Emerging Technologies for Measuring Individual Exposomes

DECEMBER 8–9, 2011 • THURSDAY, 8:30–5:00, FRIDAY, 8:30–NOON*
HOUSE OF SWEDEN EVENT CENTER, 2900 K STREET, NW, WASHINGTON, DC
THIS WORKSHOP WILL BE WEBCAST.

Welcome and workshop objectives

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Environmental exposures and disease

- Two thirds of global mortality caused by chronic diseases
- Genetic factors account for less than 30% of the global burden of chronic diseases
- Environmental (i.e. non-genetic) factors are likely to be the major causes

But what are the causative exposures?
The exposome – promoting discovery of environmental causes of disease

Christopher Wild defined the ‘exposome’, representing all environmental exposures (including diet, lifestyle, and infections) from conception onwards, as a complement to the genome in studies of disease etiology.

Editorial

Complementing the Genome with an "Exposome": The Outstanding Challenge of Environmental Exposure Measurement in Molecular Epidemiology

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EMERGING SCIENCE FOR ENVIRONMENTAL HEALTH DECISIONS

WORKSHOP

The Exposome: A Powerful Approach for Evaluating Environmental Exposures and Their Influences on Human Disease

FEBRUARY 25-26, 2010 • WASHINGTON, DC
THURSDAY, 8:30–5:00, FRIDAY, 8:30-NOON • NAS BUILDING, 2100 C STREET, NW, AUDITORIUM
Capturing exogenous and endogenous exposures

The exposome includes all chemicals in the internal chemical environment

Although the risks of developing chronic diseases are attributed to both genetic and environmental factors, 70 to 90% of disease risks are probably due to differences in environments (1, 2). Yet, epidemiologists increasingly use genome-wide association studies (GWAS) to investigate diseases, while relying on questionnaires to characterize “environmental exposures.” This is because GWAS represent the only approach for exploring the totality of any risk factor (such as in this case) associated with disease prevalence. Moreover, the value of costly genetic information is diminished when inaccurate and imprecise environmental data lead to biased inferences regarding gene-environment interactions (4). A more comprehensive and quantitative view of environmental exposures is needed if epidemiologists are to discover the major causes of chronic diseases.

An obstacle to identifying the most important environmental exposures is the fragmentation of epidemiological research along lines defined by different factors. When epidemiologists investigate environmental risks, they tend to concentrate on a particular category of exposures involving air and water pollution, occupation, diet and obesity, stress and behavior, or types of infection. This slicing of the disease pie along parochial lines leads to scientific separation and confuses the definition of “environmental exposures.” In fact, all of these exposure categories contribute to chronic diseases and should be investigated collectively rather than separately.

To develop a more cohesive view of environmental exposure, it is important to recognize that toxic effects are mediated through chemicals that alter critical molecules, cells, and physiological processes inside the body. Thus, it would be reasonable to consider the “environment” as the body’s internal chemical environment and “exposures” as the amounts of biologically active chemicals in this internal environment. Under this view, exposures are not restricted to chemicals (toxicants) entering the body from air, water, or food, for example, but also include chemicals produced by inflammation, oxidative stress, lipid peroxidation, infections, gut flora, and other natural processes (5, 6) (see the figure). This internal chemical environment continually fluctuates during life due to changes in external and internal sources, aging, infections, lifestyle, stress, psychosocial factors, and preexisting diseases.

The term “exposome” refers to the totality of environmental exposures from conception onwards, and has been proposed to be a new paradigm needed to assess how a lifetime of exposure to environmental factors affects the risk of developing chronic diseases.
Emerging science for characterizing individual exposomes

- Existing methods are inadequate (single pollutants, limited coverage of non-chemical and endogenous stressors)
- Improvements needed
  - Personal monitors and systems for characterizing multiple external stressors
  - Omic strategies for exposome-wide association studies (EWAS)
  - Integrating external and internal measurements
Ubiquitous sensing

University of South Florida, Dept. of Computer Science and Engineering
http://www.csee.usf.edu/REU/home.html
EWAS and biomarker discovery

Lin et al., J Proteome Res, 2010, 10, 1396-1405

Sreekumar et al., Nature, 2009, 457, 910-16
Objectives

- Compare technologies and methods for measuring individual exposures
- Discuss complementary roles played by external and internal measurements
- Discuss implications for understanding and preventing diseases