This Week's Citation Classic®

Stow R W, Baer R F & Randall B F. Rapid measurement of the tension of carbon dioxide in blood. *Arch. Phys. Med. Rehabil.* 38:646-50, 1957.
[Section of Physical Medicine and Rehabilitation, Coll. Medicine, Ohio State Univ., Columbus; Toledo Society for Crippled Children, Opportunity Home, OH; and Coll. Medicine, Univ. Missouri, Columbia, MO]

The paper reviews the basic concepts pertaining to blood gases and the chemical methods of analyzing blood samples for the partial pressure of CO_2. Physical methods of analysis are outlined. The construction of and the results obtained with the pCO_2 electrode are described. [The *SCI*® indicates that this paper has been cited in over 115 publications, making it the most-cited paper for this journal.]

Richard W. Stow
24851 State Route 56
S. Bloomingville, OH 43152

March 12, 1987

I presume this paper has been cited many times because it is the only refereed paper we published on the pCO_2 electrode. The essential and at that time new idea was first published as the abstract of a paper given at the fall meeting of the American Physiological Society in 1954.[1] The cited paper was given at the annual meeting of the American Academy of Physical Medicine and Rehabilitation in 1956. Publication was delayed because the manuscript was lost in the editorial office.

Before I came to Ohio State University in the fall of 1953, I had laid the groundwork for the pCO_2 electrode work with my research in cardiorespiratory physiology at the Mayo Foundation. There I had learned that rubber bags were leaky for CO_2 and that the chemical means of measuring the pCO_2 of blood were laborious and time consuming. I was without a laboratory when I first moved to Ohio State, so there was nothing to do but think.

Blood is such a complex system that it seemed important, if possible, to simplify the system before measurement. What better way could there be than to use a semipermeable membrane, and what better material could there be for that than rubber? Rubber is impermeable to water (I thought) and probably to electrolytes and certainly to large molecules and cells. Actually, rubber is permeable to water vapor, O_2, N_2, and other small neutral molecules. Of the physical properties that could be measured behind a rubber membrane, the pH was attractive. The sensors and meters were available. However, the dead space behind the membrane was a problem if commercially available glass and reference electrodes were used.

Since I could blow glass, I constructed a pair of electrodes with a calomel cell along the axis of a cylinder and the glass electrode concentrically along the annular space. A finger cot stretched over the wetted pair completed the device. The meter reading was responsive to the CO_2 of the environment of the device and insensitive to the pH outside the membrane. The deflections for CO_2 were small, but they were in the right direction and were proportional to the log of the pCO_2. To get an unmistakable deflection I exposed the device to a fresh sample of Coca-Cola. The response was gratifying, to say the least. The pCO_2 electrode was off and running.

Although I was alone in the early work on the electrode, B.F. Randall assisted valuably in the later work, and R.F. Baer did his master's thesis on the electrode. In 1985 I received the Nernst Award.

[For recent developments in the field see reference 2.]

1. **Stow R W & Randall B F.** Electrical measurement of the pCO_2 of blood. (Abstract.) *Amer. J. Physiol.* 179:678, 1954.
2. **Astrup P & Severinghaus J W.** *The history of blood gases, acids and bases.* Copenhagen: Munksgaard, 1986. 332 p.

CC/LS 1A21