THE 20th INTERNATIONAL CONFERENCE ON LUNG SOUNDS

第20回国際肺音学会

Presented by

The International Lung Sounds Association

October 11-13, 1995

California State University, Long Beach
Long Beach, California, U.S.A.

Department of Electrical/Biomedical Engineering
California State University, Long Beach
Long Beach, CA 90840, U.S.A.

THE 20th INTERNATIONAL CONFERENCE ON LUNG SOUNDS

第20回国際肺音学会

Presented by
The International Lung Sounds Association

October 11-13, 1995
The Queen Mary & CSULB
Long Beach, California, U.S.A.

FINAL PROGRAM AND ABSTRACTS

20th International Conference on Lung Sounds

Long Beach, California, U.S.A. October 11-13, 1995

1976 Boston, MA
1977 Cincinnati, OH
1978 New Orleans, LA
1979 Chicago, IL
1980 London, England
1981 Boston, MA
1982 Martinez, CA
1983 Baltimore, MD
1984 Cincinnati, OH
1985 Tokyo, Japan
1986 Lexington, KT
1987 Paris, France
1988 Chicago, IL
1989 Winnipeg, Canada
1990 New Orleans, LA
1991 Verona, Italy
1992 Helsinki, Finland
1993 Calgary, Canada
1994 Haifa, Israel
1995 Long Beach, CA

Organization
Steering Committee

Wilmot Ball, M.D.	Baltimore, Maryland
David Cugell, M.D.,	Chicago, Illinois
Filiberto Dalmasso, M.D.	Torino, Italy
Sadamu Ishikawa, M.D.	Boston, Massachusetts
Steven Kraman, M.D.	Lexington, Kentucky
Shoji Kudoh, M.D.	Tokyo, Japan
Robert Loudon, M.D.	Cincinnati, Ohio
Masashi Mori, M.D.	Tokyo, Japan
Raymond Murphy, M.D.	Boston, Massachusetts
Hans Pasterkamp, M.D.	Winnipeg, Canada
Anssi Sovijarvi, M.D.	Helsinki, Finland
S.A.T. Stoneman, M.D.	Swansea, United Kingdom

Conference Chairmen

Christopher Druzgalski, Ph.D.
California State University
Electrical/Biomedical Engineering
Long Beach, CA 90840
Tel: (310) 985-8054 or (310) 985-8043
FAX: (310) 985-5899 or (310) 985-7561
Email: ilsac@csulb.edu
Web: http://www.csulb.edu/~ilsac

Raymond L.H. Murphy, M.D.
Faulkner Hospital/Pulmonary
1153 Centre Street
Boston, MA 02130
Tel: (617) 522-5800 x1968
FAX: (617) 524-8663

Address of the International Lung Sounds Association

INTERNATIONAL LUNG SOUNDS ASSOCIATION
Raymond L.H. Murphy, M.D.
1153 Centre Street
Boston, MA 02130
Tel: (617) 522-5800 x1968

20th International Conference on Lung Sounds

Long Beach, California, U.S.A. October 11-13, 1995

1976 Boston, MA
1977 Cincinnati, OH
1978 New Orleans, LA
1979 Chicago, IL
1980 London, England
1981 Boston, MA
1982 Martinez, CA
1983 Baltimore, MD
1984 Cincinnati, OH
1985 Tokyo, Japan
1986 Lexington, KT
1987 Paris, France
1988 Chicago, IL
1989 Winnipeg, Canada
1990 New Orleans, LA
1991 Verona, Italy
1992 Helsinki, Finland
1993 Calgary, Canada
1994 Haifa, Israel
1995 Long Beach, CA

PREFACE

We are pleased to present a scientific program that will provide an excellent opportunity for a rewarding information exchange. All of us, scientists, physicians, engineers, and physicists, share common interests and goals in better understanding and use of lung sounds to the benefit of medicine and health care. We would like to express our gratitude to all whose individual commitment and collaborative efforts have made this conference possible.

We extend our warmest welcome to you, and hope that your experience at the 20th International Conference on Lung Sounds will be fulfilling.

Chris Druzgalski
Robin Loudon
Ray Murphy

Conference assistants and staff :

Gerry Gugliuzza
Barbara Keith
Sabina Pradhan
Lily Vinh

Department of Electrical/Biomedical Engineering, California State University, Long Beach
1250 Bellflower Boulevard, Long Beach, CA 90840-8303, (310) 985-8054

20th International Conference on Lung Sounds

Long Beach, California, U.S.A. October 11-13, 1995

1976 Boston, MA
1977 Cincinnati, OH
1978 New Orleans, LA
1979 Chicago, IL
1980 London, England
1981 Boston, MA
1982 Martinez, CA
1983 Baltimore, MD
1984 Cincinnati, OH
1985 Tokyo, Japan
1986 Lexington, KT
1987 Paris, France
1988 Chicago, IL
1989 Winnipeg, Canada
1990 New Orleans, LA
1991 Verona, Italy
1992 Helsinki, Finland
1993 Calgary, Canada
1994 Haifa, Israel
1995 Long Beach, CA

GENERAL INFORMATION

About Long Beach ...Long Beach is known as the city with the "most on the coast" and is steps away from the ocean, great deserts, and mountains. One visit here and you'll understand how Long Beach got its name. The brisk ocean air surrounds its lovely marinas, stately well-kept homes, and quaint boutique-lined avenues. The city offers tranquility of beaches and the freedom of getting on one of many freeways that will take you down to San Diego or Mexico, which are only two hours away. Attractions are even closer: Disneyland (30 min.), Knott's Berry Farm (30 min.), Universal Studios (50 min.), Hollywood/Beverly Hills (40 min), Los Angeles (30 min), Catalina Island, the Capri of Southern California (55 min), Sea World (2 hrs.). Long Beach is the proud home of "Planet Ocean" the world's largest mural and the Pyramid. This graceful city is close to the historic Queen Mary. The Queen Mary offers a unique way to see the world without leaving Long Beach. This 81,000 ton, 12-deck ship is the largest, most luxurious ocean liner afloat and is permanently docked across from downtown Long Beach. First launched in 1934, this elegant ocean liner made 1001 Atlantic crossings and served as a troop ship during World War II before coming to its present home in Long Beach. You may enjoy many attractions aboard the ship or just enjoy the views and sit back and imagine what it was like to be one of its original voyagers. At the Hotel Queen Mary, people do not just attend a meeting, they become a part of Her history and the excitement that still surrounds Her. With one of California's only true downtown waterfront locations, Long Beach captures the cool easygoing essence of Southern California.

Climate: The weather is sure to ignite anyone into the desire of strolling along the beach and enjoying pleasant ocean water. It's sunny by day, nice and fresh at night. Temperature Averages (max/min) for October - 77/57 F.

Airports and Transportation: Los Angeles International Airport (30 min) LAX: $13/person. John Wayne (Orange County) Airport (30 min) SNA: $32/first + $9/each additional. Long Beach Airport LGB: $15/first + $9/each additional. Transportation from/to airports on airport shuttle. Local transportation: The Runabout offers free shuttle service around the downtown area. Also, you can pick up the Metro Blue Line from Downtown Long Beach and take it all the way into Downtown L.A. Both are easy, relaxing ways to get around.

Conference Site and Accommodations: Conference will be held aboard the Queen Mary. QUEEN MARY (1126 Queen's Highway, Long Beach, CA U.S.A. 90802, ph. 310 432-6964, 800 437-2934; Telex 496 -17017, Fax 310 437-4531). Special rates are available to the participants registered prior August 25, 1995. However, availability of rooms in a specific category can only be assured by early reservation. Indicate ILSAC when making reservations. Domestic and international reservations can be made via U-Tell or directly with Queen Mary. Inquire for your country U-Tell reservation office number if not listed below.

Conference Stateroom Rates - ILSAC rates (Range: $69.00 - $89.00); ***Regular Stateroom Rates*** (Range: $80.00 - $160.00); ***Suite Rates*** (Range: $190.00 - $375.00)

Travel Lodge Hotel ($65; 700 Queens Way Drive, Long Beach, CA U.S.A. 90802
ph. 310 437-7676, 800 578-7878; FAX 310 437-0866)

Howard Johnson Plaza Hotel ($40; 1133 Atlantic Avenue, Long Beach, CA U.S.A. 90813
ph. 310 590-8858; FAX 310 983-1607

Participant's and Companion's Programs - Organized (See Flyer) or individual day tours. Inquire about other accommodations or programs.

Department of Electrical/Biomedical Engineering, California State University, Long Beach
1250 Bellflower Boulevard, Long Beach, CA 90840-8303, (310) 985-8054

20th International Conference on Lung Sounds

Long Beach, California, U.S.A. October 11-13, 1995

Authors Index

1976 Boston, MA
1977 Cincinnati, OH
1978 New Orleans, LA
1979 Chicago, IL
1980 London, England
1981 Boston, MA
1982 Martinez, CA
1983 Baltimore, MD
1984 Cincinnati, OH
1985 Tokyo, Japan
1986 Lexington, KT
1987 Paris, France
1988 Chicago, IL
1989 Winnipeg, Canada
1990 New Orleans, LA
1991 Verona, Italy
1992 Helsinki, Finland
1993 Calgary, Canada
1994 Haifa, Israel
1995 Long Beach, CA

Department of Electrical/Biomedical Engineering, California State University, Long Beac
1250 Bellflower Boulevard, Long Beach, CA 90840-8303, (310) 985-8054

20TH INTERNATIONAL CONFERENCE ON LUNG SOUNDS
AND
INTERNATIONAL LUNG SOUNDS ASSOCIATION
ANNUAL MEETING

Aboard the Queen Mary
Long Beach, California, October 11-13, 1995

Wednesday, October 11

3:00 - 5:00	Workshop -- The Role Of The Internet in Assisting Lung Sound Research- H. Pasterkamp, C. Druzgalski (Transportation to/from CSULB - Bus Departure 3:00 pm)
6:00 pm	A "Welcome to the Queen Mary" Get Together (Victoria Room)

Thursday, October 12

8:15 am	Registration (Windsor Salon)
8:45 - 9:00	Welcome Address -- Christopher Druzgalski

Session A
(Windsor Salon)
Dr. Steven Kraman & Dr. Robert Loudon, Chairmen

9:00 - 9:20	Spatial Reconstruction of Acoustic Sources in the Thorax- M. Kompis, G. Wodicka, Purdue Univ., West Lafayette, IN, USA
9:20 - 9:40	Evidence of Chaotic Dynamics in Normal Lung Sounds- L. Vannuccini , C. Mocenni, M. Rustici, M. Rossi, F. Dalmasso, G. Righini, U.U Pneumologia USL 8, Arezzo; Univ. Di Siena, Universita di Sassari, Osp. Mauriziano "Umberto I", 1st Elettrotecnico Nazionale "Galileo Ferraris",Torino; Italy
9:40 - 10:00	Classification of Respiratory Sounds Based on Visual Displays- E. G. Guler, B. Sankur, Y. Kahya, Bogazici Univ., Istanbul, Turkey; S. Raudys, Institute of Math. & Informatics, Vilnius, Lithuania
10:00 - 10:20	Coffee Break
10:20 - 10:40	Classification of Respiratory Sound Patterns by Means of Cooperative Neural Networks- E. G. Güler, B. Sankur, Y. P.Kahya, Bogazici Univ., Istanbul, Turkey ; S. Raudys, Institute of Math. & Informatics, Vilnius, Lithuania
10:40 - 11:00	Ambient Respiratory Noise Effect on Expiratory Lung Sound Recordings - H. Pasterkamp, Y. Oh, Univ. of Manitoba, MB, Canada; G. Wodicka, Purdue Univ., West Lafayette, IN, S. Kraman, VA Medical Center, Lexington, KY; USA
11:00 - 11:20	Changes of Tracheal Sounds After the Expandable Metallic Stent Insertion to Bronchus or Trachea- Y. Taniguchi , S. Kudoh, A. Murata, Nippon Medical School, M. Nakjima, Kenz Medico Co. Ltd.; A. Shibuya, Japan Women's Univ., Tokyo, Japan
11:20 - 11:40	Localization of Pulmonary Adventitious Sounds- R. Murphy, J. Shane, C. Duggan, J. Schmelz, Faulkner Hospital, Boston, MA ,USA
11:40 - 12:00	Photo
12:00 - 1:30	Lunch

Session B
(Windsor Salon)
Dr. Filiberto Dalmasso & Dr. Hans Pasterkamp, Chairmen

1:30 - 1:50	Effect of Gas Density on Expiratory Sounds- H. Pasterkamp, Y. Oh, U. Of Manitoba, MB, Canada; S. Kraman, VA Medical Center, Lexington, KY, USA; G.Wodicka, Purdue Univ., West Lafayette, IN, USA
1:50 - 2:10	Use of Flow Gating in the Study of Lung Sound Spectra- L. Pesu, P. Helisto, P. Malmberg, A. Sovijarvi, T. Katila; Helsinki Univ. Of Technology, Helsinki Univ. Central Hospital, Helsinki, Finland
2:10 - 2:30	A Simple Model for Flow Limitation During Forced Expiration- F. Sakao, M. Mori, H.Sato; Kinki Univ., Takaya, Higashihiroshima , Tokyo National Chest Hospital, Institute of Flow Research; Tokyo, Japan
2:30 - 2:50	Coffee Break
2:50 - 3:10	The Factors Which May Influence the Waveforms of Percussion Sounds- M. Mori, H. Katayama, M. Ono, Tokyo National Chest Hospital, F. Sakao, Kinki Univ., Hiroshima; H. Sato, Institute of Flow Research; Tokyo, Japan
3:10 - 3:30	Frequency Dependence of Sound Transmission in the Human Respiratory System Between 50 and 500 Hz- A. H. Leung, J. D. Young, S. Sehati, C. N. Mcleod, Oxford Brookes Univ., Univ. of Oxford, Oxford, U.K.
3:30 - 3:50	Effect of Lung Volume on Sound Transmission Through the Respiratory System- F. Davidson, J. Schmelz, C. Duggan, J. Shane, R. Murphy, Faulkner Hospital, Boston, MA, USA
3:50 - 4:10	Monitoring of Respiration Using a Sensor Based on Mode-Single Fiber Optic and Expert System to Medical Diagnosis- E. Suaste, J. L. Avila, A. Martinez, CINVESTAV - IPN, Zacatenco, Mexico
5:30 pm	Banquet -(Wild West Dinner Extravaganza - Bus Departure 5:30 pm)

Friday, October 13

Session C
(Windsor Salon)
Dr. Shoji Kudoh & Dr. Sadamu Ishikawa, Chairmen

9:00 - 9:20	Frequency Spectral Analysis of Breath Sounds in Newborn Infants and Children- T. Imai, Y. Inaba, K. Shirota, Y. Yoshida, Nippon Medical School; Tokyo, Japan
9:20 - 9:40	Study of Frequency Spectrum Analysis of Sound Through Asthma Lungs- Q. Qiyuan, Z. Yan, Hospital of Fudan Univ.; Q. Lun, Huashen International Enterprise Circle Ltd.; F. Didi, Hada Industry and Commerce Co.; Shanghai, China
9:40 - 10:00	Effects of Methacholine on Spectral Characteristics of Cough Sounds in Asthmatics"-S. Ishikawa, E. Trayner, S. Del Re, H. Gill, L. Kenny, G. Hayes, K. F. McDonell, B. Celli; St. Elizabeth's Medical Center, Tufts Univ. School of Medicine, Boston, MA, USA
10:00 - 10:20	Coffee Break
10:20 - 10:40	Initial Cough Sound: Relationship to EMG Signals- P. Ayres, R. Loudon, Proctor and Gamble Co., Univ. of Cincinnati; Cincinnati, OH, USA

10:40 - 11:00	Site of Capture Affects Acoustic Features and Significance of Snoring-F. Dalmasso, G. Righini, R. Prota, L. Vannuccini, M. Rossi, Osp. Mauriziano, Instituto Elettrotecnico Nazionale G. Ferraris, Osp. C. Arezzo; Torino, Italy
11:00 - 11:20	Characteristics of Lung Sounds in Chronic Obstructive Pulmonary Disease- M. Murphy, E. Abad, J. Schmelz, R. L. Murphy, Boston College, Chestnut Hill and Faulkner Hospital, Jamaica Plain; MA, USA
11:20 - 12:00	Guest Speaker- Prof. Richard Birkemeier, CSULB, Long Beach, CA USA The Sounds of Music
12:00 - 1:30	Lunch
1:30 - 2:00	Business Meeting

Session D
(Queen Elizabeth Room)
Dr. Masashi Mori & Dr. Margaret Murphy, Chairpersons

2:00 - 2:20	Volume Reduction Surgery for Emphysema: A Prospective Controlled Trial- R. J. Fischel, M. Brenner, R. J. McKenna, A.F. Gelb, A.F. Wilson, N. Singh, UC Irvine Medical Center and Chapman General Hosp., Orange, CA, USA
2:20 - 3:00	PANEL DISCUSSION: Use of lung sounds in screening, monitoring and assessing the results of volume reduction surgery. Discussion Leader: Robert Baughman, Univ. of Cincinnati; Cincinnati, OH, USA
3:00 - 3:20	Efficacy of Wireless Stethoscope for Auscultatory Education(Third)- A. Murata, S. Kudoh, Y. Taniguchi, Y. Yoshida, K. Hayakawa, Nippon Medical School, M.Nakajima, Kenz Medico Co. Ltd., A. Shibuya, National Institute of Materials & Chemical Research; Tokyo, Japan
3:20 - 3:40	Coffee Break
3:40 - 4:00	Evaluation of an Educational Lung Sound Video-H. Melbye, U. Aasebø, I. Aaraas, Univ. of Tromsø, Tromsø, Norway
4:00 - 4:20	Clinical Diagnosis of Bronchial Obstruction - Value of an Educational Intervention- H. Melbye, I. Aaraas, Univ. of Tromsø, Norway
4:20 - 4:40	Crackles in Court: a Case for Biologic Standardization- R. Murphy, J. Gee, Faulkner Hospital, Boston, MA, USA
4:40 - 5:00	Web Pages with Global Linkage and Accessibility of Lung Sounds Resources- C. Druzgalski, J. Lim, CSULB, Long Beach, CA, USA
5:00 - 5:10	Closing Remarks - Raymond Murphy
5:10 - 6:00	Steering Committee Meeting

ABSTRACTS

Session A
(Windsor Salon)
Dr. Steven Kraman & Dr. Robert Loudon, Chairmen

9:00 - 9:20	Spatial Reconstruction of Acoustic Sources in the Thorax- M. Kompis, G. Wodicka, Purdue Univ., West Lafayette, IN, USA
9:20 - 9:40	Evidence of Chaotic Dynamics in Normal Lung Sounds- L. Vannuccini , C. Mocenni, M. Rustici, M. Rossi, F. Dalmasso, G. Righini, U.U Pneumologia USL 8, Arezzo; Univ. Di Siena, Universita di Sassari, Osp. Mauriziano "Umberto I", 1st Elettrotecnico Nazionale "Galileo Ferraris",Torino; Italy
9:40 - 10:00	Classification of Respiratory Sounds Based on Visual Displays- E. G. Guler, B. Sankur, Y. Kahya, Bogazici Univ., Istanbul, Turkey; S. Raudys, Institute of Math. & Informatics, Vilnius, Lithuania
10:00 - 10:20	Coffee Break
10:20 - 10:40	Classification of Respiratory Sound Patterns by Means of Cooperative Neural Networks- E. G. Güler, B. Sankur, Y. P.Kahya, Bogazici Univ., Istanbul, Turkey ; S. Raudys, Institute of Math. & Informatics, Vilnius, Lithuania
10:40 - 11:00	Ambient Respiratory Noise Effect on Expiratory Lung Sound Recordings - H. Pasterkamp, Y. Oh, Univ. of Manitoba, MB, Canada; G. Wodicka, Purdue Univ., West Lafayette, IN, S. Kraman, VA Medical Center, Lexington, KY; USA
11:00 - 11:20	Changes of Tracheal Sounds After the Expandable Metallic Stent Insertion to Bronchus or Trachea- Y. Taniguchi , S. Kudoh, A. Murata, Nippon Medical School, M. Nakjima, Kenz Medico Co. Ltd.; A. Shibuya, Japan Women's Univ., Tokyo, Japan
11:20 - 11:40	Localization of Pulmonary Adventitious Sounds- R. Murphy, J. Shane, C. Duggan, J. Schmelz, Faulkner Hospital, Boston, MA ,USA
11:40 - 12:00	Photo
12:00 - 1:30	Lunch

SPATIAL RECONSTRUCTION OF ACOUSTIC SOURCES IN THE THORAX

Martin Kompis and George R. Wodicka

School of Electrical and Computer Engineering, Purdue University,
West Lafayette, IN 47907-1285, U.S.A.

Simultaneous multi-microphone recordings of lung sounds contain spatial information of diagnostic value. To begin to access this spatial information, an algorithm for the reconstruction of thoracic acoustic sources was implemented. For any given point within the thorax, the algorithm tests the hypothesis that it contains the only relevant acoustic source for a set of measurements on the chest wall. A hypothetical source signal is calculated by a least squares estimation procedure to explain a maximum of the variance of all microphone signals. This procedure is repeated for all points 1 cm apart on an equally spaced grid yielding a 30 x 30 x 16 cm representation of the thorax. Underlying model assumptions include a constant speed of sound of 30 m/s and no damping. The explained fraction of the variance of all microphone signals is then displayed as a function of space in a 3-dimensional gray-scale coded image.

To evaluate the algorithm preliminarily, acoustic measurements were performed on a healthy male subject in an acoustic chamber. 8 Sony ECM-T150 microphones in 10 mm conical couplers were placed in the corners of two rectangles lying on the anterior and posterior chest surfaces, measuring 18 cm horizontally by 16 cm vertically. They were centered around the median plane, the upper anterior microphones overlying the 2nd inter-costal space. Initially the subject breathed through a pneumotachograph at target airflows of 2 l/s while lung sounds were recorded. Secondly, white noise was introduced into the mouth of the subject and transmission measurements were performed. Segments of 0.1 s were corrected for amplitude and phase differences between the microphones. Then, the middle 0.05 s of each segment was analyzed by the reconstruction algorithm.

Preliminary findings suggest that inspiratory sounds are produced more peripherally in the thorax, while expiratory sounds and low frequency (100-300 Hz) transmitted sounds originate more centrally. High frequency (300-1000 Hz) transmitted sounds are estimated to leave the airways mainly in the upper parts of the lung. Some of the computed images depict features that correlate with anatomical structures, such as the trachea and the heart, however the accuracy and reproducibility of these findings are unknown at this time.

Current efforts include recordings from additional subjects with more microphones, as well as investigating the influence of different sound speeds and damping factors on the reconstruction algorithm.

This work was supported by the Swiss National Science Foundation, the Roche Research Foundation and the U.S. National Science Foundation (BCS-9257488).

EVIDENCE OF CHAOTIC DYNAMICS IN NORMAL LUNG SOUNDS

L. Vannuccini*, C. Mocenni°, M. Rustiçi@, M. Rossi*, F. Dalmasso#, G. Righini+.

* U.U. Pneumologia USL 8 Arezzo, Italia; ° Dipartimento di Chimica, Università di Siena, Italia; @ Dipartimento di Chimica, Università di Sassari, Italia; # Div. Pneumologia Osp. Mauriziano "Umberto I", Torino, Italia; + Ist. Elettrotecnico Nazionale "Galileo Ferraris", Torino, Italia.

The theory of nonlinear dynamics has developed new methods for quantitative analysis of experimental time series. It can be shown that, from measurement of a single time series, the time variations of all pertinent variables, describing the dynamics of a system, may be assessed. The phase portrait (the trajectories of the state vector in a D-dimensional phase space) may be reconstructed in D_e-dimensional space with $D_e \geq D+1$ [1]. The phase portrait represents an attractor that can be chaotic.

In this work we show that lung sound (LS), captured on the chest wall, in healthy subjects is associated to chaotic behaviour. Its broad power spectrum, falling as inverse power-law (1/f-like), is the first indication of chaotic behaviour.

Two dynamic parameters of the attractor are evaluated: the largest Lyapunov exponent (λ)[2] and the correlation dimension (D_c)[3]. We use the time delay method [1] to reconstruct the phase space in which we evaluate D_c and λ. If D_c becomes independent from D_e, then the time series should posses a chaotic attractor; a positive λ suggests unambiguously its presence. These methods have been applied to LSs of healthy subjects captured on the middle line under-scapular on the posterior right region of the chest (Prefiltering: high-pass 60 Hz, 12 dB/oct. Digitization: 16 bit, 8200 Hz).

We have found that: D_c values from different subjects become independent from D_e when $D_e \geq 10$ and they vary from 1.15 and 1.3, λ is always positive and varies from 0.002 and 0.005.

These results establish the presence of chaotic attractors in LSs. This implies the existence of deterministic dynamics that may be described by several variables. D_c is an evaluation of the degrees of freedom and estimates a lower boundary of the number of independent variables necessary to modulate the dynamic of the system.

REFERENCES:

[1] Takens, F.: Detecting strange attractors in turbulence, *Lecture notes in Mathematics*, D.A. Rand & L.S. Young (Springer, Berlin,1981),898:336-381.

[2] Eckman J.P. et al.: Lyapunov exponent from time series, *Phys. Rev A*, 34:4971-4979,1986.

[3] Grassberger A., Procaccia I.: Measuring the strangeness of strange attractors, *Physica*, 9D:189-208, 1983.

CLASSIFICATION OF RESPIRATORY SOUNDS BASED ON VISUAL DISPLAYS

E. Çağatay Güler†, Bülent Sankur‡, Yasemin P. Kahya‡ and Sarunas Raudys§

†Biomedical Eng. Inst., ‡Electrical Eng. Dept., Boğaziçi University , Bebek-80815, İstanbul, Turkey, §Institute of Mathematics and Informatics. Akademijos 4, 2600, Vilnius, Lithuania

Medical doctors are inclined to work in cooperation with engineers in the classification of lung sounds. The aim of this cooperation for engineers is to design assistive classification tools for pulmonologists to be used in the diagnoses of pathologies. Diagnostic tools may utilize knowledge basis and heuristic rules as well as linear discriminant analysis, nonparametric methods, neural networks that have been successfully used in classifying respiratory data. However, a classification technique that appeals to the intuition of the pulmonologist is desired such that it could potentially incorporate his/her rules and knowledge, and build up confidence and interaction with these diagnostic aids. A simple classification percentage that one of the formal methods yields does not avail the physician of such an intuition and interaction. The interaction of a physician is possible if, for example, the data for classification are presented *visually*.

In this work, we aim to design a novel *nonlinear mapping method for visual classification* of respiratory patterns based on multilayer perceptrons and class target values. In training the perceptron, one or more target output values in a 2-dimensional space for each class can be used. Thus the mapping is obtained by training using class membership information, input data, and target values. Target values guide the original data to locations where they are transformed in the plane. From the medical diagnosis standpoint, the advantages of this method are as follows: (1) The targets can be selected to reflect the doctor's "psychology", e.g., *interactively* with them. For example targets can be chosen to reflect their notion of distance, or multiple targets can be selected to account for alternate symptoms of the same pathology, (2) *Prototype patients* can be selected as targets, whereby the doctor can search for other patients that map close to the original selected ones. A particular mapping procedure and an experiment to test the interaction of our mapping with human users have been developed. To this purpose a three class problem, namely the asthmatic, pneumonic and healthy classes, has been taken into consideration. In order to test the interaction of human observers with the graphical display of the data, we asked four observers to draw piecewise linear decision boundaries on the image obtained from the training data; we then redraw these decision boundaries on the image obtained from the test data. The average correct classification performance determined by four observers on the test image is 92.54%. Most of the errors were common for all observers. Results showed consistency with our previous classification experiments using different methods.

This work was supported by TÜBİTAK under contract EEEAG-127.

CLASSIFICATION OF RESPIRATORY SOUND PATTERNS BY MEANS OF COOPERATIVE NEURAL NETWORKS

E. Çağatay Güler†, Bülent Sankur‡, Yasemin P. Kahya‡ and Sarunas Raudys§

†Biomedical Eng. Inst., ‡Electrical Eng. Dept., Boğaziçi University , Bebek-80815, İstanbul, Turkey, §Institute of Mathematics and Informatics, Akademijos 4, 2600, Vilnius, Lithuania

Three-class recognition problem of respiratory sounds using neural networks is addressed. To this purpose, a new *hierarchical decision fusion scheme* based on the *cooperation* of neural networks is developed. The method consists of dividing segmented and parametrized respiratory sound cycle of a patient into six phases as early, mid, late expiration/inspiration, and classifying each phase with a separate multilayer perceptron which is called a *phase expert*. Expert decisions on phase segments of a patient are then consulted via various decision fusion schemes which can be interpreted as *boss experts*. The four decision fusion algorithms, namely, the *multinomial classifier* (M), the *decision tree classifier* (DT), *Parzen window classifier* (P), *voting* (V) schemes are compared.

Respiratory signals are nonstationary due to changes in lung volume and flow rate with a large inter-subject variability resulting in a significant overlap between classes. The novelties brought to an improved solution of such problems can be summarized as: (i) Data from respiratory cycles of patients have been re-organized into phases, and a separate phase expert is designed for each phase. Due to different sound production mechanisms and stationarity requirements, the signals should be partitioned into separately treated phases resulting in a reduced dimensionality of the feature space, (ii) Phase expert opinions are fused via a *consultation process*. The classification performance of phase experts was rather mediocre (63% correct classification on the average) on three classes consisting of 18 asthmatic, 19 pneumonic, 20 healthy subjects. Their performance was boosted up by the strategy of using a second stage decision on the pattern of segment decisions, that is by a consultation of experts. It has been observed that all fusion schemes bring significant improvements but to varying degrees. M, DT, P and V methods resulted in 67%, 84.2%, 86%, 82.5% correct classification performance on subjects, respectively. It was interesting to note that the classification of a whole signal record via a neural network, i.e., without dividing it into phases and thus without using a second stage fusion, resulted in 67% classification performance.

This work was supported by TÜBİTAK under contract EEEAG-127.

AMBIENT RESPIRATORY NOISE EFFECT ON EXPIRATORY LUNG SOUND RECORDINGS

Hans Pasterkamp[1], Yuns Oh[1], George R. Wodicka[2], and Steve S. Kraman[3]
U. of Manitoba[1], Winnipeg, MB, Canada; Purdue University[2], West Lafayette, IN, USA;
VA Medical Center[3], Lexington, KY, USA

<u>Background</u>: Expiratory sound spectra exhibit spectral peaks above 300 Hz similar to those of tracheal sounds but not found in inspiratory spectra (Kraman SS et al., CHEST [in press]; Pasterkamp H, Sanchez I, AJRCCM [submitted])

<u>Objective</u>: To determine whether expiratory lung sound spectral peaks simply reflect ambient respiratory noise.

<u>Design</u>: Three adults and 2 children with normal lung function were studied. Lung sounds were recorded anteriorly at the RUL, posteriorly at the RLL, and at the trachea with contact sensors (Siemens EMT25C). Ambient noise was measured 10 cm from the chest sites with the microphones suspended in air (Sony ECM140). Subsequent recordings over the RUL were performed using a) Sony ECM155 in a 15 mm conical coupler, b) 10 g Haifa PPG sensor, and c) 30 g Haifa PPG sensor, concurrently with the Sony ECM140 microphones in air. The subjects first breathed though a J-valve open at the expiratory port and then closed with corrugated tubing leading outside of the acoustic chamber. Flow was measured at the mouth during all of the measurements with a heated (Fleisch #3) pneumotachograph and a (Validyne) pressure transducer. Sampling of the acoustic data was performed at a target flow of 30 ml/s/kg ± 20% tolerance. At least 30 s of recording was made in each case, and the average spectra were computed from 2048 point FFTs with a 50% overlap of adjacent 200 ms segments.

<u>Observations</u>: There was a spectral peak congruence between expiratory tracheal and RUL lung sounds occurring between 710 and 760 Hz in adults and 850 and 900 Hz in children that was not affected by ambient noise reduction. There was also an expiratory peak at approx. 950 Hz in all subjects that was reduced by approx. 20 dB in air and 8 dB at the RUL through the use of the tubing (see adult case example, Figs. 1 & 2). The signal-to-noise ratio of high frequency expiratory sounds at the RLL was too low for quantitative comparisons. The ambient expiratory noise effect was greatest with the unshielded microphone, somewhat less with the 10g PPG, and significantly less with 30g PPG and Siemens sensors.

<u>Conclusions</u>: Expiratory lung sounds at the anterior RUL depict spectral peaks at the same high frequencies as tracheal sounds that are not explained by ambient noise. Sound sensors and their attachment, as well as the breathing apparatus and shielding, determine the degree to which ambient respiratory noise contaminates lung sound recordings.

Figure 1

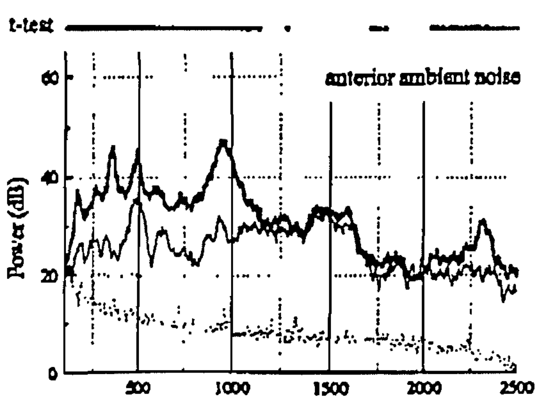
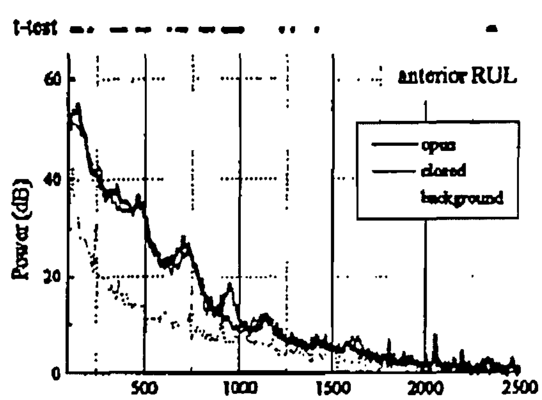


Figure 2



Note: Horizontal bars at the top indicate significantly greater sound intensity on open circuit ($p<0.01$).

20th International Conference on Lung Sounds
Long Beach, California, U.S.A. October 11-13, 1995

CHANGES OF TRACHEAL SOUNDS AFTER THE EXPANDABLE METALLIC STENT INSERTION TO BRONCHUS OR TRACHEA

Yasuyuki Taniguchi[1], Shoji Kudoh[1], Akira Murata[1], Makio Nakjima[2], Atsuo Shibuya[3]
[1]4th Dept. Intern. Med. Nippon Medical School, Tokyo, Japan, [2]Kenz Medico Co. Ltd., [3]Japan Women's University

We inserted expandable metallic stents (EMS) into the stenosed trachea or bronchi of patients with lung cancers. In this study we report the analytical data of changes of tracheal sounds before and after the EMS insertion for 3 cases. We recorded tracheal breath sounds at the neck, and analyzed them with a phonopeumograph.

Case 1 was a male with squamous cell carcinoma at right S^{10}. Tumors invaded carina, and right and left main bronchi remarkably stenosed. We each inserted EMS in both of main bronchi, so dyspnea of patient improved. Frequency more than 1500 Hz of the tracheal sounds decreased in expiration and inspiration after the EMS insertion. Case 2 was a male with squamous cell carcinoma of right upper lobe. We inserted three EMS in the stenosed trachea, right and left main bronchi. After the EMS insertion, blood gas improved and frequency of the sounds more than 1500 Hz decreased in inspiration. Case 3 was a male with adenocarcinoma of unknown origin. The trachea and the right main bronchus stenosed by extramural compression. After EMS insertion into the trachea and the right main bronchus,the intensity of breath sounds improved and frequency of the tracheal sounds less than 1000 Hz increased. These findings mentions above suggested that changes of the characteristics of tracheal sounds are a good clinical parameters for improvement of air way stenosis of lung cancer after EMS insertion.

Localization of Pulmonary Adventitious Sounds

R. Murphy, J. Shane, C. Duggan and J. Schmelz
Faulkner Hospital, Boston, Massachusetts

In previous presentations at this conference, we described a method designed to attempt to localize intrathoracic sounds. In 1993 we reported failure. In 1994 we located an intrathoracic wheeze in a patient with a lung tumor. As the patient also had asthmatic bronchitis, we were uncertain as to the exact origin of the wheeze. We also located an intrathoracic suctioning sound but were unable to distinguish changes in its location. We recently have improved the technique previously described by refining the method of detection of arrival times and determining more precisely the coordinates of the microphones in space. This method, which will be described in our presentation, was used to study a patient with bronchomalacia who consistently had wheezing on forced expiration. The bronchomalacia and associated airway collapse was noted at bronchoscopy to be present in the right mainstem bronchus. The origin of the roentgenographic wheeze determined by this method was compared to the location of the right main stem bronchus. Results are as follows:

	Calculated Coordinates	Measured Coordinates
x	6.3	4
y	-16.5	-18
z	- 4.5	- 4.5

The discrepancy in these values is likely accounted for by the fact that the chest roentgenogram was taken at total lung capacity, and the wheeze occurred during forced expiration. Sound speed of this wheeze was 9.2 cm/ms. We also measured the coordinates of crackles in a patient with bronchiectasis (BR) and a patient with interstitial pulmonary fibrosis (IPF). This provided a method of displaying the sounds 3 dimensionally. We believe this method will aid in correlation of lung sounds with pulmonary pathophysiology.

Session B
(Windsor Salon)
Dr. Filiberto Dalmasso & Dr. Hans Pasterkamp, Chairmen

1:30 - 1:50	Effect of Gas Density on Expiratory Sounds- H. Pasterkamp, Y. Oh, U. Of Manitoba, MB, Canada; S. Kraman, VA Medical Center, Lexington, KY, USA; G.Wodicka, Purdue Univ., West Lafayette, IN, USA
1:50 - 2:10	Use of Flow Gating in the Study of Lung Sound Spectra- L. Pesu, P. Helisto, P. Malmberg, A. Sovijarvi, T. Katila; Helsinki Univ. Of Technology, Helsinki Univ. Central Hospital, Helsinki, Finland
2:10 - 2:30	A Simple Model for Flow Limitation During Forced Expiration- F. Sakao, M. Mori, H.Sato; Kinki Univ., Takaya, Higashihiroshima , Tokyo National Chest Hospital, Institute of Flow Research; Tokyo, Japan
2:30 - 2:50	Coffee Break
2:50 - 3:10	The Factors Which May Influence the Waveforms of Percussion Sounds- M. Mori, H. Katayama, M. Ono, Tokyo National Chest Hospital, F. Sakao, Kinki Univ., Hiroshima; H. Sato, Institute of Flow Research; Tokyo, Japan
3:10 - 3:30	Frequency Dependence of Sound Transmission in the Human Respiratory System Between 50 and 500 Hz- A. H. Leung, J. D. Young, S. Sehati, C. N. Mcleod, Oxford Brookes Univ., Univ. of Oxford, Oxford, U.K.
3:30 - 3:50	Effect of Lung Volume on Sound Transmission Through the Respiratory System- F. Davidson, J. Schmelz, C. Duggan, J. Shane, R. Murphy, Faulkner Hospital, Boston, MA, USA
3:50 - 4:10	Monitoring of Respiration Using a Sensor Based on Mode-Single Fiber Optic and Expert System to Medical Diagnosis- E. Suaste, J. L. Avila, A. Martinez, CINVESTAV - IPN, Zacatenco, Mexico
5:30 pm	Banquet -(Wild West Dinner Extravaganza - Bus Departure 5:30 pm)

EFFECT OF GAS DENSITY ON EXPIRATORY SOUNDS

Hans Pasterkamp[1], Yuns Oh[1], Steve S. Kraman[2], and George R. Wodicka[3]
U. of Manitoba[1], Winnipeg, MB, Canada; VA Medical Center[2], Lexington, KY, USA;
Purdue University[3], West Lafayette, IN, USA

Background: The spectra of expiratory tracheal and lung sounds depict distinct peaks (Sanchez I et al., ARRD 1993) that shift upward in frequency on Heliox breathing (Pasterkamp H et al., AJRCCM [submitted]).
Objective: To study whether spectral peaks that are shared between expiratory tracheal and chest wall sounds exhibit the same upward shift on breathing Heliox.
Design: Measurements were performed on 3 adults and 2 children with normal lung function. Sounds at the posterior RLL and LLL, both superior and basal segments, the anterior RUL and LUL, and the trachea were measured with contact sensors (Siemens). The subjects breathed air through a J-valve, and then a 80% He and 20% O_2 mixture from a reservoir bag. One minute was allowed for gas wash-in. Flow was measured at the mouth with a heated (Fleisch #3) pneumotachograph and (Validyne) pressure transducer and data sampling was performed at target flows of 30 ml/s/kg ± 20% tolerance with a correction for Heliox breathing of +10%. At least 30 s of recording was made for each case and respired gas, and average spectra were computed from 2048 point FFTs with 50% overlap of adjacent 200 ms segments.
Observations: Tracheal peaks at 700 to 750 Hz in adults and 850 to 900 Hz in children shifted upward in frequency by approximately 60% when breathing Heliox (see adult case example, Fig.1a). These tracheal peaks on air breathing were visible on spectra from upper chest sites during expiration but not during inspiration. The high frequency (> 1000 Hz) tracheal peaks found on Heliox breathing did not generally appear in expiratory sounds at the chest wall because of low signal-to-noise ratio. Lower frequency peaks (< 500 Hz) in tracheal and lung sounds during expiration could be identified, and they followed similar upward shifts during Heliox breathing (see simultaneously recorded chest wall sounds, Fig.1b). Higher frequency inspiratory sounds were significantly reduced in their intensity on Heliox. Respiratory sounds at normalized air flows did not show symmetrical behavior at homologous recording sites.
Conclusions: The maximal peaks at 700 to 750 Hz in adults and 850 to 900 Hz in children of expiratory tracheal and upper chest sounds shift upward during Heliox breathing in a predictable fashion. The shift is consistent with effects of gas density and indicates central airway resonances. This study and our observations on ambient respiratory noise effects provide supportive evidence for the proposed central origin of expiratory, but not inspiratory lung sounds (Kraman SS, ARRD 1980).

Figure 3a

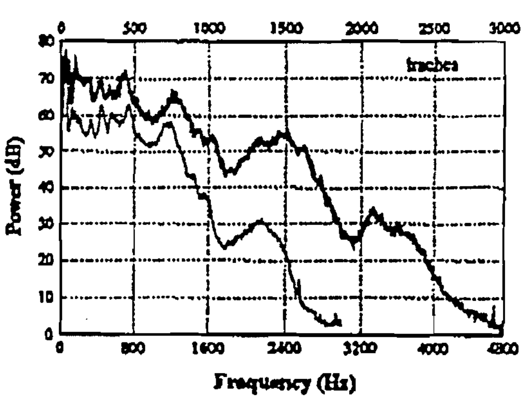
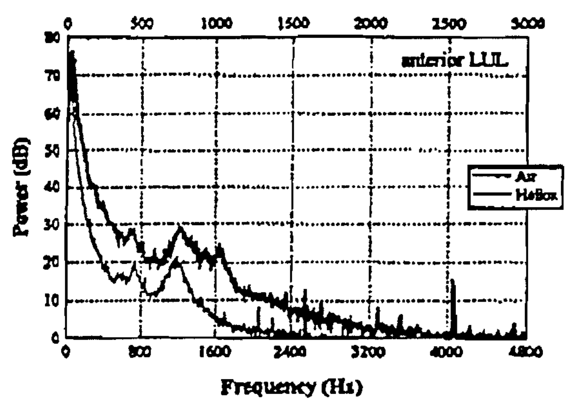


Figure 1b



Note: The frequency scales for air (top) and Heliox (bottom) are different (60% expansion for Heliox).

USE OF FLOW GATING IN THE STUDY OF LUNG SOUND SPECTRA

L.Pesu, P.Helistö, P.Malmberg*, A.Sovijärvi*, T.Katila
Laboratory of Biomedical Engineering, Helsinki University of Technology
Rakentajanaukio 2 C, FIN-02150 Espoo
*Helsinki University Central Hospital, Lung Function Laboratory,
Stenbäckinkatu 9, FIN-00290 Helsinki, Finland
lette@gamma.hut.fi

The variation of lung sound characteristics due to changes in the respiration flow rate may give valuable information in the diagnosis of certain pulmonary diseases.

In this work, flow-gated spectra are calculated from the lung sound signal, that has been sampled at a rate of 12 kHz. The sound data are divided into sequences corresponding to user-defined flow windows, and FFT using Welch method is calculated for each sequence separately. Finally, the average spectra of all the sequences corresponding to the same flow window are calculated.

From the spectra the following parameters are calculated: the frequency of maximum intensity, quartile frequencies F25, F50 and F75, RMS-value and power in the frequency bands of 100-200 Hz, 200-300 Hz, 300-400 Hz and 400-500 Hz. In coherence with earlier results, the spectral parameters indicate a nonlinear increase of intensity and pitch as a function of increasing flow rate.

In the study of wheezing sounds, flow-gating offers some advantages. Wheezes often appear at a certain flow rate, or change as a function of flow, so flow-gated spectra reveal more information on the wheeze than a spectrum calculated over the whole respiratory cycle. Also wheeze detection becomes easier, as can be seen in the asthmatic patient's expiratory spectra in Figure 1.

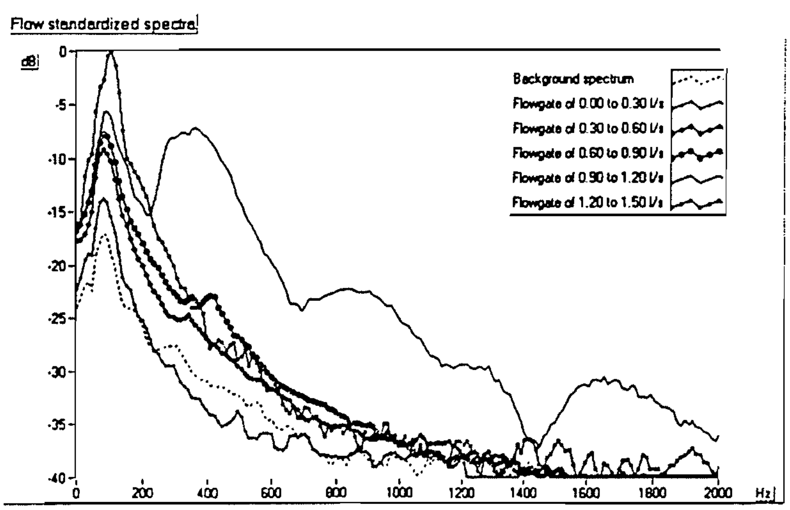


Figure 1. Flow gated lung sound spectra of an asthmatic patient

2oth International Conference on Lung Sounds
Long Beach, California, U.S.A. October 11-13, 1995

A SIMPLE MODEL FOR FLOW LIMITATION DURING FORCED EXPIRATION

Fujihiko SAKAO, Masashi MORI*, and Hiroshi SATO**
School of Engineering, Kinki University, Takaya, Higashihiroshima, Japan 739-21,
*Tokyo National Chest Hospital, **Institute of Flow Research

An easily collapsible section, if any, of human airways may decrease its cross-sectional area and consequently limit exhalation flow rate when the outside pressure is higher than the inside. The outside pressure is actually the intrapulmonary pressure, which is in turn determined by flow resistance between the alveoli and the mouth. For the sake of simplicity, the decrease in the cross-sectional area is assumed to be proportional to the pressure difference in- and out-side there, while the total-head loss across the constriction is calculated by "the momentum theorem" of fluid mechanics. With such a model, it is found that the flow rate may be decreased, even to zero, by excessive increase in the intrapulmonary pressure. By adding non-collapsing tubes in parallel, or assuming a lower limit for cross-sectional area, pressure-flow rate relations similar to those observed in clinical practice are easily deducible from the present model.

Although it is expected that waves or oscillations may appear on the airway walls near the site of stricture, they are results of stricture in the elastic wall exposed to high speed air flow, not the cause of flow limitation.

THE FACTORS WHICH MAY INFLUENCE THE WAVEFORMS OF PERCUSSION SOUNDS.

Masashi MORI, Hirohumi KATAYAMA, Mariko ONO

Tokyo National Chest Hospital, Tokyo, JAPAN

Fujihiko SAKAO

School of Engineering, Kinki University, Hiroshima, JAPAN

Hiroshi SATO

Institute of Flow Research, Tokyo, JAPAN.

Waveforms of percussion sounds are quite reproducible if recorded under the same conditions. The conditions or factors which may influence the waveforms are, 1.recording equipments and positioning of the microphone, 2. the way and the site of percussion and who does the percussion, and 3.physical conditions at the site of percussion such as presence of fluid or free-airspace under the site of percussion.

We may ignore the first condition because the percussion sounds were all recorded in the same way.

To test the second and the third conditions, we examined the waveforms of percussion sounds by, 1.changing the percussor, that is who does the percussion and which plexor to be used, finger-tip or a hammer, 2.changing the pleximeter, a finger or a coin, 3.following the waveforms after total pneumectomy to see the effect of air in the thoracic cavity.

To keep the various factors constant during the procedure was rather difficult but we found that the parts of the waveforms affected by changing percussor or plexor were the initial segments and that the latter segments were determined mainly by the physical characteristics of the underlying tissues, the volume of air-containing thoracic cavity for instance

FREQUENCY DEPENDENCE OF SOUND TRANSMISSION IN THE HUMAN RESPIRATORY SYSTEM BETWEEN 50 AND 500 Hz

A.H. Leung, J.D. Young*, S. Sehati, C.N. Mcleod.
School of Engineering, Oxford Brookes University, Gipsy Lane Campus, Headington, Oxford OX3 0BP, U.K.
**Nuffield Department of Anaesthetics, University of Oxford, Radcliffe Infirmary, Oxford OX2 6HE, U.K.*

The velocity of sound through lung parenchyma depends on alveolar size, so mapping sound velocity to the body surface may provide a non-invasive technique to monitor alveolar morphology. Previous studies of sound transit time through the lung used white noise, which may introduce errors as transit time may be frequency dependent. To investigate the importance of frequency on transit time we have studied the sound transit time from the trachea to four points on the anterior chest wall in the midclavicular line in 10 healthy subjects at frequencies from 50 to 500Hz. The transit times were unchanged between 100 and 300 Hz, 2.06 ± 0.21 ms at the level of the second chondral cartilage on the left, 2.05 ± 0.35 ms on the right and 2.32 ± 0.88 ms and 2.01 ± 0.77 ms on the left and right at the fifth chondral cartilage. The minimum transit time was at 450Hz (0.6 ± 0.1 ms , 0.67 ± 0.1 ms, 0.43 ± 0.15 ms and 0.4 ± 0.12 ms respectively). The frequency dependence of transit time may be due to differences in sound conduction velocity through lung parenchyma, or may represent deeper penetration of sound into the airways at higher frequencies, minimising the amount of lung tissue traversed by the sound.

Contact person and address:
Aiken Leung
Oxford Brookes University
School of Engineering
Gipsy Lane Campus
Headington, Oxford OX3 0BP
U.K.

Tel: +44 (1865) 483500 or +44 (1865) 483552
FAX: +44 (1865) 483637
Email: 93506252@brookes.ac.uk

Effect of Lung Volume on Sound Transmission Through the Respiratory System

F. Davidson, J. Schmelz, C. Duggan, J. Shane, and R. Murphy

The transit time/speed of sound in the lung has been studied by various investigators: Rice & Rice (1987), Kraman (1983), and Wodicka, Aguirre, DeFrain, & Shannon (1992). These studies were all performed at one lung volume. We speculated that lung gas content might affect sonic transit time.

We studied the speed of sound transmission from the mouth to sites over the lung bases in a normal human subject sitting upright using two different sounds: (1) an explosive sound produced by compressing a packing bubble, and (2) a square wave generated by a Hewlett Packard Pulse Generator (Model HP8011A). Realistic microphones imbedded in chest pieces of Littman Cardiology stethoscopes were applied with double-sided adhesive.

Studying our data in the time domain, we were unable to determine consistent arrival time differences at differing lung volumes. Possible explanations for this include (1) observer variability in detection of the signal onset, (2) variability in the arrival times between experiments, and (3) the low signal to noise ratio.

Transit time was calculated by using a cross correlation technique. The results demonstrated a difference in transit times between TLC and RV. The transit time of a square wave was calculated to be 1.5 msec at TLC and 1.9 msec at RV. The transit time of the explosive pop was calculated to be 1.4 msec at TLC and 1.8 msec at RV.

In addition, the amplitude of the transmitted sound was significantly louder at RV than at TLC.

MONITORING OF RESPIRATION USING A SENSOR BASED ON MODE-SINGLE FIBER OPTIC AND EXPERT SYSTEM TO MEDICAL DIAGNOSIS.

E. Suaste, J.L. Avila and Ana Ma. Martinez*
Bioelectronic and Computer* Sections, CINVESTAV-IPN, México.IPN 2508, Zacatenco, México.
E-mail: esuaste@cinvesmx.bitnet

A relation between bending radius and attenuation of silica single fiber optic is the principal characteristic of sensing on this new method in order to monitor respiratory rates. By means of the simple attachment and the small size it offers easy handling. Improved the movements of the rib cage when those tending to raise or lower in the inspiratory and expiratory respectively. The measuring instrument is based in a emisor, fiber optic sensor, receptor and computer programs (Signal processing and System Expert). For means of a sensor with fiber meanders which could be attached to the chest wall in the region of maximum inspiratory. Any variation of the circumference of the chest wall changes the bending radius of the meanders. The measured signal at the photodiode depends on the elongation of the fiber. The bending radius should be changed between 10.75 mm and 13 mm. The source is a LED of 640 nm was pulsed with a frequency of 1 kHz, the light was guided by one fiber optics (core of polimetil-metacrilato, refraction index=1.49, numerical aperture=0.47, Toray Industries, Japan), the photodiode signal is digitized with A/D converter to be processed through a computing program associated a Expert System.

Session C
(Windsor Salon)
Dr. Shoji Kudoh & Dr. Sadamu Ishikawa, Chairmen

9:00 - 9:20	Frequency Spectral Analysis of Breath Sounds in Newborn Infants and Children- T. Imai, Y. Inaba, K. Shirota, Y. Yoshida, Nippon Medical School; Tokyo, Japan
9:20 - 9:40	Study of Frequency Spectrum Analysis of Sound Through Asthma Lungs- Q. Qiyuan, Z. Yan, Hospital of Fudan Univ.; Q. Lun, Huashen International Enterprise Circle Ltd.; F. Didi, Hada Industry and Commerce Co.; Shanghai, China
9:40 - 10:00	Effects of Methacholine on Spectral Characteristics of Cough Sounds in Asthmatics"-S. Ishikawa, E. Trayner, S. Del Re, H. Gill, L. Kenny, G. Hayes, K. F. McDonell, B. Celli; St. Elizabeth's Medical Center, Tufts Univ. School of Medicine, Boston, MA, USA
10:00 - 10:20	Coffee Break
10:20 - 10:40	Initial Cough Sound: Relationship to EMG Signals- P. Ayres, R. Loudon, Proctor and Gamble Co., Univ. of Cincinnati; Cincinnati, OH, USA
10:40 - 11:00	Site of Capture Affects Acoustic Features and Significance of Snoring-F. Dalmasso, G. Righini, R. Prota, L. Vannuccini, M. Rossi, Osp. Mauriziano, Instituto Elettrotecnico Nazionale G. Ferraris, Osp. C. Arezzo; Torino, Italy
11:00 - 11:20	Characteristics of Lung Sounds in Chronic Obstructive Pulmonary Disease- M. Murphy, E. Abad, J. Schmelz, R. L. Murphy, Boston College, Chestnut Hill and Faulkner Hospital, Jamaica Plain; MA, USA
11:20 - 12:00	Guest Speaker- Prof. Richard Birkemeier, CSULB, Long Beach, CA USA The Sounds of Music
12:00 - 1:30	Lunch
1:30 - 2:00	Business Meeting

FREQUENCY SPECTRAL ANALYSIS OF BREATH SOUNDS IN NEWBORN INFANTS AND CHILDREN

Taiyo Imai MD, Yaoki Inaba MD, Kazuhiko Shirota MD, Yutaka Yoshida MD,
Department of Pediatrics, Nippon Medical School, Tokyo, JAPAN

We compared the characteristics of breath sounds using frequency spectral analysis in normal newborn infants to older children. Seventy subjects (male 35, female 35) were divided into three groups: (1) 13 term infants less than 24 hours of age; (2) 42 term infants 1 to 14 days of age; and (3) 15 children age 5 to 14 years. Peak frequency (PF, in Hz) of the spectrum of breath sound was significantly higher in group 1 than in group 2 or in group 3. The decline of power spectrum from PF (slope; in dB/octave) was not significantly different between the three groups. Neither PF nor slope correlated with the subject's gestational age, body length and height in groups 1 and 2, while PF decreased significantly with increasing body height in group 3. There was a linear correlation of slope with PF in each group, and the correlation coefficients in each group were not significantly different from one another. The breath sounds of newborn infants contained higher sound spectra than older children as previously described, however, this was more pronounced soon after birth. This study suggests that the difference in lung sounds among newborn infants is more attributable to their sound origin in the airway (expressed as PF) than their transmission effects such as lung parenchyma and chest wall (expressed as slope).

STUDY OF FREQUENCY SPECTRUM ANALYSIS OF SOUND THROUGH ASTHMA LUNGS

Qian Qiyuan Zhao Yan
(Hospital of Fudan University Shanghai China)

Qian Qi Lun
(Huashen International Enterprise Circle LTD. Shanghai China)

Fan Bidi
(Hada Industry and Cmmerce Company Shanghai China)

ABSTRACT

The noise was transmitted into lungs of patient with Asthma through patient's mouth by a pipe, then a microphone was placed on the chest wall and the information was picked up. Electrical signals from the microphone can be amplified and be up into the computer. The A/D transducer is 2KHz. Frequency spectrum analysis and varied parameter was computed by FFT. The main frequency between normal men and asthma cases was different. These were 28 patients with asthma, among whom 20 were males, 8 were females, and whose ages ranged from 20 to 65. 16 were normal. their ages ranged from 21 to 49. The main frequency of 16 health men was of an average of 17.3+5.2Hz while 28 cases of asthma was of an average of 30.6+9.1Hz. The difference between them was very obvious (P<0.01). There was no difference of X-ray examination between the patients and the comparing health group.

Key words: Lung Sound
Asthma
Human

EFFECTS OF METHACHOLINE ON SPECTRAL CHARACTERISTICS OF COUGH SOUNDS IN " ASTHMATICS".

S.Ishikawa*, E.Trayner, S.Del Re, H.Gill, L.kenny, G.Hayes, K.F.McDonell,and B.Celli. Tufts Lung Station St Elizabeth's Med.Ctr.and Dept.of Med.Tufts Univ. School of Medicine, Boston, MA. U.S.A.

Cough sounds spectra before and after methacholine challenge in 50 consecutive patients who were refered to our laboratory as having suspected bronchial hyperreactivity were studied.

Subjects were instructed to make 6 voluntary coughs within 6 seconds. Sound signals recorded at the neck with contact microphone were digitized and real time spectrograph displayed. "Nonresponders" to methacholine showed all signals were within 1 kHz and peak energy 554±48Hz before and 577±57Hz after methacholine.

"Responders" to methacholine ("asthmatics") showed 2 distinct spike complexes. One of which were within 1 kHz and peak energy 542±45Hz before and 560±49Hz after methacholine. The second peak were between 1 and 2 kHz with peak energy 1510±520 Hz and 1423±621 Hz after methacholine.

Predictive value for" Asthma" from cough was 82%.

INITIAL COUGH SOUND: RELATIONSHIP TO EMG SIGNALS. Peter J.W. Ayres and Robert G. Loudon. Worldwide OTC Development Division, Procter and Gamble company and University of Cincinnati College of Medicine, Cincinnati, OH.

The sound of a cough is variable, and contains some diagnostic information. The initial, explosive opening sounds of coughs produced on request by healthy subjects correlated with the peak flow rate achieved at the mouth in a study reported at the 19th International Lung Sounds Conference, Haifa, Israel, 1994. The variation in the magnitude of physiological measurements and in their patterns during expulsive expiratory maneuvers is probably related in part to the intensity and the site of the stimulus evoking the cough, and in part to the pathological changes present in individual subjects. For individual coughs, it appears unlikely that any one measurement can effectively measure the intensity of cough (Loudon, AJRCCM 1995;151:A296). One potentially useful measurement of the effort expended is the electromyographic (EMG) signal from the external abdominal oblique muscle, shown to be more specifically involved in cough than in other activities (Floyd WF and Silver PHS 1950. J Anat; 84:132-145). This EMG signal has been related by us to effort during forced expiratory maneuvers. Sound is the simplest aspect of cough to measure, but the EMG is a close second. We recorded sound and anterior abdominal EMG signals from patients with various respiratory disorders, for two four hour periods on two successive days, and have analyzed and related these two signals. Results will be presented which show the complexity of their relationships, in spontaneously occurring bouts composed of varying numbers of coughs.

SITE OF CAPTURE AFFECTS ACOUSTIC FEATURES AND SIGNIFICANCE OF SNORING

F.DALMASSO,G.RIGHINI*,R.PROTA,L.VANNUCCINI**,M.ROSSI**

DIVISIONE DI PNEUMOLOGIA,OSP.MAURIZIANO,TORINO;*ISTITUTO ELETTROTECNICO NAZIONALE G.FERRARIS,TORINO;**DIVISIONE DI PNEUMOLOGIA,OSP.C.AREZZO,ITALY

The aim of the study was to evaluate the characteristics of snoring sounds(SS)detected at the mouth and over the trachea near the sternal notch. As no substantial differences were found between the features of the simulated and real snoring sounds signal(1),seven subjects,4 males,3 females with average age of 38(25-60)yrs,were instructed to simulate snoring in supine position.Using electret microphones(Sony,ECM 150 T)the SS were simultaneously detected at 15 cm from the mouth(A) and,by an air coupled,over the trachea(B)and digitally recorded on magnetic tape(Casio,DA-R-100).The signals were analyzed in time and frequency domain by LPC technique and FFT. In order to substantiate the considerable differencies between two kinds of signal the power spectrum,averaged on 7 snoring acts was integrated vs frequency and following parameters are calculated:a)Central frequency(CF),defined by its own integral formula.b)Frequencies,F25,F50,F75,corresponding to the 25,50 and 75 percentiles of integrated spectrum.The results are reported:

Location	CF	F25	F50	F75
A	**549 ± 62**	**200 ± 112**	**544 ± 246**	**1017 ± 133**
B	232 ± 47	120 ± 45	196 ± 84	303 ± 103

The data show clearly that the signals from location A and B differ more significantly($P<0.001$)for CF,F50,F75 and less($P<0.01$)for F25.
The LPC and FFT algoritms show the bandwidth of the SS signal over the trachea(B)is clearly limited by low-pass filtering action of its own and it can be employed only to underline its presence and its timing such-as in polysomnographic investigations.Instead the SS signal at the mouth(A) allow us to infer on the mechanism of snoring trough LPC technique as we have already done in previous works(1).

(1)Dalmasso F et al.;Eur Respir J 1990,3-II,528-532.

Murphy, M. A., Abad, E., Schmelz, J. and Murphy, R.L.H.

Boston College School ofNursing, Chestnut Hill, MA and
Faulkner Hospital, Jamaica Plain, MA

CHARACTERISTICS OF LUNG SOUNDS IN CHRONIC OBSTRUCTIVE PULMONARY DISEASE

The purpose of this pilot study was to examine the patterns of lung sounds in patients with chronic obstructive lung disease, using a multichannel lung sound analyzer. Data were collected from 7 COPD outpatients and 7 normal controls. Lung sound recordings were made at 24 sites over the chest wall and over the trachea. Both length and amplitude of inspiration and expiration were noted and the RATIO [1] (R1) and RATIO x measures of amplitude over the chest wall in inspiration (R2) were calculated. A low R1 represents a relatively prolonged expiration.

We analyzed variations in the time, amplitude and the 2 RATIO variables and the relationship of each of these variables to the FEV1 as percent of predicted and to the diagnosis of COPD . The RATIO showed the best correlation with the FEV1, (r = .74), and a negative correlation with the diagnosis of COPD (r = - .78), as well as a significant difference between the 2 groups (z = -2.747, p = .006). The averaged amplitude over the chest wall during inspiration correlated positively with the FEV1 (r = .65) and negatively with the diagnosis of COPD, (r = - .54) but showed no significant differences between groups. The RATIO x amplitude variable (R2) correlated negatively with COPD (r = - .71), but there was no significant difference between groups.

Our goal with a larger number of subjects is to show increased effect of combination of time and amplitude variables over time alone.

1. $\text{RATIO} = \frac{\text{length of inspiration}}{\text{length of expiration}}$

Session D
(Queen Elizabeth Room)
Dr. Masashi Mori & Dr. Margaret Murphy, Chairpersons

2:00 - 2:20	Volume Reduction Surgery for Emphysema: A Prospective Controlled Trial- R. J. Fischel, M. Brenner, R. J. McKenna, A.F. Gelb, A.F. Wilson, N. Singh, UC Irvine Medical Center and Chapman General Hosp., Orange, CA, USA
2:20 - 3:00	PANEL DISCUSSION: Use of lung sounds in screening, monitoring and assessing the results of volume reduction surgery. Discussion Leader: Robert Baughman, Univ. of Cincinnati; Cincinnati, OH, USA
3:00 - 3:20	Efficacy of Wireless Stethoscope for Auscultatory Education(Third)- A. Murata, S. Kudoh, Y. Taniguchi, Y. Yoshida, K. Hayakawa, Nippon Medical School, M.Nakajima, Kenz Medico Co. Ltd., A. Shibuya, National Institute of Materials & Chemical Research; Tokyo, Japan
3:20 - 3:40	Coffee Break
3:40 - 4:00	Evaluation of an Educational Lung Sound Video-H. Melbye, U. Aasebø, I. Aaraas, Univ. of Tromsø, Tromsø, Norway
4:00 - 4:20	Clinical Diagnosis of Bronchial Obstruction - Value of an Educational Intervention- H. Melbye, I. Aaraas, Univ. of Tromsø, Norway
4:20 - 4:40	Crackles in Court: a Case for Biologic Standardization- R. Murphy, J. Gee, Faulkner Hospital, Boston, MA, USA
4:40 - 5:00	Web Pages with Global Linkage and Accessibility of Lung Sounds Resources- C. Druzgalski, J. Lim, CSULB, Long Beach, CA, USA
5:00 - 5:10	Closing Remarks - Raymond Murphy
5:10 - 6:00	Steering Committee Meeting

VOLUME REDUCTION SURGERY FOR EMPHYSEMA: A PROSPECTIVE CONTROLLED TRIAL.

RJ Fischel, Matthew Brenner, RJ Mc Kenna, AF Gelb, AF Wilson, N Singh. UC Irvine Medical Center, and Chapman General Hosital, Orange, CA

Introduction: There is resurgent interest in surgical approaches to treatment of pulmonary emphysema. We report the results of a prospective trial in 155 patients comparing 3 surgical approaches to emphysema treatment 1) unilateral Nd: YAG laser pleural surface exposure 2) unilateral thoracoscopic volume reduction with bovine pericardium buttressed stapling, or 3) bilateral thoracoscopic volume reduction with buttressed stapling.

Methods: Patients with severe symptomatic emphysema were treated with one of the 3 surgical procedures. Pre-operative pulmonary function and radiographic presentation were classified according to predominant location of emphysematous changes (upper lobe, lower lobe, diffuse) and correlated with objective pulmonary response to treatment.

Results: Follow-up pulmonary function is now available on 77 (50%) of patients who underwent surgery. Mortality rate was 3%. Mean pre-operative FEV1 was 0.67 ± 0.02 and increased by 34% from baseline following surgery ($p<0.01$). Improvement was greatest in patients with upper lobe predominance who underwent bilateral stapling ($p<0.02$ ANOVA by procedure and location):

Percent Change from Baseline in FEV-1 Following Surgery

	Bilateral Staples	Unilateral Staples	Unilateral Laser
Upper Lobe	82	29	6
Lower Lobe	32	35	-
Diffuse	53	11	3

Conclusion: Volume reduction surgery improves objective pulmonary function in patients with emphysema at short term follow-up. Bilateral stapled volume reduction for upper lobe disease shows greatest improvement. Long term follow-up is needed.

Supported by Grants: NIR RR01192-16 and DEA DE-FG03-91ER61227

EFFICACY OF WIRELESS STETHOSCOPE FOR AUSCULTATORY EDUCATION(Third)

Akira Murata[1)], Shoji Kudoh[1)], Yasuyuki Taniguchi[1)], Yutaka Yoshida[2)], Kohichi Hayakawa [3)], Makio Nakajima[4)], Atsuo Shibuya[5)]
[1)]4th Dept.Intern.Med., [2)] Dept.Pediatrics, [3)]1st Dept. Intern. Med., Nippon Medical School, Tokyo, Japan, [4)]Kenz Medico Co. Ltd., [5)]National Institute of Materials and Chemical Reseach

We developed a new FM wireless stethoscope (β fon ; Kenz Medico Co. Ltd.). And we presented the efficacy of simultaneous auscultatory education on lung sounds using the wireless stethoscope in comparison with the conventional stethoscope for eighteen subjects at the 18th international conference on Lung sounds and a loud speaker for 65 students and 10 doctors at the 19th conference.

In this study, to compare the auscultation using wireless stethoscope with that using a loud speaker in the lecture hall, we performed following two experiments. For 61 medical students, we investigated their acoustic threshold on separation of two pulse-sounds (Exp.1), and studied the acoustic discrimination of 4 kinds of pulse sounds with different intervals (5, 10, 15, 20msec.) and compared the rate of their correct answer (Exp.2). In results, using wireless stethoscopes, the acoustic threshold of the interval was significantly shorter (a loud speaker v.s. wireless stethoscope : 11.07msec. v.s. 6.65msec.), and the rate of correct answers significantly increased (38.34% v.s. 69.46%).

We conclude that wireless stethoscope is more excellent to discriminate the two pulses sounds in comparison with a loud speaker system. very useful for education of lung sounds auscultation.

EVALUATION OF AN EDUCATIONAL LUNG SOUND VIDEO

H.Melbye*, U.Aasebø**, I. Aaraas*. *Institute of Community Medicine and **Institute of Clinical Medicine, University of Tromsø, Norway.

We wanted to evaluate a 35 minutes educational video, which demonstrates lung sounds related to airflow in normal adults and patients with asthma and chronic obstructive pulmonary disease (COPD). Auscultatory findings recorded by 10 fourth year students who had watched the video, were compared to the recordings of a control group of 11 students, and evaluated against a consensus of three experienced clinicians, who had examined the same three patients. For baseline registrations the students examined three patients with asthma or COPD. No clinical information about the patients was given. They recorded whether the following findings were present or not in the inspiratory and expiratory phase: diminished breath sounds, sibilant wheezes, rhonchi, and crackles, and whether the expiratory phase was prolonged or not. At a similar follow-up auscultation session a mean increase from 73 to 79 % in correct registrations was found in the intervention group, compared to a decrease from 71 to 68% in the control group. The difference in change did not reach statistical significance. A significant difference between the two groups was found for diminished versus normal breath sound: an increase from 50 to 71% right recordings in the intervention group, compared to a decrease from 58 to 47% in the control group ($p=0.02$).

Conclusion: Videorecordings of lung sounds may be a valuable tool in the teaching of medical students, particularly in the difficult and important distinction between normal and diminished breath sounds.

CLINICAL DIAGNOSIS OF BRONCHIAL OBSTRUCTION - VALUE OF AN EDUCATIONAL INTERVENTION

Hasse Melbye, Ivar Aaraas, Institute of Community Medicine, University of Tromsø, Norway.

Aim: We wanted to study general practitioners' (GP) assessment of bronchial obstruction in adult patients and the effect of a short educational intervention on the agreement between estimated and measured FEV_1% predicted.

Phase 1: 11 GPs recorded lung findings in 351 adult patients, and estimated their FEV_1% predicted. Spirometry was carried out after the recordings. When comparing measured and estimated FEV_1% predicted, we found a weighted kappa-agreement of 0.33 after dividing FEV_1% predicted into three cathegories: <60, 60-79 and 80 or more. When diminished lung sounds were recorded the mean FEV_1 was 58% predicted, while the GP's mean estimate in these patients was 66% predicted. A mean FEV_1% predicted of 81 was measured in the patients with rhonchi, while the mean estimate was 74% predicted. Multiple regression confirmed that too much emphasis was laid on rhonchi and insufficient emphasis on diminished lung sounds in the assessment of bronchial obstruction.

The intervention: The GPs received feed-back from the results of the first phase, a review of clinical epidemiological studies on lung sounds and bronchial obstruction, and watched a lung sound video demonstrating diminished lung sound and wheezes in patients with bronchial obstruction. The intervention was arranged as a three hours meeting.

Phase 2: The same procedures as in the first phase were followed, and each of the 11 GPs examined a similar number of patients. When comparing measured and estimated FEV_1% predicted we found a weighted kappa of 0.43, an improvement in agreement compared to the first phase, that did not reach statistical significance. The mean estimate of FEV_1% predicted in 11 patients with rhonchi as the only pathologiocal chest finding was 91 in the second phase compared to 79 in the 12 patients with only rhonci in the first phase. The mean measured FEV_1% predicted was 92 in both phases. The change in mean estimate was statistically significant ($p<0.005$).

Conclusion: A short educational intervention on lung sounds resulted in a small but statistically insignificant improvement in agreement between estimated and measured FEV_1% predicted. A more adequate emphasis laid on rhonchi could be observed after the intervention.

CRACKLES IN COURT: A CASE FOR BIOLOGIC STANDARDIZATION

R. Murphy, J. Gee

Bilateral basilar crackles that did not clear with cough were heard by a physician during an examination performed at the request of the patient's attorney. The examining physician recorded the sounds on a commercially available device for making visual displays of sounds (Blood Line Technology Graphic Auscultation System (BLT)). This physician testified that the crackles supported the hypothesis that the patient had interstitial pulmonary fibrosis (IPF) secondary to asbestos exposure. The patient was re-examined at the request of a defense attorney. The re-examination consisted of auscultation at multiple sites using an acoustic stethoscope, examination with a BLT device and with a multichannel lung sound analyzer (MCLSA). The latter band pass filtered sounds from Radio Shack Realistic microphones imbedded in Littman Cardiac Stethoscope chest pieces from 80 to 2000 Hz. The microphones were attached to the chest wall using double sided adhesive disks (Double-Stick Disco 3012181). Six microphones were placed sequentially on four locations: A lateral and posterior site on both the right and left bases. Ten seconds were recorded at each site. On auscultation with an acoustic stethoscope, numerous pan inspiratory coarse crackles were heard at the left base laterally. Coarse crackles were heard at the left base posteriorly as well. One site with fine crackles was noted at the right base and recorded.

A total of 52 crackles were noted on time expanded waveform analysis (TEWA); (36 coarse, 12 medium, 4 fine). The mean IDW was 1.4 $\pm$ .37; crackles measured on a patient with IPF using the same MCLSA measured .87 $\pm$ 0.36. The ratio of IDW in the plaintiff to that of the IDW in the IPF patient was 0.62. This ratio for IPF vs. chronic obstructive pulmonary disease calculated from previous reports varied from 0.62 to 0.71. (Bettencourt PE, Del Bono EA, Spiegelman P, Amer J Resp & Crit Care Med 1994;150:1291-1297; Munakata, Mitsuru, Hideaki U, Isamu D, Thorax 1991;46:651-657; and Piirila P, Sovijarvi ARA, Kaislas T,et al, Chest 1991;99:1076-1083) The second examining physician testified that the crackles were not due to IPF secondary to asbestos exposure. The jury's verdict will be announced.

WEB PAGES WITH GLOBAL LINKAGE AND ACCESSIBILITY OF LUNG SOUNDS RESOURCES

Christopher Druzgalski, John Lim
California State University, Long Beach, CA

The dynamic growth of activities on Internet and ease of access to the information superhighway provide new capabilities for storage, retrieval, and exchange of information concerning lung sounds. In particular, the World Wide Web, which is the fastest growing part of the Internet, is leading to a fundamental shift in access to information that essential components include sound and graphics in addition to text. The Web explosive growth and popularity have been due to its relative simplicity in navigation through intuitive point-and-click commands and also easy conductivity via a server at an academic institution, hospital or a dial-up account at home. Thus, The Net with media-rich Web sites, where text-dominated information can be easily supplemented with audio and visual information representing graphics, video and/or sound waveforms, is ideally suited to the interactive multimedia presentation of lung sounds and its global access.

Specifically, the purpose of this undertaking is to present available resources concerning lung sounds on the information superhighway, development of ILSAC Web home page (http://www.csulb.edu/~ilsac) at CSULB and its linkage with other existing Web pages such as one at University of Manitoba authored by Hans Pasterkamp. The individual Web sites can include selected storage of references, or patient data including lung sounds in audio and graphic modes, or data base information concerning the conference. The existing sites demonstrate that a broader accessibility to NCSA Mosaic and Netscape Navigator, or other World Wide Web browsers, provides irresistible opportunity to a special, lung sounds oriented, interest forum and development of a real-time platform that provides capabilities for extended year-round conferences on lung sounds that allow to share text, video and audio information. Usenet like news groups related to lung sounds such as fot-group@mailbase.ac.uk initiated at MRCPI Southampton General by D. MacLeod. These formats allow to connect pieces of information related to lung sounds from all over the world, that reside in different databases and on different machines. Each site can decide and create its own hypertext links to other documents and Internet resources using URL's (Uniform Resource Locators). In this information sharing project each site preserves its identity and information content. Thus, the wealth of information on lung sounds can be easily available on Internet, which at this time connects 42,000 computer networks in more than 80 countries with over 35 million users and is rapidly growing. Most importantly, it can be easily accessible to any physician or medical student

The fundamentals of getting on the Net and hypertext links with commercial domains, as well as a quick overview of the Web page and its development in the hypertext markup language (HTML) and information content will be presented. The presentation will also be used to further involvement of other lung sounds researchers in the global electronic linkage of lung sounds resources. This linkage provides an effective tool and closer cooperation of the scientific community interested in the advancement of lung sounds recording, analysis and recognition as well as global reference and improved standardization of lung sounds.

L · O · N · G B · E · A · C · H

CALIFORNIA, U.S.A.

THE 20TH INTERNATIONAL LUNG SOUNDS CONFERENCE

October 11 - 13, 1995

The 20th International Conference on Lung Sounds and International Lung Sounds Association Annual Meeting will be held in Long Beach, California, October 11 -13, 1995 aboard The Queen Mary.

International Steering Committee

Wilmot Ball, MD	Baltimore, Maryland
David Cugell, MD	Chicago, Illinois
Filiberto Dalmasso, MD	Torino, Italy
Sadamu Ishikawa, MD	Boston, Massachusetts
Steven Kraman, MD	Lexington, Kentucky
Shoji Kudoh, MD	Tokyo, Japan
Robert Loudon, MD	Cincinnati, Ohio
Masashi Mori, MD	Tokyo, Japan
Raymond Murphy, MD	Boston, Massachusetts
Hans Pasterkamp, MD	Winnipeg, Canada
Anssi Sovijarvi, MD	Helsinki, Finland
S.A.T. Stoneman, MD	Swansea, United Kingdom

CALL FOR ABSTRACTS

Papers for presentation during the Conference will be selected by the Program Committee. Abstracts should not exceed 200 words in length and may relate to any aspect of lung sounds; examples are studies of mechanisms of production, clinical implications, physiological correlations, methods for recording, analysis or representation. Abstracts should be typed on an 8 1/2" x 11" sheet of bond paper. Please allow a 1/2" margin on all sides. Abstracts should be single spaced, include title in all caps, all authors with presenting author listed first, and name and address of institution where work was completed. Abstracts will be reproduced as submitted. Please check for clarity and accuracy. Please indicate whether oral or poster presentation is preferred and equipment needs. Posters will be displayed throughout the meeting. Presentation of recordings and of video-posters will be possible.

IMPORTANT DATES:

NOW begin planning to submit an abstract and/or attend. RSVP (Mail, FAX, E-mail - [1]) the title of your abstract or inquire to receive additional information.

· Abstract deadline (mail to [2])	July 15, 1995
· Notification of acceptance	August 1, 1995
· Registration (mail to [1])	August 10, 1995
· Conference sessions	October 11-13, 1995

Registration fee of $200 includes conference proceedings, social events [reception, Conference Banquet (included if registration fee received before Aug. 10), lunch and more]. Companion registration fee, $100. Banquet $50 (included if registration fee received before Aug. 10). Please make check or bank draft, in U.S. funds, payable to ILSAC and mail to [1]. Further details regarding travel and accommodations, special events or tours, will be forthcoming.

For more **INFORMATION** regarding the conference please contact:

[1] Christopher Druzgalski, Ph.D.
California State University
Electrical/Biomedical Engineering
Long Beach, CA 90840
Tel: (310) 985-8054 or 985-8043
FAX: (310) 985-5899 or
(310) 985-7561
Email: ilsac@csulb.edu
Web: http://www.csulb.edu/~ilsac

[2] Raymond L.H. Murphy, M.D.
Faulkner Hospital/Pulmonary
1153 Centre Street
Boston, MA 02130
Tel: (617) 522-5800 x1968
FAX: (617) 524-8663