THE 41st ANNUAL CONFERENCE OF
INTERNATIONAL LUNG SOUNDS ASSOCIATION

第 41 回肺音（呼吸音）研究会

FINAL PROGRAM AND ABSTRACTS

7th - 8th October 2016,

Convention Hall, Ie-No-Hikari

Tokyo, Japan

WELCOME MESSAGE

Welcome to Tokyo and the 41st ILSA Conference on October 7 and 8, 2016. This time of the year is one of the best seasons to visit Tokyo, and this is the fourth time for Tokyo to host the ILSA Conference. The first one in Tokyo was the 10th Conference organized by Prof. Riichiro Mikami, which dates back to 1985. Considering the long-standing history of ILSA, and the fact that it is a bicentennial celebration year since the invention of stethoscope by Rene Laennec in 1816, we are greatly honored to host this meeting again in Tokyo.

We organized this conference with a special symposium on the lung sounds of asthma, and five sessions consisting of 17 excellent papers. You can learn and discuss the summary of findings of the earlier studies of lung sounds in asthma and many exciting new topics and challenges in the variety of lung sound studies. I wish all of you would enjoy the talks and further discussions.

This time, we chose the venue overlooking the Outer Moat of Edo Castle and located at the corner of historical Kagurazaka district, which is famous for the large variety of excellent restaurants. At the end of the conference, all attendants from abroad are invited to join the luncheon at the traditional Japanese restaurant Kaga. After the meal, please enjoy a guided walking tour of Kagurazaka.

Masato Takase, MD, PhD   Shoji Kudoh, MD, PhD
Director   Chairman of the Board of Directors,
Department of Pediatrics,   Japan Anti-Tuberculosis Association
Nippon Medical School
Tama-Nagayama Hospital

LIST OF ILSA CONFERENCES

No.	Date	Place	Local Organizer(s)
1.	October 1976	Boston, MA	Raymond L.H.Murphy,Jr.
2.	September 1977	Cincinnati, OH	Robert Loudon
3.	September 1978	New Orleans, LA	William Waring
4.	September 1979	Chicago, IL	David Cugell
5.	September 1980	London, England	Leslie Capel & Paul Forgacs
6.	October 1981	Boston, MA	Raymond L.H.Murphy,Jr.
7.	October 1982	Martinez, CA	Peter Krumpe
8.	September 1983	Baltimore, MD	Wilmot Ball
9.	September 1984	Cincinnati, OH	Robert Loudon
10.	September 1985	Tokyo, Japan	Riichiro Mikami
11.	September 1986	Lexington, KY	Steve S. Kraman
12.	September 1987	Paris, France	Gerard Charbonneau
13.	September 1988	Chicago, IL	David Cugell
14.	September 1989	Winnipeg, Canada	Hans Pasterkamp
15.	October 1990	New Orleans, LA	David Rice
16.	September 1991	Veruno, Italy	Filiberto Dalmasso
17.	August 1992	Helsinki, Finland	Anssi Sovijärvi
18.	August 1993	Alberta, Canada	Raphael Beck
19.	September 1994	Haifa, Israel	Noam Gavriely
20.	October 1995	Long Beach, CA	Christopher Druzgalski
21.	September 1996	Chester, England	John Earis
22.	October 1997	Tokyo, Japan	Masahi Mori
23.	October 1998	Boston, MA	Sadamu Ishikawa
24.	October 1999	Marburg,Germany	Peter von Wichert
25.	September 2000	Chicago, IL	David Cugell
26.	September 2001	Berlin, Germany	Hans Pasterkamp
27.	September 2002	Helsinki, Stockholm	Anssi Sovijärvi
28.	September2003	Cancun, Mexico	Sonia Charleston, Ramón Gonzales Camarena & Tomás Aljama Corrales
29.	September 2004	Glasgow, Scotland	Ken Anderson & John Earis
30.	September 2005	Boston/Cambridge, MA	Raymond L.H.Murphy,Jr.
31.	September 2006	Halkidiki, Greece	Leontios Hadjileontiadis
32.	November 2007	Tokyo, Japan	Shoji Kudoh
33.	October 2008	Boston, MA	Sadamu Ishikawa & Raymond L.R. Murphy,Jr.
34.	September 2009	Haifa, Israel	Noam Gavriely
35.	October 2010	Toledo,OH	Dan E. Olson
36.	September 2011	Manchester, UK	Ashley Woodcock
37.	October 2012	Rochester, Minnesota	Michael E. Nemergut
38.	November 2013	Kyoto, Japan	Yukio Nagasaka
39.	October 2014	Boston, MA	Sadamu Ishikawa
40.	September 2015	St. Petersburg, Russia	Alexander Dyachenko, Vladimir Korenbaum & Zafar Yuldashev
41.	October 2016	Tokyo, Japan	Masato Takase &Shoji Kudoh

GENERAL INFORMATION

Conference Venue/Accommodation
Convention Hall, Ie-No-Hikari
11, Funagawara-machi, Ichigaya Shinjuku-ku, Tokyo 162-8448, Japan

Official language: English

Registration
Registration will be held in front of the Convention Hall (7th Floor) on:
Friday, October 7th   9:00am - 4:30pm
Saturday, October 8th   9:00am - 11:30pm

Registration fees
$100 / ¥10,000 : (Members/Non-members)
*Note that NO CREDIT CARD will be accepted.
Registration fee includes Get-together party and Lunch, on October 7th.

ILSA annual membership fee
$90 / ¥9,000
*Note that NO CREDIT CARD will be accepted.
ILSA members are required to pay the membership fee (if it hasn't paid yet) followed by the ILSA2016 conference registration fee.

Certificate of attendance
Participants, duly registered, will receive certificates of attendance upon requests.

Social Events
Get-together party will be held on October 7th at The Agnes Hotel and Apartments Tokyo (Room "Agnes Hall", B1 Floor).
*Business meeting will be held around 5:00pm on October 7th, at Ie-No-Hikari.

Supporting organizations
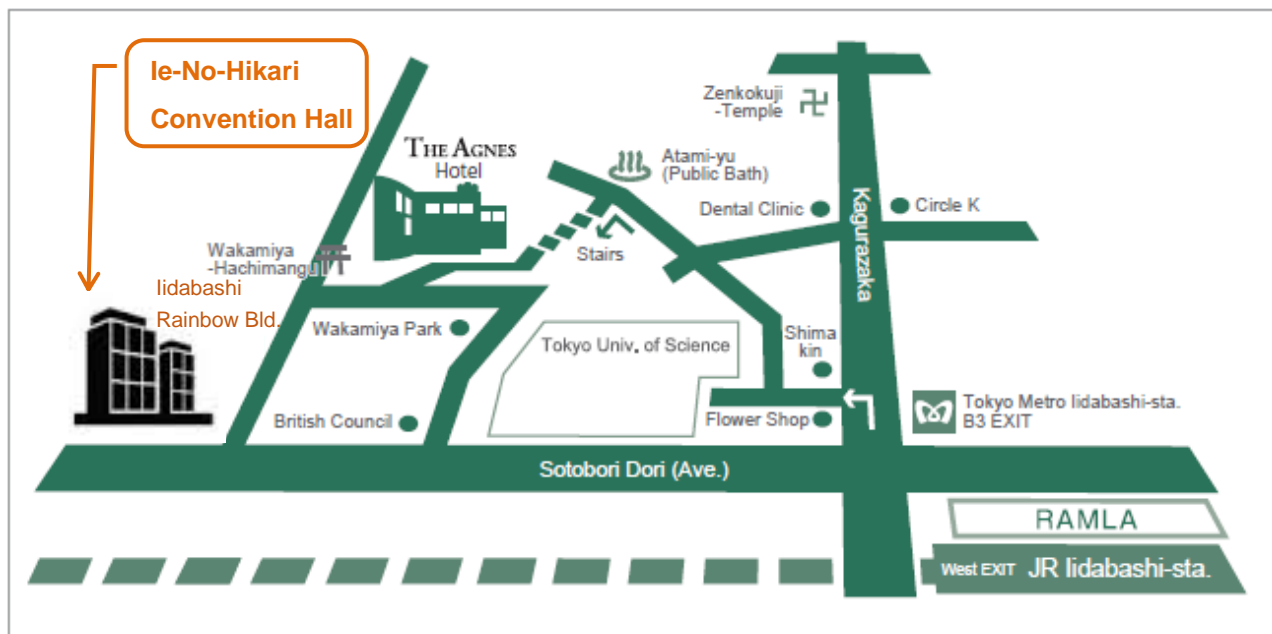Nippon Medical School
Japan Anti-Tuberculosis Association

Sponsors
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Access Map

Transportation Fare & Time to Venue from Narita Airport

Narita Airport	Limousine Bus ← → 55min/¥2,900	Tokyo City Air Terminal (TCAT)	Taxi 30-40min ← → Approximately 3,000-¥4,000	Ie-No-Hikari Convention Hall 11,Funagawara-machi, Ichigaya Shinjuku-ku, Tokyo 162-8448
	Limousine Bus ← → 90-100min/¥3,000	Hotel Grand Palace Tokyo Dome Hotel	Taxi 5-10min ← → Approximately 1,000-¥1,500	
	Keisei Skyliner ← → 60min/¥1,920	Keisei Ueno Station	Taxi 20-30min ← → Approximately ¥3,000	
	Narita Express ← → 50min/¥2,940	Tokyo Station	Taxi 20-30min ← → Approximately ¥3,000	
	Taxi 80-90min ← → Approximately ¥22,000-¥25,000			

Transportation Fare & Time to Venue from Haneda Airport

Haneda Airport	Monorail ← → 15min/¥470	Hamamatsucho Station	Taxi 20-25min ← → Approximately ¥2,000-¥3,000	Ie-No-Hikari Convention Hall 11,Funagawara-machi, Ichigaya Shinjuku-ku, Tokyo 162-8448
		Akihabara Station JR Yamanote Line 15-20min/¥160	← → Iidabashi Station JR Sobu line 6min/¥160 *5min Walk	
	Limousine Bus ← → 25-30min/¥800	Tokyo City Air Terminal (TCAT)	Taxi 30-40min ← → Approximately ¥3,000-¥4,000	
	Taxi 45-60min ← → Approximately ¥8,000-¥9,000			

PROGRAM

		FRIDAY, OCTOBER 7
9:00~		REGISTRATION
9:30		OPENING REMARKS
9:40 - 12:00		**SYMPOSIUM-What we know about lung sounds in asthma** **Chairpersons: Masato Takase & Hans Pasterkamp**
9:40-10:15	S1	**Wheezing - Pathologic, diagnostic and epidemiologic significance** Hans Pasterkamp *University of Manitoba, Winnipeg, Canada*
10:15-10:50	S2	**Acoustic monitoring of asthma** Noam Gavriely *Technion-Israel Institute of Technology, Rappaport Faculty of Medicine, Haifa, Israel*
10:50-11:25	S3	**Lung sound analysis in childhood asthma** Chizu Habukawa *Department of Pediatrics, Minami Wakayama Medical Center, Wakayama, Japan*
11:25-12:00	S4	**Lung sound analysis in adult asthma** Yukio Nagasaka *Department of Pulmonary Medicine, Rakuwakai Otowa Hospital, Kyoto Japan*
12:00 - 13:00		LUNCH
13:00 - 14:00		**Session I** **Chairpersons: Yukio Nagasaka & Noam Gavriely**
13:00-13:20	1	**Method for live production of synthetic lung sounds in an online auscultation simulator** Thomas B. Talbot, et al. Keck School of Medicine of the University of Southern California & *USC Institute for Creative Technologies, Los Angeles, CA, USA*
13:20-13:40	2	**Play back of respiratory sounds recorded with Bluetooth®-based wireless microphone** Makoto Yonemaru et al. *Respiratory Medicine, Yanagibashi Annex, Eiju General Hospital, Tokyo, Japan*
13:40-14:00	3	**Respiratory sound recording using a smartphone built-in microphone** Hiroshi Nakano, et al. *Fukuoka National Hospital, Fukuoka, Japan*
14:00 - 14:10		COFFEE BREAK

		FRIDAY, OCTOBER 7
14:10 - 15:30		**Session II** **Chairpersons: Mitsuru Munakata & Steve Kraman**
14:10-14:30	4	**Elasticity and viscosity of human chest wall surface tissues and their effect on registration of lung sounds** Alexander I. Dyachenko, et al. *Prokhorov General Physics Institute, Russian Academy of Sciences, Moscow, Russia*
14:30-14:50	5	**First experience of electronic intrapulmonary auscultation in patients with COPD and bronchial asthma** Yuriy V. Petrov, et al. *Ryazan State Medical University, Ryazan, Russia*
	6	**Cancelled**
14:50-15:10	7	**Acoustic esophageal cardiopulmonary monitoring during general anesthesia** Jukka Räsänen, Osama Hafez, David Thrush, Noam Gavriely *Department of Anesthesiology, H. Lee Moffitt Cancer Center, Tampa, FL* *Technion-Israel Institute of Technology, Rappaport Faculty of Medicine, Haifa, Israel*
15:10 - 15:20		COFFEE BREAK
15:30 - 16:50		**Session III** **Chairpersons: Shoji Kudoh & Alexander Dyachenko**
15:30-15:50	8	**Out-of-hospital acoustic cardio-pulmonary monitoring - Project description and preliminary data** Noam Gavriely, et al. *AST, CA, USA*
15:50-16:10	9	**Cardiac response to respiration in deep breathing by chest vs. abdomen** Sadamu Ishikawa, et al. *Pulmonary & Critical Care, Steward St Elizabeth's Medical Center, Dept. of Medicine, Tufts University School of Medicine, Boston, MA, USA*
16:10-16:30	10	**Rumbling rhonchi and bronchial inflammation in patients with bronchial asthma** Yukio Nagasaka, et al. *Department of Pulmonary Medicine, Rakuwakai Otowa Hospital, Kyoto, Japan*
16:30-16:50	11	**The effect of body position on the lung sounds intensity in patients with interstitial pneumonia** Michiko Tsuchiya, et al. *Department of Pulmonary Medicine, Rakuwakai Otowa Hospital, Kyoto Japan*
17:00 - 17:30		BUSINESS MEETING
18:00 - 20:00		GET TOGETHER PARTY (The Agnes Hotel & Apartments Tokyo, Agnes Hall, B1)

		SATURDAY, OCTOBER 8
9:00~		REGISTRATION
9:30 - 10:30		**Session IV** **Chairpersons: Makoto Yonemaru & Sadamu Ishikawa**
9:30 - 9:50	12	**Application of the forced expiratory tracheal noise time to monitor lung function in special physiology** V. Malaeva, V. Korenbaum, et al. *Pacific Oceanologic Institute of Russian Academy of Sciences, Vladivostok, Research Institute for Space Medicine, FBMA of Federal Research Clinical Center, Moscow, Russia*
9:50 - 10:10	13	**Lung sound terminology in western languages** Hans Pasterkamp and Kostas Priftis *University of Manitoba, Winnipeg, Canada* *University of Athens Medical School, Athens, Greece*
10:10 - 10:30	14	**Crackles or wheezes are heard in nearly 1/3 of adults aged 40 year or more** **Preliminary results from an ongoing epidemiological study on lung sounds** Hasse Melbye and Juan Carlos Aviles Solis *General Practice Research Unit, UIT the Arctic University of Tromsø, Tromsø, Norway*
10:30 - 10:40		COFFEE BREAK
10:40 - 12:00		**Session V** **Chairpersons: Hiroshi Nakano & Hasse Melbye**
10:40 - 11:00	15	**The assessment of asthma with a novel 24-hour cough frequency monitor** Junpei Saito, et al. *Department of Pulmonary Medicine, Fukushima Medical University, Fukushima, Japan*
11:00 - 11:20	16	**Clinical utility of new diagnostic tool for analyzing lung sounds** Takeshi Saraya, et al. *Dept. of Respiratory Medicine, Kyorin University School of Medicine, Tokyo, Japan*
11:20 - 11:40	17	**Consistency of interpretation of lung sounds between experienced physicians and automatic analysis** Sadatomo Tasaka, et al. Department of Respiratory Medicine*, Hirosaki University Graduate School of Medicine, Hirosaki, Japan*
11:40 - 12:00	18	**Aerodynamic sound generation study using patient-based tracheobronchial model** Gabriel Pramudita Saputra, Satoshi Ii, Shigeo Wada *Dept. of Mechanical Science and Bio-Engineering, Graduate School of Engineering Science, Osaka University, Osaka, Japan*
12:00 - 12:30		CLOSING REMARKS & PHOTOGRAPH

WHEEZING – PATHOLOGIC, DIAGNOSTIC AND EPIDEMIOLOGIC SIGNIFICANCE

Hans Pasterkamp

University of Manitoba, Winnipeg, Canada

Wheezing is the most widely used term of lung sounds. The understanding of this term, however, differs between lay persons, people of different cultural and language backgrounds, and even among health care professionals. The consequence of the variable interpretation of wheezing is a frequently mistaken classification of related medical conditions, particularly of asthma. Most cases of asthma have their first manifestation during the early years of life when reversible airway obstruction is difficult to measure. Much relies therefore on second hand observations by parents and caregivers and their reporting of symptoms, including wheezing. The present review addresses our current understanding of the mechanisms behind wheezing, its acoustical measurement and presentation, its relation to the severity of airflow obstruction, its relevance to medical management and to observations in public health.

ACOUSTIC MONITORING OF ASTHMA

Noam Gavriely MD

DSc Technion, AST and Respiri Ltd.

Asthma is a condition where the airways become narrow for minutes, hours or days. When the airways constrict the resistance to flow increases and more work need to be applied to move the air in and out of the lung. As a result, the distribution of turbulence in the airways can change and some airway can become flow limited, meaning that despite increasing the pressure gradient along an airway, the flowrate does not increase. These changes are associated with distinct changes in the sounds emitted from the lung during breathing. This review will look specifically on the sounds characterized as "Continuous Adventitious Breath Sounds" or CABS in asthmatic patients.

CABS are produced in the larger airways – generations 1 to 5 or 6. There are 3 types of CABS: Rhonchi, Wheezes and Whistles. Rhonchi are low frequency and caused by flapping flatter; Wheezes are caused by airway flutter and have medium frequency, from about 150 up to 1000 Hz; Whistles are generated by eddy shedding with a frequency of over 700 Hz. They are all manifestations of flow of air through constricted airways.

All CABS have distinct spectral patterns and can be identified by auscultation or by using signal processing techniques. The optimal position for recording of CABS is over the trachea (in large children and adults) and on the sternal notch/manubrium in small children. The sensors must have response from about 100 Hz to about 2000 Hz to detect all kinds of CABS. Sensors with limited frequency response such as modified stethoscopes are likely to miss CABS at frequencies higher than 700 Hz. CABS are best quantified by their overall duration as function of time (Wz%); not by their amplitude or frequncy. CABS that are ambiently heard over the patient's mouth with an ambient microphone or by the ear are likely to be generated in the vocal box, except in small children.

The following are a number of clinical generalizations that are true except for exceptions: (1) an asthmatic patient who is wheezing at any time during the day or night is poorly controlled; (2) an asthmatic patient who is not wheezing day and night is "well controlled" (questions: what is the threshold of Wz% that is "normal") (exception: very sick asthma patients who have "silent lung"; (3) the Wz% in asthma diminishes when effective bronchodilators (BD) are administered – see sonograms on right showing wheezes before BD and no wheezes after BD. The bottom sonogram shows ambient "leak"

of some of the wheezes, but not others indicating a mixture of true asthma and VCD; and (4) Wz% is non-linearly related to FEV1% - as shown in right bottom graph. CABS only start when FEV1% falls below about 60%. However, Symptoms score also start to rise only when FEV1% falls below 60% and Wz% exceeds 5% (below, left).
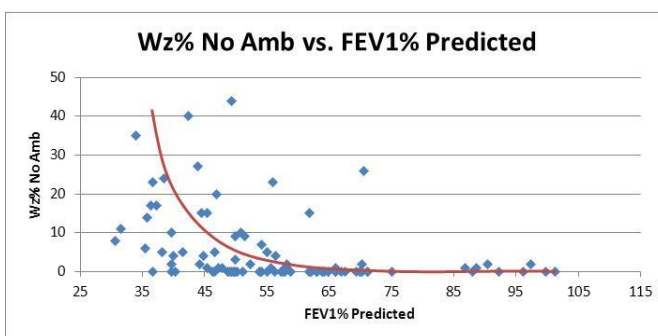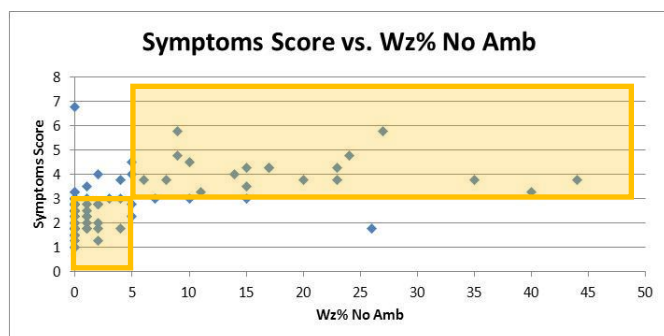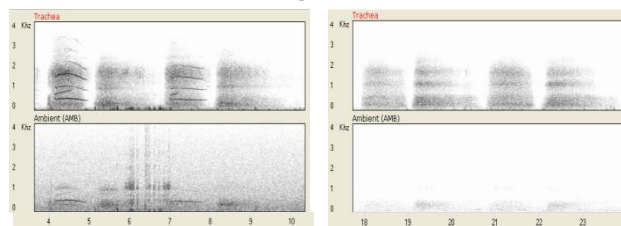
LUNG SOUND ANALYSIS IN CHILDHOOD ASTHMA

Chizu Habukawa, M.D.[1,2], Katsumi Murakami, M.D. [3], Yukio Nagasaka, M.D.[4]

[1]Department of Pediatrics, Minami Wakayama Medical Center,
[2]Department of Mechanical Science & Bioengineering, Graduate School of Engineering Science,
Osaka University,
[3]Department of Psychosomatic Medicine, Kinki University Sakai Hospital,
[4]Department of Pulmonary Medical Center, Otowa Hospital

Asthma is a disease characterized by chronic inflammation of the airway which leads to changes in airway structure and airflow limitation. Lung sound analysis is useful for objective evaluation of airways even in asymptomatic asthma. However, the relationship between lung sounds and morphological changes in the asthmatic airways has not been elucidated. Objectives of our study are to explore the relationship between chronic morphological changes in asthmatic airway and the lung sounds in an animal asthma model and to develop an automatic lung sound analyzer for monitoring the asthmatic children.

We examined the relationship between chronic morphological changes in the airways during the progression of asthma from the onset and the lung sounds in guinea pigs. The guinea pigs were sensitized and repeatedly challenged by inhaling albumin chicken egg. We measured lung sounds for 21 weeks. After the final antigen challenge, the lungs were excised for histological examination. There was significant difference of lung sound intensity between asthma model and control. The lung sound intensity correlated with peripheral airway wall thickness. The inspiratory sound intensity was shown to be an indicator of morphological changes in small airways in asthmatic animal model.

In clinical medicine, reliable assessment of lung function and effect of ICS treatment is essential in asthma management. We developed a new technology for analyzing breath sounds and assessed its clinical usefulness in asthmatic children. We automatically calculated the new index of intensity at 700 Hz (ic700) of inspiratory breath sounds. The ic700 was shown to be an indicator bronchial dysfunction and useful in predicting the asthma symptoms within 2 weeks in rather stable asthmatic children.

In summary, we showed that lung sound intensity reflected airway wall thickness in an animal model of chronic asthma. The ic700 was useful to assess the clinical stability of asthmatic children.

LUNG SOUND ANALYSIS IN ADULT ASTHMA

Yukio Nagasaka

Department of Pulmonary Medicine, Rakuwakai Otowa Hospital

Asthma is recognized as a bronchial inflammatory disease with varying degree of airways narrowing. To study lung sounds in bronchial asthma (BA) is to clarify the sounds created by bronchial inflammation and airway narrowing.

The broncho-provocation studies suggested that increase of pitch or intensity of lung sounds were early findings of airway narrowing. Wheezing may not be as sensitive as changes of basic lung sounds especially in case of acute airway narrowing of adult asthmatic subjects. (Nagasaka: Allergol Int. 2012)

An increase of frequency or intensity of breath sounds are good index of acute bronchospasm. When there is airway narrowing, the breath sounds become harsher and are expressed as bronchial breath sounds.

We reported that increased expiratory (E) / inspiratory (I) ratio of sound intensity suggests increased airway inflammation and mild airway narrowing in rather asymptomatic children and adults. (Shimoda: J Allergy Clin. Immunol. Pract. 2014, 2016) This finding suggests that when we hear expiratory breath sounds clearly in rather stable asthmatic patients, their asthma control may be suboptimal.
It is also true that for unexperienced physicians it is difficult to tell whether expiratory breaths sounds are loud or not. Automated analysis of lung sounds may overcome this difficulty in auscultation in the near future. (Habukawa: Allergol Int. 2015)

Wheezes are best known signs of asthmatic attack. Wheezes with a single peak or with its harmonics are called monophonic wheezes and wheezes with variable peaks other than harmonics are called polyphonic wheezes. We reported that the percentage of inflammatory cells in induced sputum correlated with the number of wheezing sound peaks and also with the percent length of wheezes to inspiratory time. (Yasuda: JRS 2005) These findings supported our empirical approach to patients with asthmatic fit, i.e., when we heard polyphonic wheezes, they should be treated by systemic steroids.

The rumbling rhonchi imply retained secretion in the airway which may be caused by airway inflammation. (35th ILSA 2010) We will report that in the relatively asymptomatic asthmatic patients, rumbling rhonchi are more common those who showed increase of fraction of exhaled nitric oxide (FENO). The grade of rumbling rhonchi did not correlate with the pulmonary functions but rumbling rhonchi were heard more often in asthma patients who had history of smoking in the past.

In summary, the relatively loud expiratory breath sounds are early sings of worsening of bronchial inflammation in asthma. Rhonchi suggest the presence of bronchial inflammation and should be carefully monitored for the better control of asthma. Wheezes are signs of prominent airways narrowing. To determine whether the wheezes are mono-phonic of poly-phonic is essential to decide the treatment of asthmatic attack. Those lung sounds are important in the management of asthma but may be difficult to use for unexperienced physicians. Automated analyzer of lung sounds is waited to manage asthma more efficiently and precisely.

METHOD FOR LIVE PRODUCTION OF SYNTHETIC LUNG SOUNDS IN AN ONLINE AUSCULTATION SIMULATOR

オンライン聴診シミュレータの合成肺音のライブの製造方法

T.B. Talbot, MD[1,2], K. Christoffersen[2]

[1]Keck School of Medicine of the University of Southern California,
[2]USC Institute for Creative Technologies, Los Angeles, California, United States.

We are researching the development of an advanced auscultation simulator [1] that will provide for a dynamic examination with varying acoustic output based upon listening location [2], respiratory effort & phase. The simulator will be delivered online through web browsers and support a novel pedagogical approach [3]. Most extant lung sound samples are recorded at a single location and are rife with noise contamination [4], making them unsuitable. Thus, we employ synthetic lung & breath sounds with a clean acoustic profile so that numerous sounds can be mixed without degradation.

Two categories of sounds are created: vesicular and adventitious. Vesicular sounds [5] include normal breath, diminished breath, tracheal, & bronchovesicular sounds plus variants. Inspiratory & Expiratory vesicular sounds are selected separately and are combined to produce the desired rate & I:E ratio (Figure 1). Vesicular sounds form the basis of the respiratory loop and represent the 'base note' of the exam.

Adventitious sounds include varieties of fine crackles, course crackles, wheezes, rhonchi, pleural rubs, and squalks [6,7]. One or more sounds are mixed over vesicular sounds. The adventitious sounds must be very clean as there will already be audible airflow. Sounds are intended to be clear and distinct for the benefit of the learner. At a point within the defined respiratory loop, adventitious sounds are placed at will by a case author (Figure 2). The author may set the effective spatial area of the sounds in order to provide for localized findings which are a common finding in the pulmonary exam [8]. With control over the respiratory loop, spatial & temporal presentation, and access to a variety of synthetic lung sounds, a wide variety of clinical presentations may be created.

The next problem involves the live coordination & mixing of sounds during the simulation. A challenge because our simulator runs on web browsers, we employ the new open-source Web Audio API [9] to handle sound processing. The API uses Audio Nodes that provide for Sound Sources, Gain Nodes, Filters, Processors and Mixers (Figure 3). A Biquad Filter has many modes including Low Pass which can simulate the 200Hz attenuation of healthy lung tissue and vary the effect by listening locale. Other filters provide for phase, frequency, wave-shaping and environmental acoustic effects. Listening locale presentation is customized by manipulating Gain Nodes.

This method allows for a clean auscultation exam with clear and easily identifiable sounds which should aid in the learning process. Single sounds can be isolated during the dynamic exam as a teaching tool. Conversely, more complex and challenging presentations can be created.

One drawback to this approach is the expense and effort of creating the synthetic sounds, though once made they can be reused a great deal. When completed, our synthetic sounds will be posted on an open-source exchange [10]. Eventually, it may be possible to use high-quality processed lung recordings with this method.

Condition	Inspiration (sec)	Pause (sec)	Expiration (sec)	Pause (sec)	Breaths / min	I:E Ratio
normal	1.5	0.15	2.5	0.85	12	1.67
asthma	1.5	0.15	5.0	0.85	8	3.3
tachypnea	0.5	0.10	1.4	0.20	30	2.8
atelectasis	2.5	0.15	5.0	0.85	7	2

Figure 1 – Six fixed length vesicular sounds (3 insp / 3 exp) allow a variety of respiratory rates and I:E ratios.
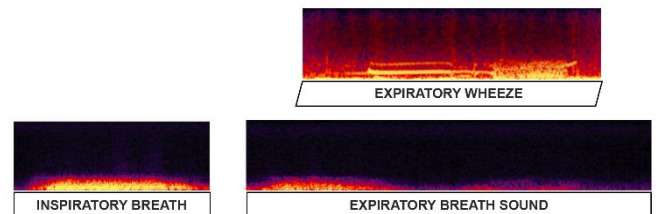

Figure 2 – Sound mixing employs vesicular sounds as a base which defines the respiratory loop. One or more synthetic adventitious sounds are then layered over. A synthetic wheeze would appear cleaner than this example.
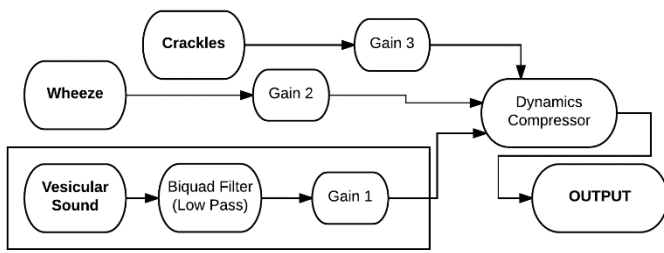
Figure 3 – Audio Nodes provide effects processing and gain control in real-time using the Web Audio API.

References

[1] Talbot TB. "USC Standard Patient" accessed at www.standardpatient.org on 15 August 2016.

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[10] Talbot TB, Christoffersen K. Medical Media Exchange accessed at https://medicalmediaexchange.org on 15 August 2016.

PLAY BACK OF RESPIRATORY SOUNDS RECORDED WITH BLUETOOTH®-BASED WIRELESS MICROPHONE

Makoto Yonemaru, MD, PhD [1], Kazuma Soeta [2], Takafumi Kizuki [3]

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Research Institute, Tokyo, Japan,
[2]Koriyama R&D center, Ado Corp., Fukushima, Japan,
[3]Technology Strategy Department, JVCKenwood, Yokohama, Japan

Introduction: Since Japanese population is getting older quite rapidly, home-health care is urged to play an important role for a management modality of senile patients with frailty. Thus, it will be of significant clinical utility to record and transmit respiratory sounds from patient's home to a remotely located medical facility and access the patient's condition by respiratory specialists. Bluetooth-based microphone could be used as a sound sensor and fulfill such needs in home-health care management.

Purpose: To evaluate the auditory sensation of the respiratory sounds recorded with Bresco®, a Bluetooth-based wireless microphone designed for auscultation.

Methods: We compared the reference respiratory sounds widely accepted in Japan and the recorded those sounds with Bresco® to an iPod touch with a customized application. We played back and listened to those sounds to judge by ear whether or not the recorded sounds retain characteristic auditory sensation.

Results: The respiratory sounds are play-backed for presenting the results at the conference. By listening to the play-backed sounds, Bresco® recorded-sounds were judged to retain the sufficient sound quality for clinical assessment.

Conclusion: Along with mobile recording devices which can be connected to internet, Bluetooth-based wireless microphone may be useful for assessing respiratory status in the home-health care front line.

RESPIRATORY SOUND RECORDING USING A SMARTPHONE BUILT-IN MICROPHONE

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Introduction

Recently, smartphones have been used as tools for home healthcare. We already proposed a lung sound analyzer using a smartphone connected to an external microphone (free application software: SmartLSA is provided at http: //www.interq.or.jp/kyuushu/sas/tsa/smartLSA.htm; only for android system). In this presentation, we tried to use the built-in microphone of a smartphone as a respiratory sound sensor.

Method

Subjects: A normal subject, outpatients (bronchial asthma, COPD, etc).

Smartphone: Two smartphones (Galaxy S II, Samsung Electronics Co., Ltd; AQUOS CRYSTAL, Sharp Corporation) were used. The smartphones were covered by a silicon or plastic case, which has a hole for the opening of the built-in microphone.

Recording: The smartphones were placed on the neck over the trachea or the chest wall and pressed against the surface tightly. Respiratory sounds were captured using the SmartLSA software. Simultaneous respiratory sound recording using an air-coupled ECM and an IC-recorder (ordinary system) was performed in the normal subject.

Result

1. Comparison of acoustic characteristics between the smartphones and ordinary system

Smartphones have wider frequency characteristics, extending to at least 5kHz, compared to the ordinary system. The figure shows sound spectrogram of tracheal breath sound in a normal subject.

The frequency characteristics were also different between both smartphones especially in incorporated high-pass filter.
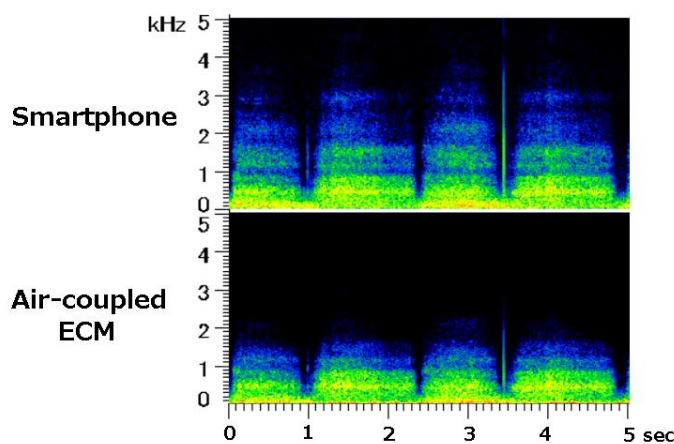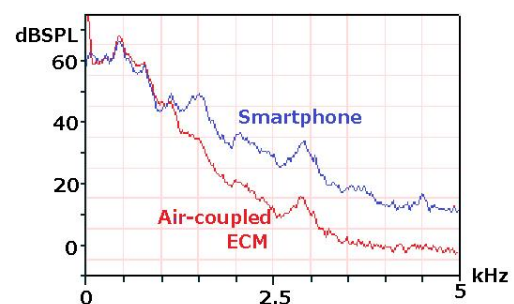
2. Respiratory sound recording in patients

The most impressive difference from recording by the ordinary system was detectability of very high pitched wheezes. Wheezes with a fundamental frequency of >3kHz were detected.

Conclusion

Respiratory sound recording using smartphones via the built-in microphone is very easy. They have excellent high frequency characteristics. However, difference of frequency characteristics among smartphones should be kept in mind for the interpretation of the data.

ELASTISITY AND VISCOSITRY OF HUMAN CHEST WALL SURFACE TISSUES AND THEIR EFFECT ON REGISTRATION OF LUNG SOUNDS

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Introduction: Registration of lung sounds on the surface of the human chest wall is usually provided by one of the following sensors: 1) electret microphones with coupling chambers, 2) accelerometers, 3) heavy sensors with a longitudinally deformed piezotransducer between the surface of the body and the sensor housing. Sensors are fixed in some way at the chest wall surface and in this way undergo some mechanical interaction with chest wall surface tissues. Mechanical/acoustical behavior of sensors and registered acoustical signals could depend upon elasticity and viscosity of chest wall surface tissues.

The objectives of this study were: 1) to measure elastisity and viscositry of human chest wall surface tissues; 2) estimate effect of on registration of lung sounds on the surface of the chest wall.

Materials and methods: 1) A group of 12 normal male volunteers aged 20-21 years participated in the study. In each volunteer tissue elasticity and viscosity were measured at six different points located on the right side surface of the chest wall. 2) A laboratory viscoelastometer (model VEM-5) with harmonically vibrating indenter (diameter 8 mm) with frequency 40 Hz and amplitude 0,1 mm provided measurements of vibration pressure of indenter on chest wall tissues and acceleration of indenter. Effective shear elastic modulus and viscosity of the surface chest wall tissues were determined suggesting Voight rheological model of tissues. Effective modulus and viscosity means elastisity and viscosity determined considering contact of the indenter with semi-infinite half-space of tissue. In fact these parameters define effect of tissues on any objects fixed at the tissue surface.

Results: 1) Fig. depicts effective shear modulus E and shear viscosity V in the group of 12 subjects. Each experimental point represents results of one test of E, V measurement. One may see that there are significant differences of viscoelasticity among subjects and chest wall locations. Mean shear elastic modulus and shear viscosity (mean ± SD) in the group of 12 normal volunteers, 6 locations on the right chest wall surface of each volunteer, were 4.3±2.2 kPa, 9.7±4.5 Pa*s respectively.
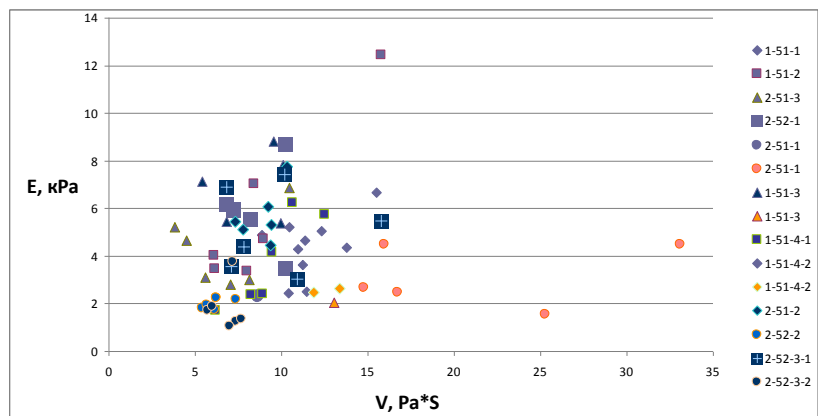
2) With a simple lumped-parameter model we estimated effect of suspension resonance determined by the mass of a sensor and viscoelasticity of biological tissues on amplitude-frequency (AFC) and phase-frequency characteristics (PFC) of transducers. Numerical simulation of effect in the frequency range 0-1000 Hz for observed tissues and a light accelerometer with mass 5.5 g and diameter 2.5 cm revealed two types of PFC. In the 1-st type of PFC there is a surge in the frequency range 75-296 Hz. The relevant experimental values of E, V are depicted by blue and gray on the fig. In the 2-nd type of PFC there is no any surge. The relevant experimental values of E, V are depicted by orange on the fig. Other kinds of transducers would have another PFC with or without surge depending on the mass of sensor, viscoelasticity of tissue and frequency band under study.

Discussion: The values of E, V are useful for estimation of frequency bands in which different acoustical sensors mounted on the surface of the chest wall would provide reliable AFC and PFC. The numerical estimation conforms results of Korenbaum et al., 2013, that light sensors could have uneven AFC and PFC in the frequency range of lung sounds and supports use of heavy sensors.

Conclusions: 1) There are significant differences of elasticity and viscosity of chest wall surface tissues among subjects and chest wall locations. 2) Amplitude-frequency and phase-frequency characteristics of light accelerometer depend significantly quantitatively and qualitatively upon viscoelasticity.

FIRST EXPERIENCE OF ELECTRONIC INTRAPULMONARY AUSCULTATION IN PATIENTS WITH COPD AND BRONCHIAL ASTHMA

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The pathophysiological mechanisms of generation of wheezing in patients with asthma are complex and not fully established. At the present time to the drive mechanisms include flutter - vibration airway walls during the passage of air through narrowed bronchi. However, almost no discussion affects whether and, if affected, then as bronchial walls vibration on the inflammation in the airways.

In connection with the data of some foreign studies (Puig F. et al, 2005 and Cho Jin-G et al, 2011), you can make the assumption that flutter in patients with asthma and can lead to the same pathologic changes: inflammation and changes in the microvasculature lower respiratory tract infections, angiogenesis, metabolic disturbances and transport.

Objective: creation and implementation of a method of studying pulmonary lung sounds, based on the simultaneous internal visual inspection and auscultation of the respiratory tract, with the possibility of registration of gas exchange parameters to improve the quality of diagnosis and treatment of respiratory diseases.

Materials and methods. During the traditional bronchoscopy (Karl Storz Tele Pack X) is performed simultaneously with video bronchoscope intrapulmonary registration acoustic phenomena specifically designed to work with the bronchoscope microphone that is attached to the instrument channel of a bronchoscope and at different levels of the tracheobronchial tree, down to bronchi 3-4 orders of magnitude, allowing conduct remote analysis of acoustic phenomena on the computer. Video shooting in various modes will clarify the presence of airway flutter. At the same time, it produced a record lung sounds auscultation electronic method using an electronic stethoscope (3M Littmann Electronic Stethoscope 3200) for further analysis and data comparison.

By recording in 10 patients with asthma and COPD. The diagnosis was established in accordance with the GINA (2014) and GOLD (2014). The findings demonstrate the advantage of intrapulmonary auscultation before electronic - higher frequency response, a lower level of external acoustic noise, an increase in the amplitude of the sound waves as you get closer to the site of occurrence of wheezing. Further analysis of sounds.

Thus, we can conclude that this study will help to solve several tasks: to expand knowledge about the acoustic biomechanical phenomenon wheezing in patients with asthma and other respiratory diseases, as well as to explore possible features flutter airways in patients with asthma and its role in occurrence of wheezing and inflammatory reactions in bronchial tubes.

ACOUSTIC ESOPHAGEAL CARDIOPULMONARY MONITORING DURING GENERAL ANESTHESIA

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Electronic esophageal auscultation provides noninvasive acoustic access to both the heart and the lungs and could hence prove useful in the assessment of circulatory and respiratory function. We evaluated the cardiac and pulmonary acoustic signals obtainable using a standard esophageal stethoscope in 16 stable, healthy, anesthetized, mechanically ventilated adults.

Methods: A standard esophageal stethoscope was positioned at the lower third of the esophagus and connected to an electret condenser microphone. The microphone output was picked up with a digital voice recorder. The recording was continued throughout the surgical procedure (44100 Hz, 16 bits) and analyzed off-line.

Results: Analyzable recordings could be obtained in all 16 patients allowing examination of both lung and heart sounds and their interaction. Respiratory modulation of S1 amplitude was observed consistently as a decrease in late inspiration followed by recovery during the expiratory phase. Similar modulation of S2 was observed to a lesser degree.

The detection of S1 and S2 allowed the respiration-associated variation in heart rate to be broken down to its systolic and diastolic components. This revealed that the generally low heart rate variability was in several patients the result of 180 degree out of phase changes in systolic and diastolic durations. Non-respiratory related heart rate changes always resulted from alterations in diastolic duration. In two patients, we observed a clustering of heartbeats indicating synchronization of cardiac and respiratory activity.

The lung sound frequency spectrum had the characteristics of a transition between tracheal and peripheral respiratory sounds. No crackles were heard in any patient at any phase of the recording.

Discussion: The respiration-induced amplitude modulation of S1 confirms earlier results in animals and humans. It is multifactorial correlating best with changes in left ventricular contractility. Whether it can be used as a proxy of blood and pulse pressure changes to indicate volume status requires further study in changing hemodynamic conditions.

The opposite respiratory variation in systolic and diastolic durations reveals a new layer of complicity in interpreting heart rate variability and may favor phonocardiography over electrocardiography in the evaluation of it. The synchronization of heartbeat to respiratory phase has been observed previously in young athletes but its significance in them and in our subjects is unclear.

Prior research shows that atelectasis of dependent lung is practically unavoidable under the conditions of our study. The absence of crackles in our recordings likely means that positive pressure ventilation does not open atelectatic areas during inspiration. Alternatively, esophageal recordings may be insensitive to detecting crackles in the lung periphery.

Conclusion: Our results indicate that cardiopulmonary monitoring of heart and lung sounds can easily and accurately be conducted using a standard esophageal stethoscope. Such recordings open new avenues for the study of cardiopulmonary physiology.

OUT-OF-HOSPITAL ACOUSTIC CARDIO-PULMONARY MONITORING – PROJECT DESCRIPTION AND PRELIMINARY DATA

Noam Gavriely[1], Larry Murdock[1], Jukka Rasanen[2]

[1]AST, CA, [2]Moffitt Center, FL

Timely detection of health-status changes in CHF, COPD, asthma, CF and other chronic cardio-pulmonary conditions is the focus of this project. We are developing an acoustic technological platform to do so. Using our sensitive coin-size vibro-acoustic sensors it is possible to pick up, record, and analyze the sounds of the heart and the lungs in high fidelity. Using the signals it is feasible to obtain the heart rate and regularity, heart rate variability, cardiac contractility index, systolic/diastolic duration ratio, respiratory rate and regularity including apnea detection and identification of Cheyne-Stocks breathing, respiratory crackle count and timing, airway obstruction index, cough and snore counts. The scope of this research and development project is to optimize, test, regulate and standardize this technology. In the first phase of this project we intend to accomplish the following Specific Aims:

1. Optimize and test the sensors and recording system.
2. Optimize and validate the analysis algorithms platform
3. Obtain regulatory (FDA) clearance (510k – using electronic recording stethoscope as predicate device)
4. Record and off-line analyze heart and lung signals recorded overnight from 30 patients with each of CHF, COPD, asthma and CF (total of at least 120 patients). Use the data to demonstrate the technological and clinical feasibility of acoustic cardio-pulmonary monitoring.

In this presentation we shall show data from one case: a 3 year old child with chronic tracheostomy who is a candidate of weaning and cannula removal. The technical quality of this >10 hour recording conducted at the patient's home under parents supervision was good and allowed detailed analysis of the data. Relative to hospital or sleep lab settings the ambient noise level was low and the inherent noise rejection by the sensors was sufficient. The resting breathing was regular with rate within the normal range for her age. There were no signs of airway obstruction. A couple of episodes of inspiratory crackles are compatible with reversible atelectasis of a lung segment. The apnea/hypopnea index was low and the present apneas were short. The prevalence of secretion sounds was high and the patient lacked the ability to clear the secretions effectively due to the presence of the tracheal tube. Her cough reflex seemed to be intact. The interactions between the tracheal tube and the tracheal wall were noisy at times (flutter). Throughout the recording there were no signs of respiratory distress or cardiac issues.

Top: Segment showing breathing activity, heart sounds and a brief 7 sec hypopnea period.
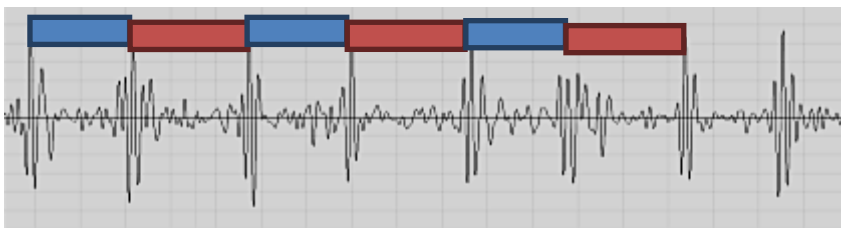
Bottom: Segment showing S1 and S2 heart sounds and systolic (blue) and diastolic (red) time intervals.

CARDIAC RESPONSE TO RESPIRATION IN DEEP BREATHING BY CHEST VS. ABDOMEN

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Dept. of Medicine, Tufts University School of Medicine, Boston, Ma. U.S.A.

It has been said that the Heart rate becomes slower on Inspiration, when one takes deeper Breath, as more negative pressure within the Chest is generated which leads to more blood returning to the Left ventricle, hence a delay of heart beat on inspiration.

We intended to see whether deep breathing by Chest or Abdomen may make difference in reduction of Heart rate on Inspiration vs Expiration. (I am able to breathe deeper by Abdominal -Diaphragamic breathing comparing to conventional Chest deep breathing)

We used 2 channel   ECG/ Lung sounds, to simultaneously record ECG and Tracheal sounds.

20 randomly selected Nonsmoking subjects were studied, at sitting position.

2 QRS intervals became 45 msec on Inspiration to Expiration 30 msec.on averageof all subjects.

However because of unfamiliarity of Abdominal-Diaphragmatic breathing, most subjects   failed to take deeper breath by Abdomen, using Diaphragm hence we failed to see advantage of Diaphragmatic breathing.   I strogly believe that I can show that by Abdominal-Diaphragmatic breathing, I can achieve much slower heart rate, therefore, I will continue this project by training subject to become familiar with Abdominal-diaphragmatic breathing like Opera Singers.

RUMBLING RHONCHI AND BRONCHIAL INFLAMMATION IN PATIENTS WITH BRONCHIAL ASTHMA

Yukio Nagasaka, Michiko Tsuchiya, Youske Nakanishi, Chikara Sakaguchi, Hitomi Ajimizu, Seiya Nishiyama, Yasuyuki Hayashi, Noboru Morikawa

Department of Pulmonary Medicine, Rakuwakai Otowa Hospital

Introduction:

The rumbling rhonchi have non-sinusoidal wave in their time-expanded wave form and imply retained secretion in bronchi, thus supposed to reflect an aspect of airway inflammation. (35th ILSA2010, Allergol Int. 2012; 61:353) As there have been no previous studies on the clinical implication of presence of rumbling rhonchi in patients with bronchial asthma, we examined pulmonary function and FENO (fraction of expired nitric oxide) as parameters of airway inflammation in rather stable asthmatic patients, with or without rumbling rhonchi.

Methods:

We studied eighty cases of non-smoking adult asthmatics (Age: 62.9 ± 15.62, M/F: 36/31) when they had no acute symptoms. All of the ex-smokers involved in this study quitted smoking for more than three years. After careful auscultation of the lung, the patients were examined pulmonary function and FENO (fraction of expired nitric oxide). The loudness of the rumbling rhonchi was classified into three grades, Grade 0 (no rumbling rhonchi), Grade 1 (present, but faintly audible) and Grade 2 (present and loudly audible). These grades were determined by the loudness of the rumbling rhonchi irrespective of their extent.

Results:

There were 18 patients (three ex-smokers and 15 never smokers) in Grade 0, 37 patients (11 ex-smokers and 26 never smokers) in Grade 1 and 25 patients (11 ex-smokers and 14 never smokers) in Grade 2. Inspiratory or expiratory short wheezes were heard in seven patients in Grade 0, three patients in Grade 1 and two patients in Grade 2. These wheezes were heard in small area, less than one quarter of anterior or posterior chest.

FENO was significantly higher in Grade 2 than in Grade 0 ($p<0.05$) and Grade 1 ($p<0.05$). There was no significant difference of FENO between Grade 0 and Grade 1 ($p=0.23$). There was no significant difference of pulmonary function among Grade 0, Grade 1 and Grade 2. (Table)

Conclusions:

Rumbling rhonchi reflected airway inflammation as shown in increase of FENO. However, the grade of rumbling rhonchi did not correlate with the pulmonary functions or presence of short wheezes.

Rumbling rhonchi were heard more often in patients who had history of smoking in the past. Thus, the presence of rumbling rhonchi was assumed to reflect eosinophilic airway inflammation and also chronic airway inflammation caused by smoking of more than years ago.

Table

Rumbling rhonchi	FENO (ppb)	FEV1/FVC (%)	FEF75*/predFEF75 (%)
Grade 0　　(n=18)	23.6 ± 12.78	69.8 ± 12.50	53.9 ± 28.52
Grade 1　　(n=37)	32.2 ± 19.20	78.1 ± 12.27	81.6 ± 47.43
Grade 2　　(n=25)	63.3 ± 93.09	72.4 ± 24.29	62.0 ± 36.64

*FEF75: expiratory flow rate at 75% of FVC (forced vital capacity).

THE EFFECT OF BODY POSITION ON THE LUNG SOUNDS INTENSITY IN PATIENTS WITH INTERSTITIAL PNEUMONIA

Michiko Tsuchiya, Yukio Nagasaka, Chikara Sakaguchi, Hitomi Ajimizu, Yosuke Nakanishi, Seiya Nishiyama, Yasuyuki Hayashi, Noboru Morikawa

Department of Pulmonary Medicine, Rakuwakai Otowa Hospital

Background: Lung sounds of patients with stable interstitial pneumonia (IP) are usually examined in the sitting position, whereas in critically ill conditions, patients often lie or be placed in the right or left decubitus positions and auscultations tend to be done in these positions. Murphy and colleagues reported that crackles were markedly increased in the dependent lung by time-expanded wave form analysis.   The objective of our study is to compare the lung sound intensity in various body positions in patients with IP.

Methods: Eight patients with IP who had crackles were studied while they were in stable condition. Lung sounds were recorded in sitting, supine, prone, and lateral decubitus positions. Two acoustic sensors were placed on the right and left back. Lung sounds were recorded for ten seconds and analyzed by sound spectrometer, LSA2012 (Kenz-Medico). We divided sound frequency ranges into three parts, low (L: 200-390Hz), middle (M: 400-790Hz), and high (H: 800-1600Hz), and evaluated the averaged sound power (ASP) of each frequency ranges.

Results: ASP was significantly greater in supine position than in prone position in all frequency ranges in the right lung.   As for the left lung, only ASP in H range was significantly greater in supine position than in prone position.   There was no significant difference in ASP between supine and sitting position in the both side of the lungs except for that in M range of the right lung. In the lateral decubitus positions, ASP of the dependent side was significantly greater than that of the nondependent side in all frequency ranges.

Conclusions: Lung sounds of IP was influenced by body positions although the difference between sitting and supine position was not significant. The changes of lung sound intensity by body positions were not symmetrical.

Sound spectrogram of lung sounds from a patient with IP.
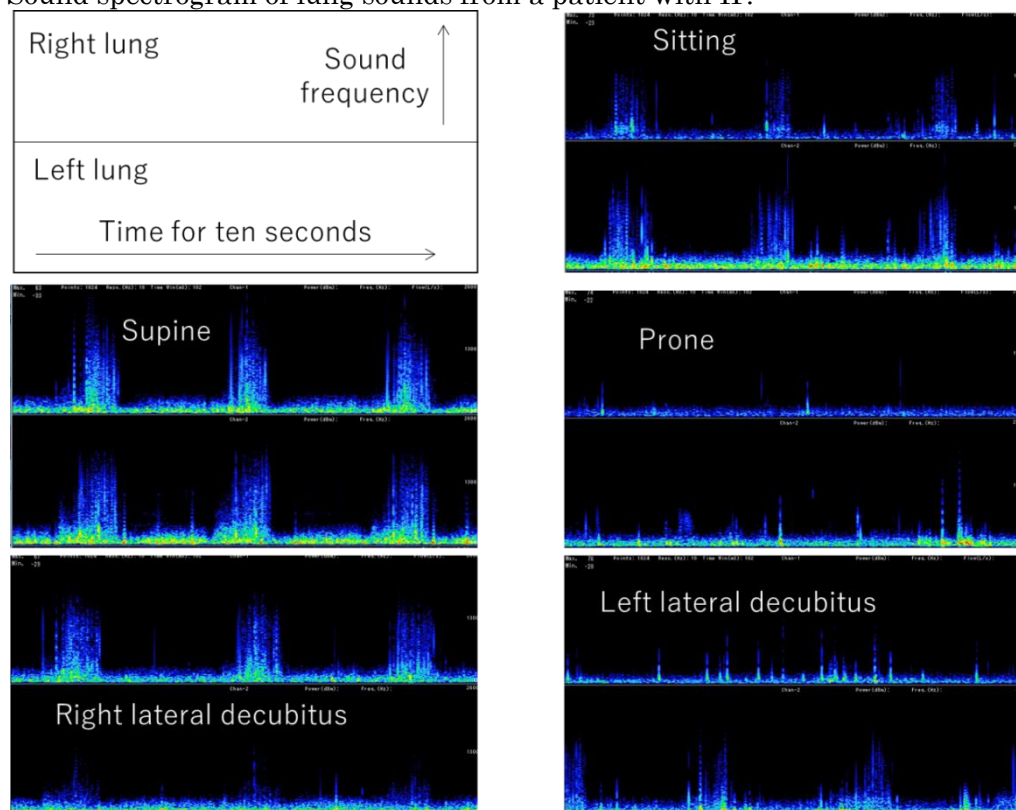
APPLICATION OF THE FORCED EXPIRATORY TRACHEAL NOISE TIME TO MONITOR LUNG FUNCTION IN SPECIAL PHYSIOLOGY

V. Malaeva, V. Korenbaum, I. Pochekutova, V. Katuntsev, V. Baranov, A. Kostiv, S. Shin

Pacific Oceanologic Institute of Russian Academy of Sciences, Vladivostok,
Research Institute for Space Medicine, FBMA of Federal Research Clinical Center, Moscow

Background Monitoring the status of human respiratory system exposed to extreme conditions is relevant to many areas of special physiology including spaceflights and diving. The acoustic forced expiratory time (FETa) estimation was shown to be promising for this aim (Pochekutova and Korenbaum, 2011; Dyachenko et al., 2014).

Objective Detailing possibilities of FETa to monitor lung function under extreme conditions.

Methods The basic method was evaluation of dynamics of tracheal FETa, recorded in frequency band of 200-2000 Hz before, during and after load tests in comparison with spiromery data. Experiments were carried out with 11 volunteers subjected by 21-day simulated load of microgravity (head-down −6° position) and lunar gravity (head-up +9.6° position), and with 6 diver, performed real wet dives, using closed type breathing apparatus.

Results An essential FETa increase was found among the group after microgravity load in comparison with background status (Mann-Whiney test). A half of the group fixed in microgravity position demonstrated further sufficient increase of FETa during load continuation. The predominant individual reply under changing microgravity to lunar gravity positions in the second half of the group was FETa decrease. By means of 2-way ANOVA statistically significant excess of FETa in microgravity group was revealed relatively to lunar gravity group. Spirometry data did not demonstrate distinctions between these groups. After finishing the load FETa values in both groups returned to background level. According to acoustic & physiologic considertions an elongation of FETa under simulated microgravity may be connected to additional increase of aerodynamic resistance of airways in relation to pure postural (lunar gravity) status.

For group of 6 divers, performed wet submersions in modern closed type breathing apparatus Amphora (AquaLung) statistically significant increase of FETa was found in relation to background status by means of Kolmogorov-Smirnov test. This response may be treated as an adverse influence of even a short hyperbaric hyperoxia on bronchial resistance. This effect is consistent with those obtained for closed cycle breathing apparatus of the previous generation (Pochekutova, Korenbaum, 2011). Evaluation of the individual response of the acoustic parameter FETa to dive in comparison with natural intraindividual variability (Korenbaum et al., 2009) allowed to monitor individual features of divers lung function undetectable by spirometry.

Conclusions It was demonstrated that an evaluation of the forced expiratory tracheal noise time in the frequency band of 200-2000 Hz may be used as a simple, affordable and highly sensitive tool to assess the impact of extreme factors such as spaceflights and diving on human respiratory system.

LUNG SOUND TERMINOLOGY IN WESTERN LANGUAGES

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Background: Twenty years ago, the European Community financed a BIOMED 1 Concerted Action project entitled Computerized Respiratory Sound Analysis (Sovijärvi A et al., Eur Resp Rev 2000). With regard to terminology, this CORSA Task Force focused on sound recording and digital signal analysis. In 2011, the European Respiratory Society (ERS) established a Task Force on lung sounds with the objective to build a reference database of audio-visually recorded respiratory sounds to standardize nomenclature in clinical practice. The collection of information on current lung sound nomenclature in the countries of Europe became an additional objective.

Method: A questionnaire was prepared for online distribution and collection of responses (FluidSurveys, Ottawa, Canada). The English nomenclature in the questionnaire was based on a recent review (Bohadana A et al., NEJM 2014) and included the terms *normal lung sound, bronchial breathing, stridor, wheeze, rhonchus, fine crackle, coarse crackle, pleural friction rub* and *squawk*. Collaborators in the survey of lung sound nomenclature in European countries had either volunteered at ERS Assembly meetings to participate in this project or were identified from the ERS directory as national representatives. In the recruitment of collaborators, we took into account publications or otherwise documented interest in this area. We aimed to achieve national representation in both pediatric and adult respiratory medicine. The goal was to obtain two replies from each country on this first attempt in gathering the information.

Results: The questionnaire on lung sound nomenclature in European countries was sent with three iterations to improve the response rate. A total of 66 completed surveys (64 from countries other than the United Kingdom) were received from 99 invitees. These represented 33 countries and 29 languages. The term "normal lung sounds" was used in 24/29 languages while the term "vesicular sounds" was used in 19/29. "Murmur" was mentioned in 6/29 languages to describe normal (basic) sounds. "Crepitations" to describe crackles was reported in 16/29 languages. "Rhonchus" was used in the same or very similar form in 15/29 languages while 4/19 used "rales" or "crackles" in 2/29. One report from France mentioned the interchangeable use of "rale" and "rhonchus". Only 15/29 responses mentioned a term corresponding to "squawk".

Recommendations: 1) The term "*vesicular lung sounds*" should be replaced by "*normal*" or "*basic*" lung sounds. 2) The interchangeable use of "*fine crackles*" and "*crepitations*" may be considered, but "*coarse crackles*" should be kept, considering that there are different mechanisms of sound origin. 3) Since a low pitched wheeze may signify different pathology than a snore-like sound, "*rhonchus*" should probably be placed in its own category, i.e. somewhere between a musical and non-musical sound. 4) Recognizing that short inspiratory wheezes may signify pathology different from the longer, predominantly expiratory wheezes in asthma may justify the use of a separate term, e.g. "*squawk*". However, the lack of a corresponding term in most of the European languages highlights a need for further education in this regard.

CRACKLES OR WHEEZES ARE HEARD IN NEARLY 1/3 OF ADULTS AGED 40 YEAR OR MORE
PRELIMINARY RESULTS FROM AN ONGOING EPIDEMIOLOGICAL STUDY ON LUNG SOUNDS

Hasse Melbye, Juan Carlos Aviles Solis

General Practice Research Unit, UIT the Arctic University of Tromsø

Background   More evidence is needed regarding the usefulness of pulmonary auscultation for the diagnosis of heart and lung diseases.   We are collecting lung sound recordings in participants of the Tromsø survey, and many of these also undergo spirometry and echocardiography. This will give a good opportunity for studying how the presence of crackles and wheezes is associated with airflow limitation and heart failure.

Methods   The main study will include approximately 2000 participants of the 7th Tromsø study aged 40 years or more, who also take part in spirometry and echocardiography. In addition we will have lung sound recordings from approximately 3000 participants examined with spirometry but not with echocardiography.   A wireless Sennheiser microphone (Sennheiser MKE 2-EW with Sennheiser wireless system EW 112-P G3-G) placed in the tube of a Littmann Classic stethoscope will be used in the recordings. The primary classification of the sounds will be done by two independent observers, and disagreements solved through discussions with a third expert observer. Variables that may explain the presence of abnormal lung sounds and the predictive value of lung sounds for reduced lung function and heart failure will be evaluated by univariable and multivariable methods. Advanced analyses will include subcategories of wheezes and crackles and characteristics of lung sounds as determined by computerized analysis.

Preliminary results   By June 2016, approximately 1500 have been included in the main study and we have lung sound recordings from altogether 4800 participants. 8706 recordings from 1451 participants have been subject to a primary classification. Wheezes is heard in 450 of the recordings (5.2%) and in 295 of the participants (20.3%). Crackles is heard in 376 recording (4.3%) and in 247 participants (17.0%). In 476 participants (32.8%) either wheezes or crackles is heard, whereas both wheezes and crackles are heard in 66 (4.5%). Many wheezes are of very short duration and several of the crackles are single standing inspiratory "pops".

Conclusion so far   Wheezes and crackles are frequently heard, but in most participants these sounds are only found in one out of the six recordings. Many of the wheezes and crackles may be of minor clinical importance, and sub-classifying into clinically relevant categories may be important for the diagnostic study.
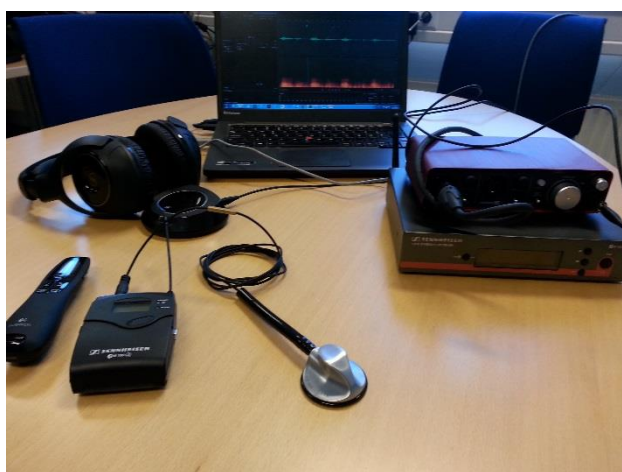
Equipment used in the recording of lung sounds in the Tromsø study

THE ASSESSMENT OF ASTHMA WITH A NOVEL 24-HOUR COUGH FREQUENCY MONITOR

Junpei Saito[1], Atsuro Fukuhara[1], Surinder S Birring[2], Suguru Sato[1], Manabu Uematsu[1], Yasuhito Suzuki[1], Togawa Ryuichi[1], Yuki Sato[1], Kenichi Misa[1], Takefumi Nikaido[1], Xintao Wang[1], Yoshinori Tanino[1], Mitsuru Munakata[1]

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[2]Division of Asthma, Allergy and Lung Biology, King's College London

Background:
Cough is a major symptom of asthma. Cough frequency monitoring devices are now available to objectively measure cough and they have the potential to assess the severity of asthma and monitor the response to treatment.

Objective:
Firstly, we examined whether there is a difference in cough frequency pattern between asthmatic and non-asthmatic cough. Secondary, cough frequency monitoring could be applicable for assess the response to asthma therapy.

Methods:
Fifty five asthmatic subjects and 72 non-asthmatic subjects who were suffering from cough were enrolled in the study. They wore the automated Leicester cough monitor (LCM), which is a validated cough monitoring tool, for 24 hours before treatment. At the same time Visual Analog Scale (VAS) and Leicester cough questionnaire (LCQ) were completed. 23 asthmatic subjects, also completed LCM and questionnaires after asthma treatment.

Results:
Cough frequency while sleeping was significantly higher in asthmatic subjects than in non-asthmatic subjects (14 vs 4c/hr; $p=0.009$). Cough frequency significantly correlated with VAS (cough severity, frequency) and LCQ scores ($r=0.51$, 0.46, -0.59, respectively; $p<0.001$). In 23 asthmatic subjects, cough frequency significantly decreased after treatment (574 vs 102, $p<0.001$) and its change was significantly correlated with ΔVAS and ΔLCQ.

Conclusions:
LCM appears useful to objectively assess cough in asthma management. Furthermore, a raised cough frequency during sleep may raise the possibility of allergy induced cough.

CLINICAL UTILITY OF NEW DIAGNOSTIC TOOL FOR ANALYZING LUNG SOUNDS

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Recently, a new diagnostic method for lung sounds has been developed by JVC kenwood company. Lung sounds were recorded during quiet breathing using a teaching stethoscope (Littmann® Classic II S.E. 2138; 3M, Maplewood, MN, USA) with a microphone placed inside one of the hollow tubes. The microphone was connected to an iPod touch (Apple Inc., CA, USA) that has a newly developed application for automatic detection together with analyzing abnormal lung sounds. This automatic analysis clearly divided the lung adventitious sounds into continuous (wheezes/rhonchi) or discontinuous sounds (crackles) in a visible manner. Regarding with the continuous sounds, those were easily classified into low (<400Hz) or high pitch (>400Hz) sounds in an exact way. Herein, we present some characteristic lung sounds in adult patients with respiratory diseases which can illuminate the clinical utility of this novel application.

CONSISTENCY OF INTERPRETATION OF LUNG SOUNDS BETWEEN EXPERIENCED PHYSICIANS AND AUTOMATIC ANALYSIS

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Background: Listening and interpreting lung sounds by a stethoscope has been an important component of screening and diagnosing lung diseases. However, this practice is vulnerable to inter-observer variations and difficulty in comparison with previous findings. In this study, we aimed to examine the consistency of interpretation of lung sounds between experienced physicians and automatic analysis using a newly developed algorithm based on the acoustic characteristics.

Methods: In 39 patients with various respiratory diseases, lung sounds were recorded with a stethoscope microphone on the chest. We compared 1) evaluation of live lung sounds by the attending physician, 2) evaluation of recorded lung sounds by the attending physician, 3) evaluation of recorded lung sounds by other physicians who were blinded to the underlying diseases, and 4) results of automatic analysis using a newly developed algorithm based on the acoustic characteristics.

Results: Among the lung sounds recorded, fine crackles were identified in 18 patients, coarse crackles in 5, and wheezes in 4. In 36 (92%) patients, the interpretation of live lung sounds by the attending physician was consistent with that of recorded lung sounds by the same physician. In 23 (59%) patients, the interpretation of recorded lung sounds by the attending physician agreed with that by other physicians. In 63% of the lung sounds with any inconsistency of interpretation, the consensus interpretation was same as the original interpretation by the attending physician. Automatic analysis and physicians' diagnosis agreed in 62% of the study subjects.

Conclusions: Repeated hearing of recorded lung sounds may exceed live auscultation in a clinic. Recording and analyzing lung sounds may contribute to further improvement of auscultation.

AERODYNAMIC SOUND GENERATION STUDY USING PATIENT-BASED TRACHEOBRONCHIAL MODEL

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Introduction: One of the efforts to improve the accuracy and objectivity of the respiratory diseases detection by lung sound analysis is by improving our knowledge of the sound generation mechanisms. Here, experimental and computational aerodynamic sound generation studies were performed to reveal the factors affecting the sound generation in a tracheobronchial model. ***Method:*** In the experiment, a silicone airway model based on CT-image of an 11 years old boy was constructed. The model is a silicone block with tracheobronchial cavity reconstructed from the CT-image with 39 bronchi ends. Acoustic pressure of 680 points was measured when air flowing through the airway cavity at inspiratory and expiratory direction at constant flow rate of 30 L/min. The pressure sound density of each point was mapped to the corresponding location. This enables us to locate the original aerodynamic sound sources as fluid moves through the tracheobronchial without considering the complexity of the tissues and bones in the chest anatomy. To observe the flow condition by relying on the sound generation in the silicone airway model, computational fluid simulations were performed for the same geometry and the same flow rate used in the measurement. The fluid flow simulation was performed using OpenFOAM 2.3.0. The sound source terms were calculated according to the source terms of the Lighthill's acoustic analogy. The location of sound sources and the frequency dependency of the sound sources were observed and compared to the results of the experiments. ***Results:*** The experimental results show different characteristics of the inspiration and expiration sound in the aspect of the frequency contents and location of detection. In inspiration case, the sound spectra was found at the range of 1000-2000 Hz, while in expiration, a wide band sound frequency ranging from 1000 Hz to 4000 Hz can be detected. At frequencies between 900 and 1500 Hz, the trachea region shows higher sound level compared to the small airways and can be observed at both inspiration and expiration. However, at frequencies higher than 2000 Hz small airways are generating higher sound level compared to trachea and main bronchus region and can be observed only at expiration. From the fluid simulations, some locations with high velocity fluctuation were observed which may be related to the locations observed in the experiments. The frequency distribution of the expiration are similar to the one observed on the experiment though some differences were observed for inspiration case. ***Discussion:*** The distribution of the sound frequency is indicating that the generated sound depends on the geometry and the dimension of the airways. Low frequency sounds correspond to the large diameter airways, while high frequency sounds correspond to small diameter airways. Comparing the results of the sound source distributions between simulations and experimental measurements, we observed a similar tendency of the frequency characteristics. Sound in trachea region has low frequency characteristics, while sound observed in the small airways has high frequency characteristics. The computational simulations show a different flow condition related to the sound generation in expiration and inspiration. In expiration case, flow collision, flow impingement, and flow separation are observed in the location related with the sound source location. While flow impingement and flow separation are the main mechanisms contributing in the sound generation in the inspiration maneuver. This differences of the sound generation mechanisms and the geometry of the airway may further change the characteristics of the sound sources observed in the tracheobronchial airways.

第6回肺聴診セミナープログラム

日　　程　：　平成２８年１０月９日（日）9時55分～15時15分（受付開始9時30分より）

場　　所　：　家の光会館　７階　コンベンションホール

　　　JR「飯田橋」駅西口から徒歩６分

　　　地下鉄 有楽町線/南北線「飯田橋」駅から徒歩５分、東西線/大江戸線「飯田橋」駅から徒歩９分（B3 出口）

　　　〒162-8448 東京都新宿区市谷船河原町 11 番地　TEL：03-3260-4791

　　　（http://www.ienohikariss.co.jp/bld/access/）

講習会長　：　高瀬　眞人（日本医科大学多摩永山病院）・工藤　翔二（公益社団法人結核予防会）

主　　催　：　肺音(呼吸音)研究会

後　　援　：　東京都医師会、東京都看護協会

定　　員　：　200 名

参 加 費　：　第６回肺聴診セミナー事前参加登録　　8,000円（昼食・テキスト代含む）

　　　　　　　第６回肺聴診セミナー ＋ ILSA2016 事前参加登録の場合 10,000 円（セット料金）

　　　　　当日参加登録　１０,０００円（昼食・テキスト代含む）*お席に余裕がある場合に限り承ります。

<プログラム>

 ９：５５-１０：００　開会の辞

１０：００-１０：４０（40 分）　肺聴診の基礎と聴診トレーニング　永寿総合病院柳橋分院　米丸 亮

１０：４０-１１：２０（40 分）　フィジカルサインとしての肺聴診 洛和会音羽病院 長坂行雄

１１：２０-１２：１０（40 分）　小児肺聴診のコツ　日本医科大学 高瀬眞人

１２：１０-１２：５０（40 分）　肺聴診のサイエンス　福島県立医科大学 棟方 充

１３：００-１３：３０（30 分）　ランチョンセミナー　ラエンネックの聴診器発明から 200 年

　　　　　　　　　　　　　　　　　　　　　　公益社団法人結核予防会　工藤 翔二

１３：４０-１４：２０（40 分）　動画とクイズ形式で学ぶ肺聴診

　　　　　　　　　　　　　　　　　　　田園調布呼吸器・内科クリニック 清川 浩

１４：２０-１５：００（40 分）　誰でもできる呼吸音計測・画像表示 国立病院機構福岡病院 中野 博

１５：００-１５：１５（15 分）　質疑応答

肺音（呼吸音）研究会ホームページ　http://coac.jp/haion/

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