthesiologists (ASA) commissioned Dr. Theodore Colton to head a group of epidemiologists-biostatisticians (Epistat Associates) to evaluate the epidemiologic surveys that had examined the putative health hazards attributed to exposure to waste anesthetic gases in the operating room. The Special Article, which appears in this issue, entitled "Health Experiences of Operating Room Personnel," by Buring *et al.*<sup>1</sup> is the abridged version of the group's report,\* the full version of which was submitted to the ASA in 1982. Although the effect of operating room employment on worker's health is less of a burning issue today than it was in the 1970s, it is still the subject of much interest and controversy. Publication of this article makes the conclusions of Colton, Buring and associates readily available to anesthesiologists and other interested parties.

Buring *et al.*<sup>1</sup> used the measurement of relative risk to describe the strength of the association between operating room work and various disease outcomes. Relative risk is defined as the ratio of the rate of disease among an exposed group compared with a control population. Results from each study are treated as individual data points that, after weighting in proportion to their sample size, are pooled. Summary relative risks and 95% confidence limits then are calculated. When the range of the 95% confidence limits does not include 1.0, the relative risk is significantly different at the  $P < 0.05$  level.

Based on this analysis, the authors concluded that the adverse health outcome for which the evidence was

most extensive and reasonably consistent was spontaneous abortion for pregnant physicians and nurses working in the operating room. The relative risk for this condition was 1.3, representing a 30% increase in risk when compared with the control population. Data for the other reproductive outcome they examined, congenital anomalies, were less conclusive. The overall relative risk for this condition was 1.2, with the difference statistically significant for women physicians but not for nurses. Among nonreproductive outcomes, there was an increase in relative risk of liver disease (men, 1.6; women, 1.5), kidney disease among women (1.3), and cervical cancer (2.8).

Having pointed out what appear to be significant health hazards, Buring *et al.*<sup>1</sup> emphasize the many limitations of their conclusions. Of the 17 articles that they considered relevant to the issue, they rejected nine because of deficiencies in study design, such as the use of noncomparable control groups. Two additional studies of dentists and their chairside assistants were eliminated because work practices and waste anesthetic gas exposure of these populations was markedly different than that of operating room personnel. Thus, Buring *et al.*<sup>1</sup> were left with only six studies to analyze.<sup>2-7</sup> Even these, they noted, had significant limitations:

"... including low response rates among potential study subjects and inadequate information on non-respondents; lack of details on amount, duration and nature of exposure; lack of confirmation and verification of reported adverse outcomes; lack of information on many possible confounding variables; the possibility of response bias both through the nature of the questionnaires or the respondents' prior beliefs regarding adverse effects; and the possibility of biased recall of events and exposures which occurred in years past."

Several of these shortcomings deserve additional discussion. Perhaps the most serious deficiency, present in all but one of the studies<sup>2</sup> examined, was the absence of verification of the medical outcomes reported in the questionnaires. It is well known among epidemiologists<sup>3</sup>

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\* Colton T: Evaluation of the epidemiologic evidence for occupational hazards of anesthetic gases. American Society of Anesthesiologists, Park Ridge, Illinois 60068, January 21, 1982.

that interviews and surveys are far less reliable than medical records for determining the incidence of most diseases. An example of this lack of correlation is illustrated in the report of the Commission on Chronic Illness.<sup>4</sup> In this study, a randomly selected 10% sample of a group of 12,000 residents of Hunterdon County, New Jersey, were invited to have complete physical examinations, including any indicated laboratory or diagnostic procedures; 72% accepted. The entire group previously had been interviewed regarding their past illnesses. When interview-reported conditions were compared with clinically detected illnesses, the overall accuracy of the match was only 24% for disabling conditions and 18% for nondisabling conditions, with both underreporting and overreporting noted. The match for some conditions was considerably poorer than the overall values noted above (table 1). An even more striking example of the poor reliability of unverified questionnaire responses comes from a study comparing patients' statements regarding their circumcision status with examination findings.<sup>5</sup> There was disagreement between the two data sources in 73 of 213 (34.4%) instances. Thus, it is difficult to accept the validity of the data from the epidemiological surveys<sup>2,6-9</sup> examined by Buring *et al.*<sup>1</sup> as they report unverified differences between exposed and control populations, which average only 4.5% for spontaneous abortion, 0.2% for neoplasms, and 1.5% for liver disease. Data from Axelsson and Rylander,<sup>2</sup> the only study in which questionnaire data were verified by examination of medical records, support this skepticism. They studied Swedish operating room workers and found the interview reported incidence of abortion of workers exposed to trace anesthetic gases was 30% higher than that of controls; however, when medical records were examined they found a 30% incidence of unreported abortion in the control population compared with no unreported abortions in the exposed group.

Buring *et al.*<sup>1</sup> recognized the limitations of the data they analyzed, noting that the small increases in relative risk they calculated were well within the range that might be due to bias or to uncontrolled confounding variables. In fact, when examining results using the technique of relative risk, epidemiologists recognize that values less than two to three may occur as a result of misclassification.<sup>10</sup> Examples of strong correlations using relative risk analysis are the risks of 8 to 12 for the association of cigarette smoking and lung cancer for all United States men<sup>11</sup> and 14 for British male doctors.<sup>12</sup> To further put the values calculated by Buring *et al.*<sup>1</sup> in perspective, it is interesting to note that the age-adjusted relative risks of second-trimester spontaneous abortion are 1.03 (not significant), 1.98 ( $P < 0.01$ ), and 3.53 ( $P < 0.01$ ) for women imbibing less than one, one to two,

TABLE 1. Proportions of Match between Interview-reported and Clinically Evaluated Conditions Data from Tussel and Elinson, Commission on Chronic Illness: Chronic illness in the United States, vol 3. Chronic Illness in a rural area: The Hunterdon Study. Boston, Harvard University Press, 1959.

Disease Classification	Percent Matching Interview-reported Conditions	
	Disabling	Nondisabling
All conditions present during interview year	24	18
Infective; parasitic	22	8
Neoplasms, benign and malignant	15	7
Allergic	57	12
Anaemias; other blood conditions	52	0
Nervous system	39	26
Eye	22	14
Heart	38	54
Respiratory	28	54
Genitourinary	7	16

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and more than three drinks daily, compared with non-drinkers.<sup>13</sup> Cigarette smokers have a relative risk of 1.8 ( $P < 0.001$ ) for spontaneous abortion when compared with nonsmokers.<sup>14</sup>

The authors make another important point regarding the failure to document exposure to waste anesthetic gases in the so-called "exposed" groups. They note that in *no* study was exposure actually measured. Most studies employed the simple dichotomy of "exposed-unexposed" or exposure status was derived solely from job classification or membership in a professional society. Hence, they conclude that ". . . we cannot be certain that waste anesthetic gases are responsible for the observed effects let alone assess dose-response trends and threshold levels. . . ." They add that the studies provide no basis for developing standards for operating rooms or setting exposure limits to waste anesthetic gases. That the studies do not indict waste anesthetic gases as the cause of adverse effects bears emphasis. Factors such as exposure to methylmethacrylate, radiation, stress, hepatitis virus, *etc.*, could be responsible. In fact, Colton, Buring and associates spell out this argument in detail in the unabridged version of their report.†

"Rather, due to the types of study design employed, the hypothesis tested in these investigations has been whether those who work in occupations where exposure to anesthetic gases is common (e.g., in an operating room) are at increased risk of

† Colton T: Evaluation of the epidemiologic evidence for occupational hazards of anesthetic gases. American Society of Anesthesiologists, Park Ridge, Illinois 60068, January 21, 1982, p 5.

experiencing adverse health outcomes. The difference is not merely semantic; the positive result of a test studying the latter hypothesis could be due to the action of an anesthetic agent, but it could also result from some other factor associated with ostensible exposure to anesthetics."

In conclusion, Buring *et al.*<sup>1</sup> point out that conditions in operating rooms have changed since the data they examined were collected, *i.e.*, scavenging waste anesthetic gases now is the rule in the United States. (Average exposures to waste anesthetic gases probably have been reduced by tenfold, compared with the levels present when the epidemiologic surveys were conducted.<sup>15</sup>) They added that if meaningful conclusions are to be drawn regarding the health experience of operating room personnel, they can only come from new, carefully controlled prospective studies, where outcomes are precisely defined and verified, and exposure to waste anesthetic gases is measured. It seems clear that the data from previous studies are not relevant to current practice and do not warrant reexamination.

We must conclude by stating that, despite the lack of evidence that waste anesthetic gases are hazardous, it also cannot be proven that exposure to the gases is safe. Particularly, it appears that nitrous oxide at much higher than waste gas concentrations, *i.e.*, when used "recreationally," has significant adverse effects.<sup>16</sup> Thus, continued waste gas scavenging and monitoring in operating rooms, as outlined in the 1982 ASA publication<sup>‡</sup> on the subject, is justified, if only for aesthetic reasons and to improve the morale of operating room personnel. We would emphasize, as has Buring *et al.*,<sup>1</sup> that there is no basis at this time for federal government (OSHA) regulation of waste gas exposure or scavenging.

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‡ Waste Anesthetic Gases in Operating Room Air: A Suggested Program to Reduce Personnel Exposure. Edited by Lecky JH. American Society of Anesthesiologists, Park Ridge, Illinois 60068, 1982.

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