Historical Note

Claude Bernard and Anesthesia

The brilliant French physiologist, Claude Bernard (1813–1878), pioneered in the development of a theory of general anesthesia based on experimental evidence. Bernard also made practical contributions to anesthetic techniques, being first to explore curare scientifically and suggesting its clinical use.

Although aspiring to become a tragic poet, Claude Bernard was advised to forget his melodramatic urge and turn toward science. Fortunately, he was inspired by the handsome and keen medical teacher, François Magendie (1783–1855), who established the first experimental physiology laboratory in Paris at the Collège de France. Bernard was chosen to be Magendie's assistant, and at the latter's death, succeeded him. Bernard's life has been well described by my late colleague, James M. D. Olmsted (1886–1956), in his book, Claude Bernard, Physiologist (Harper, New York, 1938).

Bernard fashioned his famed lectures on the examples set by Magendie. Most of Bernard's great physiological contributions were summarized in a remarkable series of published lectures, beginning with Leçons de physiologie experimentale (Baillière, Paris, 1855–56), and concluding with Leçons de physiologie opératoire (Baillière, Paris, 1879). Of particular interest to anesthesiologists are: Leçons sur les effets des substances toxiques et medicamenteuses (Baillière, Paris, 1857) and Leçons sur les anesthésiques et sur l'asphyxie (Baillière, Paris, 1875). As suggested in the title page (Fig. 1), the latter summarized Bernard's many years of thought and experimentation on a matter of prime interest to him.

As early as 1855, Bernard experimented with chloroform and curare, reporting his scientific findings as he went along. These appeared in the current scientific journals after presentation at a meeting, quite as we do today. The 1857 lectures on toxic substances contained descriptions of the analyzed gaseous content of blood and a full account of the mechanism of toxicity of carbon monoxide. He demonstrated that the lethal effects of carbon monoxide were due to irreversible combination with hemoglobin, thus preventing transport of oxygen to tissues. The lectures included discussions on asphyxia and artificial respiration. In a clear account of curare's effects, he demonstrated that the drug causes paralysis by blocking the transmission of nerve impulses to muscles. After consideration of the poisonous actions of strychnine, venoms and nicotine, Bernard discussed the toxicity of alcohol, ether and chloroform, noting their interference with pancreatic and intestinal secretions, and with liver function. Ether, he suggested, rendered an animal diabetic, probably by disturbing the glycogenic function of the liver. This was one of his great discoveries.

In his lectures on anesthetic agents, Bernard returned to his early studies on chloroform, from which he suggested a theory for general anesthesia. He disputed the belief, commonly held in 1870, that asphyxia was the chief causal factor in the production of anesthesia. Instead, he regarded asphyxia as a danger. It may have been this general misapprehension which persuaded Bernard to offer a series of formal lectures on anesthesia in which he reviewed his earlier experiments with chloroform and proposed a theory of anesthesia.

Bernard, a skilled experimenter, was accustomed to working on isolated nerve–muscle preparations, as in his studies with curare. When he applied chloroform to muscle, he found that it lost excitability and gradually became rigid and opaque. Nerve also, he noted, lost conductivity and became opaque. When the concentration of chloroform was not too great, Bernard found that washing away the chloroform with physiologic salt solution restored the ability of nerves and muscles to conduct impulses and contract. He noted similar results with ether and alcohol, and proposed that anesthesia was the result
of reversible coagulation of the chemical constituents of nerves and muscles, chiefly proteins.

Bernard's theory of anesthesia was promptly criticized on the grounds that the concentration of anesthetic agent necessary to cause coagulation was higher than that which caused anesthesia. Years later, however, Bernard's reversible protein coagulation theory of anesthesia was revived, when W. D. Bancroft (1867-1953) and G. H. Richter of Cornell showed that low concentrations of volatile anesthetics produce reversible coagulation in various colloidal systems, even in yeast cells (Proc. Nat. Acad. Sci. 16: 573-577, 1930). Professor Bancroft's experimental evidence was weak, and he was generally suspected of wishful thinking, quite the antithesis of Claude Bernard's rigorous self-criticism. Yet, Bernard's theory of anesthesia was conclusively shown untenable in a careful study by V. E. Henderson (1877-1945) and G. H. W. Lucas of Toronto, well respected for their scientific work on anesthesia, leading to the development of cyclopropane.

Claude Bernard's theory was actually a general theory for narcosis. He recognized the progressive stages of central nervous system depression from analgesia through anesthesia to death. In connection with his general theory of narcosis, Bernard suggested premedication with morphine before anesthesia to reduce the amount of inhalation anesthetic necessary for satisfactory anesthesia. Bernard had noted in 1864 that morphine potentiates chloroform activity. L. Labbe (1832-1916) popularized the use of morphine premedication among French surgeons (Compt Rend. Acad. Sci. 74: 627-29, 1872). Later, atropine was added to counteract morphine depression and also to prevent the vagal effects of chloroform on the heart.

As Henderson later showed (Physiol. Rev. 10: 171-220, 1930), no satisfactory general theory for anesthesia has yet been proposed. As Bernard suspected, it may be a phenomenon in which many factors are operative, and may contribute. Claude Bernard well deserves the respect of anesthetologists for his pioneering efforts to explain anesthesia, for his practical suggestion of morphine premedication before anesthesia, and for his study of curare, suggesting its cautious use for relaxing muscles. Bernard set a great example of thoughtful effort in trying to offer satisfying explanations of living phenomena, one of the most interesting of which remains anesthesia. Since Claude Bernard is considered by so many to have been the pioneer in scientific pharmacological study of anesthesia, and its practical applications, it is fitting that this issue of Anesthesiology, devoted to anesthesiology and clinical pharmacology, be dedicated to him.

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