SPECTROGRAPHIC ANALYSIS OF NORMAL AND CONTINUOUS ADVENTITIOUS BREATH SOUNDS IN CHILDREN

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OBJECTIVE

Diagnosing pulmonary diseases with auscultation of breath sounds in children is often difficult because of its high dependence on the clinician's experience of special circumstances involving children. The purpose of this study was to analyze the spectrograms of normal and continuous adventitious breath sounds to reproducibly find the appropriate character of breath sounds through a mechanical analysis.

METHODS

Subject

Period : May, 2019 – September, 2019
Place : Eun-pyeong st. Mary's Hospital, outpatient clinic of Pediatrics
Subject : Children visited for medical treatment **(n=432)**

Collection of data

Respiratory sound files were recorded **(n=2217)**
Instrument : Electronical stethoscope (JABES®)
Position : Right and left side of both anterior and posterior chest (total of 4)

Selection of data

Well-recorded normal and continuous adventitious breath sounds were selected
Selected files were cut into **one respiratory phase unit** (inspiration & expiration)
Total of **289 files from 91 subjects** were obtained

Classification of selected data

Normal breath sounds
Continuous adventitious breath sounds
Wheezing : continuous sound over 400 Hz., mostly in expiration
Rhonchus : continuous sound under 200 Hz., mostly in expiration
Mixed : continuous sound between 200 and 400 Hz., mostly in expiration

Data analysis

Spectrogram of 289 files were drawn and common characteristics were found

Statistical analysis
IBM SPSS Statistics 21.0 program
One-way ANOVA(Duncan)

CHARACTERISTICS OF SUBJECTS AND SAMPLES

Table 1. Subjects characteristics (n=91)

Characteristics	Value
Sex	
Male	52 (57.1)
Female	39 (42.9)
Age (yr)	5 (0-14)
Clinical diagnosis	
Asthma	19 (20.9)
Bronchitis or pneumonia	21 (23.1)
Bronchiolitis	5 (5.5)
Common cold	28 (30.8)
Other respiratory disease*	12 (13.2)
non-respiratory disease	6 (6.6)

Values are presented as number (%) or median (range)

*sinusitis, otitis media, allergic rhinitis, etc.

Table 2. Classification of breath sound files (n=289)

Characteristics	Value
Normal breath sound	189 (65.4)
Continuous adventitious breath sound	
Wheezing	31 (10.7)
Rhonchi	40 (13.8)
Mixed	29 (10.0)

Values are presented as number (%)

RESULTS

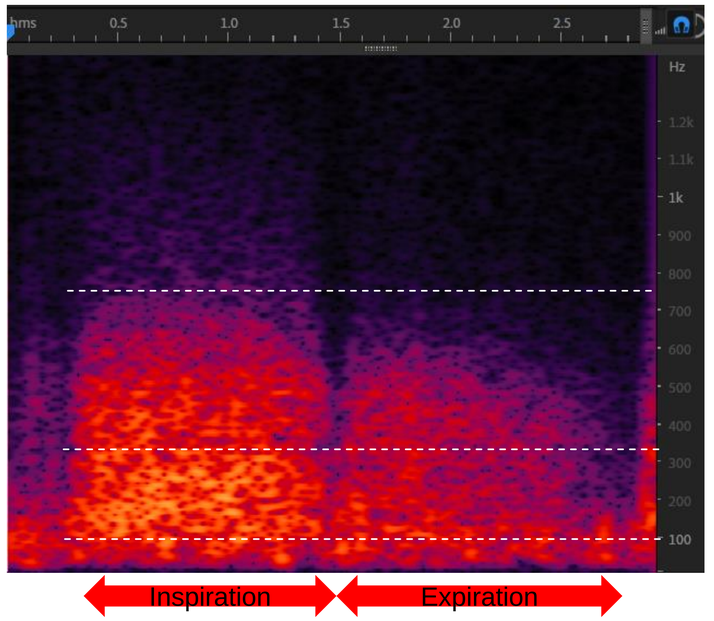


Figure 1. Spectrogram of normal breath sound
Shows even distribution of sound forming a typical dome shape. The power of sound is highest between 100 and 300 Hz. with energy drop around 700 Hz.

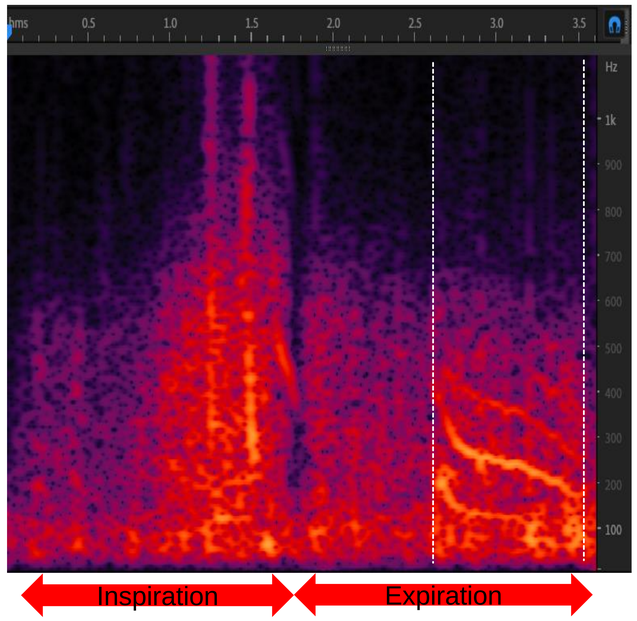


Figure 2. Spectrogram of continuous adventitious breath sound
Descending lines in expiration showing continuous sound. Most yellowish line shows strongest power of continuous sound

Table 3. Statistical characteristics of normal breath sounds (n=189)

Variables	Values
Frequency range of sound **energy drop** (Hz.)	
Upper limit	716.82±93.14 (550-1200)
Lower limit	0 (0)
Frequency range of sound with **highest amplitude** (Hz.)	
Upper limit	305.93±106.09 (100-600)
Lower limit	136.51±81.64 (0-400)
Duration of respiration (second)	
Inspiration	0.78±0.24 (0.35-1.60)
Expiration	0.80±0.27 (0.30-1.80)

Values are presented as mean±standard deviation (range)

Table 4. Statistical characteristics of continuous adventitious breath sounds(n=100)

Variables	Wheezing (n=31)	Rhonchus (n=40)	Mixed (n=29)	P value
Frequency range of continuous sound (Hz.)				
Upper limit	645.81±242.42 (420-1600)	345.38±190.67 (110-750)	451.72±107.54 (300-820)	
Lower limit	300.65±150.66 (100-620)	97.13±45.01 (30-190)	168.62±60.04 (80-320)	
Frequency range of highest ampilitude (Hz.)				
Upper limit	550.48±110.11 (420-800)	187.50±52.17 (80-280)	352.07±59.12 (240-460)	
Lower limit	411.61±89.78 (280-620)	122.63±42.74 (30-190)	226.55±60.61 (100-360)	
Average	**481.05±87.80 (400-665)**	**155.06±44.89 (55-200)**	**289.31±49.20 (210-370)**	
Duration of continuous sound (second)	**0.33±0.21 (0.20-1.20)**	**0.54±0.28 (0.20-1.20)**	**0.43±0.21 (0.20-1.00)**	**0.002**
Number of continuous sound per file (n)	**2.39±1.43 (1-6)**	**2.93±1.53 (1-7)**	**2.28±0.88 (1-4)**	**0.097**

Values are presented as mean±standard deviation (range)

CONCLUSION

In this study, typical characteristics of normal and continuous adventitious breath sounds were determined from the corresponding spectrograms. In statistics of continuous adventitious sounds, durations of wheezing, rhonchus and mixed sound showed significant difference. Number of continuous sound per files, on the other hand, didn't show significant difference. Spectrographic data of more samples would improve our understanding of the characteristics of different breath sounds that are not well-known to date.