

Preface

*Look back on time with kindly eyes
He doubtless did his best*

Emily Dickinson

The study of the mechanics of the lung and chest wall goes back to ancient times. This study was revived in the renaissance and continued with the rise of science in subsequent centuries. The modern surge in respiratory mechanics is traced to the work of Otis and Rahn at the University of Rochester, stimulated by the drive to fly at higher altitudes and with greater accelerations during and after WWII. The field blossomed beginning in about 1960. Strong groups emerged at several institutions: Montreal led by Peter Macklem and Millic-Emili, Mayo Clinic led by Bob Hyatt, Johns Hopkins led by Sol Permutt, and, in more isolated instances, Nick Antonisen in Winnipeg, the group of anatomists led by Weibel at Bern, Jack Hildebrandt in Seattle, and surfactant scientists John Clements at UCSF and Sam Schurch in Manitoba. The foremost group was that at the Harvard School of Public Health, headed by the dean of the field, Jere Mead.

I began applying fluid mechanics to respiratory problems on my own, but by the mid-1960s, Jere Mead had taken on an engineer, and Bob Hyatt wanted to follow suit. I began collaborating with him and later with Joe Rodarte and Ken Beck at Mayo. Collaboration with Andre De Troyer began at Mayo and continued after he returned to Brussels. These people provided my education, guidance, encouragement, and scientific resources. They also introduced me to the larger community, and that community, following Jere's lead, welcomed newcomers gladly. The following 50 years have been productive and enjoyable, and I am grateful to the community in general and the group at Mayo in particular for the pleasure of spending my professional life in their company.

This monograph contains three chapters. The first describes the mechanics of the parenchyma that underlies the pressure–volume curve for uniform lung expansion and describes two important nonuniform lung deformations. The second describes the action of the respiratory intercostal muscles and the diaphragm. The third

describes flow, including maximum expiratory flow, gas transport in the airways, and what is known phenomenologically at this point about nonuniformity of alveolar ventilation. It seems logical to include the pulmonary circulation and gas exchange as part of respiratory mechanics, but for some reason, perhaps simply by historical accident, the community that studied those topics was somewhat separate from the community that studied the topics covered here.

I know of no monograph on this subject, except perhaps for the volumes on mechanics in the 1986 edition of the *Handbook of Physiology: Respiration*. In the preface to those volumes, Mead and Macklem wrote that “We are still just beginning to describe breathing adequately, let alone understand it. We have only the vaguest notion as to the relative importance of tissue and surface forces in lung recoil. We appear to have no idea at all about the physiological role of smooth muscle. We have yet to agree on the actions of the respiratory muscles, and the ghost of Hamberger is back among us.” Since then, the contributions of surface tension and tissue forces to lung recoil and the respiratory action of the intercostal muscles have been described. Although the physiological function of smooth muscle is still unknown, much more is now known about the properties of smooth muscle and the mechanics of constricted lungs. In addition, the source of ventilation/perfusion heterogeneity and the mechanics of the pleural space are better understood.

In the late 1980s, NIH gave ample warning that money was shifting to molecular and cellular biology. NIH is insulated from and unfettered by concerns about the welfare of people on its grant payrolls. It does not fire anyone or dictate anyone’s activity; it simply takes the money from here and puts it there. Some 40–50 references are cited in each chapter of this book. Except for the book by Hamberger (1740), the dates range from 1951 to 2014 with the peak years in the 1980s and 1990s. Like symphony orchestras, newspapers, and fountain pens, the study of respiratory mechanics has disappeared from human affairs. But the physiology has not, and I hope our understanding of that physiology is preserved.

A final note on the field. Much of the data on respiratory mechanics was obtained in dogs. Now, animal rights groups have imposed restrictions on the use of dogs in research, and as a result, experiments on dogs have decreased to nearly zero. Only bred-for-research dogs that have minimal contact with humans are used. Thus, despite the fact that tens of thousands of dogs are euthanized in pounds each year, more dogs are being created to be killed intentionally. I do not see that the welfare of animals has been served.

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