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Lung Function Testing

Edited by
R. Gosselink and H. Stam

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Lung Function Testing

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EUROPEAN RESPIRATORY MONOGRAPH

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Preface

Although diagnosis always begins with a careful history and physical examination and a physician is obligated to consider more than the diseased organ, testing of lung function has become standard practice to confirm the diagnosis, evaluate the severity of respiratory impairment, assess the therapy response and follow-up patients with various cardio-respiratory disorders. Ventilation, diffusion, blood flow and control of breathing are the major components of respiration and one or more of these functional components can be affected by any disorder. Frequently, no single pulmonary function test yields all the information in an individual patient and multiple tests have to be combined to allow proper evaluation of the patient. The pulmonary function laboratory is therefore very important in pulmonary medicine to provide accurate and timely results of lung function tests.

The purpose of this issue of the *European Respiratory Monograph* is to provide up-to-date information on the application and interpretation of different pulmonary function tests in the work-up of patients suffering from cardio-respiratory diseases. In each chapter of this issue, the contributors have attempted to relate theoretical considerations of the different physiological tests to clinical application. New insights into the diagnostic approach to patients with respiratory impairment form an integrated part of the different chapters. This issue not only offers the reader a state-of-the-art approach to pulmonary function testing, but also contributes significantly to a better understanding of the pathophysiological processes underlying various diseases and contributing to the morbidity of patients.

The guest editors of this issue, Henk Stam and Rik Gosselink, have done a great job in the coordination and planning of this issue of the *European Respiratory Monograph*. The authors of the different chapters have really tried to give the reader up-to-date information about the different lung function tests. Therefore, I am convinced that the knowledge and information provided in this issue of the *European Respiratory Monograph* will contribute to the best possible evaluation and care for afflicted individuals.

E.F.M. Wouters
Editor in Chief

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INTRODUCTION

H. Stam, R. Gosselink

The first indirectly described spirometer system consisted of a glass bottle without a bottom, which was placed in a tub of water. The centre of gravity was so low that the bottle did not capsize. The neck of the bottle was closed with a tap. The patient expired *via* a tube, which led through to the underside of the bottle. Expiratory vital capacity could be determined from the bottle's displacement. There have been many changes since these first descriptions of spirometry. Lung function research is a relatively young science. Physicists have historically made an important contribution to the scientific development of lung function analysis due to the importance of topics such as elasticity, resistance, muscular strength and the work of breathing. These pioneers saw parallels with models in electricity, with which they could calculate and predict lung function results. However, the system of millions of alveoli and small airways are studied with a relatively small number of indices, all measured at the mouth. In practice, simple models appeared to give the most useful information. Nowadays, accurate measuring techniques and the use of fast computers offer the pulmonologist lung function data that gives specific information on, for example, airway resistance, ventilation equality, ventilation-perfusion mismatch, diffusion characteristics of the blood-gas barrier, *etc*.

In this issue of the *European Respiratory Monograph* experts describe the state of the art of a specific topic within the field of lung function. In each chapter, background, technical possibilities and impossibilities, the importance in diagnosis and the consequences for treatment are discussed. The measurement of lung function indices in adults, as well as children, and the possibilities of measuring lung function in the intensive care unit are described. The topics vary from simple office spirometry, as performed by the general practitioner, to more sophisticated techniques, such as impulse oscillometry performed in a lung function laboratory. Performing simple office spirometry is not as simple as it seems. The spirometric indices are maximal measurements and instruction is crucial. When equipment delivers a flow–volume curve the appearance of the curve offers the general practitioner information on the correctness of the measurement. Adults are relatively easy to instruct, but the instruction of small children can be problematic. Measurements that do not require the cooperation of the child are therefore preferable. An important development in paediatrics could be the forced oscillation technique. In this method measurements are performed during spontaneous breathing. With the help of superimposed pressure oscillations, information on airway resistance is obtained. In spirometry the forced expiratory volume in one second is an indirect measure of airway obstruction. In the Chapter 2 the measurement of airway resistance using body plethysmography is described. The difference between total lung capacity (TLC) obtained with the helium dilution technique and TLC obtained with body plethysmography is a measure for trapped air. For a proper gas exchange alveolar oxygen partial pressure needs to be high and carbon dioxide partial pressure low. The ventilation process refreshes the alveolar gas breath-by-breath, while ventilation is controlled by chemical and mechanical receptors. The arterial blood gas tensions provide

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the simplest indicator of the adequacy of ventilatory control. Where there is little or no mechanical abnormality, an elevation of the CO_2 tension is an indication of inadequate ventilation and impaired control mechanisms. The respiratory muscles play a crucial role in the ventilation process. In Chapter 4 tests to evaluate the strength and endurance of the respiratory muscles are described. The main function of the lung is the exchange of O_2 and CO_2 between the ambient air and the capillary blood. Diffusion characteristics of the alveolo-capillary membrane and ventilation-perfusion mismatch play an important role in gas exchange. These items are discussed extensively in Chapters 6 and 7. Finally, exercise testing, where all the aforementioned systems are subjected to stress, is reviewed in Chapter 8.

Unfortunately, a chapter dealing with reversibility and provocation tests in patients with asthma to study hyperreactivity of the airways could not be included in this Monograph. However, we are convinced that the most important issues concerning lung function testing are reviewed.