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This Week's Citation Classic

Fry D L & Hyatt R E. Pulmonary mechanics: a unified analysis of the relationship between pressure, volume and gasflow in the lungs of normal and diseased human subjects. *Amer. J. Med.* 29:672-89, 1960.
[Cardiodynamics Sect. Natl. Heart Inst., NIH, Bethesda, MD and Cardiopulmonary Lab., Beckley Memorial Hosp., Beckley, WV]

The mechanical behavior of the human lung may be described by three simultaneous variables, 'intrapleural' pressure (P), respiratory gas flow (F), and lung volume (V), which can be viewed in a three-dimensional diagram. This provided a unified picture of the interrelated mechanical events during breathing and led to the description of the 'expiratory flow-volume curve.' [The *SCI®* indicates that this paper has been cited over 255 times since 1961.]

Donald L. Fry
Laboratory of Experimental Atherosclerosis
College of Medicine
Ohio State University
Columbus, OH 43210

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"Bob Hyatt and I are pleased that 'Pulmonary mechanics' has proved to be a useful reference in the field of pulmonary physiology and pathophysiology. This work allowed us to organize observations from many workers into a simpler, conceptually more easily assimilated, pattern of information.

"Earlier work had introduced the concept of pulmonary isovolume pressure-flow curves.[1] We extended this concept to show that the mechanical behavior of the lung could be described rather uniquely by three simultaneous variables, 'intrapleural' pressure (P), respiratory gas flow (F), and lung volume (V), which could be viewed in three-dimensional space as a PFV surface. All respiratory maneuvers could be represented as circuitous trajectories on this surface.

"We found various disease states to be associated with characteristic distortions of the shape of the PFV surface which suggested that early pathological changes should be associated with more subtle changes. We set about examining various ways of quantifying these changes with the goal of correlating these with various lesions in the lung. These efforts resulted in only modest progress toward the ultimate objective because of the enormous difficulty of making the necessary local mechanical measurements to correlate with the global behavior of the PFV surface.[2]

"In retrospect, the most useful result of these activities occurred at the outset when one day we were looking at the PFV diagram and noted an obvious and invariant feature of the diagram, namely, the shape of its silhouette projected onto the expiratory half of the flow-volume coordinate plane. We named the perimeter of this projection the 'maximum expiratory flow-volume' (MEFV) curve. This curve represents a plot of the flow maxima of the expiratory isovolume pressure-flow curves versus the corresponding volumes.[3] The MEFV curve is easily obtained from the simultaneous measurement of respiratory flow and lung volume. This measurement requires very little patient cooperation, does not require the measurement of the 'intrapleural' pressure, is invariant in a given subject, and, most importantly, is sensitive to changes inherent to the pulmonary system since the MEFV curve is determined solely by the aerodynamics, conduit geometry, and rheological properties of the intrathoracic pulmonary system.[2,3] It has become a valuable objective measurement of pulmonary mechanical function with a variety of diagnostic and investigative applications.[4]

"Thus there are probably two reasons for the frequent citing of this paper: first, it provided a useful unified analysis of pulmonary mechanical function which facilitated one's ability to conceptualize the interrelated set of mechanical events associated with breathing. Second, it directed attention to the significance of a simple but unique parameter of pulmonary function, the MEFV curve."

1. Fry D L, Ebert R V, Stead W W & Brown C C. The mechanics of pulmonary ventilation in normal subjects and in patients with emphysema. *Amer. J. Med.* 16:70-97, 1954.
2. Fry D L. A preliminary lung model for simulating the aerodynamics of the bronchial tree. *Comput. Biomed. Res.* 2:111-34, 1968.
3. Hyatt R E, Schilder D P & Fry D L. Relationship between maximum expiratory flow and degree of lung inflation. *J. Appl. Physiol.* 13:331-6, 1958.
4. Hyatt R E & Black L F. The flow-volume curve. A current perspective. *Amer. Rev. Resp. Dis.* 107:191-9, 1973.