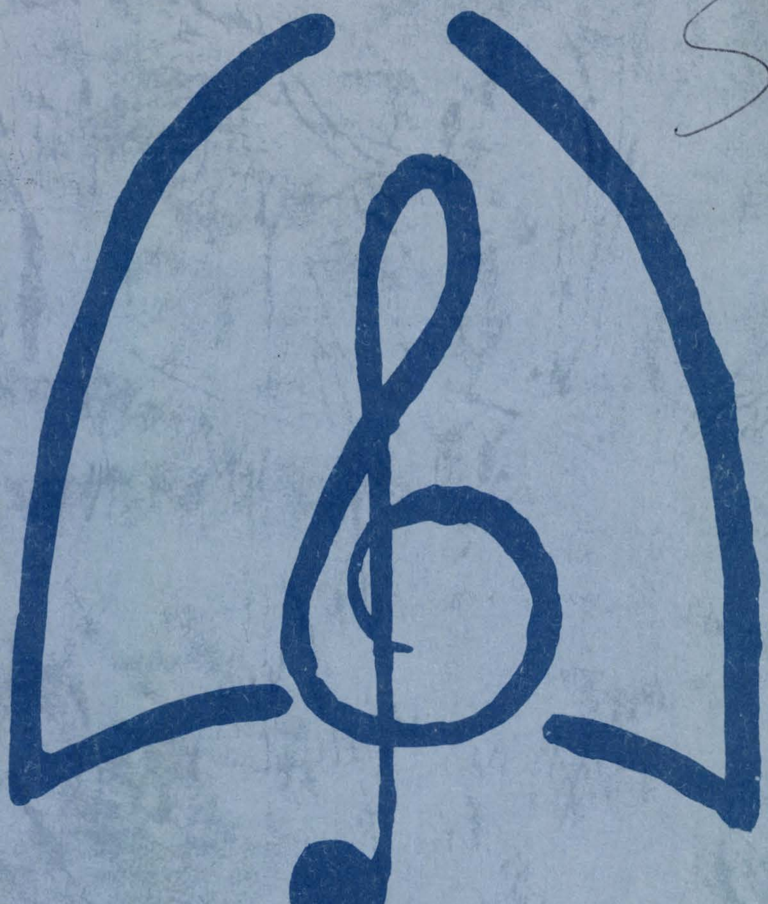

S.K

S. Kudo.

TENTH INTERNATIONAL CONFERENCE ON LUNG SOUNDS

第10回 国際肺音学会

SEPTEMBER 18-20, 1985

Tokyo, Japan

PRESENTED BY

The International Lung Sounds Association

Steering Committee

Wilmot C. Ball, M.D.	Baltimore, Maryland
David Cugell, M.D.	Chicago, Illinois
Sadamu Ishikawa, M.D.	Boston, Massachusetts
Steve Kraman, M.D.	Lexington, Kentucky
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Robert G. Loudon, M.B., Ch.B.	Cincinnati, Ohio
Riichiro Mikami, M.D.	Nara, Japan
Raymond L.H. Murphy, M.D.	Boston, Massachusetts

Tenth International Conference on Lung Sounds

Tokyo, Japan

Program

Wednesday, September 18, 1985 — Hotel Grand Palace Rm. 303

Workshop — Dr. Masashi Mori and Dr. Tadashi Abe, Moderators .... 3:00 PM
1. Cracklefest
2. Rhonchi and Wheezes

Thursday, September 19, 1985 — Keidanren Kaikan

Registration .... 8:30 AM

Opening Remarks — Dr. Riichiro Mikami .... 9:00 AM

Keynote Address — Dr. Sadamu Ishikawa .... 9:05 AM

Session A — Dr. Peter Cole and Dr. Riichiro Mikami, Moderators .... 9:15 - 11:55 AM

Photograph .... 11:55 - 12:10 PM

Lunch .... 12:10 - 1:00 PM

Session B — Dr. William Waring and Dr. Shoji Kudoh, Moderators .... 1:00 - 4:40 PM

Debate: Resolved: The term "medium crackles" should be abolished — .... 4:40 - 5:15 PM
Pro: Dr. Steve Kraman
Con: Dr. Raymond L.H. Murphy

Cocktails and Buffet .... 6:30 PM

Friday, September 20, 1985

Session C — Dr. David Cugell and Dr. Yukihiko Homma, Moderators .... 9:00 - 2:20 PM

Mechanism of phonation — from airflow to sound — ...11:00 - 11:45 AM
Dr. Masayuki Sawashima
Guest lecture

Business Meeting .... 11:45 - 12:00 PM

Lunch .... 12:00 - 1:00 PM

Session D — Dr. Wilmot C. Ball and Dr. Tadashi Abe, Moderators .... 2:20 - 5:20 PM

Summary — Dr. Masashi Mori .... 5:20 - 5:35 PM

Session A

Drs. Peter Cole and Riichiro Mikami, Moderators

9:15- 9:35 AM	Frequency analysis of breath sounds in asthmatic children. Changes in frequencies of breath sounds during exercise	J. Sakamoto Y. Mukawa T. Igarashi S. Manabe Y. Saka T. Yasuda Y. Yoshida Y. Ueda A. Shibuya S. Kudoh
9:35- 9:55 AM	Comparison of lung sound spectra and spirometric indices after histamine challenge and subsequent bronchodilation	P. Piirilä A. Sovijärvi R. Aulanko
9:55-10:15 AM	The lung as a filter, changes in pneumonia	R. Baughman R. Loudon
10:15-10:35 AM	COFFEE BREAK	
10:35-10:55 AM	Lung sounds in patients with pulmonary tuberculosis	Y. Koyama N. Shioya F. Shirai S. Kudoh R. Mikami
10:55-11:15 AM	Expiratory crackles in interstitial pulmonary disease	H. Ogasawara M. Munakata Y. Homma M. Matsuzaki K. Tanimura H. Kusaka Y. Kawakami
11:15-11:35 AM	Characterization of adventitious lung sounds in bronchopulmonary dysplasia (BPD)	J. Kanga S. Kraman
11:35-11:55 AM	Chest auscultation and objective lung sound analysis in pipe coverers exposed to asbestos: A 19 year follow up	R. Murphy E. Del Bono E. Gaensler
11:55-12:10 PM	PHOTOGRAPH	
12:10- 1:00 PM	LUNCH	

FREQUENCY ANALYSIS OF BREATH SOUNDS IN ASTHMATIC CHILDREN. CHANGES IN FREQUENCIES OF BREATH SOUNDS DURING EXERCISE

J. Sakamoto
Y. Mukawa
T. Igarashi
S. Manabe
Y. Saka
T. Yasuda
Y. Yoshida
Y. Ueda
A. Shibuya
S. Kudoh

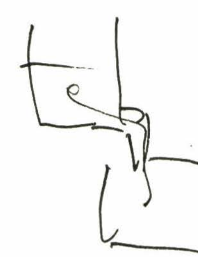
In this study, we examined the breath sounds of 16 children between 8 and 14, afflicted with bronchial asthma prior to and after excise, with 12 healthy children as a control group.

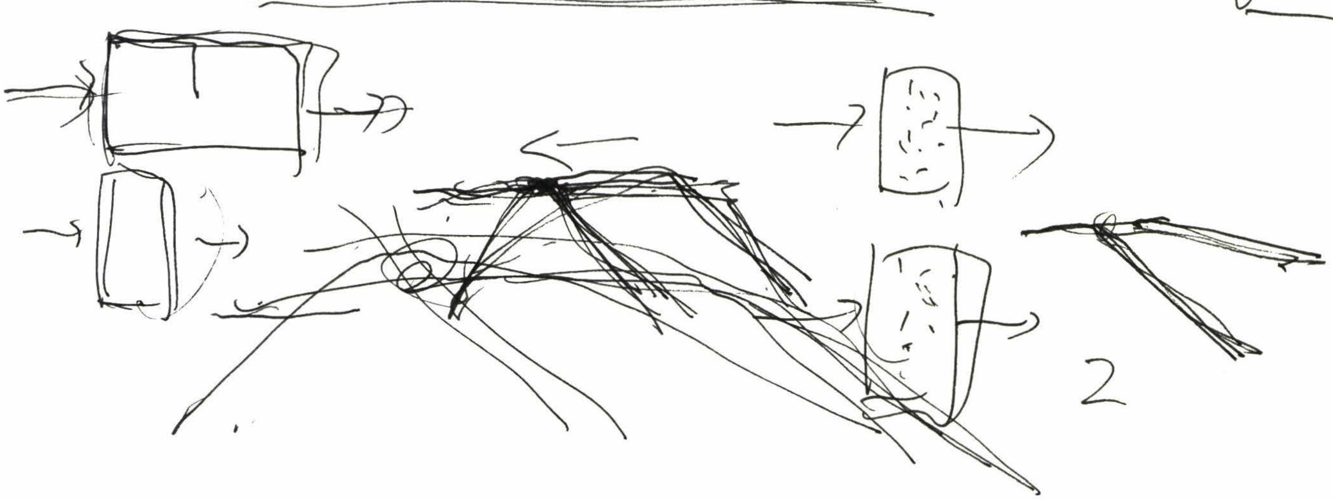
Breath sounds were recorded from 5 microphones placed on the chest and neck. As exercise stress, a treadmill was utilized, and recordings of breath sounds and lung function were made 'before' exercise and 5, 15, 30 minutes 'after' exercise. 0.5 seconds of the inspiratory phase was analyzed by Fourier transform, and the mean of 10 summated inspiratory phase Fourier transform obtained. We designated the frequency at which breath sound after Fourier transform was maximum, "peak frequency" (PF), and spectrum attenuation/frequency, "slope". Exercised induced bronchospasms (EIB) occurred in 8 of the 16 asthmatic children. Changes in value of PF were higher in the asthmatic group than in the control group. Changes in value of slope with exercise were also higher in the asthmatic group, although initial values were smaller. Changes in both PF and slope were especially marked in the EIB positive group.

① flow rate を一定にすること ?

② PF と Slope を [illegible]より

Transmission に関係ある





COMPARISON OF LUNG SOUND SPECTRA AND SPIROMETRIC INDICES AFTER HISTAMINE CHALLENGE AND SUBSEQUENT BRONCHODILATION

P. Piirilä
A. Sovijärvi
R. Aulanko

We have studied the relationship between the lung sound spectra and forced vital capacity (FEV_1) after histamine challenge and subsequent bronchodilation in 15 consecutive patients with suspected bronchial hyperreactivity.

The patients with subjective dyspnea and a peak flow depression of 8 per cent or more in histamine challenge test were included to the study. The lung sounds were recorded with two condenser microphones situated at the back base of both lungs. The recordings of the sounds and flow volume spirometry were performed immediately after the histamine challenge and ten minutes after inhalation of a bronchodilator (Salbutamol 0.2 mg). The frequency analysis of the sounds was based on the fast Fourier transform.

Ten patients (67%) showed wheezing sound pattern after histamine challenge either during inspirium or expirium (frequency peaks usually below 500 Hz). Wheezing peaks were more intensive during inspiration. The level of obstruction after histamine of all patients was regarded as slight or moderate. Wheezing peaks disappeared in 7 patients after bronchodilator (ΔFEV_1 + 17%) but in three patients additional frequency peaks appeared in the spectrum (ΔFEV_1 + 9%).

These preliminary results suggest a non-uniform correlation between sound patterns and spirometric indices studied after histamine challenge and subsequent bronchodilation.

THE LUNG AS A FILTER, CHANGES IN PNEUMONIA

R. Baughman
R. Loudon

The lung and chest wall act as a filter to sounds generated at the trachea. We recorded the sound auscultated over involved and noninvolved portions of the lung of three patients with pneumonia who were asked to say the letter "e". In all three, there was a change in the sound auscultated over the involved lung, where "e" now sounded like "a". Spectral analysis of the sounds corresponding to "e" and "a" were performed using Fast Fourier Transformation of the time amplitude signal, examining a frequency range of 1 to 1000 Hz. Over the chest wall, the sound of the letter "e" had a fundamental frequency of 132 Hz, with two major harmonies at 266 and 398 Hz. The intensity of sound at the highest frequency was less than one third of the lowest frequency. The sound of the letter "a" had frequencies of 122, 244, and 366 Hz. The intensity was higher at all three frequencies than for similar frequencies recorded for the letter "e". The highest increase in sound intensity was at the highest frequency, which was 5 times louder than the letter "e". These changes in sound character are consistent with alternations in the filtering properties of the lung in bronchopneumonia.

LUNG SOUNDS IN PATIENTS WITH PULMONARY TUBERCULOSIS

Y. Koyama
N. Shioya
F. Shirai
S. Kudoh
R. Mikami

Lung sounds in patients with pulmonary tuberculosis is an old topic, but a study was performed in current cases in accordance with the new classification of auscultatory terms. Auscultation was performed by 3 trained physicians on 117 patients with pulmonary tuberculosis (84 males and 33 females) demonstrating a positive bacillary discharge at admission.

Auscultatory findings and chest X-rays were compared. X-ray findings were classified into the following three types:

Type I; Infiltrative, pneumonia-like shadow. Type II; Sclerotic type. Type III; Severe, mixed type. The main auscultatory findings in each type are as follows: Type I; No abnormality in auscultatory findings in 23/52 (44.2%). Type II; Bronchial breath sounds in 29/90 (32.2%), coarse crackles in 26/90 (28.9%). Type III; Bronchial breath sounds 10/30 (33.3%), rhonchi in 2/31 (6.45%) and coarse crackles in 12/31 (38.7%).

Type I is a pneumonia-like shadow, but hardly any crackles are auscultated, compared with other types of bacillary pneumonia. The sclerotic type II is characterized by bronchial breath sounds and is often accompanied by coarse crackles at the same time. Type III had auscultatory abnormalities in all cases, and variegated auscultatory findings were obtained.

EXPIRATORY CRACKLES IN INTERSTITIAL PULMONARY DISEASE

H. Ogasawara
M. Munakata
Y. Homma
M. Matsuzaki
K. Tanimura
H. Kusaka
Y. Kawakami

Fine crackles are usually heard in patients with interstitial pulmonary disease such as idiopathic pulmonary fibrosis (IPF), collagen vascular disease (CVD) and asbestosis. These have been pointed out by many investigators to be heard characteristically in late inspiratory period. But we sometimes experience to hear crackles in expiratory period in patients with those disease. We recorded and analysed these crackles using our phonopneumograph reported previously to evaluate expiratory crackles in interstitial pulmonary disease.

Forty eight patients with diffuse interstitial pulmonary disease (IPF 24, CVD 24) were studied. Recorded expiratory crackles were divided by the agreement of three experienced pulmonary physicians into 3 groups; constantly heard in expiration (group 1), transiently heard (group 2) and never heard (group 3). Clinical data were studied in each group. In the patients of group 1, we measured first 1/4 cycle duration (TB), 9/4 cycle duration (TF) and polarity of initial deflection of each crackle on time intensity plots with an expanded time axis, comparing those characteristics of inspiratory crackles with expiratory ones.

Results were as follows;
1) Expiratory crackles were heard constantly in 7 of 48 patients (15%, IPF 5, CVD 2), transiently in 13 (27%).
2) In 7 patients with constant expiratory crackles, TB and TF were slightly longer in expiration than in inspiration. Five patients expectorated some sputa and 4 patients showed abnormal chest X-ray findings suggesting pleural thickenings.
3) According to analyses by phonopneumogram, these crackles in expiration seemed to include several kinds of crackles, that is, fine crackles, coarse crackles and pleural friction rubs.

These results indicate that careful auscultation of the patients with interstitial pulmonary disease must be required for evaluation of the pathophysiology of the disease.

CHARACTERIZATION OF ADVENTITIOUS LUNG SOUNDS IN BRONCHOPULMONARY DYSPLASIA (BPD)

J. Kanga
S. Kraman

BPD is a clinical-radiographic complex that is seen in 10 to 15% of newborn infants that require mechanical ventilation. It is classified into stages I through IV. Stage I and II are clinically and radiographically difficult to distinguish from hyaline membrane disease. Stage III is characterized by slow weaning from mechanical ventilation and small cystic lesions on chest radiograph. Stage IV is characterized by oxygen dependency past 4 weeks of age and chest radiograph showing larger cystic changes, hyperinflation and areas of patchy opacification or atelectasis.

Lung sounds have not been well described in BPD. Auscultation frequently reveals discontinuous adventitious sounds. We studied 137 crackles from four infants with stage IV BPD. The recordings were made at the bed-side. The crackles were displayed on an oscilloscope and measured by hand according to the method of Holford et al. Our results revealed a width of the initial deflection (IDW) of 0.64 ± 0.17 m secs. (mean ± 1 SD) and a duration of the first two cycles (2CD) of 3.77 ± 0.75 m secs. We found that the IDW and 2CD were considerably shorter than the fine crackles described by Holford, thus, we refer to them as "ultra fine". In two patients on whom recordings on two separate occasions were available, the means of IDW and 2CD showed no significant difference.

This is a preliminary study on crackles in BPD. More work is needed to relate the auscultatory findings to the pathophysiology of this disease.

CHEST AUSCULTATION AND OBJECTIVE LUNG SOUND ANALYSIS IN PIPE COVERERS EXPOSED TO ASBESTOS: A 19 YEAR FOLLOW UP

R. Murphy
E. Del Bono
E. Gaensler

Chest sounds of 27 shipyard pipe coverers (PC) and a control group of 24 shipyard workers (CG) were observed in 1965, 1966, 1972, and 1985. Asbestosis was defined as the presence of three or four of the following criteria: vital capacity <80% predicted, DL <80% predicted, chest roentgenographic evidence of opacifications of 1/2 or greater by the UICC classification and crackles in two or more of four basilar sites observed by a physician. All four of the pipe coverers who met these criteria had fine crackles. The relationship of crackles heard by a technician to these criteria exclusive of the crackles heard by a physician was as follows:

	Crackles Observed by Technician			
	Present		Absent	
# of Criteria Positive	PC	CG	PC	CG
0	5	3	8	17
1	3	0	5	2
2	2	0	1	2
3	3	0	0	0

The concordance between the auditory and visual analysis was 93.3% (Kappa = .85). The ratio of positivity of criteria in the pipe coverers as compared to the controls was 6/1 for X-ray; 4/1 for DL; 2.5/1 for VC; 4/1 for MD crackles; and 4.3/1 for technician crackles. Chest auscultation by a technician is a useful method of detecting asbestosis and is comparable in sensitivity and specificity to standard methods; auscultatory findings can be objectively verified by time expanded waveform analysis.

Session B

Drs. William Waring and Shoji Kudoh, Moderators

1:00-1:20 PM	Non-invasive evaluation of cigarette smoking patterns using tracheal sound recordings	P. Krumpe
1:20-1:40 PM	Respiratory monitoring by tracheal sound	K. Yamawaki Y. Satomura
1:40-2:00 PM	Frequency analysis of discontinuous lung sounds by maximum entropy method	M. Yonemaru T. Abe H. Kobayashi T. Kawashiro T. Yokoyama
2:00-2:20 PM	Measurement of acoustic transmission of the human respiratory system using the pulse-train method and pseudo-random signal	K. Wagatsuma T. Muraoka S. Seto Y. Maeda T. Shida K. Nitta
2:20-2:40 PM	Transmission paths of crackles in the lung	T. Abe M. Yonemaru H. Kobayashi T. Kawashiro T. Yokoyama
2:40-3:00 PM	A classification of crackles using LPC method	Y. Maeda K. Wagatsuma T. Muraoka M. Horiuchi Y. Yui T. Shida
3:00-3:20 PM	COFFEE BREAK	
3:20-3:40 PM	Compendious array of sound characteristics	C. Druzgalski A. Wilson
3:40-4:00 PM	Which information can be deduced from the Fourier analysis of a crackle?	T. Bosser P. Chapelle E. Lens G. Postiaux
4:00-4:20 PM	Phonopneumograph using a micro-computer	S. Inui A. Shibuya S. Kudoh N. Shioya R. Mikami
4:20-4:40 PM	Videodisplay of computer-analyzed breath sounds in asthma	H. Pasterkamp R. Fenton V. Chernick
4:40-5:15 PM 4:20 – 5:00	Debate: Resolved: The Term "Medium crackle" should be abolished. Pro: S. Kraman Con: R. Murphy	
6:30 PM	Cocktails and Buffet, Chinzanso	

NON-INVASIVE EVALUATION OF CIGARETTE SMOKING PATTERNS USING TRACHEAL SOUND RECORDINGS

P. Krumpe

The use of tracheal sound recordings to monitor respiratory patterns has proven useful in the evaluation of sleep apnea. I have applied similar methodology by recording the filtered and amplified tracheal sounds envelope to the study of cigarette smoking patterns. The following parameters during cigarette smoking are quantitated by measuring tracheal sound intervals: puff duration, inspiratory time, breath hold time, expiratory time, between puff interval and number of puffs per cigarette. Puff timing parameters were observed during each smoking bout and initial puff parameters were compared to end of cigarette puff parameters in lifetime heavy smokers (greater than 100 pack years) and in recent smokers (greater than one but less than five pack years). Smoking patterns were studied comparing vented (low tar cigarettes) and non-vented cigarettes. Consistency of patterns was evaluated by comparing serial cigarettes smoked by the same subject.

These studies demonstrate that tracheal sounds are a reproducible non-invasive method to study different patterns of smoking and to identify changes in smoking patterns related to cigarette characteristics.

Supported by the Veterans Administration Medical Service and a Grant from Merrill-Dow Pharmaceutical Company

RESPIRATORY MONITORING BY TRACHEAL SOUND

K. Yamawaki
Y. Satomura

The development of a respiratory monitoring system with the tracheal sound for intensive care of patient is described. The tracheal sound level and the tracheal ventilation volume for each person is well correlated and the accuracy of measurement of the tracheal ventilation volume with the tracheal sound is within 20%.

The power spectra obtained by the Fourier Transform of the tracheal sound show distinction between the normal sound and the abnormal one for each person and between the normal sound of a healthy person and the abnormal one of a patient. The method for the detection of abnormal tracheal sound during respiratory monitoring used the Auto-regression Model can well discriminate between the normal sound and abnormal one for each person. However, it is difficult to discriminate between the normal tracheal sound of a healthy person and the abnormal one of a patient.

1) 5ℓ以下では、非正常性 (2ℓ以下では、呼吸ではない)

2) 150例のlong time monitor.

FREQUENCY ANALYSIS OF DISCONTINUOUS LUNG SOUNDS BY MAXIMUM ENTROPY METHOD

M. Yonemaru
T. Abe
H. Kobayashi
T. Kawashiro
T. Yokoyama

The maximum entropy method (MEM) allows one to calculate the high-resolution spectrum from a signal that is composed of a few cycles of oscillation. The authors placed their aim to apply the MEM for their frequency analysis of discontinuous lung sounds. Discontinuous sounds, obtained on 5 patients with interstitial pneumonia as well as 12 patients with either bronchitis or with bronchiectasis, were recorded on magnetic tape. The signals were fed to computer through A/D converter. 5 discontinuous sounds on each subject were chosen on the computer graphic display. In total, 85 waveforms were selected to analyze using the MEM.

19 out of 25 discontinuous sounds obtained on patients with interstitial pneumonia had spectral peaks approximately 200 and 1000 Hz. 55 out of 60 discontinuous sounds obtained on patients either with bronchitis or with bronchiectasis had a spectral peak approximately 200 Hz. The results suggest that MEM can be applied to analyze discontinuous lung sounds in the frequency domain.

MEASUREMENT OF ACOUSTIC TRANSMISSION OF THE HUMAN RESPIRATORY SYSTEM USING THE PULSE-TRAIN METHOD AND PSEUDO-RANDOM SIGNAL

K. Wagatsuma
T. Muraoka
S. Seto
Y. Maeda
T. Shida
K. Nitta

The authors measured acoustic transmission characteristics of the normal human respiratory system with a pulse-train method.

In this measurement, a sound source was located inside the bronchus.

The clinical significance of this measurement is that more exact evaluation of lung sounds became possible by utilizing the results.

We found that the transmission characteristics was different from the results measured previously.

Two turn-over frequencies were observed in the frequency characteristics, one was around 120 Hz and the other was around 550 Hz. In the frequency range over the higher turn-over frequency, the attenuation rate became larger, and resonance peaks were also observed at the turn-over points respectively. The authors thought low-pass characteristics were mainly formed by the chest wall, and resonance was related to the lung tissue.

Moreover, the authors will try to improve the above measurement procedures using pseudo-random signal.

These measurements will provide us with much valuable information about morbid lungs.

○ (主として) 肺・胸部等で、生じるのでは、

○ 気管中の伝達特性は、flat.

TRANSMISSION PATHS OF CRACKLES IN THE LUNG

T. Abe
M. Yonemaru
H. Kobayashi
T. Kawashiro
T. Yokoyama

We investigated transmission paths of experimentally produced crackles in the canine lung. Crackles were induced during spontaneous breathing on five anesthetized dogs by introducing a small amount of liquid into the right upper bronchi. The crackles were recorded on the chest wall over the right lower lobe using electret condenser microphones before and after the occlusion of the truncus intermedius.

The following findings were observed: (1) the polarity of the initial deflections of crackles was reversed by the occlusion; (2) the beginning of the initial deflections was delayed by the occlusion; and (3) the amplitude of crackles was not changed after the occlusion.

Our findings suggest that transmission of the oscillation composing the initial deflection of crackles is predominantly through the airways and that of the oscillation composing the amplitude of crackles is predominantly through the lung parenchyma.

A CLASSIFICATION OF CRACKLES USING LPC METHOD

Y. Maeda
K. Wagatsuma
T. Muraoka
M. Horiuchi
Y. Yui
T. Shida

Acoustic characteristics of crackles are well represented by their spectra. We tried to classify crackles by their spectral envelope's shapes using LPC method.

In this method, spectral envelope of a crackle can be represented by LPC parameters. These parameters are useful to classify the crackles into some types objectively.

These parameters for each crackle can be considered as a vector. Similarity of some crackles can be expressed by the distances among these vectors.

Principal Component Analysis was adopted to these vectors to extract main factors which characterize the crackles.

We analyzed ten crackles and obtained two main factors. One factor was related to the bandwidth and another one to the slope of high end.

The crackles were grouped into two types, wide and narrow one. Each type has some variations according to its high end slope.

We will study the validity of the above classification with more samples.

COMPENDIOUS ARRAY OF SOUND CHARACTERISTICS

C. Druzgalski
A. Wilson

Commonly used frequency domain or time domain displays of respiratory sounds' characteristics show amplitude vs time or frequency variability. It usually represents an acoustic signal analyzed over a relatively short period of time at a particular point within the respiratory cycle. This time interval of the analyzed signal, that usually represents small portions of a second, depends on a desired frequency resolution of these spectral characteristics. Although these characteristics provide scientifically valid and important information, their direct clinical applicability is limited due to the number of graphs required to characterize long term evolution of a disease process or therapeutic management.

In order to provide concise information concerning respiratory sounds' characteristics, inspiratory/expiratory spectral characteristics of respiratory sounds are projected on a contour of lung lobes indicating auscultatory sides. A microcomputer generated graphic representation of the sound intensity includes corresponding numerical values. Specifically, this includes peak amplitude and corresponding frequency, or amplitude at a given frequency of interest, or selected standard frequencies and corresponding amplitudes. The frequency characteristics displayed represent frequency spectra, averaged over a number of respiratory cycles, for a given time interval on respiratory airflow or volume curves. However, one may display the discrete frequency spectra in a similar fashion if desired. The averaged spectra are more desirable because they represent overall status of respiratory airways as a generator of respiratory sounds under varying conditions of ventilation. Color identification of respiratory phases and/or pre and post medication characteristics of respiratory sounds allow easier differentiation of ventilatory conditions and effectiveness of therapy involving bronchodilator drugs or other treatment. Due to the fact that these arrays of sound characteristics are microcomputer generated and all data is stored on 5 1/4" diskettes it allows easy data retrieval and provides capabilities for a broad comparative assessment. Particularly, it allows long time and/or therapeutic variance comparison.

Clinically informative representation of diagnostic data is of fundamental importance and this compendious array of lung sounds' characteristics intends to provide this partial information as applied to the acoustic characterization of respiration.

WHICH INFORMATION CAN BE DEDUCED FROM THE FOURIER ANALYSIS OF A CRACKLE?

T. Bosser
P. Chapelle
E. Lens
G. Postiaux

Fourier spectra Y(f) of crackles recorded on patients with different kinds of pulmonary disorders generally show a zero of the spectrum between 1.2 and 1.4 KHz. It seems logical to assume that this frequency coincides with the first zero 1/T of the spectrum X(f) of the original impulse of duration T; it can be deduced that T is about 0.8 ms.

The spectrum of the crackle recorded on the chest wall is given by Y(f) = X(f) H(f) where H(f) is the transmittance between the original impulse and the microphone transducer on the chest.

The information contained in Y(f) is mostly due to the transmittance H(f) and generally two resonances are emphasized: the lowest one, at about 200 Hz, corresponding to the natural frequency of the thoracic cavity and the highest one, between 300 and 1000 Hz, corresponding to the natural frequency of the cavities where the original impulse is born.

It can be concluded from our analysis that the FFT analysis Y(f) of a crackle on the chest gives more information on the transmittance H(f) than on the original impulse X(f).

PHONOPNEUMOGRAPH USING A MICRO-COMPUTER

S. Inui
A. Shibuya
S. Kudoh
N. Shioya
R. Mikami

As we have already reported, the simultaneous recording of the lung soundspectrogram and the respiratory cycle is useful for understanding the general characteristics of lung sounds.

In this study, to analyse quantitatively the waveforms in each kind of adventitious lung sounds, we designed a digital soundspectrogram using a micro-computer system, showed a new phonopneumograph and proposed lung sounds analysing system. The digital soundspectrograph can record the sounds at the full scale of time of 6 sec. to 12 sec. and can display the result on color graphic display. Waveforms of only the useful parts of the lung sounds can be obtained by setting the cursor at the optional points of the digital soundspectrogram. The waveforms are analysed and that of discontinuous adventitious lung sounds can be classified into fine, medium and coarse by this system.

We show some actual examples of analysis by this method applied to discontinuous and continuous lung sounds from the patients with bronchitis, asthma and so on.

VIDEODISPLAY OF COMPUTER-ANALYZED BREATH SOUNDS IN ASTHMA

H. Pasterkamp
R. Fenton
V. Chernick

We have used recorded breath sounds from asthmatic children for computer aided spectral analysis by Fast Fourier Transformation (FFT). Ten to 15 seconds of continuous sounds were analyzed and the power spectrum of each 100 msec segment was displayed on the monitor screen. From there these spectra were filmed sequentially, exposing three frames per image. Using a playback speed of 30 frames per second the film was transferred onto video tape and the corresponding breath sound samples were synchronously recorded.

We chose four examples for video display of breath sounds in asthma: a) simultaneous lung and tracheal sounds during acute exercise induced bronchospasm, b) tracheal sounds in asymptomatic asthma, c) tracheal wheezing at regular intervals following exercise challenge and resolution after salbutamol inhalation, d) tracheal sounds with inspiratory wheezing during acute spontaneous asthma.

Wheeze quantification as present inspiratory and expiratory time (Fenton et al IEE Trans Biomed Eng 1985) and pulmonary function (FEV 1 and FEF 50) were included for each sample.

Conventional display of respiratory sounds in real time is done by electrical band-pass filtering. In contrast, our video tape shows continous FFT-analysis over several breaths together with the actual respiratory sounds.

Session C

Drs. David Cugell and Yukihiko Homma, Moderators

9:00- 9:20 AM	Relation(s) of lung sounds and flow rate at the mouth in normal subjects	G. Charbonneau M. Sudraud
9:20- 9:40 AM	The effect of lung volume and airflow on the frequency spectrum of vesicular lung sounds	S. Kraman
9:40-10:00 AM	A study on the posturally induced crackles (PIC) and respiratory function	S. Ohshima Y. Yagi K. Gotoh M. Iida M. Osamura S. Hirakawa
10:00-10:20 AM	Gap between inspiratory and expiratory breath sounds	R. Loudon R. Baughman Y. Ploysongsang
10:20-10:40 AM	Vortices, sounds and choking. Are they related?	M. Mori M. Ohno T. Hisada H. Kino K. Kinoshita H. Morinari T. Shiraishi S. Koike T. Sugimoto
10:40-11:00 AM	COFFEE BREAK	
11:00-11:45 AM	Invited Physiology Lecture — "Mechanism of Phonation — from Airflow to Sound"	M. Sawashima
11:45-12:00 PM	BUSINESS MEETING	
12:00- 1:00 PM	LUNCH	
1:00- 1:20 PM	Longitudinal wave propagation perpendicular to the living body surface	N. Nagayama S. Kudoh A. Shibuya
1:20- 1:40 PM	Relationship between the low frequency vibration on the xiphisternum and transpulmonary pressure	M. Takahashi S. Morikawa T. Suzuki K. Kido
1:40- 2:00 PM	Is normal breath sound white noise, pink noise or what?	M. Ohno M. Mori H. Kino T. Hisada K. Kinoshita H. Morinari T. Shiraishi S. Koike T. Sugimoto
2:00- 2:20 PM	Frequency distribution of crackles initial deflection width	F. Davidson R. Murphy E. Del Bono

RELATION(S) OF LUNG SOUNDS AND FLOW RATE AT THE MOUTH IN NORMAL SUBJECTS

G. Charbonneau
M. Sudraud

Despite the evidence of a correlation between airflow and lung sounds, only few studies have been done in order to precise the relationship between them. Yet, some data are available for flow rates above 1.5 l/s but it is interesting to have results at lower flow rates, because it would be very useful to can evaluate (even approximately) the flow rate from lung sound when the subject breathes at current flow rate and is unable to perform spirometric measurements (children, sleeping patients, ...etc.) in order to detect abnormal falling flow rate.

During studies related to connected topics, we have observed that different parameters of the sound are influenced by the flow rate, namely, the amplitude of the signal, and both the mean frequency and the integral of the frequency spectrum. For examining the relationship between sound and flow rate more precisely, we recorded 12 normal subjects (6 males and 6 females) at 6 different levels of peak flow rate, starting from apnea and reaching about 1.6 l/s. Using the three above referenced parameters, we computed a value varying with the flow rate V(f).

The results indicate that the relationship between sound and flow is more complicated that it seems to be at first. Basically, there are two parts in the function V(f): from apnea until a flow rate around 0.5 l/s, the curve is about independent of the subjects and can be fairly approximated by a linear function. Above this level, V(f) strongly depends on the subject, grows rapidly and should be approximated by higher degree polynomial fit or maybe by exponential function. These results will be discussed in terms of flow conditions in the airways.

THE EFFECT OF LUNG VOLUME AND AIRFLOW ON THE FREQUENCY SPECTRUM OF VESICULAR LUNG SOUNDS

S. Kraman

In recent years, the characteristics of lung sounds, ie, timing, frequency spectrum, amplitude, and the relationships of both inspiratory airflow and lung volume to lung sound amplitude have been examined by objective techniques. However, the effects of lung volume and airflow on the vesicular lung sound frequency spectrum have not been defined. It was the purpose of the present study to do so. 9 healthy young nonsmokers were studied. The dependent variables were the points that divide the power spectrum of the vesicular lung sound into quarters (1st, 2nd and 3rd quartiles [Q1, Q2 & Q3]. Recording sites were the upper anterior (RUL) and lower posterior (RLL) right chest. The sounds were filtered below 100 Hz. to attenuate cardiovascular and muscle sounds. To assess the effect of volume, lung sounds were recorded during an inspiratory vital capacity (VC) maneuver at relatively constant airflow rates. The frequency spectral parameters were determined at each sixth of the VC. To assess airflow, 5 of the subjects breathed from resting lung volume at peak inspiratory airflows of 1 to 2.5 L/s for a total of 12 breaths each and the frequency parameters of the lung sounds occurring during peak inspiratory airflow were determined. RESULTS: Volume, RLL. — Q1, Q2 & Q3 were independent of volume except near TLC. Volume, RUL. — There was a small but significant decrease in all three parameters with increasing lung volume. This was predominantly due to data acquired at the lowest and highest portions of the VC. Airflow — All parameters were independent of airflow except for a weakly positive relationship ($r=0.285$, $P<0.05$) for Q3 at the RUL location. These results suggest that the frequency composition of the vesicular lung sound in healthy adults is minimally affected by changes in lung volume or airflow.

A STUDY ON THE POSTURALLY INDUCED CRACKLES (PIC) AND RESPIRATORY FUNCTION

S. Ohshima
Y. Yagi
K. Gotoh
M. Iida
M. Osamura
S. Hirakawa

This study was carried out to examine the relationship between the PIC and the parameters of respiratory function, particularly reflecting the peripheral airway function. For this purpose, various respiratory function tests, including spirogram, flow-volume ($\dot{V}$-V) curve and single breath nitrogen washout test, were performed together with regional pulmonary function test with ^{133}Xe. PIC were positive, by definition, when crackles were not heard in the sitting position, but heard in a supine position. We obtained the following results; (1) There occurred insignificant difference in the various parameters in the spirogram and $\dot{V}$-V curve between patients with positive and negative PIC. (2) The patients with positive PIC had a significantly higher values only in a supine position for CV/VC and CC/FRC compared with those with negative PIC. (3) There occurred insignificant difference in diffusing capacity between 2 groups. (4) There were decreased regional ventilation in the basal lung field examined with ^{133}Xe inhalation method in those with positive PIC compared to those with negative PIC only in a supine position.

GAP BETWEEN INSPIRATORY AND EXPIRATORY BREATH SOUNDS

R. Loudon
R. Baughman
Y. Ploysongsang

Vesicular and bronchial breath sounds are distinguished from one another by several characteristics; one is the presence of a gap between the inspiratory and expiratory portions of the bronchial breath sounds. This silent gap cannot usually be detected when listening to vesicular sounds.

Six healthy subjects were studied, recording vesicular sounds from the right base posteriorly and tracheal sounds at the suprasternal notch; airflow at the mouth was measured by pneumotachygraph, and volume change by integration of the flow signal. The four channels of information were recorded on FM magnetic tape at 15 i.p.s., for subsequent analysis. A series of tidal breaths were recorded, then a series of breaths with similar volume and flow characteristics, but with a breathhold of one to two seconds at the end of inspiration. After another period of normal tidal breathing a series of breaths with end-expiratory breathhold was recorded.

The gap between the inspiratory and expiratory portions of the bronchial breath sounds was readily detectable by listening to the tape or by inspecting the time-amplitude waveform. It averaged 582 msecs. for eight breaths from each of six subjects. End-inspiratory breathhold added the duration of breathhold to the gap. The gap started (sound ceased) at the equivalent flow rate for each set of maneuvers. The vesicular sound amplitude was considerably less; the equipment for the two channels was the same, and no automatic gain control was used. With the lower amplitude signal, the signal-to-noise ratio (S/N) was less for vesicular than for bronchial sounds. No clear-cut gap between inspiration and expiration could be detected during tidal breathing. During end-inspiratory hold maneuvers, however, a silent gap during the breathhold could be readily detected. The differences in pitch and intensity between inspiratory and expiratory segments of the vesicular sounds were unaltered by the breathholding gap but more apparent as a result of their artificial separation.

VORTICES, SOUNDS AND CHOKING. ARE THEY RELATED?

M. Mori
M. Ohno
T. Hisada
H. Kino
K. Kinoshita
H. Morinari
T. Shiraishi
S. Koike
T. Sugimoto

By spectral analysis of tracheal sounds recorded during forced expiration we can demonstrate development of prominent discrete spectra. These line spectra are supposed to be generated by vortices. The purpose of this study is to provide a direct evidence that vortices do produce line spectra and speculate how they affect the flow.

A plastic tube (19 cm internal diameter and 54 cm long) with a nozzle of variable diameter was made. The gas was blown off by forced pumping of the piston. A stream of smoke was introduced at the orifice and a microphone (SONY ECM150) was placed at the nozzle. Both the sounds and the flow profile were recorded in a videorecorder (SONY SL-F7). We were able to confirm both the formation of vortices and the development of discrete spectra.

How these vortices affect the flow? We speculate that the formation of vortices reduces the downstream pressure so that the pressure ratio (downstream/upstream) may reach the critical value where choking starts to develop.

LONGITUDINAL WAVE PROPAGATION PERPENDICULAR TO THE LIVING BODY SURFACE

N. Nagayama
S. Kudoh
A. Shibuya

From a few experimental results previously reported by some authors we can assume a group velocity model of longitudinal waves propagating perpendicular to the living body surface ($d\omega/dk = 10.0(f/80)^{1/2}$ m/sec, where f is wave frequency in cps). Using the model we calculated the phase velocity profile ($\omega/k = 5.0(f/80)^{1/2} / \{1-0.5(80/f)^{1/2}\}$) in the frequency range between 80 and 10^5 cps. Then applying Kramers-Kronig relations we computed the attenuation coefficient.

The result is summarized as follows. First the phase velocity increases rapidly with frequency (approximately in proportion to $f^{1/2}$), that is the living body is highly adversely dispersive in the same frequency range. Secondly the phase velocity jumps from some 200 m/sec to 1500 m/sec (ultrasonic sound velocity in soft tissue) around 10^5 cps. Lastly the attenuation coefficient α is roughly approximated as $\alpha \simeq \mathrm{Log}_{10}(f/80)$/cm for $80<f<400$ cps and $\alpha \simeq (f/10^3)^{0.6}$/cm for $10^3<f<10^5$ cps. From the former we can qualitatively account for the slope of the power spectrum of normal breath sounds (2.5L dB/Oct, wtere L(cm) represents the path length in the chest wall).

RELATIONSHIP BETWEEN THE LOW FREQUENCY VIBRATION ON THE XIPHISTERNUM AND TRANSPULMONARY PRESSURE

M. Takahashi
S. Morikawa
T. Suzuki
K. Kido

It is experimentally found that there is approximately linear relation between the transpulmonary pressure and the power of low frequency vibration around 30 Hz picked up on the xiphisternum. Subjects are male volunteers, who did not suffer from any chronic or acute illness, breathe from residual volume to total lung capacity, and then breath-hold, with the glottis open for one or two seconds, at a number of different lung volumes as the inspiration proceeds in a sitting position. In a similar fashion, the subject breathes back out from total lung capacity to residual volume. Vibration is picked-up with a contact accelerometer type transducer, which is attached to the skin using an adhesive tape. The frequency spectra are calculated using the fast Fourier transform method. Other physiological variables are recorded using standard techniques. A pneumotachygraph with associated pressure transducer and carrier amplifier is used to record airflow, and a standard respiratory integrating unit is used to obtain a continuous recording of volume from the flow signal. A pressure transducer with a carrier amplifier is used with an esophageal balloon to record transpulmonary pressure.

IS NORMAL BREATH SOUND WHITE NOISE, PINK NOISE OR WHAT?

M. Ohno
M. Mori
H. Kino
T. Hisada
K. Kinoshita
H. Morinari
T. Shiraishi
S. Koike
T. Sugimoto

Seven years ago in this conference we presented a paper "Spectral Analysis of Normal Breath Sounds", in which we suggested that the spectra of normal breath sounds consist of 7 to 9 discrete spectra because there exist in the lung resonators with resonant frequencies determined by the geometry of the airways and the lung volume at each bronchial generation. The purpose of this presentation is to reconfirm our previous findings providing new evidences.

Breath sounds signals, which were recorded in a FM tape recorder (TEAC XR510) were band-pass filtered (cut-off frequencies at 100 Hz and 1000 Hz), and digitized (12 bit, 2000 Hz, FACOM 7091A). Six to ten cycles of inspiratory or expiratory breath sounds were collected and the power spectra were obtained by FFT (FACOM 1700). The results supported our previous findings. Normal breath sounds do not sound like those with pure tones because the quality factors of the resonators are low.

FREQUENCY DISTRIBUTION OF CRACKLES INITIAL DEFLECTION WIDTH

F. Davidson
R. Murphy
E. Del Bono

To study the relationship of crackle measurements to tidal volume in patients with congestive heart failure we measured the following crackle parameters: initial deflection width (IDW) two cycle duration (2CD), and zero crossing average (ZCA). The following average results were obtained:

Tidal Volume	IDW	SD	2CD	SD	ZCA	SD
650	0.98		6.14		1.73	
800	0.97		5.69		1.55	
900	0.94		5.76		1.66	

There were no statistically significant differences between these crackle measurements at the various volumes measured. To our surprise, however, we observed that there were fewer crackles of larger IDW than those of shorter IDW. In fact, in the range from .8 to 1.3 the relationship appeared to be linear. Accordingly, we examined the frequency distribution of IDW in several other disease processes. Our observations appear to fit the theory of Fredberg and Holford that IDW reflects the size of the airway in which crackles are generated. The limitations in this conclusion will be discussed.

Session D

Drs. Wilmot C. Ball and Tadashi Abe, Moderators

2:20-2:40 PM	Analysis of continuous adventitious lung sounds in various lung diseases — wheeze or rhonchus?	N. Shioya Y. Koyama S. Kudoh A. Shibuya R. Mikami
2:40-3:00 PM	Incidence of occurrence of posturally induced crackles (PIC) in various diseases, with particular reference to the ischemic heart disease	Y. Yagi S. Ohshima M. Osamura M. Iida K. Gotoh I. Kuriyama S. Hirakawa
3:00-3:20 PM	Noninvasive assessment of pulmonary function in patients with C.O.P.D. during acute ventilatory failure	S. Ishikawa L. Kenny B. Upadyay S. Doss M. Dulfano K. MacDonnell
3:20-3:40 PM	COFFEE BREAK	
3:40-4:00 PM	A case with bronchial tuberculosis detected by wheezes	T. Itoh M. Matsuzaki H. Morimoto M. Urasaki J. Shimomura R. Ohashi Y. Homma
4:00-4:20 PM	Lung sounds and indices of pulmonary congestion and edema in dogs	Y. Ploysongsang R. Michel L. Zocchi A. Rossi J. Milic-Emili N. Staub
4:20-4:40 PM	Crackles in experimental lung edema	K. Tanimura Y. Homma M. Munakata H. Kusaka H. Ogasawara Y. Kawakami
4:40-5:00 PM	Fine crackles in a patient with idiopathic pulmonary fibrosis	Y. Homma M. Munakata K. Tanimura H. Ogasawara H. Kusaka
5:00-5:20 PM	The sound of cough	H.O.S. Husodo
5:20 PM	Summary of Conference	M. Mori

ANALYSIS OF CONTINUOUS ADVENTITIOUS LUNG SOUNDS IN VARIOUS LUNG DISEASES—WHEEZE OR RHONCHUS?

N. Shioya
Y. Koyama
S. Kudoh
A. Shibuya
R. Mikami

Wheezes or rhonchi are heard not only in patients with asthma but in various respiratory diseases. We examined the continuous adventitious lung sounds auscultated in 85 patients with asthma, lung cancer, chronic obstructive lung disease (Type B), bronchiectasis, pneumonia, pulmonary tuberculosis and other diseases.

The continuous sounds recorded on the chest with quiet breathing maneuver were analysed by a phonopneumographic method using a sound-spectrograph, and we measured the pitch and the duration of the sounds. "Short wheezes" or "squawk sounds" were excluded and the continuous sounds shorter than 100 ms were also excluded.

The pitch of the continuous sounds sampled from 85 patients ranged from less than 100 Hz to 880 Hz.

The pitch of the continuous sounds in patients with asthma (336+170 Hz) is higher than that in lung cancer (181+71 Hz) or COLD (194+85 Hz).

In asthmatic patients, high pitched sounds of 400 Hz or more (wheezes) were found in 30% and low pitched sounds of 200 Hz or less (rhonchi) were found in 28%. But, in nonasthmatic patients, most of the sounds were lower than 400 Hz.

INCIDENCE OF OCCURRENCE OF POSTURALLY INDUCED CRACKLES (PIC) IN VARIOUS DISEASES, WITH PARTICULAR REFERENCE TO THE ISCHEMIC HEART DISEASE

Y. Yagi
S. Ohshima
M. Osamura
M. Iida
K. Gotoh
I. Kuriyama
S. Hirakawa

To examine the incidence of occurrence of fine crackles induced by position change in various cardiac and non-cardiac diseases, crackles were detected by auscultation of the lungs along the posterior axillary line at the level of 8th-10th intercostal spaces, with the patients in 3 different positions, i.e., (1) sitting, (2) supine and (3) supine plus passive leg elevation at an angle of about 30 degrees, for 3 min. respectively. PIC was positive, by definition, when crackles were found only in a supine and/or with legs elevation, but not in a sitting position. A total of 605 patients with various cardiac and non-cardiac diseases was examined for crackles in a total of 1616 times. As a result, a high incidence of positive PIC test was found in those with myocardial infarction, angina pectoris, liver cirrhosis and lung diseases. In patients with ischemic heart diseases, there occurred insignificant difference in the hemodynamic parameters, including pulmonary artery wedge pressure and pulmonary blood volume, between those with positive and negative PIC tests, whereas, there was a decreasing tendency in the ejection fraction, obtained with left ventriculography, in those with positive PIC test.

NONINVASIVE ASSESSMENT OF PULMONARY FUNCTION IN PATIENTS WITH C.O.P.D. DURING ACUTE VENTILATORY FAILURE

S. Ishikawa
L. Kenny
B. Upadyay
S. Doss
M. Dulfano
K. MacDonnell

In the Respiratory Intensive Care Unit, we monitored patients with C.O.P.D. during acute ventilatory failure.

Continuous recording of lung sounds and inductive plethysmography and periodic determination of auscultatory percussion (during the chest wall percussion, input sound signal was recorded next to the site of percussion using electronic stethoscope) were carried out. The recordings were then transcribed onto a paper at the speed of 25 mm and 800 mm/sec. Wave form analysis was performed and IDW and 2CD were obtained. At the advanced stages of ventilatory failure there were increased respiratory frequency (>35), shortening of inspiratory time (Tl) (<0.456), shortening of inspiratory time over total respiratory cycle (Tl/Ttot) (<0.336), markedly decreased tidal volume (TV) (<4 ml/kg), IDW < 5, 2CD < 15 were observed. Increasing pCO_2 was correlated with decreasing intensity of peripheral breath sounds, decreasing IDW and 2CD at FRC and shortening of Tl/Ttot.

A CASE WITH BRONCHIAL TUBERCULOSIS DETECTED BY WHEEZES

T. Itoh
M. Matsuzaki
H. Morimoto
M. Urasaki
J. Shimomura
R. Ohashi
Y. Homma

A 75-year-old man visited our clinic with the history of non-productive cough and mild fever for three months. Physical examination showed relatively loud low-pitched wheezes (rhonchus) both on inspiration and on expiration with a maximal intensity over the left upper lung field. Plain chest films showed only a slight streaky shadow in the left upper lung field. A tuberculin test was positive. Fiberoptic bronchoscopy revealed stenosis of the left upper lobe bronchus due to a white necrotic mass covering the inner wall. Microscopical examination of smears of the necrotic mass revealed numerous acid-fasting bacilli. He was placed on INH and RFP.

Tracheobronchial tuberculosis is frequently overlooked for its paucity of subjective symptoms and roentgenological findings. Otherwise, it may be misdiagnosed as bronchial asthma because wheezing sounds are often widely audible in this disease. Careful auscultation of lung sounds is needed for early detection and correct diagnosis of tracheobronchial tuberculosis. Some statistical data will be presented.

LUNG SOUNDS AND INDICES OF PULMONARY CONGESTION AND EDEMA IN DOGS

Y. Ploysongsang
R. Michel
L. Zocchi
A. Rossi
J. Milic-Emili
N. Staub

We studied changes of lung sounds in pulmonary congestion and edema dogs to detect early and subclinical pulmonary edema. Five mongrel dogs (2 interstitial and 3 alveolar edema) were studied. A Swan Ganz catheter was inserted through a femoral vein to measure the pulmonary artery pressure. Edema was produced by infusion of Ringer's lactate solution. Lung sounds were recorded from the dependent part of the chest wall after being shaved. All signals were recorded on tapes for further analysis. Lung sounds signals were played back, high pass filtered at 100 Hz and subjected to FFT. The infusion lasted for about 0.5-1 hr, followed by a recovery period of 30-45 minutes. Samples of lung sounds were analyzed before (control) and at 5, 10, 20, 30, and 40 minutes after the infusion. The power spectra of all samples showed a normal distribution with a slight skewness to the left. The mean, median and mode frequencies of the control were respectively: 169.6±29.19, 129.6±29.81, and 136.0±29.87 Hz (X±SD). These values increased significantly at 5 minutes after infusion to 194.0±26.08 ($p<0.0037$), 150.2±23.48 ($p<0.0085$), and 164.6±28.74 ($p<0.02$) Hz respectively. These values stayed significantly elevated at 10, 20, 30 and 40 minutes. On the other hand the intensity of lung sounds did not change with fluid infusion. The pulmonary arterial and wedge pressures also increased significantly at 5, 10, 20, 30, and 40 after infusion. There were no adventitious sounds at 5 and 10 minute after infusion. We conclude that pulmonary congestion alters the frequency characteristics of lung sounds early before the occurrence of adventitious sounds. These altered lung sounds may be used as an index of pulmonary congestion and impending edema.

This work was done during Dr. Y. Ploysongsang's sabbatical leave to McGill University.

CRACKLES IN EXPERIMENTAL LUNG EDEMA

K. Tanimura
Y. Homma
M. Munakata
H. Kusaka
H. Ogasawara
Y. Kawakami

The production mechanism of crackles experienced in lung edema is still obscure. To clarify this mechanism, we experimentally induced lung edema in the isolated canine lung lobe by perfusing whole blood. The excised lobe was ventilated manually in an airtight hard lucid box. Crackles were picked up from the inside of the capsule attached to the surface of the lobe by an electret condenser microphone (SONY ECM-150). We simultaneously recorded total airflow (v) at the airway opening, transpulmonary pressure (Ptp), and lung sounds with a polygraph. When recording, we chose three conditions, perfused at the levels of pulmonary venous pressure 0 or 10 cmH_2O or not perfused as a control, while arterial pressure was kept 20 cmH_2O. After full inflation of the lobe at Ptp of 30 cmH_2O, end inspiratory Ptp was controlled constant at about -10 cmH_2O, while end expiratory Ptp (EEPtp) was increased from -5 cmH_2O to 15 cmH_2O gradually, breath by breath. By this maneuver, the relationship between the number of crackles generated and EEPtp was investigated.

Obtained results were as follows;
1) In normal control without perfusion, crackles were produced at EEPtp under -1 to 1 cmH_2O and increased in number with the decrease of EEPtp.
2) In perfused lobe with venous pressure 0 cmH_2O, crackles were produced at EEPtp under -3 to -1 cmH_2O and more crackles was produced than control.
3) With venous pressure of 10 cmH_2O, crackles were produced at EEPtp under -5 to -2 cmH_2O and the number of crackles was more than that with venous pressure 0 cmH_2O.

From these results, the production mechanism of crackles in lung edema will be discussed.

FINE CRACKLES IN A PATIENT WITH IDIOPATHIC PULMONARY FIBROSIS

Y. Homma
M. Munakata
K. Tanimura
H. Ogasawara
H. Kusaka

The sounds produced in the lung are believed to be changed in quality and attenuated in intensity by the thoracic wall. However, precise information on this subject is scant. In a patient with idiopathic pulmonary fibrosis, 54 y/o male, we recorded fine crackles from the chest wall just a few days before death and from the surface of the postmortem excised lung ventilated manually. Recordings of these sounds were analyzed on time intensity plots with an expanded time axis using our phonopneumograph previously reported and spectral analysis. Comparing these two sounds, the effect of the thoracic wall on the acoustical characteristics of fine crackles seemed to be smaller than we had supposed.

To determine whether fine crackles are generated by abrupt airway opening, we also traced fine crackles picked up from the manually ventilated excised lung and simultaneously measured alveolar pressure by pleural capsule method. From this result, we will discuss the production mechanism of fine crackles.

In connection with this presentation a demonstration of the opening appearance of peripheral airspaces of the excised lung lobe will be given.

THE SOUND OF COUGH

H.O.S. Husodo

Contrary to the general opinion that cough is a defense mechanism and as such implies that it is beneficial to the patient, one has to admit that in most instances it is at least troublesome, often harmful and even hazardous. Most coughing patients who visit a doctor ask to be relieved from it.

To be able to help a patient, the exact nature of the cough must be known. One which is caused by tickling at one's external ear canal, must be differently managed from the cough of an asthmatic patient. Cough suppressive drugs may aggravate an existing bronchial spasm and can lead to more serious coughing when given to the latter.

Cough which has it's origin in various divisions of the respiratory tract, the pleura or other parts of the body, has its own characteristics. By listening carefully at it, it's quality can be appreciated. Not only are there deviations from the "basic cough", adventitious sounds are also present. Little investigation has as yet been done in this field.

This article is an attempt to bring more insight into the sound of cough.

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Kanebo Pharmaceuticals Co., Ltd.
Key Pharmaceuticals, Inc. Miami, Florida
KISSEI PHARMACEUTICAL CO., LTD.
Kowa Co., Ltd.
KYORIN Pharmaceutical Co., Ltd.
KYOWA HAKKO KOGYO CO., LTD.
Lederle Japan Co., Ltd.
MORISHITA PHARMACEUTICAL CO., LTD.
Nippon Boehringer Ingerlheim Co., Ltd.
NIKKEN CHEMICALS Co., LTD.
NIPPON UNIVERSAL PHARMACEUTICAL CO., LTD.
NIPPON WELLCOME K.K.
Otsuka Pharmaceutical Co., Ltd.
PFIZER TAITO CO., LTD.
Rion CO., LTD.

SANDOZ PHARMACEUTICALS, LTD.
Sanea Kagaku Kenkyusho Co., LTD.
SANITA TRADING CO., LTD.
Sankyo Co., Ltd.
SHIONOGI & Co. LTD.
Special Reference Laboratories Inc.
SS PHARMACEUTICAL CO., LTD.
Stethophonics Boston, Massachusetts
Sumitomo Pharmaceuticals Co., Ltd.
Taiho Pharmaceutical Co., Ltd.
Takeda Chemical Industries, Ltd.
Tanabe Seiyaku Co., LTD.
TERUMO JAPAN CO., LTD.
The Green Cross Corporation
Thieme-Stratton, Incorporated of New York
Tokyo Tanabe Company Limited
TORII & CO., LTD.
TOYAMA CHEMICAL Co., Ltd.
TSUMURA JUNTENDO, INC.
Vitalograph Limited Buckingham, England
Yamanouchi Pharmaceutical Co., Ltd.
Yoshitomi Pharmaceutical Industries, Ltd.