effect on operative outcome." Furthermore, they were so convinced of the correctness of this conclusion that ". . . We felt it necessary to terminate the study . . . because the overall complication rate was strikingly higher in group II patients."

The flaw in their reasoning is their tacit acceptance of the logical fallacy known as the *post hoc* fallacy. (*Post hoc, ergo propter hoc,* or after this; therefore, because of this). In the *post hoc* fallacy, one concludes that, because a temporal relationship is present, a causal relationship exists as well. For example, if Event A precedes Event B, then clearly one cannot conclude therefore that Event A caused Event B. In the study of Yeager *et al.*, there is a statistically significant difference—four deaths in group II *versus* no deaths in group I. But this merely means that a statistically significant difference exists in mortality rates between the two groups—and nothing more. Differences which are statistically significant tell one nothing about the cause of that difference. Causality must be determined at its own level, on its own terms, by its own criteria.

The authors could have avoided the *post hoc* fallacy when interpreting these findings if they had reviewed the records of the four patients in group II who died, and tried to determine what the actual causes of death were. They could have consulted with the surgeons and the other physicians involved in the care of these patients. There are few anesthesia complications which lead to death 13–37 days postoperatively. It is more likely that the deaths were related to the high-risk status of the patients rather than to the anesthetic technique.

The take-home message of Yeager's study is "There were no deaths in group I and 5 in group II. Therefore, do not use group II technique." The logical approach presented here will likely have little impact following publication of the original article. More relevant is the old Russian proverb: "What is written down with a pen can not be chopped out with an axe."

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Epidural Anesthesia and Analgesia in High-risk Surgical Patients. III.

To the Editor:—Yeager *et al.* conclude that epidural anesthesia and postoperative analgesia, when compared with general anesthesia, exerted a significant beneficial effect on operative outcome in a group of high-risk surgical patients.[1] Unfortunately, confidence intervals for the differences between the two groups were not given, and highly significant differences cannot be assumed from this small study.

When comparing the efficacy of two treatments, estimation of the range of possible differences between the two provides more information than hypothesis testing. The confidence interval is a range of values that is likely to cover the true but unknown value. Both the *British Medical Journal* and the *Lancet* have encouraged the wider use of confidence intervals.[2,3] The use of confidence intervals and methods of calculation have been reviewed in both these journals.[4,5]

If confidence intervals are calculated for some of the data presented by Yeager *et al.*, the imprecision due to the limited sample size is shown. Four of 25 patients in the general anesthetic group died compared with none in the epidural group. While the best estimate of the difference in the percentage of patients dying is 16%, the 99% confidence interval (CI) ranges from −5% to +37%. The best estimate of the difference in the percentage of patients developing cardiovascular failure is 38%, the 99% CI ranges from 6–70%. The best estimate of the difference in the percentage of patients developing major infection is 33%, the 99% CI ranges from 3–63%. Finally, the difference in the mean cortisol excretion in the first 24 h is 36.6 μg/h, with 99% CI from −10.9 μg/h to +84.1 μg/h.

It is unfortunate that the authors felt it necessary to terminate their study after only 53 patients. Like Dr. McPeek, I am concerned that a difference was detected where, in fact, no difference exists.[6] I am unwilling to change my practice on the basis of such a small, imprecise study.

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Epidural Anesthesia and Analgesia in High-risk Surgical Patients. IV.

To the Editor:—In the recent report by Yeager *et al.*,[1] the study was terminated because "the overall complication rate and complication intensity were strikingly higher in group II patients." It seems that the more ethical course would have been to continue the data gathering to make the study even more persuasive by virtue of larger numbers. Since these data would indicate that common present practice may be deficient, it seems to me that terminating the study for the stated reason is indefensible.

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Epidural Anesthesia and Analgesia in High-risk Surgical Patients. V.

To the Editor:—Drs. Yeager, Glass, Neff, and Brinck-Johnsen are to be commended in their attempt to compare the outcome of two fundamentally different anesthetic techniques in high-risk surgical patients.[1]

Key to the interpretation of outcome is the claim that the two study groups were similar. Despite the fact that patients were randomly assigned to the two treatment groups, it is quite possible that, by chance alone, group II included a few extra high-risk patients compared to group I. This dissimilarity could account for some of the differences in outcome rather than anesthetic technique.

In Yeager *et al.*'s study, the most important comparisons of patient characteristics are the ASA physical status classification and the Goldman index, as indicated in their Table 1. I am not sure the statistics used are valid. What is an ASA physical status of 2.79 (±0.55) or a Goldman Index of 9.1 (±6.8)? The ASA physical status classification and the Goldman Index meet the definition of ordinal data, since they represent categories which can be ranked.[2] The numbers are nothing more than a form of shorthand for groups defined clinically,[3] and, although they can be ranked, the "distance" between any two groups or classes may be variable.[2] An ASA physical status or a Goldman Index could easily be given a letter instead of a number. The numbers do not come from a set of continuous data, and it is inappropriate to calculate means, standard deviations, and *P* values using these numbers.[3] Because of this, the reader cannot be sure that group II did not include several more high-risk patients compared to group I.

The authors should present their data so that we can compare the number of high-risk patients having high-