

ade. Therefore, he ventilates well going down the hall to the recovery room. There he is placed in a soft bed, and for the first time in several hours he is left alone. His total afferent inflow declines, his reticular formation is not "jangled" so much, and as a result he becomes unable to continue "firing through" the partial neuromuscular blockade which he still has; he becomes, as we say, "re-curarized." His respiratory exchange decreases, he suffers from airway obstruction, his blood pressure rises, he becomes asphyxiated, and perhaps he expires.

The factors described in the preceding paragraph do help keep patients from remembering by making their anesthesia deeper than one might otherwise suspect it to be, but these mechanisms cannot be counted upon to protect everyone from perception and memory of operative experience under the conditions of light anesthesia and complete muscular paralysis. Thus, for reasons of humanity and charity, not to mention the medico-legal aspects of the problem, an incidence of remembrance of operation as low as 1 in 1,000 could reasonably be considered to justify a

plea for a little more anesthesia and a little less relaxant. The plea is indicated, if we consider the occasional patient who *consciously* remembers discomfort and recall also the probability that *subconscious* postoperative memory of pain may persist in certain individuals! How many patients have been influenced as far as their future personalities and actions are concerned by perceived but only subconsciously remembered pain stimuli?

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### Anesthesia and the Levels of Consciousness

IN this issue there appears an article describing the use of nitrous oxide for the study of various aspects of human consciousness. The authors properly point out that the use of nitrous oxide for this purpose is not new, and that in 1799 Humphrey Davy recorded the sensations produced by the agent. Upon closer inspection of the literature of the early nineteenth century, one finds that for nearly fifty years prior to the first use of nitrous oxide to relieve the pain of surgical procedure, interest was manifested in the agent primarily because of its ability to alter the level of consciousness. A careful study of Davy's observations suggest that the current report has duplicated most of them, although in a more refined manner. Thus, Davy observed on nearly every occasion in which he breathed nitrous oxide that "pleasurable, thrilling sensations" (paresthesias) occurred in his legs. He noted that hearing became more

acute and light more intense. Fullness of the head, and increased motor activity were noted. He seemed particularly impressed with the vivid ideas that raced through his mind and at the completion of one of his experiments reputedly said, "What an amazing concentration of ideas!" Perhaps this flight of ideas is analogous to the euphoria described in the current experiments. Davy was aware that at the end of an experiment the ability to recall ideas that occurred while respiring nitrous oxide diminished rapidly. On one occasion he wrote, "As I recovered my former state of mind, I felt an inclination to communicate the discoveries I had made during the experiment. I endeavoured to recall the ideas, they were feeble and indistinct." On another day he wrote, "Had not remarks written immediately after the experiment recalled them to mind, I should have even doubted of their reality."

Prior to 1850, breathing nitrous oxide was popular among scientists and their friends. While it is assumed usually that this was a matter of frivolity, this is not necessarily so. Many worthwhile observations were made. Unfortunately most have faded into obscurity. Woodhouse, a professor of chemistry, described in 1807<sup>1</sup> the effects of nitrous oxide on a large number of students. Others must have similarly experimented with the gas because in his textbook Woodhouse quotes a Professor Silliman of Yale College as having written, "One of our gravest citizens, a man of 38 or 40 years of age, was made to caper about like a monkey, with all the extravagant gestures of a tragedian, and the grimaces of a Harlequin." Such remarks suggest that the principle interest in nitrous oxide was its effect on altering consciousness. At least one of Woodhouse's students, a W. P. C. Barton, was influenced to make a more serious study of nitrous oxide.<sup>2</sup> Barton was impressed with the euphoria produced by nitrous oxide. He wrote, "Indeed, the common expression by which we designate known feelings or sensations are but feeble and inadequate vehicles to convey a just conception as such as we have felt upon respiring this gas; and we may say of the pleasures of the nitrous oxide, as Dr. Rush has fancifully though emphatically observed of the pleasures of the moral faculty: 'It would require a pen, made of a quill, plucked from an angel's wing, to describe half the pleasures arising from this source.'" Barton subsequently conceived the idea that nitrous oxide could be used as an intellectual stimulant, as he wrote ". . . and if three cubeb, as mentioned by Etmuller, taken every day, have a wonderful effect in invigorating the memory, may not the occasional or daily inhalation of a few quarts of this airy beverage, this *boisson intellectuelle*, increase the quantum of genius in our country?" He subsequently suggested that nitrous oxide might be an effectual mental stimulant in hemiplegia, suspended animation such as in submersive asphyxia, tetanus, typhus fever, and in mania.

Not everyone has thought the inhalation of nitrous oxide a pleasant experience. Davy, Beddoes, and others noted that some (espe-

cially the emotionally unstable) considered the sensations produced to be most objectionable. This observation is likewise contained in the investigations of consciousness reported in this issue of the JOURNAL.

It is interesting that these scientists and physicians missed what to the anesthetist is the real importance of nitrous oxide. Davy realized that nitrous oxide could relieve pain, because he used it to alleviate his own toothache, and Barton wrote, "From the results of this experiment, I am decidedly of the opinion with Mr. Davy, that this gas has the power of removing intense physical pain." Others must have been similarly aware of this property of the gas. Perhaps the clinician and the scientist were not as close together in those days as we are sometimes led to believe. It is hard to imagine that a surgeon would not have immediately recognized the potential once he heard of the analgesia produced by nitrous oxide.

Some readers may ask, "What is the value of a study like this? Why bother investigating the effects of nitrous oxide on levels of consciousness? Why not let the matter lie in the grave where it appears to have rested without loss for a hundred years?" Perhaps the best answers to these questions are found in a recent article by Kety<sup>3</sup> wherein a defense of the study of the behavior of intact man is made, "There remains one biological phenomenon, more central to psychiatry than to other fields, for which there is no valid physicochemical model and (or so it seems to me) little likelihood of developing one; this is the phenomenon of consciousness—the complex of present sensations and the memory of past experience which we call the mind." ". . . We do not always get closer to the truth as we slice and homogenize and isolate—that what we gain in precision and in the vigorous control of variables we sometimes lose in relevance to normal function, and that in the case of certain diseases or problems, the fundamental processes may often be lost in the cutting."

It would appear then that a study of consciousness along the lines suggested is worthwhile and that the anesthetist has a unique opportunity for such study. Nearly

all the agents he uses alter levels of consciousness. Perhaps an exhumation of the relationships of anesthetics to levels of consciousness is long overdue. Observations accurately recorded by a discerning anesthetist could supply important data on the functioning nervous system. And all the research equipment needed would be a pad of paper and a pencil.

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### Emory A. Rovenstine 1895-1960

*The following tribute to Dr. Rovenstine, Associate Editor of ANESTHESIOLOGY for 16 years, was written by two of his former students, E. M. Papper, M.D., and S. G. Hershey, M.D.*

When Dr. E. A. Rovenstine died on November 9, 1960, it marked the end of an era. It was the end of the time of giants. This great man's influence will be felt for a long time to come since he contributed directly and forcefully, in a major way, to the effective anesthetic care of the sick.

Dr. Rovenstine will be immortal in the intellectual sense of that word. His greatest contribution, in the opinion of many of his former students, was the bringing of the scientific habit of thought to anesthesiology in a large and systematic way. He had the talent to inculcate this attitude in many of his students. A goodly number of them also contributed in the same spirit so that

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this stimulus grew and developed even further. It is no exaggeration to state that the anesthetic care of the sick in a rational fashion owes much to his influence.

His creativity extended in other directions. He was able to see, very early, the importance of quantitative measurement in relation to the anesthetic process. He saw the need to educate physicians in the finest traditions of American medicine in this specialty, so new at the time he came on the scene. He was a skillful writer, speaker, and communicator. Fortunate, indeed, are many of the population of this country that he lived. Sad and deserted are those whom he taught quietly but effectively to partake of the scientific practice of medicine. Dr. Rovenstine lives each time a patient is safely guided through anesthesia by a competent anesthesiologist, trained to use knowledge with compassion.