offering an explanation for some of the adverse effects of anesthetics. The effect of general anesthetic agents is most manifest, of course, in the response of the central nervous system. Anesthetics, however, act not only upon nerve tissue, but upon all sorts and conditions of cells. The non-anesthetic adverse effects of anesthetics are clinically most apparent in the response of the cardiovascular system to general anesthesia. The negative inotropism characteristic of general anesthetics may, for example, be associated with changes in cellular metabolism, even though the anesthetic state itself may be the result of biophysical events involving membranes within the central nervous system. More work is required before definitive answers can be supplied regarding the nature and significance of metabolic changes during anesthesia. But the outlook for such answers is increasingly optimistic.

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On the Hering-Breuer Reflex and Breathing during Anesthesia

THIS YEAR marks the hundredth anniversary of the description by Hering and Breuer of the respiratory responses to inflation and deflation of the lungs. The reflex bearing their names has been of considerable interest to anesthesiologists and to physiologists studying the control of breathing. Nerve endings in the lungs act as sensors for the regulating centers in the central nervous system to modulate the frequency and amplitude of breathing. It is now well known that this reflex is but one of the many factors influencing the act of breathing.

Breathing during anesthesia and the effect of central depressants on breathing are of primary concern to clinicians and many research workers. The Hering-Breuer reflex has been invoked to explain the rapid and shallow breathing observed during anesthesia with diethyl ether and trichloroethylene. Two or three decades ago, students of anesthesia were taught that "controlled respiration" affects the Hering-Breuer reflex and inhibits inspiration, resulting in apnea. Apparently, this teaching was a misconception and a misinterpretation of clinical observations according to current knowledge.

In this issue of the Journal, Paskin, Skovsted and Smith present evidence derived from studies in man that the Hering-Breuer reflex does not account for tachypnea encountered during anesthesia. A typical response to inflation of the lungs by imposition of an inspiratory load consisted of a decrease in tidal volume and insignificant or minor changes in respiratory frequency. Of particular interest is the observation that inflation of the lung did not evoke appreciable inspiratory inhibition except on occasions during cyclopropane anesthesia, given after premedication with morphine. Their experimental approach is admirable in its simplicity, and the results may remove yet another misconception concerining the respiratory effects of certain anesthetics.

Paskin, Skovsted and Smith properly point out that general anesthetics depress the respiratory control mechanism. This view has been supported amply by recent studies in animals and in man, some of which are referred to by the authors. The extent of depression depends on the anesthetics used and the level of anesthesia achieved.

Failure to demonstrate the reflex response is explained by the hypothesis that the Hering-Breuer reflex is not active in man or that a depressed control mechanism cannot respond even though the pulmonary stretch receptors may be sensitized. Anesthetic sensitization of

pulmonary stretch receptors is well established according to animal studies. However, this phenomena has not been demonstrated in man for obvious reasons. In any case, peripheral receptor activity is only the first of many neuronal units of a reflex arc involved in the regulation of respiration. The status of the central control mechanism, as affected by anesthetics, determines the overall response. Extension of this tenet to other physiologic control systems is suggested by the observation that baroreceptor sensitization by anesthetics is not necessarily followed by hypotension. Hypotension, if manifest, usually may be explained on some other basis. Similarly, a fall in body temperature during anesthesia does not always result in shivering.

But the pattern of rapid and shallow breathing seen during anesthesia remains unexplained. It is convenient to speculate that a depressed control system is not able to adjust its output to compensate for changes in pulmonary mechanics. Paskin and his co-workers clearly show that conscious subjects respond to viscous loading (by imposing a fixed resistance in the breathing circuit) with an increased tidal volume, whereas in anesthetized subjects the tidal volume decreases uniformly. Total thoracic and lung compliance is less than normal during anesthesia. The best of anesthetic circuits adds to the resistance to air flow. However, it is still a moot point whether shallow breathing results in change in thoracic and lung compliance or *vice versa*.

Tachypnea has been explained on several bases other than the Hering-Breuer reflex, for example: acidosis, airway irritation, direct central action. While studies in experimental animals may favor one or the other mechanism, the problem is more complex than it appears. The words of Bard concerning the center (the control system) illustrate this point. Bard defined the center (in this case, respiratory) as: "one or another circumscribed portion of the brain, the functional integrity of which is essential for certain patterned responses. An outstanding feature of the center is its capacity to weld together individual responses to form a complex reaction pattern. The center may also serve as a focus where afferent impulses or changes in the blood act to evoke or repress the total response. Furthermore, with the center intact it is found that other parts of the central nervous system normally exert modifying influences either directly upon it or at some point along the pathway over which it controls the peripheral motor neurons." [1] The complexity obviously is enhanced by the presence of a central depressant.

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Reference

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