High-Throughput Exposure Forecasting

Exposure Forecasting (ExpoCast)

EPA evaluates the potential human health and environmental risks associated with the manufacture and use of thousands of chemicals. The process of evaluating the risk from a chemical involves assessing both the potential harm, or hazard, and the degree of exposure.

In addressing the potential hazard of a chemical, EPA's Toxicity Forecaster (ToxCast) project is using advanced high-throughput screening technology to rapidly screen thousands of chemicals for potential hazards.

Complimentary to ToxCast, EPA is also working on the exposure piece of the puzzle which requires estimating levels of exposure to thousands of chemicals. Currently, there is a lack of exposure information for the majority of chemicals in commerce today. To address the need for exposure information, EPA is developing innovative high-throughput methods to estimate exposure to these chemicals. EPA refers to this high-throughput exposure estimation or "forecasting" research effort as ExpoCast

High Throughput Exposure Predictions

ExpoCast provides high-throughput exposure estimations for thousands of chemicals.

ExpoCast quickly and efficiently looks at multiple routes of exposure to provide exposure estimates, and has been applied to almost 8,000 chemicals. ExpoCast uses two types of models to estimate exposure, farfield and nearfield.

Pictured Above: Farfield Exposure Examples

Farfield Exposure Models

Farfield exposure models are used to estimate exposure from chemicals that are released into the environment.

Pictured Above: Examples of Nearfield Exposure, Consumer Use and Indoor

ExpoCast uses two already available models, USEtox and RAIDAR, to estimate chemical exposure from industrial environmental releases. These models have sufficient throughput to estimate the average amount of a chemical in air, water, and soil.

Nearfield Exposure Models

Nearfield exposure models provide estimates of exposure to chemicals found in consumer products and other in-home sources. SHEDS-High-Throughput (SHED-HT) was developed from EPA's existing Stochastic Human Exposure and Dose Simulation Model for Multimedia, Multipathway Chemicals (SHEDS-MM) model.

SHEDS-HT estimates population level distributions of exposure to nearfield chemical sources. SHEDS-HT can produce estimates for thousands of chemicals in a more rapid and cost-effective manner. SHEDS-HT accounts for multiple routes, scenarios, and pathways of exposure to understand the total exposure to these chemicals while retaining population and life stage information. It has broad applicability, is flexible for what inputs are allowed, and can easily provide exposure estimates for new chemicals.

High-Throughput Prediction Evaluation

EPA is currently evaluating the effectiveness of these high-throughput exposure models using the Systematic Empirical Evaluation of Models (SEEM) framework.

The SEEM framework includes calibration and evaluation of the models using chemical concentrations found in blood and urine samples from the National Health and Nutrition Examination Study.

EPA's high-throughput models are continually being refined as more data is gathered for consumer product use, non-targeted chemical exposure screening, and from estimates for oral doses. The SEEM framework allows for the systematic evaluation of whether the additional data improves the exposure predictions.

Consumer Product Use

High-throughput exposure models can be improved by adding more refined indoor and consumer use information. The Chemical and Product Categories database (CPCat) catalogs the use of over 40,000 chemicals in different consumer products. The chemical use information is compiled from multiple sources while product information is gathered from public Material Safety Data Sheets (MSDS) available from retail stores. EPA continually updates this database as more information is gathered from various data sources.

Non-Targeted Chemical Exposure Screening

Most exposure sampling techniques are chemical-specific and designed to test for chemicals that are suspected to be present. EPA researchers are developing "Non-Targeted Screening" methods to test indoor environmental samples for all chemicals present in the home.

High-Throughput Toxicokinetics

It is also important to be able to link the external dose of a chemical to an internal blood or tissue concentration to better inform predictions of adverse effects. This process is called toxicokinetics. EPA researchers are working to measure the critical factors that determine the distribution and metabolic clearance for hundreds of chemicals and incorporate these factors as inputs for computer models.

Using the computer models, EPA researchers can calculate the administered dose required to achieve biological activity in the ToxCast high-throughput screening assays. This process allows ToxCast data to be compared with ExpoCast predictions and other exposure data to identify chemicals with the potential to disturb cellular pathways at relevant human exposure levels.

How Exposure Fits into Risk Based Decisions

The goal is to combine HT exposure predictions with ToxCast bioactivity data to estimate potential risk to human health and the environment. ToxCast and ExpoCast will help EPA better evaluate the safety of the thousands of chemicals found in products used every day.

For more information

ExpoCast webpage:
http://www.epa.gov/ncct/expocast/

CPCat webpage:
http://actor.epa.gov/cpcat/faces/home.xhtml

ToxCast webpage:
http://www.epa.gov/ncct/toxcast/

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