INTERNATIONAL LUNG SOUNDS CONFERENCE

Boston, Massachusetts
October 10th and 11th, 2014
St. Elizabeth's Medical Center

The 40th ILSA Meeting will be in St. Petersburg, Russia
September 24th and 25th, 2015

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FRIDAY, OCTOBER 10, 2014

8:30 Registration

9:00 Opening Remarks — Dr. Nikolas E. Madias, MD
Professor of Medicine
Tufts University School of Medicine
Chairman
Department of Medicine
St. Elizabeth"s Hospital

9:20 History of ILSA — Dr. R. Murphy

SESSION 1

Chairman S. Ishikawa

10:00 -10:20 On Duration Of Tracheal Forced Expiratory Noises During Long- Term Isolation In The «Mars--500» Experiment

Alexander Dyashenko[1, 2], Vladimir Korenbaum, [3] Anna Mikhaylovskaya, [1] Antonia Osipova[1], Alexander Suvorov, [1], Svetlana Shin, [3], Irena Pochekutova[3]

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2. Prokhorov General Physics Institute, Russian Academy of Sciences, Moscow
3. V.I. Il.'ichev Pacific Oceanological Institute, Far Eastern Branch, Russian Academy of · Sciences, Vladivostok, v-kor@poi.dvo.ru
4. Far Eastern Federal University, Vladivostok

10:20-10:40 Coffee Break

10:40-11:00 The Variability And Bronchodilator Response Of Tracheal Forced Expiratory Noise Time Parameters In Asthma Patients And Healthy Subjects

Irina Pochekutova, Vladimir Korenbaum V.I. Il'ichev

Pacific Oceanologic Institute of Far Eastern Branch of the Russian Academy of Sciences, Vladivostok, Russia,

11:00-11:20 An Approximate Estimation Of Human Bronchial Resistance Under Forced Exhalation

Vladimir Korenbaum, Irina Pochekutova V.I. Il'ichev

Pacific Oceanologic Institute of Far Eastern Branch of the Russian Academy of Sciences Vladivostok, Russia.

SESSION 2

Chairman S. Kudoh

11:20-11:40 Pulmonary Sounds Classifier As A Useful Diagnostic Tool For Clinical Practice

Ipek Sen, Murat Saraclar, Yasemin P. Kahya

Bogazici University, Electrical and Electronics Engineering Department, Istanbul, Turkey, +90 212 3597475

11:40-12:00 Lung Auscultation In Children

Masato Takase, MD,PhD

Department of Pediatrics, Nippon Medical School Tama-Nagayarria Hospital

12:00-12:20 A Conceptual Audio Model For Simulating Pulmonary Auscultation In a High-Fidelity Virtual Physical Examination

Thomas B. Talbot, MD,MS,FAAP
Department of Medical Education at Keck School of Medicine of USC, Universiy of Southern California

SESSION 3

Chairman Yasemin P. Kahya

1:20-1:40 A New Teaching Method on Lung Sounds Auscultation – Simultaneous Showing of Chest Movement, Lung Sounds And Phono-Pneumograph

Kudoh S., Nagasaka Y., Kiyokawa H., Takase M., Nakano H., Murata A.

Japanese Lung Sounds Association

1:50-2:20 Sound Spectrographic Characteristics Of Fine And Coarse Crackles

Michiko Tsuchiya, Yukio Nagasaka•. Chikara Sakaguchi, Takuma Minami, Ryota Kominami, Yosuke Nakanishi, Takanori Ara, Tetsuo Hori, Masutaro Ichinose

. *Rakuwakai Kyoto Pulmonary Center Rakuwakai Otowa Hospital*

2:00- 2:20 Coffee Break

SESSION 4

Chairman T. Talbot MD

2:20-2:40 Cardiac Response To Respiration In Smokers And Ex-Smokers

Ishikawa,S, Andrey Vyshedskiy, Raymond L.H. Murphy, and Peter LaCamera,

Pulmonary & Critical Care Steward St Elizabeth's Medical Center
and Department of Medicine, Tufts University School of Medicine, Boston, MA, U.S.A.

2:40- 4:00

Poster Session 1
Chairman R. Murphy MD

1. Lung Sound Patterns in Common Pulmonary Disorders.
R. Murphy, A. Vyshedskiy, V. A. Power, C. Wilson, C. House, R. Paciej, J. Paciej,D. Bana.
2. Acoustic Imaging of the Chest.
R. Murphy, A. Vyshedskiy
3. Accuracy of Interpretation of Multichannel Computerized Lung Sound Analysis.
R. Murphy, A Wong-Tse and A. Vyshedskiy
4. Squawks in Pneumonia.
R. Paciej, A. Vyshedskiy, D. Bana, R. Murphy.

5:00 Reception

SATURDAY, OCTOBER 11, 2014

SESSION 5

Chairmen:
M. Takase MD, Phd, Y. Nagasaka

9:30-9:50 Sound Spectrographic Analysis .Of Vocal Fremitus (VF)

Yukio Nagasaka, Michiko Tsuchiya, Chikara Sakaguchi, Takuma Minami, Ryota Kominami, Yosuke Nakanishi, Takanori Ara, Tetsuo .Hori, Masutaro I.chino.se

Rakuwakai Kyoto Pulmonary Center, Rakuwakai-Otowa Hospital

9:50- 10:10 Acoustic Biomarkers Of Chronic Obstructive Lung Disease

Andrey Vyshedskiy[1] ,Andy Eaton[2], Brian Leaker[2], and Raymond Murphy[1]

[1] Brigham and Women's/Faulkner Hospital, Boston, MA
,[2] Queen Ann Street Medical Center, London, UK

10:10-10:30 Coffee Break

10:30 Poster Session 2

Chairman R. Murphy MD

5. Transmission of Crackles in Patients with Interstitial Pulmonary Fibrosis and Congestive Heart Failure.
   R. Murphy, A. Vyshedskiy.
6. Wheeze patterns in patients with vocal cord dysfunction
   R. Murphy, A. Vyshedskiy.
7. Method for Diagnosis of Centrally and Peripherally Generated Wheezes.
   R. Murphy, A. Vyshedskiy
8. Crackles in Patients With Interstitial Pulmonary Fibrosis.
   R. Murphy, A. Vyshedskiy.

11:30 Business Meeting

Chairman: S. Ishikawa, President of ILSA

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www.ilsaus.com

The-41st ILSA-meeting-will-be-in-Tokyo, Japan,

Fall, 2016

39th INTERNATIONAL LUNG SOUNDS ASSOCIATION

ANNUAL MEETING

St. Elizabeth's Medical Center

Boston, Massachusetts

October 10-11, 2014

Program Abstracts

International Lung Sounds Association Historical Notes

R. Murphy, M. D.

I shall begin by saying how I got involved in lung sound analysis. I was studying pipe coverers exposed to asbestos and when I did physical examinations on them I heard rales as they were called then (They are now called crackles). The work was part of a doctoral thesis I was doing at the Harvard School of Public Health. I showed that the workers with crackles were more likely to have other signs of asbestosis, such as abnormal x-ray findings, decreased vital capacities and abnormal respiratory symptoms as compared to those without crackles and that these findings were related to the duration of their exposure to asbestos. My mentor, a Public Health Physician, questioned the validity of my observations and asked, "How do we know that the crackles are not between your ears?"

After the thesis was done I got a job in the emergency room of the Massachusetts General Hospital seeing patients 2.7 miles away at the Logan Airport via two-way closed circuit television. This project, an early venture into Telemedicine started by Dr. Kenneth Bird, attracted many engineers from the Massachusetts Institute of Technology. They were interested in the technology used in evaluating patients at a distance. I told one of them about my crackle observations and he said "If you can hear them we can show them to you." I borrowed a tape recorder from the HSPH and an electronic stethoscope from the MGH and got on a bus to Maine where I recorded the lung sounds of the workers exposed to asbestos. I took them to a lab at MIT. This lab had a very large computer. Curiously there was a program in this computer that had been developed to study carotid sounds in the hope of detecting signs that would be helpful in identifying patients at risk of developing strokes. Fortuitously, the program had acoustic analysis in the time expanded mode. This was the equivalent of playing tape-recorded sounds back at a slow speed. The plots of the sound are expanded allowing the patterns of such things as wheezes and rhonchi to be visually distinguished from crackles and normal sound waveforms. I was particularly pleased when I saw that pleural friction rubs were different than all the other sound patterns. I believed that we had come upon something important. The MIT engineers were unimpressed and said that they did time expanded waveform analysis and asked," What is the big deal?" Somewhat later Dr. David Cugell, Professor of Pulmonary Medicine at the University of Illinois published a paper in which he said that time expanded plots were the first things to show that lung sounds could be distinguished from one another visually.

The circumstances that led to the formation of The International Lung Sounds Association began one day at a meeting of the American Thoracic Society. I had been interested in occupational asthma and gave a talk on the subject. I was puzzled by the definition of atopy. It is important in the industrial setting to know whether a worker is wheezing because of the occupational exposure or because he or she is genetically susceptible to develop asthma because of atopy. I commented that the situation reminded me of the story about the Little Prince by Antoine de Saint-Exupery. The little prince came to earth from the planet B612. He asked a man to draw him a picture of a sheep. The man drew several that the little prince didn't like. Finally the man drew a picture of a box and said to the prince "Your sheep is inside." The prince said," That's exactly what I wanted. Will he get enough to eat?" (Although I knew what atopy was none of the definitions suited me.)

Dr. Robert Loudon, Professor of Pulmonary Medicine at the University of Cincinnati, was in the audience and came up to me and said he was fascinated by a talk that incorporated the Little Prince into a medical subject. We talked for over an hour. Robin was interested in quantifying cough. He had placed a tape recorder in the room where Medical Grand Rounds were held at the University of Cincinnati and recorded coughs at the weekly Grand rounds over a long period of time. He counted the number of coughs at each session and showed that the counts correlated with the air pollution levels in Cincinnati. We talked about quantification of acoustics in medicine. Who did we know that had an interest in the subject? After the meeting we contacted a number of physicians and engineers we knew and had the first meeting in Boston at the Faulkner Hospital in1976. The meeting was attended by a surprisingly large number of very prominent scholars. Paul Forgacs from the UK, who was the author of the most widely read book on lung sounds, attended. Curiously he said that all the important things about lung sounds had been said and that there was no need for any more meetings. We have had 38 since and this is number 39. Number 40 is planned for St. Petersburg, USSR in 2014.

What has happened at these meetings and why have we had so many?

To some, such as Dr. Harrington, the former dean of Tufts Medical School, lung sounds are not an important subject. I was given an award for teaching Tufts medical students for 25 years. Dean Harrington introduced me saying that I had an ARCANE interest in lung sounds, but (perhaps to make up for it) he said I was a very good clinician. I had to go to the dictionary to look up the word arcane. It defined it as known or understood only by those having special, secret knowledge. We have had meetings in 20 cities, many countries and 3 continents.

Why should anyone be interested in lung sounds?

There are many reasons:

1) All living human beings have lung sounds.
2) Lung sounds frequently change when disease is present.
3) These changes can help clinicians know that disease is present and often what disease it is.
4) Lung sounds can help monitor the course of a variety of illnesses.
5) The stethoscope has been in use for 200 years because it can provide clinicians with important clinical information. ***It is so commonly used by physicians that it has become a symbol of the profession.***
6) Computers have greatly improved the efficiency and accuracy of getting diagnostic and monitoring acoustic information from patients. Computers circumvent the observer variability that can be a problem with clinicians use of the stethoscope.
7) Computers will not be uninvented
8) Computers have improved greatly in the past few decades and they continue to improve. (As I mentioned the first computer I used was very large-about 15 feet from front to back. A pocket pc now can more things than that computer could do.)
9) Computers have become less expensive.
10) Acoustic sensors are not very expensive
11) Computerized acoustic analysis can reduce radiation exposure (This is particularly important in the case of pregnant women and children)
12) The information obtained by computer can be telemetered. This can be of great benefit to patients in remote areas of the world.

Interest in computerized lung sound analysis is no longer “arcane”. It is “the wave of the future” as it can improve medical monitoring. It can help avoid erroneous diagnoses. It can avoid unnecessary radiation exposure. This is particularly valuable in pregnant women and children. It can save the health care system money.

ONTHE DURATION OF TRACHEAL FORCED EXPIRATORY NOISES DURING LONG- TERM ISOLATION IN THE «MARS-500» EXPERIMENT

Alexander Dyachenko[1,2],Valdimir Korenbaum[3, 4], Anna Mikhaylovskaya[1]
Antonina Osipova[1], Alexander Suvorov[1], Svetlana Shin[3], Irina Pochekutova[3]

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[2] Prokhorov General Physics Institute, Russian Academy of Sciences, Moscow
[3] V.I. Il'ichev Pacific Oceanological Institute, Far Eastern Branch, Russian Academy of Sciences, Vladivostok
[4] Far Eastern Federal University, Vladivostok

Background: Duration of tracheal forced expiratory noises proved to be a good parameter to differ normal *vs* bronchial obstruction. However there were no studies aimed at a long-term monitoring of the duration.
Objective: To study individual dynamics of tracheal forced expiratory noise duration during 520-days confinement.
Methods: Dynamics of duration of tracheal forced expiratory noises in a group of 6 male volunteers aged from 26 to 38 years was studied before, during and after 520-days confinement. The experiment imitated a space flight to Mars. The experiment took place from June 2010 to November 2011 in the on-ground experimental complex in the State Scientific Center of RF – Institute of and BioMedical Problems, Russian Academy of Sciences, Moscow. Each volunteer performed a few forced exhalations, during which he registered tracheal noises on the surface of the neck. There was a study before confinement, 6 studies during the confinement on 40-41, 90-100, 159, 252, 343, 405 days and one study on the 17-18 days after the confinement.
Results: The duration of tracheal forced expiratory noise did not change in most volunteers. It is not surprising because basic factors of space flight (low gravity and space radiation) were not involved in the experiment. However two volunteers demonstrated significant changes of tracheal forced expiratory noises duration and changes in a few spirometric parameters.
One volunteer demonstrated an increase of duration in the course of confinement. He also had reduced FEV1/FVC ratio and declared respiratory discomfort. Thus increase in duration of tracheal forced expiratory noises may reveal a ventilatory impairment of obstructive type.
Another volunteer exhibited decreased duration of noises in the middle of confinement with subsequent recovering. A submaximal forced expiratory effort was supposed, caused probably by local decrease of individual emotional status.
Spirometric results supported this assessment.
Conclusions: An analysis of duration of tracheal forced expiratory noises dynamics during prolonged confinement proves to be a sensitive technique to test the ventilator function, providing possible application to prolonged space flights.

The variability and bronchodilator response of tracheal forced expiratory noise time parameters in asthma patients and healthy subjects

Irina Pochekutova, Vladmir Korenbaum

V.I. Il'ichev Pacific Oceanologic Institute of Far Eastern Branch of the Russian Academy of Sciences Vladivostok, Russia, v-kor@poi.dvo.ru

Background: Tracheal forced expiratory noise time (FETa) is a promising test of airway obstruction in young asthma patients (Pochekutova, Korenbaum, 2013). New parameters – forced expiratory noise times in 200-Hz frequency bands between 200 and 2000Hz (t 200-400, t400-600, t 600-800....) have been developed.

Objective: To test an intra-session variability and a response of these time acoustic parameters to short-acting b2-agonist in asthma patients and healthy persons.

Methods: 58 asthma patients with airway obstruction and 60 healthy (males 17-25 years) were tested. Spirometry and tracheal forced expiratory noise recording were performed before and after 0.2 mcg salbutamol inhalation. Baseline intra-session variability was calculated as CV for 3 best attempts. Significant response to bronchodilator was assessed by 1.65*CV threshold.

Results: Significant distinctions between patients and healthy are found for CV of t 400-600 t 600-800 ($p=0.0003$), t 1200-1400 ($p=0.002$), t 1400-1600 ($p=0.00001$), t 1600-1800 ($p=0.0001$), t 1800-2000 ($p=0.008$), FETa ($p=0.02$). Significant differences are also revealed in the incidence of types of significant bronchodilator response for FETa, t 200-400, t 400-600, t 600-800, t 1000-1200, t 1200-1400, t 1400-1600. Decrease of these parameters is dominant in asthma patients ($p=0.02$-0.001). The magnitude of decrease is essentially higher in patients for FETa, t 400-600, t 600-800, t 1200-1400, t 1400-1600 ($p=0.03$-0.0004). While an increase of these parameters prevails in healthy patients ($p=0.03$-0.0006).

Conclusions: Revealed differences in the variability and bronchodilator response of tracheal forced expiratory noise band durations may be an additional instrument for acoustic discrimination of asthma patients and healthy patients. The study is supported by FEB RAS grant 12-I-P5-10 and RFBR grant 14-04-0048.

An approximate estimation of human bronchial resistance under forced exhalation

Vladimir Korenbaum, Irina Pochekutova

V.I. Il'ichev Pacific Oceanologic Institute of Far Eastern Branch of the Russian Academy of Sciences

Vladivostok, Russia,

Background: A bronchial resistance under forced exhalation has potential diagnostic power for detecting bronchial obstruction. However there are difficulties to measure this parameter directly by means of commercially available body plethismographic instruments.
Objective: To develop and analyze surrogate biomechanical, acoustic-biomechanical and acoustic-anthropometric measures of bronchial resistance under forced exhalation.
Methods: Surrogate biomechanical measures of bronchial resistance under forced exhalation have been developed which involve ratio of maximal expiratory pressure at mouth P_{emax} and maximal expiratory volume velocities $P_{emax}/MEMF_{25-75}$, P_{emax}/MEF_{75}. On the basis of tracheal forced expiratory noise time FETa acoustic-biomechanical FETa*P_{emax}/FVC and acoustic-anthropometric FETa/H measures are constructed, where FVC – forced volume capacity, H – height.
Results: It is shown in the sample of young healthy volunteers (42 male, 49 female) that biomechanical surrogate measures provide a reasonably accurate estimate of bronchial resistance in the middle and the end of the forced expiratory maneuver when compared with the independent sample (Aldrich et al., 1989). A possibility of statistical prediction of the limits of normal bronchial resistance under forced exhalation in healthy individuals has been demonstrated by means of acoustic-biomechanical and acoustic-anthropometric surrogate measures. On the basis of acoustical-biomechanical interpretation it is supposed that a ratio of increments of biomechanical and acoustical surrogate measures of bronchial resistance may predict the extent of bronchial obstruction and its probable location through levels of the bronchial tree in a patient with obstructive lung disease.
Conclusions: Developed surrogate biomechanical, acoustic-biomechanical and acoustic- anthropometric measures of bronchial resistance under forced exhalation may be useful to assess features of bronchial obstruction in patients. The study is supported by the RFBR grant 14-04-0048.

Pulmonary Sounds Classified as a Useful Diagnostic Tool for Clinical Practice

Ipek Sen, Murat Saraclar, Yasemin P. Kahya

It has already been shown in the computerized pulmonary sounds analysis literature that it is possible to predict successfully from the sounds whether the subject is healthy or some pathological conditions have developed. In such studies, certain parameters are calculated from the pulmonary sounds, and those parameters are subjected to classifier algorithms. Those algorithms first learn from the known subject groups (healthy versus pathological in this case), and then predict the group label of.the newly introduced subject. In this study, one further step is considered namely that the pathological group is divided into obstructive and restrictive categories. The aims are to observe the prediction performances with respect to the three subject groups (healthy, obstructive and restrictive) and to explore a proper design for the classifier, with an end aim to develop a diagnostic tool that is useful in clinical practice. Accordingly, 20 healthy and 20 pathological subjects are included in the study, where the obstructive (bronchiectasis) and restrictive (interstitial pulmonary disease) groups are equal in size (10 subjects each). Fourteen-channel pulmonary sounds acquired at posterior chest wall are parameterized using a vector autoregressive (VAR) model, and the estimated model parameters are fed to support vector machine (SVM) and Gaussian mixture model (GMM) classifiers. The six sub-phases of the flow cycle (early, mid, late inspiration and expiration) are considered separately during the parameterization and the classification. The decisions on the six sub- phases are later combined to predict the class label of each subject. The results show that the class labels are successfully predicted from the acoustic information (with a comparably lower rate for bronchiectasis). A hierarchical approach (i.e., first predicting whether healthy or pathological, then whether obstructive or restrictive if pathological) provides better diagnostic ability than predicting among the three class labels at one step. Bronchiectasis is confused with the other two groups equally. The performance is expected to be improved if the data size is increased and the methodology is augmented with new parameterization methods modeling the adventitious sound components better.

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Lung auscultation in children

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Respiratory sounds of infants and young children are relatively louder compared to those of adults. Wheezing, stridor and grunting are clinically important signs and are even audible without using stethoscope. Normal breath sounds are also easily heard through the stethoscopes and carry valuable information from the airways. On the other hands, children are more vulnerable to radiations, making radiological examination more challenging. Moreover, they are uncooperative with the lung function tests, and fiberscopic examinations. Thus, clinical value of chest auscultation is quite high. I am going to present some cases from our new DVD textbook on lung auscultation, recently published in Japan, in order to address the importance of auscultation and objective assessment of lung sounds in clinical assessment of children.

A Conceptual Audio Model for Simulating Pulmonary Auscultation in a High-Fidelity Virtual Physical Examination

Thomas B. Talbot, MD, MS, FAAP

Department of Medical Education at Keck School of Medicine of USC,
University of Southern California

Physician lung auscultation skills in the USA are suboptimal, primarily due to lazy technique and weak recognition of clinical findings. Virtual patients often play sampled breath sounds, but a sound in isolation is limiting because an actual lung exam varies with stethoscope location and breathing phase according to the degree of inspiratory and expiratory range. A simulator should, in theory, assess and inform technique, recognition skills and diagnostic association.
This pilot effort examines the practicality of a simulation that more faithfully replicates the patient lung exam experience.

The posterior chest is graphically portrayed and the user places a virtual stethoscope; this is duplicated for the anterior. Temporal synchronization is achieved whereby multiple lung sound tracks are timed to respiratory rate with an array of normal/pathological lung sounds.
Different sound mixes are generated for the entire range of tidal and full inspiratory/expiratory breathing combinations. Sounds are synchronized in their respiratory phase, allowing accurate timing i.e. End expiratory wheezes. To achieve global and anatomically localized sounds, each sound plays at full volume within a predetermined location in the lung and radius (umbra) with an attenuation penumbra beyond the radius. Localized sounds may include a 'negative umbra' that diminishes global sounds to emphasize a localized finding such as reduced breath sounds and crackles of lobar pneumonia.

A multi-track audio program successfully demonstrated a dynamic sound mixing method with anatomical localization of sounds that is practical and subjectively mimics reality.
Enhancement of a localized sound by inhibiting more distant ones aided identification. Fidelity was perceived to be more sensitive to sound timing errors than sound location errors.

Temporal synchronization of multiple lung sounds with user selectable depth of breathing permits faithful reproduction of lung sounds by breathing phase, emphasizing sound location by breath phase and need to instruct patients' breathing technique during an exam. Anatomical location of breath sounds with fadeout penumbrae and negative sound umbrae allow for accurate replication of the full variety of lung sounds, including their localized diminishment. These techniques appear to be successful in reproducing auscultation of varied pathologies. Such a simulation can encourage more careful auscultation in practice and reward learners with clinically accurate findings.

A New Teaching Method on Lung Sounds Auscultation – Simultaneous Showing Chest Movement, Lung Sounds and Phono-pneumograph

Kudoh S., Nagasaka Y., Kiyokawa H., Takase M., Nakano H., Murata A.

Japanese Lung Sounds Association

We published a new textbook on lung sounds auscultation with a DVD entitled "Lung Sounds Auscultation by hearing, observing and thinking".

The timing of sound generation in the respiratory cycles is an important factor on differential classification of lung sounds. So, we auscultate lung sounds simultaneously observing chest movement of the patient. Until now historically, in the beginnings when we had no recording methods of the sounds, only sound description by words in the textbook was used for teaching lung sounds auscultation. After 1950's, we have adopted various recording methods, i.e., a record player, tape-recorder and CD player for teaching actual sounds. However, these devices could not show the timing of sound generation in the respiratory cycles.

So, we published a new textbook with DVD in which chest movement and lung sounds using video recording and the phone-pneumograph of the sounds can be seen. This book has sold more than 2,000 copies during 3 months after the publication in Japan. We expect that this teaching method is useful for lung sounds education.

CARDIAC RESPONSE TO RESPIRATION IN SMOKERS AND EXSMOKERS

Sadamu Ishikaw, Andrey Vyshedskiy, Raymond L.H. Murphy,

and Peter LaCamera

Pulmonary & Critical Care Steward St Elizabeth's Medical Center
and Department of Medicine, Tufts University School of Medicine, Boston, MA, U.S.A.

It has been said that Heart beat becomes slower when one takes a deeper breath. As more negative pressure within the Chest is generated during Inspiration, which leads to more blood returning to the Heart. The Left Ventricle must pump out larger volume of blood, hence a delay in the next heartbeat.

We used a 2 channel ECG lung sounds device to simultaneously record ECG and Tracheal sounds.

ECG (QRS) was used to identify Heart beat and a tracheal sound tracing was used to monitor breathing. All recordings were done in the sitting position. Two ECG electrodes were mounted on the anterior chest, at the level of the 3rd inter-costal space, both sides of the Sternum. And the 3rd electrode was placed on the lower part of the left Chest. Tracheal sounds were recorded while listening with the Stethoscope on the neck.

After 2 or 3 regular Breaths, the subject was instructed to take a deep breath and hold for few seconds. Recordings of ECG and Tracheal sounds were made during that period. In order to ensure reproducibility, the same maneuver and recordings were made 4 times on each subject during one sitting. Measurements of QRS intervals of 2 beats during Inspiration, and QRS intervals of 2 beats before the Inspiration were carried out.

Fifty nonsmoking healthy subjects showed larger QRS intervals during Inspiration (47 msec) comparing to shorter 2 QRS intervals before the Inspiration (34 msec). This means slowing of Heartbeat (Pulse) from 76/min. to 55/min. on Inspiration.

Twenty subjects who were healthy but currently smoking, there were no difference of2 QRS intervals during Inspiration (36 msec), comparing to before the Inspiration (37 msec). This means slowing of heartbeat (Pulse) on Inspiration was not observed among smokers.

One 92 y o patient (Lebanese male), a laryngeal cancer survivor who was a former heavy smoker but stopped smoking 45 years ago, now has normal Pulmonary Function, normal ECG, normal Lung sounds, and normal Cardiac response to respiration..

Ex-smokers of less than 20 years (off cigarettes), showed the smoker's pattern of cardiac response to respiration. i.e. heartbeat (Pulse) doesn't become slower during Inspiration.

Sound spectrographic characteristics of fine and coarse crackles

Michiko Tsuchiya, Yukio Nagasaka, Chikara Sakaguchi, Takuma Minami, Ryota Kominami, Yosuke Nakanishi, Takanori Ara, Tetsuo Hori, Masutaro Ichinose

Rakuwakai Kyoto Pulmonary Center, Rakuwakai Otowa Hospital

Introduction

Fine crackles are described as brief, discontinuous high-pitched lung sounds, while coarse crackles are described to be loud and low-pitched. These descriptions are not clear in terms of acoustics. We tried to clarify the difference of fine and coarse crackles by analyzing these lung sounds by sound spectrogram.

Subjects and Methods

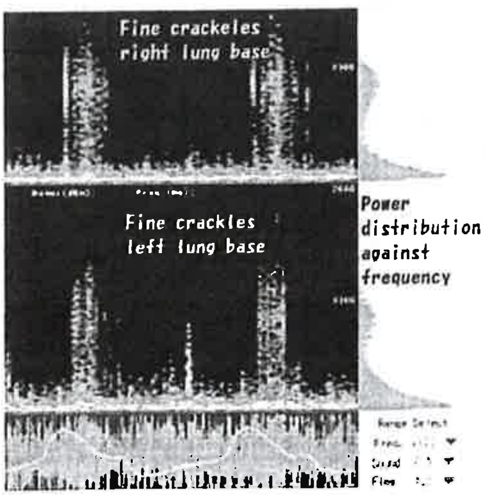
Six subjects with interstitial pneumonitis who have typical honeycombing in their chest CT and four subjects with acute pneumonia were examined. We analyzed breath sound by sound spectrometer (Kenz Medico, LSA 2010) and examined frequency-power distribution of crackles.

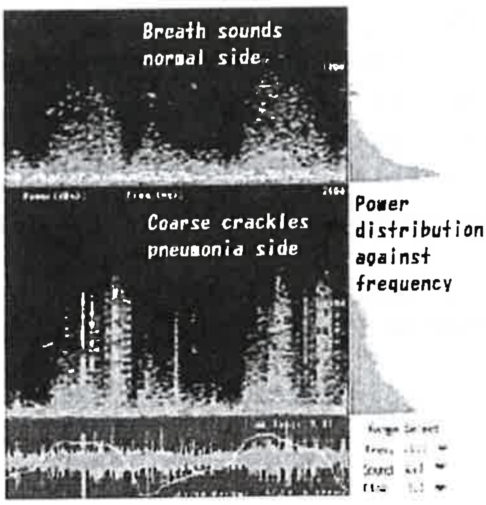
Results

Fine crackles have higher frequency than coarse crackles and show sound power peak at around 1000 Hz and power dip at around 500Hz (reverse S shape). Coarse crackles have more flat shape and no remarkable peak or dip was observed. (Figure)

Conclusions

Fine crackles have sound power peak at around 1k Hz. This high frequency peak considered to be the cause of explosive high-pitch quality of fine crackles. Thus, the difference of fine and coarse crackles can be visualized by sound spectrography.





Sound spectrographic analysis of vocal fremitus (VF)

Yukio Nagasaka, Michiko Tsuchiya, Chikara Sakaguchi, Takuma Minami, Ryota Kominami, Yosuke Nakanishi, Takanori Ara, Tetsuo Hori, Masutaro Ichinose
Rakuwakai Kyoto Pulmonary Center, Rakuwakai Otowa Hospital

Introduction
VF is transmission of the spoken voice to the chest wall, detectable by auscultation or palpation and is known to increase with lung consolidation and to decrease with pleural effusion, pneumothorax, and airway obstruction. We tried to clarify VF by analyzing vocal and transmitted chest wall sounds in normal subjects and patients with pleural effusion.

Subjects and Methods
We recorded and analyzed voice sounds in the low posterior chest wall while saying a word "*Hitoohtsu" and* compared with other words. "Hitooohtsu" means "one" and is a standard word used to examine VF just as *"neun-und-neunzi"* in Germany or *"boy"* or "toy" in the US. Each of these words have a long "oho" sound.

Results
In normal subjects, voice of saying five Japanese vowels, "aha", "ihi", "uhu", "ehe" and "oho" recorded on the chest wall showed that "oho" moderate attenuation of vocal sound on the chest wall. In a case of total atelectasis of the left lung, good transmission of the first harmonic and prominent attenuation of the second and higher harmonics was noted on the normal side while mild attenuation of the second and higher harmonics was observed. Sound spectrogram could visualize decreased VF objectively. (Figure)

Conclusions
The words containing "oho" sound has preferable attenuation in examining vocal fremitus. Sound spectrogram will be a useful tool in examining VF objectively.

Figure

Acoustic Biomarkers of Chronic Obstructive Lung Disease

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Objectives: The goal of this study was to determine lung sounds-derived biomarkers that distinguished Chronic Obstructive Pulmonary Disease {COPD) patients from age-matched controls and to see if these biomarkers were helpful in detecting early effects of smoking.

Methods: We used a multichannel lung sound analyzer {Stethographics Model STG-1602) that provides acoustic data from multiple sites on the chest wall to derive over 100 acoustic biomarker candidates. Sixteen biomarkers based on timing, frequency, amplitude, and adventitious sounds were statistically different between COPD {90 patients) and age-matched control {90) patients recruited in Boston, MA {test set). These biomarkers are:

1	Inspiratory crackle rate	9	Average lag of chest channels
2	Expiratory crackle rate	1	Inter-channel start asynchrony
3	Inspiratory wheeze and rhonchi rate	1	Inter-channel end asynchrony
4	Expiratory wheeze and rhonchi rate	1	Lead time-integrated amplitude
5	Ratio of inspiratory to expiratory duration	1	Lag time-integrated amplitude
6	Ratio of peak inspiratory to peak amplitude	1	Dynamic range
7	Ratio of low frequency to high frequency energy	1	Amplitude of inspiratory chest sounds
8	Average lead of chest channels	1	Slope of the chest versus tracheal

After examining the frequency distribution of the test set the scoring system was developed. Each of the 16 parameters was evaluated and a score was assigned based on the value of the individual parameter. The total Acoustic COPD Score was calculated as the sum of the individual score for each parameter. The Acoustic COPD Score was then evaluated in four groups of patients recruited in London, UK {control set):

1. COPD {60 patients, GOLD Stages 1-2), who are current smokers with at least a 10 pack-year smoking history;
2. Current smokers {60 patients) with at least a 10 pack-year smoking history and age-matched to the COPD cases;
3. Ex-smokers (60 patients) with at least a 10 pack-year smoking history who have not smoked for at least one year and age-matched to the COPD cases;
4. Never-smokers {60 patients) who were age-matched to the COPD cases.

Results: Acoustic COPD score was significantly greater for COPD, smokers, and ex-smokers groups compared to never smokers {$p<0.0001$ for all pair-wise comparisons with never-smoker group.

COPD score vs patient category (normalized by the mean score of never-smokers group. Weight (COPD (all) divided by normals only).