Developing, applying and evaluating models for rapid screening level chemical exposure and risk assessment

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Thousands of chemicals produced and used in society require ecological and human health assessment; however, few measured data are available. This project develops tools that can be used to rapidly screen organic chemicals based on ecological and human exposure and high-throughput risk assessment (HTRA) objectives. The Risk Assessment IDentification And Ranking (RAIDAR) model calculates chemical exposure and potential risk to ecological receptors and chemical exposure and potential risk to humans from far-field exposure pathways (outdoor air, drinking water, food source). A visual basic software version of RAIDAR can be downloaded for free at www.arnotresearch.com. To complement RAIDAR, a new model has been developed for (1) indirect near-field exposures (inhalation of indoor air, ingestion of dust, and dermal absorption) and (2) direct near-field exposures (personal care products and pharmaceuticals). The high-throughput mass balance multi-media, multi-pathway exposure models provide a holistic, screening-level framework to quantify (model output):

1. **comparative chemical exposure potential** to humans (independent of chemical emission and use rates) such as the intake fraction ($iF$; dimensionless) and whole body concentrations based on an assumed unit emission rate ($CU$; mg/kg);
2. **actual estimated exposure** to humans (dependent on chemical emission and use rates) such as the daily intake rate ($TDI$ or $IR_A$; mg/kg/day) and whole body concentrations based on an estimated actual emission rate ($CA$; mg/kg);
3. **potential risk or effect** to humans by comparing exposure estimates ($IR_A$ or $CA$) with effect estimates such as oral equivalent dose ($OED$; mg/kg/day) and steady-state blood concentration ($CSS$; mg/kg) corresponding with in vitro biological activity (AC50s).

To address data gaps for model parameterization and application to thousands of chemicals, we are developing Quantitative Structure-Activity (Property) Relationships (QSA(P)Rs) for properties such as chemical half-lives in mammals (humans), dietary assimilation efficiencies in humans and environmental degradation. To address the propagation of the uncertainty in model input parameters, on exposure and risk calculations, the models include screening-level uncertainty analysis.

**Implications:** This research builds capacity to evaluate and better understand chemical exposures and potential risks to humans and the environment. We have developed the first publically available models that predict whole body total elimination half-lives and primary biotransformation half-lives in humans from chemical structure. These models address a critical data gap for bioaccumulation, exposure, and risk assessment. We have developed the first near-field mass balance modeling framework that links chemical fate in the indoor environment with human concentrations. We have highlighted the need to better quantify in vitro testing data for high-throughput hazard- and risk-based screening.

**Key words:** high-throughput, exposure assessment, risk assessment, chemical prioritization, Quantitative Structure-Activity (Property) Relationships, mass balance models, biotransformation, sustainable chemistry

**Project start and end dates:** December 2011 – December 2014
**Project-related peer-reviewed publications:**


**Manuscripts in preparation:**


2. Arnot JA and Mackay D. Dietary assimilation efficiencies of organic chemicals in humans: dependence on $K_{ow}$.

**Other related publications:**


**Conference and Workshop Presentations:**


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