Body Plethysmography

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Body Plethysmography

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Research in Emphysema and Chronic Bronchitis


Progress in Respiration Research


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Contents

Introduction VII

I. Design and Technical Problems
Time Characteristics and Frequency Response of Body Plethysmograph. D. Bargeton and G. Barres (Paris) 2
Recent Applications of Volume Displacement Body Plethysmographs. A. Bouhuys (New Haven, Conn.) 24
Electronic Compensation of Differences in Temperature and Water Vapour Between In- and Expired Air and Other Signal Handling in Body Plethysmography. U. Smidt, K. Muysers and W. Buchheim (Moers) 39
Some Experiences with Electronic Simulation of BTPS Conditions in Body Plethysmography. H.-J. Woitowitz, W. Günthner and R. Worowrzz (Erlangen) 50
The Use of a Pneumatic Zero Correction System and a Storage Oscilloscope with the Body Plethysmograph. W.T. Suermondt (Utrecht) 61
Spirometer Response and Pressure Correction in Body Plethysmography. K. P. van de Woestijne and A. Bouhuys (New Haven, Conn.) 64

II. Measurements: Ventilation

The Transfer Function of the 'Man-in Differential Plethysmograph' System. Ch. Jacquemin and P. Varêne (Paris) 76
Plethysmographie Measurement of the Impedance of the Gaseous Ventilatory System. P. Varêne and Ch. Jacquemin (Brétigny) 88
Experimental Studies on the Existence of Isothermal Conditions in the Human Lung. D. Nolte (Giessen) 102
Loop Formation in Pressure vs. Flow Diagrams Obtained by Body Plethysmographie Techniques. M.J. Jaeger and A. Bouhuys (New Haven, Conn.).......116
Computer-aided Investigations of Airway Resistance with Time. R. Worowrzz and
VI Contents

III. Measurements: Circulation

The Mechanical Effect of the Heart Beat on the Plethysmographie Pressure. R.J. Mills (Birmingham) 164
Effect of Respiration on Pulmonary Capillary Blood Flow Measured in Man by Body Plethysmography. P. Vermeire (Gent) and J. Butler (Seattle, Wash.) 177

IV. Clinical Applications

Differences Between Intrathoracic Gas Measured by the Body Plethysmograph and Functional Residual Capacity Determined by Gas Dilution Methods. G. Reichel (Bochum) 188
Comparison Between Measurements of Functional Residual Capacity and Thoracic Gas Volume in Chronic Obstructive Pulmonary Diseases. L.J.Corbeel (Ottignies) 194
Patterns of Correlation of Pulmonary Function Values Determined by Spirography and Body Plethysmography. H. Herzog, R. Keller, R. Amrein, H. Matthys and J. Joos (Basle) 205
Bronchodilation Estimated by Body Plethysmography (Comparison Between the Panting and Spontaneous Breathing Methods). R. Peset, Ph. H. Quanjer and G. J. Tammeling (Groningen) 225
Use of the Body Plethysmography in Children. A. Zapletal, E. K. Motoyama, K.P. van de Woestijne, L.E. Gibson and A. Bouhuys (New Haven, Conn.) 228
Lung Tissue Resistance in Symptom-free Asthmatic Children. F. Geubelle and J. Senterre (Liège) 236

V. Body Plethysmography in Japan

Body Plethysmography in Japan. Y. Miyamoto (Hannover) 250
Body Plethysmography in Japan. K. Sera (Philadelphia, Pa.) 257

Introduction

A. B. DuBois
The idea of a Symposium on Body Plethysmography appears to have arisen in two places simultaneously. One was in the European Society for Clinical Respiratory Physiology; the other was in the Departments of Anesthesiology and Physiology at Nijmegen. These two groups combined their efforts. Dr. van de Woestijne undertook the organization of the Symposium, with the initial assistance of Dr. Arthur B. Otis. Then, since Dr. Otis could not make the trip, I was asked to take his place.

I had no previous idea how far this field had advanced in Europe. There was the work in the German literature dating from the 1880's; and I had visited Dr. Bargeton's laboratory in 1956. There had been rumors of elaborate, expensive, modern equipment. However, I was unprepared for, but pleased to see, the elegant Plethysmographs which are in use in Europe today. This is not a review of the development of body plethysmography. However, I might set down some of the less formal aspects.

In the hallway of the Department of Physiology in Rochester, in 1951, there stood a metallic box against which a research fellow might stumble while en route from Adolph to Otis, Otis to Rahn, or Rahn to Fenk. It seems that Dr. Blair had used it to measure abdominal gas volume [2]. He recorded \( v \) during equal degrees of abdominal straining prior to and after ingestion of a Coca Cola, which liberated 0.5 l of CO2. He solved Boyle's law by substituting into it the two sets of values for \( v \), one with and the other without 'Coke'. I suppose the measurement could equally well have been carried out with beer or champagne; though so far as I know, these have not yet been tried.

My next acquaintance with such boxes occurred in Philadelphia. Dr. McCutcheon, who was a physiologist in the School of Veterinary Medicine, had been using a closed box to measure 'alveolar pressure changes' in animals [6]. As the animal breathed, the pressure rose and fell, owing, as he thought, to the swings of alveolar pressure. Failure of the box pressure to return to baseline was attributed to air trapping. But it could equally well have been due to temperature and humidity changes of the tidal air [3].

Dr. Stella Botelho had been measuring the functional residual capacity in cats by occluding the tracheal tube throughout inspiratory effort, with the cat in a Plethysmograph constructed from a baby Drinker respirator. She obtained accurate figures for the cat's FRC.

Dr. Comroe and Dr. Botelho started some tests on man, hoping to measure first the FRC, then the airway resistance. They built a body
Plethysmograph with a cylindrical metal bottom surmounted by a plastic dome. The bottom is now used to dip and wash animal cages. Later they constructed a double chambered box whose metal walls were braced with channel irons.

It was my good fortune to be able to make the system work properly.

We were aware of Dr. Ronald Christie's review of the older German literature [4]. My German was not good enough then to realize that Pflüger's paper [7] described an FRC method which we currently call the 'decompression method' whereas the voluntary compression method had been described by Gad [5], as cited by Bass [1].

The first days of a new method are the most fun. My first normal subject for airway resistance was a physiologist in our Department named Dr. Ferdinand Kreuzer, studied on January 7, 1954. It is fitting that he is the sponsor and host for this Symposium. Another normal subject, three weeks later, was Dr. Jeanne Teychenné of the Faculté de Médecine. It is no wonder that the table of normal values applies equally well to Europeans and Americans.

I like to put visitors in the box. But one of the first 'normal' visitors showed an airway resistance of 5.5 cmH20/L/sec, at a lung volume of 3.3 l. This seemed high to me, although there were only a few normals with which to compare it. I escorted him into the next room to demonstrate the nitrogen meter single breath test. He had normal mixing. I therefore knew he did not have emphysema. It turned out that he had a funnel chest (pectus excavatum) with some compression of the trachea.

Relatives as well as visitors are interesting cases, because of the element of the unexpected. A great aunt (Aunt Bessie) had been an amateur diver, and a suffragette and was still a good sport at age 87. She fearlessly stepped into our box. I was pleased to be able to tell her that her airway resistance was the same as that of a sixteen-year-old girl.

The psychiatrists heard about our airway resistance measurements and came downstairs aflame with desire to provoke an attack of asthma. Their stress interviews on patients curled the toes of even our tough physiologists. As a control, they recorded the subject's verbal reactions to sitting in our box. From these interviews, they learned that there was one thing which upset the subjects during the airway resistance procedure. It was a placard which I had placed beneath the window: 'In case of emergency, break glass'. This was intended to amuse. But the patients wanted to know: How can you tell when there is an emergency? Anyway we did not want them to break the glass, and therefore did not provide them with a
hammer.

My current interest concerns a tank which is filled with water, and which has a lid that rests in a rubber groove. One day, the person who operated the tank forgot to turn the breathing valve, and the subject, inside, pushed out the plug in the lid, thereby releasing the water pressure, lifted the lid, and stood up like Poseidon emerging from the sea. Next day, there were rumors that the laboratory below had been deluged through its ceiling; however, the plumber had been unable to find any broken pipes. When Dr. Kawakami left to return to Japan, he reported to me that prior to his leaving Japan he had been warned by a fortune teller that ‘you will have much trouble with water’, and that he had misinterpreted this, at the time, as portending a rough voyage across the Pacific.

In the early days, there was considerable competition to decide what a body Plethysmograph might be used for if, as it repeatedly seemed, it should turn out to be useless in the laboratory. To some it was a phone booth, to others a fall-out shelter. Some believed that if grounded, it would shield out mental telepathy from a licensed medium. Children might play in it as a space rocket. But then, some utility began to appear. Grant Lee arrived, and there was eagerness to breathe nitrous oxide, partly for its euphoric effect. Dr. Dautrebande convinced us that inert particles might be pneumoconstrictors, and Dr. Comroe continually helped to organize the work.

He tells me that at a certain stage of development the box was called ‘Comroe’s Folly’. This Symposium should help to clarify to what extent the term ‘folly’ still applies.

If, during this Symposium, it should develop that the Box is now respectable, then it would seem appropriate to congratulate Dr. Comroe on his foresight in building one, to praise previous investigators for their early use of the method, and to applaud subsequent workers for their contributions to useful knowledge in the field.

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References


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