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DIFFERENCES IN AIRFLOW PATTERNS DURING VOLUNTARY COUGHS THAT RESULT FROM OBSTRUCTIVE LUNG DISEASE

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ABSTRACT

Airflow patterns were recorded during voluntary coughs to help determine how biological aerosols are transmitted between passengers in a confined space such as an airplane cabin. Coughs from both healthy men and women and men and women with obstructive lung disease were analyzed. The groups were selected based on the results of spirometry tests performed at the pulmonary clinic of West Virginia University Hospital. Airflow was measured and recorded during three consecutive cough maneuvers for each subject and the maximum airflow, average airflow and maximum gas acceleration were evaluated. Results showed that airflow parameters during a series of coughs were significantly altered by obstructive lung disease.

INTRODUCTION

Cough is one of the most common symptoms or signs of a respiratory disease and is often used as a diagnostic tool [1]. Taking advantage of the changing nature of a cough's physical properties to identify lung disease has several advantages since testing is easily administered and requires little patient training. In order to describe the events during a cough, physiologists have subdivided it into 4 phases. During the initial phase (Phase I) air enters the lungs as the subject inhales a variable volume of gas. At the beginning of the second phase (Phase II), the glottis closes for approximately 200 msec, and the muscles of expiration contract increasing thoracic pressure. As the glottis reopens during Phase III of a cough there is an initial "supermaximal" airflow transient due to the sudden compression of the airways followed by a period of maximal flow from the lung's periphery. The maximal flow is limited by the maximum expiratory flow-volume relationship that is unique for each lung. During the fourth and final phase, called the cessation phase, muscle activity is reduced and the airflow decreases as it approaches zero.

Obstructive lung diseases are associated with a decreased ability to quickly move air into and out of the lung, which should alter the effectiveness of a cough. The objective of this study was to determine how airflow patterns generated at the mouth during a voluntary cough are altered by the development of obstructive lung disease in both men and women.

MATERIALS AND METHODS

The system used to record voluntary cough flow patterns has been described previously [2]. Cough sound pressure in addition to cough airflow measurements could be measured simultaneously during

a cough, using this method, although only the results of the airflow measurements were analyzed in this study. Each test subject coughed through a mouthpiece connected to a long cylindrical tube that was coupled to a pneumotach (Fleisch #2). The pressure drop across the pneumotach, which was proportional to flow, was measured (Setra, model # 139) and digitally recorded during each cough. In this study, subjects inhaled to total lung capacity (TLC), exhaled slowly to residual volume, then inhaled a second time to TLC before coughing through a mouthpiece. Three consecutive coughs were recorded for each test subject. Groups of normal men (N = 27) and women (N=25) and men (N=27) and women (N=21) with obstructive lung disease were analyzed. Their selection was based on the results of spirometry tests performed at the pulmonary clinic of West Virginia University Hospital. Peak "supermaximal" flow, average air flow, and peak flow acceleration were determined from the cough flow - time relationships of each subject.

RESULTS & DISCUSSION

Average values of peak airflow, average airflow and peak flow acceleration (±SE) during a voluntary cough are given in Table 1.

Table 1. Average values of peak flow, average airflow, average airflow acceleration (± SE) during a voluntary cough for men and women with and without obstructive lung disease.

MEN	Normal (N=27)	Obstructive Lung Disease (N=27)
Peak flow (L/s)	8.65 ± 1.06	4.72 ± 0.90
Average flow (L/s)	1.78 ± 0.53	1.094 ± 0.49
Peak Acceleration (L/s^2)	218.0 ± 6.09	143.2 ± 4.7

WOMEN	Normal (N=25)	Obstructive Lung Disease (N=21)
Peak flow (L/s)	5.93 ± 0.91	4.02 ± 0.97
Average flow (L/s)	1.15 ± 0.48	0.812 ± 0.48
Peak acceleration (L/s^2)	147.6 ± 4.72	115.1 ± 5.16

Results showed a significant decrease ($P<0.05$) in all flow parameters of both men and women having obstructive lung disease. These observations combined with previously described alterations in cough sounds [3] should prove to be effective in diagnosing obstructive lung diseases in the future.

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