Health & Medicine

How the Science of ‘Exposomics’ Could Improve Drug Safety

Pioneering research seeks to reduce the frequency of adverse drug reactions.

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Every year, harm caused by medications sends seven hundred thousand people to emergency rooms and accounts for thousands of deaths in the US.

Learning how to prevent these accidents is one of the biggest challenges in medicine. It can help to analyze patients’ DNA before prescribing medications, but our genes aren’t solely responsible for adverse drug reactions. To craft truly personalized treatments, physicians would need to account for many other environmental and behavioral factors that affect our bodies. This is the promise of

“exposomics,” an emerging field dedicated to mapping all the key elements that influence our physiology — from air pollution and stress to diet and exercise.

Gary Miller, a professor of environmental health sciences at Columbia’s Mailman School of Public Health, is at the forefront of this field, having conducted pioneering research on how exposomics could be harnessed to improve treatments for a wide variety of conditions. Now he has received a $39.5 million award to lead a multi-institution research effort to develop new analytic tools that may revolutionize how physicians treat diabetes, Alzheimer’s disease, and many other ailments.

Supported by the federal Advanced Research Projects Agency for Health, the initiative, IndiPHARM (Individual Metabolome and Exposome Assessment for Pharmaceutical Optimization), seeks to enable physicians to assess a broad array of factors that influence drug efficacy and safety.

Unlike traditional pharmacology research, IndiPHARM will take a holistic approach, examining interactions between hundreds of drugs and thousands of common chemicals and dietary compounds. The goal of the project is to help doctors answer questions such as: What is the right drug, or combination of drugs, for an individual? How might a person’s diet or workplace exposures influence their response? What is the optimal dose for them? This will prevent adverse drug events and improve patient health overall, Miller says.

The new project will initially focus on optimizing treatments for obesity, diabetes, and fatty liver disease, along with related conditions such as hypertension and depression. To this end, Miller and his colleagues will analyze data from several large diabetes trials, together with electronic health records from the international, Columbia-managed OHDSI (Observational Health Data Sciences and Informatics) database network. But Miller says the analytic tools that his IndiPHARM team builds should ultimately be applicable to nearly all diseases and drug classes.

“In addition to improving care for individual patients, we think that our platform will detect drug interactions that are dangerous for wide swaths of the population but haven’t been flagged yet by regulators,” he says.

The IndiPHARM team includes Columbia professors Randolph Singh, Serge Cremers, and George Hripcsak ’85VPS, ’00PH, as well as researchers from Harvard Medical School, the Mayo Clinic, Emory University, Brown University, and Jackson Laboratory.

In a related effort, Miller has been selected to lead a new national exposomics coordinating center called NEXUS (Network for Exposomics in the US), established by the National Institute of Environmental Health Sciences. NEXUS will define best practices in the field and support exposomics efforts across all NIH institutes and centers.

“Our goal is to operationalize and embed exposomics throughout the entire biomedical enterprise to advance precision environmental health,” Miller says.

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