A Distributed Bronchial Mapping Software Tool for the Tracking of Cellular, Molecular and Imaging Results in the Central Airways

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Background

The natural history of premalignant changes in the central airways has been difficult to decipher because of the inaccessibility of the lower respiratory tract, and the long follow-up time to ultimate outcome. Additionally, the paucity of studies with sufficient statistical power, the inconsistency of clinical trial entry criteria and, importantly, variation in the interpretation of histological endpoints also contribute to the difficulty in assessing premalignant changes. Despite these limitations, several trials to test natural history of bronchial premalignancy, the effect of chemoprevention on lower airway epithelium and new methods for visualizing the airways are currently underway in industrialized countries. A pooling of data from these trials and a uniform interpretation of histological and molecular changes in the central airways would be highly advantageous in evaluating the outcomes of these important trials.

Methods

The EDRN Biomarker Atlas Working Group recently has developed a Biomarker Atlas software system that allows a researcher to map the bronchi and bronchioles and to associate images and clinical data with specific anatomic loci. Characteristics of the bronchoscopic procedures including white light and fluorescence methods, image records of bronchoscopic findings and histology may be accessed using web-based Biomarker Atlas tools including the Bronchial Map. Patient specimen data is annotated with a common set of data elements that allow the system to filter through and co-locate available data.

Advances in location-based data discovery and AJAX-based user interfaces, e.g., Google Maps, have allowed users to find businesses, restaurants and sites of interest using a few simple keywords and the selection of a "region" on the map. Our "Biomarker Atlas" capability is predicated upon the above recent technical advances and provides a means for lung cancer researchers to browse lung cancer specimens collected at sites participating in the distributed specimen sharing network using a location-based map of a human lung. The backend distributed data system is built upon the data grid middleware framework called OODT, the principal enabling technology of the EDRN Resource Network Exchange (ERNE).

Results

To date nearly 5000 images are on file in the Colorado data warehouse from 365 patients. Other images are being prepared for mapping at Roswell Park. The mapping tool is being used to directly compare specific bronchial sites at differing time points in regard to fluorescence and white light appearances, histology, immunohistochemistry (Ki-67) FISH and other molecular features. The map has dramatically documented spreading of carcinoma in situ through the airways and the longer progression of low-grade squamous dysplasia to carcinoma at the same site over a 14 year time frame.

Conclusions

The Bronchial Map is a useful software tool that has the potential to alter perceptions about premalignant changes in the lower airways. The initial pilot sites for the Biomarker Atlas include University of Colorado Denver and Health Sciences Center (UCDHSC) and Roswell Park Cancer Institute (RPCI). Future work entails collaborating with more sites to include specimens in the distributed Biomarker Atlas system, and increase the chances of cancer and premalignancy biomarker discovery and validation.