resolution CT allows visualization of additional detail of the lung parenchyma that further helps to identify and characterize the pulmonary process.

Are the CT appearances of pulmonary infections more specific than plain film findings? The purpose of the study by Barloon et al was to determine if CT provided additional, clinically useful information regarding the presence of pulmonary infection. Although many of the CT findings of pulmonary diseases are nonspecific, the CT findings of invasive fungal disease, particularly invasive pulmonary aspergillosis in this clinical setting, are often distinguishable from other bacterial or viral infections.\(^\text{10}\) As Barloon et al point out in their article, being able to identify CT findings of fungal infection in cases where the conventional radiographs remained nonspecific added confidence in the diagnosis of fungal infection and in the appropriateness of aggressive antifungal therapy.

Finally, do early detection and characterization of lung infection by CT improve survival and ultimate outcome? Barloon et al concluded from their study that CT does provide significant information in the febrile bone marrow transplant patient with nonspecific chest film findings, but that the mortality is quite high in this group and that it may be difficult to prove definitively that CT affects outcome. In order to test the ability of CT to affect outcome, one would need to screen all febrile aplastic patients and compare serial chest films to serial CT scans in their ability to detect and characterize early infection, at a time when intervention could affect outcome. Patients in the present study may have had fairly well-established pulmonary infection by the time the CT was performed, since those included in the study were symptomatic patients that the clinical staff suspected of having pulmonary disease, but whose serial chest radiographs failed to provide sufficient information to initiate or to continue treatment. It remains to be seen whether serial CT examinations, used as a primary screening modality, may indeed have a significant impact on mortality, particularly from fungal infection. Some clinical evidence does exist to suggest that early presumptive diagnosis of fungal infection with the aid of CT surveillance and rapid institution of aggressive antifungal therapy leads to improved survival.\(^\text{8}\) CT surveillance has also been used effectively to monitor disease activity, document progression or resolution of fungal infection in response to therapy, and detect reactivation of fungal disease during subsequent treatment cycles.\(^\text{9}\) Whether an improvement in survival from bacterial and viral infections can be demonstrated with the aid of early CT detection has yet to be demonstrated.

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**Clinical Applications of Forced Oscillation Technique**

Dubois et al\(^\text{1}\) introduced the forced oscillation technique (FOT) in 1956 as a method to characterize the mechanical properties of the respiratory system over a wide range of frequencies. However, only in the 1970s, when microprocessor techniques became available, allowing the analysis of complex signals by means of the Fourier transform, were more in-depth investigations possible of frequency characteristics of the impedance of the respiratory system and of its two components—the real part or resistance (Rrs), and the imaginary part or reactance (Xrs), which...
is influenced by both the inerance and capacitance of the system). Also, the clinical potential of the method became apparent: the FOT is rapid and demands only passive cooperation which makes it especially appealing for children, for epidemiologic surveys and for conditions in which quiet breathing instead of forced expiratory maneuvers are preferred.

Nowadays, the FOT has proved its usefulness in many conditions. The absolute value of Rrs at low measuring frequencies (up to 4-8 Hz) is very similar to that of plethysmographic airway resistance. In healthy subjects, Rrs is almost frequency independent or even increases slightly with frequency (currently applied frequencies are 2 to 25-50 Hz), except in children, in which it decreases with increasing frequency. Xrs is negative at low frequencies (capacitance prevails), it becomes zero at about 8 Hz (the resonant frequency), and it is positive at higher frequencies (inerance prevails). The pattern of impedance values (Rrs and Xrs) in the various states associated with abnormalities of pulmonary function consists of an increase in Rrs especially at low frequencies, and a decrease in Xrs with a shift of the resonant frequency to higher frequencies. These changes have been shown to be well correlated with those of routine lung function tests in different pathologic conditions such as COPD (after challenge tests or bronchodilatation), upper airways obstruction, interstitial lung disease, and chest wall abnormalities. Yet, the relative changes of impedance values with respect to other routine lung function values (FEV1, PEF, Raw) may vary depending on the type of pathology; this may be of diagnostic interest. The FOT is more sensitive to upper or lower airway obstruction than to interstitial lung disease and chest wall pathology yet, even in the latter, FOT indices may be affected. The FOT appears also to be especially suitable for challenge tests and conversely, for reversibility tests of airflow obstruction. Since it is sensitive to incipient airway obstruction it might become an interesting screening technique for epidemiologic surveys and for detecting people at risk, such as those exposed to occupational hazards.

The limitations of the FOT should be recognized similarly as for other functional techniques. Although model studies have been successfully applied to the FOT, the physiologic correlates for the changes in the different indices remain hypothetical. Furthermore, the shunt impedance of the cheeks has a major effect on the results. A comparison of the conventional technique, in which the forced oscillations are applied at the mouth, and the head generator technique minimizing the influence of the cheek suggests, however, that there is mainly a proportionality difference in the results: Rrs tends to be higher with the head generator in pathologic conditions, especially at higher frequencies, resulting in a decrease and even a disappearance of the frequency dependence. The resonant frequency is also decreased.

Investigations on future developments of the FOT are mainly directed at expanding the measuring range to higher frequencies, to measuring instantaneous impedance values, thus separating inspiratory and expiratory values, to relating impedance values to lung volumes (FRV), and to effectively bypassing the oropharynx.

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Plan to Attend ACCP’s

57th Annual Scientific Assembly
San Francisco
November 4-8, 1991