Second International Conference
on Lung Sounds

September 29, 30 and October 1, 1977 - Shriners' Burns Auditorium

University of Cincinnati Medical Center

Cincinnati, Ohio, U.S.A.

Steering Committee: Robert G. Loudon - Cincinnati

Raymond L.H. Murphy, Jr. - Boston

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SECOND INTERNATIONAL CONFERENCE ON LUNG SOUNDS

UNIVERSITY OF CINCINNATI COLLEGE OF MEDICINE

CINCINNATI, OHIO

PROGRAM

<u>Thursday, September 29, 1977</u>

Registration		8:30 am
Introduction ----------------------------Robert G. Loudon		8:45 am
Objectives and Scope of the Conference---Raymond L.H. Murphy, Jr.		8:50 am
Session A	9:00 am - 12:00 Noon	
Lunch	12:30 pm - 1:30 pm (Cafeteria - Cincinnati General Hospital)	
Session B	1:30 pm - 4:15 pm	
Panel Discussion		4:15 pm
	Cocktails and Buffet	7:00 pm

<u>Friday, September 30, 1977</u>

Session C	9:00 am - 12:00 Noon	
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<u>Saturday, October 1, 1977</u>

Committee on Lung Sound Nomenclature (Ohio Room - Terrace Hilton Hotel)	9:00 am

Session A

Mechanisms of Production

Chairman: Jere Mead

Session A: Mechanisms of Production

Chairman: Jere Mead

9:00 am	Velocity Profiles and Frequency Characteristics of Airflow in Canine Large Airways	A.T. Mosberg and R.M. Nerem
9:20 am	Fluid Dynamic Flutter of Collapsible Tubes: Eigenfrequencies and Flow Limitation	J.B. Grotberg and S.H. Davis
9:40 am	Multiple Gas Sound Transmission Studies in Excised Dog Lungs	J.J. Fredberg and R.G. DeJong
10:00 am	General Discussion	
10:15 am	Coffee	
10:40 am	Interrelationships of Rales and the Accumulation and Distribution of Lung Liquids in a Canine Pulmonary Edema Model	R. Donnerberg, D. Rice, C. Druzgalski, R. Hamlin, G. Davis and R. Campbell
11:00 am	Intracranial Sound Analysis	C. Olinger
11:30 am	Heart Sound Analysis	R. J. Adolph
12:30 - 1:30 pm	Lunch	

VELOCITY PROFILES AND FREQUENCY CHARACTERISTICS OF AIRFLOW IN CANINE LARGE AIRWAYS

A. T. Mosberg
R. M. Nerem
R. L. Donnerberg

Many investigators believe that sound production in the lung is, in many instances, related to fluid mechanical events occurring within the airways. The lung sounds that have been recorded and analyzed by others may be more fully understood when considered in conjunction with airways aerodynamics. In vivo point velocity measurements in the dog trachea and bronchi have been initiated to provide this information.

A hot-wire anemometer probe, operating with its concomitant electronics, was introduced through the lateral aspect of an exposed canine trachea. The probe was positioned 1 mm from the lateral wall by a specially designed advancing mechanism. Continuous velocities, including fluctuating components to 5,000 Hz, were measured at this location for 3 breaths. The probe was then sequenced 1 mm after every 3 breaths, thus traversing the entire lateral diameter of the trachea. This procedure was repeated in the dorso-ventral diameter of the same cross-section. Velocity profiles were determined at 8 locations along the trachea in 15 different experiments. Inspiratory centerline velocities were also determined in the large bronchi by retrograde hot-wire probes positioned by bronchoscopy. Anemometer, pneumotachygraph, and sound signals were recorded on FM tape for subsequent processing.

Velocity profiles were characteristically highly blunted, asymmetrical and time-dependent. The frequency content of the velocity signal decayed characteristically to minimal values at about 2,000 Hz. The time-dependent frequency amplitude relationship reflected the magnitude of the velocity. Sound and velocity frequency spectra exhibited similar behavior, both terminating at approximately 2,000 Hz.

FLUID DYNAMIC FLUTTER OF COLLAPSIBLE TUBES:

EIGENFREQUENCIES AND FLOW LIMITATION

James B. Grotberg
Stephen H. Davis

Airway flutter is mathematically modelled by an inviscid, incompressible fluid flowing through an infinite, two-dimensional, flexible channel. The allowable oscillation frequencies (eigenfrequencies) are determined from the linearized, unsteady perturbation equations of mass and momentum conservation, and the kinematic and stress boundary conditions. The resulting eigenfrequencies depend on the wave length, the fluid velocity and the wall and fluid material properties. Criteria for stable oscillations are established.

The velocities and hence frequencies of the predicted traveling waves are inversely related to both the wall mass and fluid mass and directly related to the wall elastance. Increasing mass flow rate, however, has two competing effects. It slows the waves but also tends to "carry" them downstream. The model may explain pitch changes in fluttering airways toward the end of inspiration or expiration. It suggests that at high enough volume flow rates, different density fluids will yield different pitches and that the flutter location may be determined. In addition, the "wave speed" flow limitation criterion (local "wave speed" of a massless, steady tube equalling the local fluid velocity), emerges as a feature of this more general approach, thus allowing a physical interpretation.

MULTIPLE GAS SOUND TRANSMISSION STUDIES IN EXCISED DOG LUNGS

J. J. Fredberg
R. G. DeJong

We have measured the ratio of airway opening pressure to normal stress at the pleura in excised canine lungs and lobes from 50 Hz to 5 kHz using air, helium, and SF_6 as working gases. These experiments used broad-band random noise for system excitation, and digital analysis for signal processing. The boundary condition at the pleural measurement position was zero velocity. Multiple gases were employed to alter acoustical and viscous time scales relative to time scales associated with mechanics of the airway walls, which are insensitive to gas choice. The data indicate that system resonant frequencies scale with gas wavespeed. System damping at resonances (1/ Quality factor) decreases in changing from air to helium, but in changing from air to SF_6 it increases in some cases and decreases in other cases. These changes in system damping are incompatible with the changes in gas viscosity, and imply that mechanisms other than gas viscosity dominate dissipation processes at high frequency. We hypothesize that the dominant mechanism is response of the airway walls which leads to dissipation in airway wall resistances. Furthermore, if the airway walls are assumed to possess elastance and inertance, in addition to resistance, the observed changes in damping are readily explained by shifts of resonant frequencies with gas wavespeed and frequency dependence of the airway wall response.
These experiments were carried out at Children's Hospital Medical Center, Boston, and were supported by NHLBI Contract NO1-HR-6-2901.

INTERRELATIONSHIPS OF RALES AND THE ACCUMULATION AND DISTRIBUTION OF LUNG LIQUIDS IN A CANINE PULMONARY EDEMA MODEL

R. Donnerberg
D. Rice
C. Druzgalski
R. Hamlin
G. Davis
R. Campbell

The interrelationship of rales and varying degrees of pulmonary edema has not been fully characterized. This was investigated in an experimental canine pulmonary edema model. Congestive heart failure was simulated by graded left atrial obstruction. This caused increased pulmonary capillary wedge pressure leading to pulmonary edema without hemodilution. Pulmonary wedge pressure was continuously monitored. Chest auscultation was performed at frequent intervals. The time of rale occurrence was noted and rales were classified into three categories (none, fine-medium and coarse). Shortly after the appearance of rales the animals were sacrificed. At necropsy lung wet to dry weight ratios (W/D) were determined and 15 sections of the lungs were taken for histopathological examination.

W/D was related to the product of pulmonary wedge pressure and time. Time from atrial obstruction to the appearance of rales was inversely correlated with the level of pulmonary wedge pressure. Inspiratory rales were noted in dependent lobes for overall W/D of 5. or greater. Type of rale was significantly related to W/D at death. Examination of the lung sections showed that fluid accumulated first in the perivascular and peribronchiolar space in the most dependent lung fields. Rales were associated with perivascular and peribronchiolar cuffing with and without alveolar flooding. Types of rales were correlated with W/D, presence of gross airway foam, large vessel congestion, and cuffing.

The association of rales with both the gross and microscopic state of the congested lung adds to the clinical value of auscultation. These studies suggest mechanisms of rale production other than the presence of intrabronchial and alveolar liquids.

SESSION B

METHODS OF ANALYSIS

CHAIRMAN: FORBES DEWEY

Session B: Methods of Analysis

Chairman: Forbes Dewey

1:30 pm	Comparative Analysis of Respiratory Sounds in Frequency and Time Domain	C. Druzgalski, R. Donnerberg, R. Campbell
1:50 pm	Some Physical Characteristics of Rales (Cracklings)	A. Ravin
2:10 pm	Time-Expanded Waveform Analysis of Adventitious Sounds	S. Holford and R. Murphy
2:30 pm	Analysis of the Rales of Patients with Fibrosing Alveolitis by a New Phonopneumographic Method	S. Hudoh
2:50 pm	Forced Expiratory Sounds	R. Huller, R. Loudon and K. Thompson
3:10 pm	Initial Observations on Airway Sound Propagation	D. Rice
3:30 pm	Distributed Response of Complex Branching Duct Networks	J.J. Fredberg and J.A. Moore
3:50 pm	Discussion	
4:15 pm	What Should Clinical Investigators Know About Sound Analysis?	Panel Discussion: C.F. Dewey S. Holford J.E. Jacobs D.W. Martin R.L.H. Murphy, Jr. W.W. Waring

COMPARATIVE ANALYSIS OF RESPIRATORY SOUNDS IN FREQUENCY AND TIME DOMAIN

C. Druzgalski
R. Donnerberg
R. Campbell

The complex signal content of respiratory sounds can be analyzed in the frequency and/or time domain. The time domain technique is particularly useful in characterization of broad frequency spectrum signals and both methods supplement each other in sound description.

The objectives of this paper are to demonstrate methods of respiratory sound analysis in frequency domain (spectral analysis) and compare this with time domain analysis involving autocorrelation function. Autocorrelation function describes variations within a signal through time and represents the average product of deviations. Plotted by computer, patterns of autocorrelation function can be used to synthesize models associated with specific respiratory sound characteristics. This approach has been used to analyze respiratory sounds recorded over pre-edematous and edematous canine lungs in a laboratory model of pulmonary edema. The patterns of autocorrelation function related to these two states of the lungs showed significant differences.

Sound data were also analyzed in the frequency domain. It was found that the frequency spectrum of pre-edematous respiratory sounds consisted predominantly of frequencies up to 300 Hz while sounds of edematous lungs contained frequency components up to 500 Hz. Respiratory sounds of edematous lungs represent higher intensity signals with the magnitude corresponding to the degree of pulmonary edema. Respiratory sounds were recorded simultaneously with physiological variables such as respiratory airflow, respiratory volume and ECG.

Methods of spectral analysis, correlation of spectral and time domain data, autocorrelation function patterns and model categorization will be discussed.

SOME PHYSICAL CHARACTERISTICS OF RALES (CRACKLINGS)

A. Ravin

A study of 1) the duration and frequency make-up of various rales, 2) the physical characteristics of sounds which mimic rales.

INITIAL OBSERVATIONS ON AIRWAY SOUND PROPAGATION

D. Rice

A 2.5 mm (13 gauge) flexible catheter was developed to produce sonic impulses with a spark gap in its tip. These impulses permit velocity as well as frequency dependent absorption measurements. The results presented here are a continuation of earlier work[1] which found that pulmonary sound preferentially propagated along the airways with a velocity equal to the algebraic sum of a basic velocity plus the airway gas flow velocity. We placed the sonic catheter retrogradely in 4 mm airways and a microphone in the trachea of dogs. By varying lung volume between FRC and TLC the following observations were made: 1) Inflation of the lung, hence the airways, increases propagation velocity. Airway wall stiffening may explain this. 2) Inflation of the lung decreases the attenuation of transmitted sound. The stiffening of airway walls may reduce viscous losses. 3) Inflation of the lung differentially decreases low frequency attenuation with respect to high frequencies. Reduced viscous losses are a possible explanation.

Support in part by OSU postdoctoral fellowship, USPHS NIH Grant No. 1 RO 2 HL-26563-02, and Central Ohio Heart Chapter.

[1]Fed. Proc. 35(3):601, 1976.

DISTRIBUTED RESPONSE OF COMPLEX BRANCHING DUCT NETWORKS

J. J. Fredberg
J. A. Moore

To interpret the influence of lung mechanical inhomogeneity upon high frequency (up to 10 kHz) response data, we developed a distributed parameter model of the lung response based upon the morphometric data of Horsfield and Cumming and the concept of network self-consistency (Fredberg and Moore, J. Acoust. Soc. Am., in press). Each airway is modeled as a cylinder of thermoviscous gas with non-rigid walls possessing inertance, compliance and resistance. This model permits efficient simulation of the input impedance, airborne sound transmission, and the spatial pressure distributions within the lung. In the simulated response the ratio of alveolar pressure to airway opening pressure diminishes rapidly with increasing frequency and exhibits modal structure. Above 100 Hz the response is influenced by branching asymmetry and dynamic airway wall deformation, but is insensitive to lung tissue or chest wall properties. Regional differences in alveolar pressure from apex to base are frequency dependent, and often exceed 30 dB. Diffuse constriction of small airways causes little change in the input impedance above 100 Hz, but causes a large defect (~20 dB) in sound transmission in the vicinity of 500 Hz. (Supported by NHLBI Contract N01-HR-6-2901.)

SESSION C

CLINICAL APPLICATIONS

CHAIRMAN: DAVID W. CUGELL

Session C: Clinical Applications

Chairman: David W. Cugell

9:00 am	Quantitation of Upper Airway Area Using Tracheal Sound Spectral Analysis	P.E. Krumpe
9:20 am	Use of Acoustic Signals and Correlation Techniques in Pulmonary Testing	J.E. Jacobs, J.D. Lewis, L.F. Mockros, D.W. Cugell
9:40 am	Discussion	
10:00 am	Coffee	
10:30 am	Correlation between Microphonic (Objective) Breath Sounds and Pulmonary Ventilation in Emphysematous Subjects	Y. Ploy-Song-Sang J.A.P. Paré and P.T. Macklem
10:45 am	Correlation between Stethoscopic (Subjective) Breath Sounds and Pulmonary Ventilation in Emphysematous Subjects	Y. Ploy-Song-Sang J.A.P. Paré and P.T. Macklem
11:00 am	Discussion	
11:30 am	Early Inspiratory Crackles and the Mechanical Effects of Breathing	P.H. Wright and L.H. Capel
12:30 - 1:30 pm	Lunch	

Quantitation of Upper Airway Area Using

Tracheal Sound Spectral Analysis

P. E. Krumpe

Resistance to flow through the larynx depends upon the area of the vocal cord aperture (A_L). A_L can be photographed bronchoscopically or R_L can be measured directly by dividing the pressure drop across the vocal cords by mouth flow ($\dot{V}$); both methods are invasive.

At the high linear velocities (U) which occur in the larynx, $\dot{V}$ becomes turbulent. Analysis of the sound power spectrum radiated from this turbulence can provide a non-invasive means to estimate A_L, using the methods described by Duncan et al (NEJM 293:1124, 1975).

Turbulent sound intensity increases with increasing frequency, then declines beyond an identifiable "break frequency". In the calculation of A_L, the triangular space between the cords was assumed to behave as a circular orifice with radius (r). Since $2r = U/f_0$, then $A_L = \sqrt[3]{\pi(\dot{V}/2f_0)^2}$.

Tracheal sound was recorded using a General Radio 1964-9640 microphone applied to the lateral neck just below the cricoid. $\dot{V}$ was measured by a pneumotachygraph at the mouth. Peak sound intensity occurred coincident with Peak $\dot{V}$.

Sound from 10 consecutive breaths with identical inspiratory $\dot{V}$ peak were ensemble averaged and analyzed for spectral composition using a Nicolet 444 FFT real time analyzer.

Tracheal sound was observed to increase as frequency increased and then to decline beyond f_0. At inspiratory $\dot{V}$ of 3 liters/sec, f_0 was measured to be 1550 Hz. A_L was calculated to be 1.1 cm^2. This value is in close agreement to published data for A_L obtained by invasive methods.

Tracheal sound analysis can provide a non-invasive method to measure upper airway area, and by inference, to study the laryngeal control of upper airway resistance in man.

USE OF ACOUSTIC SIGNALS AND CORRELATION TECHNIQUES IN PULMONARY TESTING

J. E. Jacobs
J. D. Lewis
L. F. Mockros
D. W. Cugell

In the work reported here, an acoustic "white noise" signal (equal power at each frequency), introduced at the mouth, propagates down the airways and is detected by two microphones at the thoracic surface. The driving "white" noise and detected electrical signals are stored on magnetic tape for later correlation studies. These data are then processed by a newly developed analog correlator to give the mechanical properties of the intervening thorax.

This approach has the advantage that the results obtained are based upon well-established mathematical and signal processing theory which readily lends itself to analytical and experimental confirmation.

For the transmission of sound, the lung acts as a multi-section acoustic filter. Sound energy at the resonant frequencies passes readily, whereas at other frequencies the energy is dissipated. The correlation functions of the detected signal exhibit periodic components corresponding to these resonant frequencies, the amplitude of these components being proportional to the degree of resonance..

Preliminary clinical studies indicate recognizable resonance patterns for healthy non-smokers and different resonant frequencies for smokers of as little as 5 pack-years.

This research supported in part by NHL grant HL16218-01.

CORRELATION BETWEEN MICROPHONIC (OBJECTIVE) BREATH SOUNDS AND PULMONARY VENTILATION IN EMPHYSEMATOUS SUBJECTS

Y. Ploy-Song-Sang
J. A. P. Paré
P. T. Macklem

We recorded breath sounds and sound transmission characteristics of lung and chest wall objectively with a microphone-amplifier system in 8 emphysematous subjects. We compared the sound production and transmission in emphysematous subjects to those in normal subjects and found them to be different. In the majority of subjects there were areas in the lungs of both decreased sound production and transmission. There were few areas of increased sound transmission. When we compared the recorded breath sound loudness both with (compensated breath sounds) and without (uncompensated breath sounds) compensation for the differences in sound transmission with Xenon ventilation done in the same subjects, we found that in the group as a whole both uncompensated breath sounds and compensated breath sounds correlated as well with regional ventilation as studied by Xenon. But when we looked at each subject individually, the compensated breath sounds were better indices of regional ventilation than uncompensated breath sounds. Both compensated and uncompensated breath sounds used in combination correlated with Xenon regional ventilation individually in 7 out of 8 subjects.

CORRELATION BETWEEN STETHOSCOPIC (SUBJECTIVE) BREATH SOUNDS AND PULMONARY VENTILATION IN EMPHYSEMATOUS SUBJECTS

Y. Ploy-Song-Sang
J. A. P. Paré
P. T. Macklem

We recorded breath sound loudness both subjectively using a stethoscope and objectively with a microphone-amplifier system in 8 emphysematous subjects. We compared breath sound loudness with Xenon ventilation done in the same subjects. We found that the breath sound loudness as perceived by a physician using his stethoscope did not correlate with regional ventilation, the ventilating lung volume, and the ventilation per unit lung volume. We also found that the stethoscopic breath sound loudness did not correlate with the microphonic breath sound loudness both before and after compensation for the differences in sound transmissions. On the other hand, the microphonic breath sounds correlated well with Xenon regional ventilation. From these results we conclude that regional breath sound loudness as perceived subjectively does not correlate with regional ventilation because of (1) the sound threshold of hearing in the human ear, (2) poor sound gradation ability of the human ear, (3) no compensation for the differences in sound transmission characteristics of lung and chest wall with subjective method.

EARLY INSPIRATORY CRACKLES AND THE MECHANICAL EVENTS OF BREATHING

P. H. Wright
L. H. Capel

Inspiratory crackles can be classified as early and late according to their timing in the respiratory cycle. Late inspiratory crackles tend to repeat from one breath to another, and the occurrence of an individual crackle (index crackle) can be related to a particular lung volume and transpulmonary pressure. This tends to confirm the idea that such crackles are usually due to explosive opening of airways in territories of the lung deflated to residual volume. Early inspiratory crackles are a feature of severe airflow obstruction and may be heard at the mouth and over the lung bases. The mechanism of their production has not been studied. In an attempt to do this the lung sounds of patients with early inspiratory crackles were recorded simultaneously with lung volume and transpulmonary pressure. Strapping the chest shifts the pressure/volume relationship of the lungs. To try to distinguish the effects of change in transpulmonary pressure from those of change in lung volume index crackles were studied before and after strapping the chest. It was found that: 1. Early inspiratory crackles repeat from breath to breath. 2. With light strapping of the chest the volume at which an index crackle occurs is decreased while the transpulmonary pressure remains the same. 3. With tight strapping of the chest a new set of crackles develops at higher lung volumes. Since early inspiratory crackles can be heard at the mouth as well as at both lung bases it might be thought that they arise in the trachea. Examination of the recordings showed completely different patterns of crackles at the two lung bases; early inspiratory crackles cannot therefore be produced in the upper respiratory tract or trachea. It is concluded that early inspiratory crackles are pressure dependent and are only indirectly volume dependent, and arise beyond the carina, evidence in favour of the suggestion that they are produced in the same way as late inspiratory crackles.

SESSION D

CLASSIFICATION, NOTATION, NOMENCLATURE

CHAIRMAN: GILES FILLEY

Session D: Classification, Notation, Nomenclature

Chairman: Giles Filley

1:30 pm	The "Bronchial Leak Squeak" - A Sign of Bronchopleurocutaneous Fistula	P.E. Krumpe, T.N. Finley, and L.M. Wong
1:50 pm	Differential Segmental Auscultation	W.W. Waring
2:10 pm	Lung Sound Terminology in Case Reports	N.J. Bunin and R.G. Loudon
2:30 pm	Systems of Musical Notation	P. Palombo
3:00 pm	Break	
3:15 pm	Lung Sounds Quiz	R.L.H. Murphy, Jr.
3:30 pm	Teaching of Lung Sounds in Physical Diagnosis	R.G. Loudon, R. Buncher and R.L.H. Murphy, Jr.
4:00 pm	Summary of the Conference	A. Renzetti

The "Bronchial Leak Squeak" - A Sign of Bronchopleurocutaneous Fistula

P. E. Krumpe
T. N. Finley
L. M. Wong

We describe the unique physical findings of a patient with a bronchial stump air leak. The patient was 6 months post left pneumonectomy (for benign disease), and 3 months post rib resection for drainage of an empyema cavity. A 10 cm crescentic opening was present on the lateral chest wall. The right lung demonstrated normal tactile fremitus, percussion resonance, and auscultation. Over the left hemi-thorax, tactile fremitus and breath sounds were markedly decreased. Resonance to percussion resembled that of a hollow gourd. Chest roentgenogram demonstrated an air-filled left hemi-thorax and a large pleurocutaneous fistula.

During cough or Valsalva maneuver, we noted a continuous high pitched squeaking sound, localized over the anterior third left intercostal space. With increasing force of a Valsalva maneuver, the pitch of the squeak increased. No sucking noise was present over the wide lateral chest wall opening.

A fish mouth opening was observed in the left main stem bronchus during fiberoptic bronchoscopy; Methylene blue dye placed in the left bronchus disappeared rapidly and appeared at the skin opening.

In the body plethysmograph during a 7.5 second Valsalva maneuver from FRC, a 1.0 liter leak in lung volume was found. Bronchial leak flow was therefore 0.14 liters/second. A sustained driving pressure of 10 cm H_2O (P mouth - P left chest cavity) was simultaneously measured. Bronchial leak resistance was calculated to be 75 cm H_2O/liter/second.

We speculate that in typical bronchopleural fistulae, without communication to atmosphere, the increase in pleural pressure during Valsalva maneuver would decrease driving pressure and reduce leak flow, thus producing no squeak. Access of the bronchial leak to atmospheric pressure in our patient permitted sufficient driving pressure to cause leak flow and produced the bronchial leak squeak.

DIFFERENTIAL SEGMENTAL AUSCULTATION

W.W. Waring

Differential segmental auscultation (DSA) of the lungs requires a double stethoscope which is used to compare simultaneous breath sounds from 9 auscultatory loci on each hemithorax. These loci correspond to the presumed topographical midpoints of homologous bronchopulmonary segments and are numerically designated to conform with the system of Boyden (e.g., the left lateral basal segmental locus L9 is compared with the right lateral basal segmental locus R9, etc.). Breath sounds are compared for loudness, synchrony, and pitch, as well as presence or absence of adventitious sounds. The diseased (or more diseased) segment is usually indicated by 1) lesser amplitude, 2) delays in onset or peaking of inspiratory sounds, 3) higher pitch, and 4) presence of adventitious sounds. Modifications of the stethoscope chest pieces to allow instantaneous off-on control of sound transmission permits more precise comparisons, especially of pitch and adventitious sounds.

The validity of the concepts of DSA has been strengthened by objective analysis of differentially recorded breath sounds (differential segmental phonopneumography) by which the parameters of amplitude, phasing, and peak frequency can be quantitated.

DSA has also created the need for new descriptive auscultatory terms whose use, although somewhat cumbersome, avoids much periphrasis. Homophony indicates that the amplitude, phasing, and pitch of inspiratory breath sounds of a homologous segmental pair are the same. Heterophony indicates significant discrepancy of one or more of these parameters of inspiratory sounds in such a segmental pair. Because pulmonary disease is rarely perfectly uniform in distribution, homophonous breath sounds in the nine paired segmental loci are a strong argument for pulmonary health.

LUNG SOUND TERMINOLOGY IN CASE REPORTS

N. J. Bunin
R. G. Loudon

Terms used to describe lung sounds in published case reports were tabulated, including qualifying adjectives. General medical journals, chest disease journals and pediatric journals published in the U.S. and in Britain were reviewed, starting with the current issues and working back until more than 100 case reports were included for most journals.

It is evident from the frequency of usage and similarity of qualifying adjectives that the terms "rales" and "crepitations", the latter used predominantly in Britain, are equivalent. Sixteen descriptive adjectives, such as "fine", "moist" or "sibilant", were applied to these sounds. Their timing within the respiratory cycle was specified in 18% of U.S. descriptions and 7.8% of U.K. descriptions. There is little difference between the general and specialist journals in the frequency with which qualifying adjectives are used and timing is specified.

The terms "rhonchus" and "wheeze" are used with approximately equal frequency in most journals, and both terms are modified by similar adjectives and are described as occurring at any point during the respiratory cycle. Some authors probably regard the terms as synonymous, while others distinguish between the two. The basis for this distinction is not clear, and probably varies from author to author.

From our studies, it is evident that authors of case reports recognize the importance of describing lung sounds and feel a need to differentiate among different sounds within the same basic category. It is also evident that current usage varies widely, even in the terminology of the basic categories of sounds. The development of a standard classification and nomenclature would benefit those who write and read case reports, and presumably all others who study, teach, or practice medicine.

TEACHING OF LUNG SOUNDS IN PHYSICAL DIAGNOSIS

R.G. Loudon
R. Buncher
R.L.H. Murphy, Jr.

A teaching tape of lung sounds was played to a class of second year medical students who had had no previous instruction in the subject. The students listened to the sounds through their stethoscopes, applying the chest-piece to a "stethobox" - a small individual speaker provided to each student. Those students who had not yet purchased stethoscopes for the physical diagnosis class were loaned inexpensive stethoscopes of a standard pattern for purposes of this study. Half of the students, chosen by random allocation, were provided with an illustrated text designed to accompany the teaching tape.

Fourteen sounds were then used as a test, the students being asked to name each sound. They were also asked to note whether they had the text, whether they took notes, what type of stethoscope they used, and several other questions. Results will be discussed in terms of the light they throw on teaching methods.

COMMITTEE ON LUNG SOUND NOMENCLATURE

SATURDAY, OCTOBER 1, 1977

THE OHIO ROOM - THE TERRACE HILTON HOTEL .

9:00 AM UNTIL 12:00 NOON

CHAIRMAN: DR. WILLIAM W. WARING

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