

The Risk of Anesthesia

Alexander Goldstein, Jr., M.D.,* and Arthur S. Keats, M.D.†

Errors in judgment must occur in the practice of an art which consists largely in balancing probabilities—Sir William Osler

DURING the late nineteenth century, enough British physicians became alarmed over a seemingly high incidence of sudden death during chloroform anesthesia to provoke the British Medical Association, in 1875, to appoint a Committee "to inquire into . . . the relative advantages of chloroform, ether, nitrous oxide gas and other agents." This initial Committee was followed by others, and these by the Hyderabad Commission, whose two reports only added to the controversy. During the extended debate on the relative hazards of chloroform and ether, the *Lancet* sponsored a survey of anesthesia practices and deaths. A questionnaire was sent to each hospital with more than ten beds in the United Kingdom and to larger hospitals in the United States, Europe and India. The results published in 1893, revealed that reports of deaths from chloroform administered without an inhaler were twice those when an inhaler was used, that there were large geographical differences in the usage of ether and chloroform, and that important details were missing in more than half the reports of fatalities. The major question remained unanswered. The *Lancet* commented, "We have, however, no figures to show the number of times these inhalers are used, and, in the absence of these, there is no accurate basis for comparison in regard to their safety or danger."¹ Sadly, the relative safety of ether and chloroform anesthesia remains unknown, and sadder still, the relative

risk of all anesthetics commonly used today remains unknown.

Risk is widely understood as the degree of probability of loss or injury associated with an action. The definition of risk in Medicine is more precise: loss means morbidity and mortality, and these are associated with a disease process and any attempts to modify it. In Medicine, risk is usually balanced against the probability of gain as a consequence of a therapeutic or prophylactic action. Decisions are based on relative loss-to-gain values, even though gain is not an element in the concept of risk. Since anesthesia is rarely therapeutic, it offers no gain values and, perhaps for this reason, risk of exposure to anesthesia has received much deserved attention.

Since risk estimates are so vital in medical decisions, their quality should be appreciated. This quality differs vastly depending on whether the estimate is applied to a group or to an individual in the group. All estimates of risk are based on previous experience, whether data are collected retrospectively or contemporaneously. Estimates represent, after analysis, the behavior of some antecedent group, characterized by some disease or therapy. Based on previous performance, the risk estimate predicts, as a statistical probability, the incidence of morbidity and mortality for a similar theoretical group now at risk. Such estimates applied to groups have often achieved remarkable precision and are the basis of life expectancy tables, which have proved invaluable in judging efficacy of many prophylactic measures and treatments. This precision for groups contrasts sharply with the value of the same statistic applied to individuals within the group. For example, predictions of remarkable accuracy can be made regarding survival of patients with Stage III cancer of the cervix for any period up to five years. It would be folly, however, to predict

* Assistant Professor of Anesthesiology.

† Professor of Anesthesiology.

Received from the Department of Anesthesiology, Baylor College of Medicine, Houston, Texas. Supported in part by Project 22 of the Cardiovascular Research and Training Grant #HE-05435-10 from the National Heart Institute, Public Health Service.

The authors gratefully acknowledge the helpful suggestions and assistance of John D. Turner, M.D., Assistant Professor of Medicine, Baylor College of Medicine, in preparation of this manuscript.

which patient within the group will survive two, and which four, years. Risk estimates, therefore, have served progress in medicine and therapeutics well; they have served poorly to predict for individual patients, who constitute the practice of medicine.

Estimates of risk of anesthesia have been derived from study of large samples, and these estimates range widely. When applied to individual patients, risk estimates have been so inaccurate as to be little more than intuitive; this is the state of the art. Since estimates of morbidity following anesthesia are more equivocal, and since morbidity represents a graded response compared with the enumerative quality of death, we will limit ourselves primarily to risk of mortality. This review will summarize efforts to estimate risk, their limitations, and some approaches toward refining future estimates.

Anesthetic Deaths

Central to the question of anesthetic risk is the definition of an anesthetic death. This is yet to be defined within any reasonable limits. A number of factual and philosophical considerations complicate attempts to derive a precise definition.

Since anesthesia is usually administered only to permit or facilitate a diagnostic or therapeutic procedure, anesthesia risk is largely confounded with surgical risk and a second set of persons and procedures. Indeed, only events between induction of anesthesia and onset of operation clearly relate the risk of anesthesia to patient diseases. But only 5 to 15 per cent of deaths attributed to anesthesia occur during induction of anesthesia, and the causes of deaths during and after operation are usually speculative.^{2, 3, 4, 5} For most deaths, assignment of the relative roles of anesthesia, surgery and patient disease is based on retrospective assumptions, hindsight judgment, bias, and incomplete information.

The multiplicity of drugs constituting the modern anesthetic contributes to the difficulty in estimating anesthetic mortality. Drugs are given by several routes, eliminated by multiple mechanisms at different rates, and have largely unknown interactions. When administration of drugs not associated with anesthesia and nonspecific responses to operation are also con-

sidered, an extraordinarily complex clinical situation evolves, which defies study by classical pharmacologic techniques. Under these circumstances, almost any untoward event could be ascribed to an anesthetic drug.

There is also no agreement concerning the period during which anesthesia is vulnerable as a cause of death. Some studies have considered the role of anesthesia in total hospital surgical mortality; some have limited the period to 30 days; some have considered only events in the operating room and in the immediate postanesthetic period; some have considered only "cardiac arrests." Recently accumulated knowledge concerning metabolism of anesthetic agents and the slow elimination of their metabolites, and knowledge that the onset of fatal hepatitis caused by halothane may appear ten days after exposure, and that fatal hepatitis may be related to an anesthetic exposure in the distant past, all defy attempts to delimit a period of anesthetic vulnerability.⁶

Extensive studies of risk which have been carried out point up further limitations. Deaths from anesthesia are uncommon. To accumulate numbers sufficient to provide risk estimates, an anesthetic experience extending over years is necessary. During the period of study, anesthetic practices change, new agents are introduced, new knowledge is applied, and some causes of anesthetic mortality are either eliminated or ascribed to nonanesthetic causes. Because of changing practices, such estimates serve poorly as historical controls. In addition, most studies fail to describe the types of events which lead to judgments that anesthesia was a primary or contributory cause of mortality. Without knowledge of these judgments, definitions of anesthetic death are unrecorded, and an essential for repetition of the study, therefore, is missing. In studies which report, even briefly, causes of mortality, deaths are often ascribed to "inadequate ventilation," "inadequate blood replacement," "hypotension," or "error in judgment." Details providing the bases for these retrospective judgments are not available. Considering the relative ease with which measurement of blood gases and central venous pressure can now often document inadequacy of ventilation or transfusion, little reliance can be placed on such retrospective judgments as data for historical controls.