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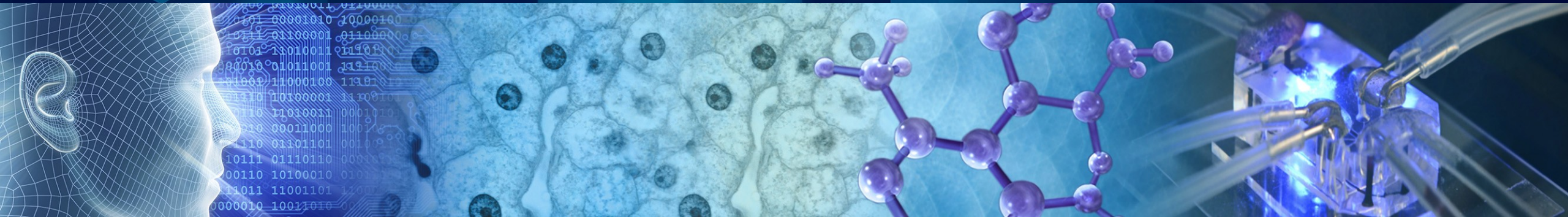
Division of Translational Toxicology



New Apps for Skin Sensitization

Emily N. Reinke, PhD, DABT
Inotiv, Inc., in support of National Toxicology Program Interagency Center for the Evaluation of Alternative Test Methods (NICEATM)

September 12, 2025

Disclaimer: Inotiv staff provide technical support for NICEATM, but do not represent NIEHS, NTP, or the official positions of any federal agency.

Disclaimer

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Impetus for Development of Skin Sensitization Applications and Tools

- NICEATM goals include the development of user-friendly applications and tools for multiple endpoints
  - Examples include the IVIVE and PBPK models available in ICE
- Development and acceptance of Defined Approaches for Skin Sensitization Test Guideline 497 at OECD means integrating data from multiple sources into one decision
  - Guideline 497 includes approaches for determining hazard, UN GHS sub-categorization, and derivation of a point-of-departure
- Multiple options for risk assessment – Human predictive patch test (HPPT) data or Skin Allergy Risk Assessment – Integrated Chemical Environment (SARA-ICE) model

Latest updates on Guideline 497

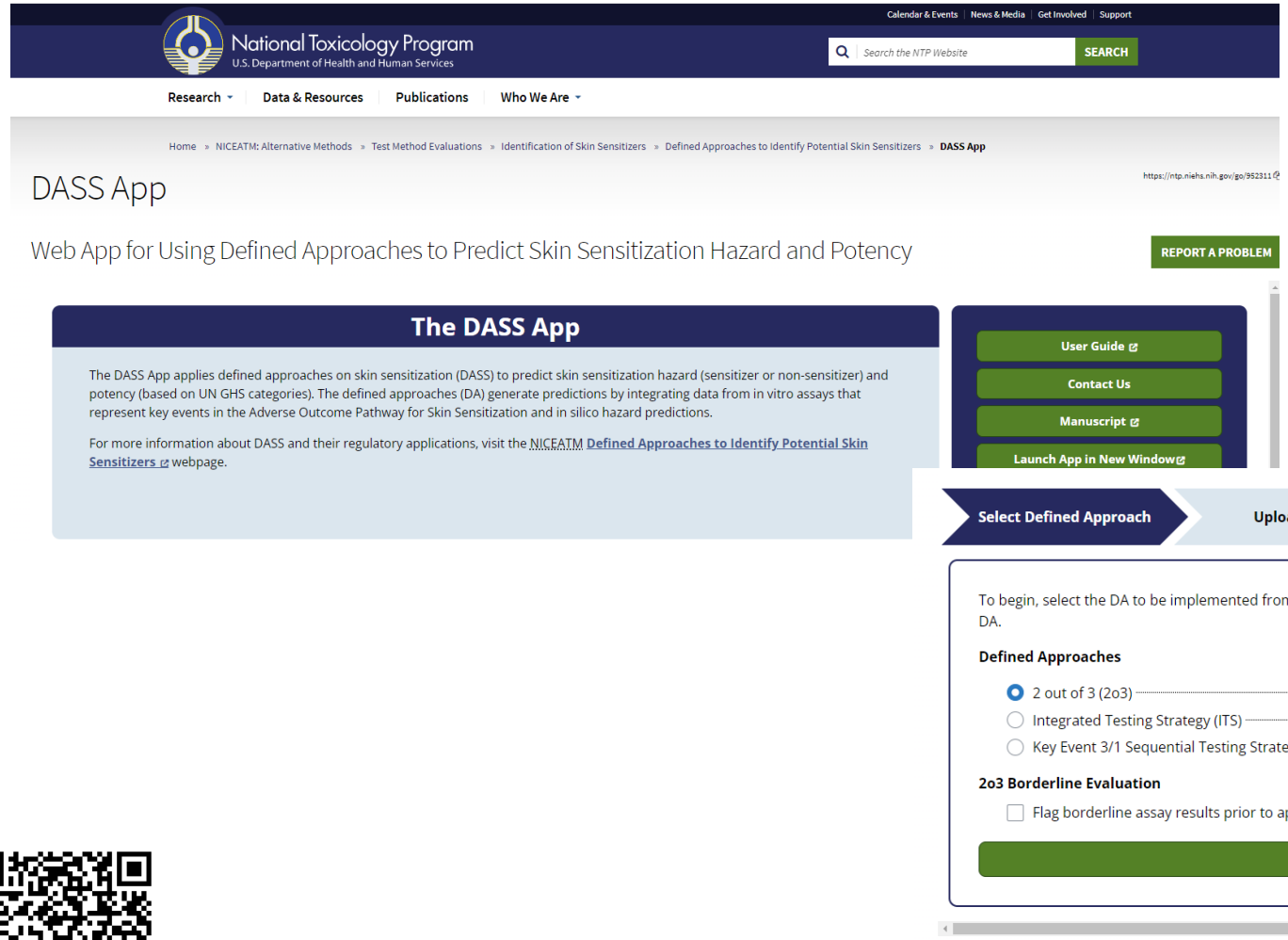
- Guideline 497 updated to include three sections and additional test methods:
  - Hazard identification – 2 out of 3 (2o3) DA
    - Added six additional test methods for use within the DA (24 potential combinations)
      - KE1: Amino acid-derived reactivity assay (ADRA), Direct Peptide Reactivity Assay (DPRA)
      - KE2: EpiSensA, LuSens, KeratinoSens
      - KE3: U-SENS, IL-8, GARDskin, Human Cell Line Activation Test (h-CLAT)
  - GHS sub-categorization – Integrated Testing Strategy (ITS) DA (12 potential combinations)
    - Added 3 new assays for use
      - KE1: ADRA, DPRA
      - KE3: U-SENS, GARDskin, h-CLAT
  - **New**: Potency estimate – (SARA-ICE)

DASS app developed for use with Guideline 497

- Initially launched in 2023 to aid in prediction of 2o3 and ITS for the original Guideline 497
  - Required that borderline predictions in the 2o3 be accounted for
  - Calculated ITS scoring based on data input
- Updated in 2024 and 2025 to include the addition of the new methods and their scoring criteria
  - Calculates borderline calls from individual runs for all included test methods
  - Added ability to evaluate performance (user provided reference data) or against chemical reference lists in ICE. Presented as confusion matrices

https://ntp.niehs.nih.gov/whatwestudy/niceatm/test-method-evaluations/skin-sens/da/dass-app

DASS app



https://ntp.niehs.nih.gov/whatwestudy/niceatm/test-method-evaluations/skin-sens/da/dass-app

DASS app

Before uploading your file, ensure that the data meet the data and formatting requirements. More details are available in the user guide.

A table template is provided in tab-delimited or Excel format. The template contains columns for every possible assay endpoint. If an assay endpoint will not be used, the corresponding column can be deleted but that is not required. Using the template is not required.

Download Data Template (.xlsx)
Download Data Template (.txt)

Use demo data

Show 10 entries

Sort	CASRN	Curated_name	ADRA_call	ADRA_mean_dep	ADRA_NAC_dep	ADRA_NAL_dep	DPRA_call	DPRA_mean_dep	DPRA_Cys_dep	DPRA_Lys_dep	KeratinoSens_call	LuSens
A	All	All	All	All	All	All	All	All	All	All	All	All
1	514-10-3	Abietic acid	1	65.35	97.6	33.1	1	58.1	99.9	16.3	1	
2	100-06-1	Acetanisole	0	0.286475	0.572950749	0	0	2.411942781	4.7238855620000004	0.1	1	
3	874-23-7	2-Acetylcyclohexanone	NA	NA	NA	NA	0	2.5	5	0	1	
4	140-67-0	4-Allylanisole	1	26.26794	41.38529284	11.15058522	1	10.31				
5	7493-74-5	Allyl phenoxyacetate	1	9.15	13.6	4.7	0					

Select Columns

Below, there are sections corresponding to the information sources required for your selected DA. Within each section, use the dropdown lists to select the columns containing the data for the endpoint shown. Columns are automatically selected for an endpoint if the column name matches the corresponding column name in the data template. A column must be selected for each endpoint shown. When you are finished, click "Done".

Click on the information buttons next to the dropdown list label to view information about the required data and formatting. Values that are incorrectly formatted or invalid will be treated as missing data and may affect the results. More details are given in the User Guide.

Key Event 1

KE1 Call

Derive call from quantitative data.

Call Column

ADRA_call

Key Event 2

KE2 Call

Call Column

KeratinoSens_call

Key Event 3

KE3 Call

Call Column

GARDskin_call

Done

DASS app

Results of the DASS App analysis are appended to your data in the table below. By default, the table shows the first three columns of data, your selected input columns, and the DA results. The "Column Visibility" dropdown list above the table can be used to hide or show columns. Use the "Download Results" button to export your results to an Excel spreadsheet or text file, which may allow for easier viewing.

Table Key | Column Visibility | Download Results

Show 10 entries · must

Sort	CASRN	Curated_name	ADRA_call*	KeratinoSens_call*	GARDskin_call*	2o3.hazard
All	All	All	All	All	All	All
1	514-10-3	Abietic acid	1	1	1	Positive
2	100-06-1	Acetanisole	0	1	NA	Inconclusive

Select One or More Reference Columns

HDSG_call

ICE Reference Data

☑ Use reference data from ICE.

Choose the reference chemical lists you want to use. The data will be matched by a chemical identifier that you specify. Use the dropdown list to select the column in your data containing the appropriate chemical identifiers.

Select ICE Chemical Quick List

- ☑ OECD Defined Approach to Skin Sensitization: Human (R)
- ☐ OECD Defined Approach to Skin Sensitization: LLNA (R)

Select Identifier Type

- ◉ CASRN
- ○ DTSXID
- ○ QSAR-Ready SMILES

DASS app

Select Reference

HDSG_call

Comparison Tables
Reference Column: HDSG_call
Prediction Column: 2o3 Hazard

Confusion Matrix

		Reference	
		Positive	Negative
Predicted	Positive	38	1
	Negative	7	9
	Inconclusive	4	1

Performance Metrics

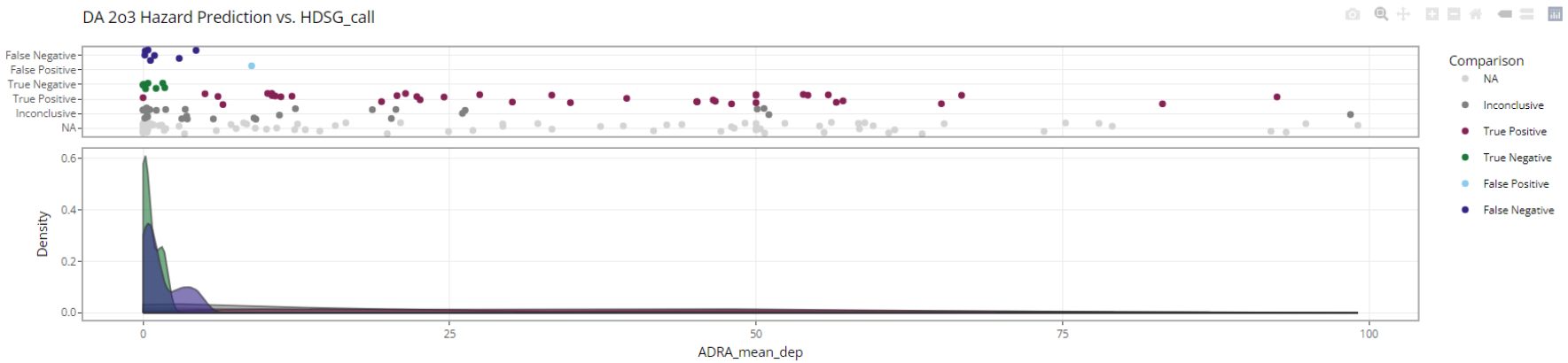
Metric	Value
N	55
True Positive	38
False Positive	1
False Negative	7
True Negative	9
Inconclusive	29
Sensitivity	84%
Specificity	90%
Balanced Accuracy	87%
Accuracy	85%
F1 Score	90%

Select Reference to Visualize

HDSG_call

Select Quantiative Data to Visualize

ADRA_mean_dep



Quantitative Data Summary

	N	Min	Mean	Median	Max
True Positive	38	0	35.42	34.1	92.5
True Negative	9	0	0.58	0.2	1.76
False Positive	1	8.85	8.85	8.85	8.85
False Negative	7	0.14	1.36	0.6	4.32
Inconclusive	27	0	15.85	5.73	98.49
NA	84	0	28.91	18.23	99.1

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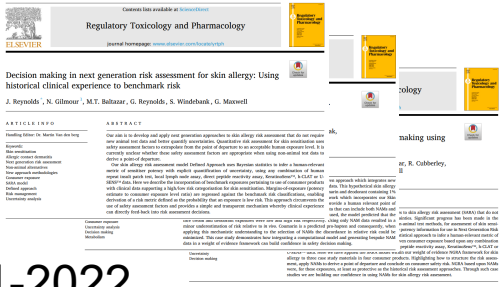
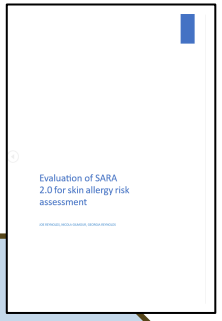
SARA-ICE for a point-of-departure development timeline


Regulatory Toxicology and Pharmacology

Decision making in next generation risk assessment for skin allergy: Using historical clinical experience to benchmark risk

J. Reynolds, N. Gilmour, M.T. Baltazar, G. Reynolds, S. Windebank, G. Maxwell


Evaluation of SARA 2.0 for skin allergy risk assessment

2017-2019

A prototype Bayesian statistical model was developed at Unilever to estimate a no-effect-dose from HPPT data. This model was published in 2019.

2019-2021

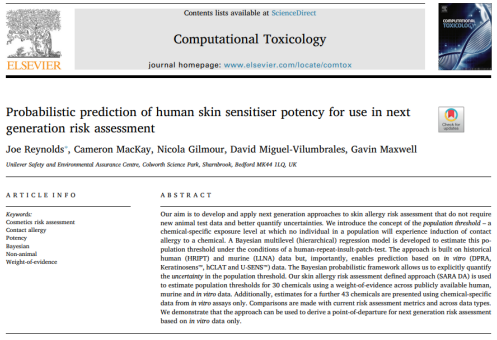
The model and underlying database were revised and expanded. Unilever performed an internal evaluation and applied the model for risk assessment.

2021-2022

SARA is published within a set of 3 papers describing the model and exploring its use in case study risk assessment scenarios.

2023 - present

Unilever begin to develop SARA 2.0, starting from the SARA-ICE database and evaluate the model.


Contents lists available at ScienceDirect

Computational Toxicology

journal homepage: www.elsevier.com/locate/comtox

Probabilistic prediction of human skin sensitiser potency for use in next generation risk assessment

Joe Reynolds*, Cameron MacKay, Nicola Gilmour, David Miguel-Vilumbrales, Gavin Maxwell

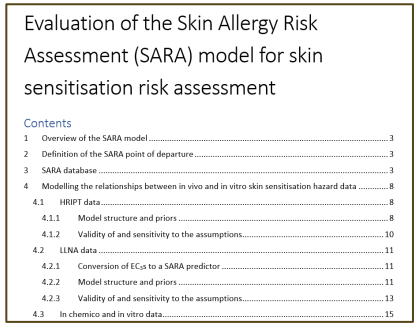
Unilever Safety and Environmental Assurance Centre, Colworth Science Park, Sharnbrook, Bedford MK44 1LQ, UK

ARTICLE INFO

Keywords:
Cosmetics risk assessment
Contact allergy
Potency
Bayesian
Non-animal
Weight-of-evidence

ABSTRACT

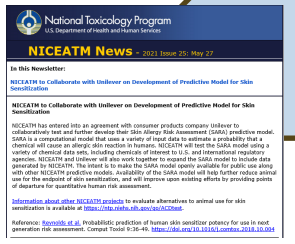
Our aim is to develop and apply next generation approaches to skin allergy risk assessment that do not require new animal test data and better quantify uncertainties. We introduce the concept of the *population threshold* – a chemical-specific exposure level at which no individual in a population will experience induction of contact allergy to a chemical. A Bayesian multilevel (hierarchical) regression model is developed to estimate this population threshold under the conditions of a human-repeat-insult-patch-test. The approach is built on historical human (HRIPT) and murine (LLNA) data but, importantly, enables prediction based on *in vitro* (DPRA, Keratinosens™, hCLAT and U-SENS™) data. The Bayesian probabilistic framework allows us to explicitly quantify the *uncertainty* in the population threshold. Our skin allergy risk assessment defined approach (SARA DA) is used to estimate population thresholds for 30 chemicals using a weight-of-evidence across publicly available human, murine and *in vitro* data. Additionally, estimates for a further 43 chemicals are presented using chemical-specific data from *in vitro* assays only. Comparisons are made with current risk assessment metrics and across data types. We demonstrate that the approach can be used to derive a point-of-departure for next generation risk assessment based on *in vitro* data only.


Evaluation of the Skin Allergy Risk Assessment (SARA) model for skin sensitisation risk assessment

Contents

2021 - present

Unilever begin working with NICEATM to adapt SARA for regulatory use. The SARA database is merged with the ICE database and the SARA-ICE model is developed and evaluated at the OECD.


National Toxicology Program
U.S. Department of Health and Human Services

NICEATM News – 2021 Issue 25: May 27

In this Newsletter:

NICEATM to Collaborate with Unilever on Development of Predictive Model for Skin Sensitization

NICEATM to Collaborate with Unilever on Development of Predictive Model for Skin Sensitization

NICEATM has entered into an agreement with consumer products company Unilever to collaboratively test and further develop their Skin Allergy Risk Assessment (SARA) predictive model. SARA is a computational model that uses a variety of input data to estimate a probability that a chemical will cause an allergic skin reaction in humans. NICEATM will test the SARA model using a variety of chemical data sets, including chemicals of interest to U.S. and international regulatory agencies. NICEATM and Unilever will also work together to expand the SARA model to include data generated by NICEATM. The intent is to make the SARA model openly available for public use along with other NICEATM predictive models. Availability of the SARA model will help further reduce animal use for the endpoint of skin sensitization, and will improve upon existing efforts by providing points of departure for quantitative human risk assessment.

Information about other NICEATM projects to evaluate alternatives to animal use for skin sensitization is available at https://ntp.niehs.nih.gov/go/ACDNext.

Reference: Reynolds et al. Probabilistic prediction of human skin sensitizer potency for use in next generation risk assessment. Comput Toxicol 9:36–49. https://doi.org/10.1016/j.comtox.2018.10.004


Current Research in Toxicology
Volume 8, 2025, 100205

Research Paper

The skin allergy risk assessment-integrated chemical environment (SARA-ICE) defined approach to derive points of departure for skin sensitization

Emily N. Reinke, Joe Reynolds, Nicola Gilmour, Georgia Reynolds, Judy Strickland, Dori Germolec, David G. Allen, Gavin Maxwell, Nicole C. Kleinstreuer

National Institute of Environmental Health Sciences
Division of Translational Toxicology

SARA-ICE

The aim of the Unilever and NICEATM collaboration was to create a version of the SARA Model, SARA-ICE, which would be useful to wider industry, a model that could define points of departure (PoD) for use in risk assessment and have functionality for regulatory classification.

Database

The core dataset underpinning the model uses data in the ICE database.

434 chemicals

1,407 in vivo studies

2,575 in vitro studies

Input Assay Types

OECD TG NAM Assays aligned to key events in the skin allergy AOP.

- DPRA, kDPRA (KE1)
- KeratinoSens (KE2)
- U-Sens, hCLAT (KE3)

- Human (HMT/HRIPT) & LLNA studies may also be used.

Model Outputs

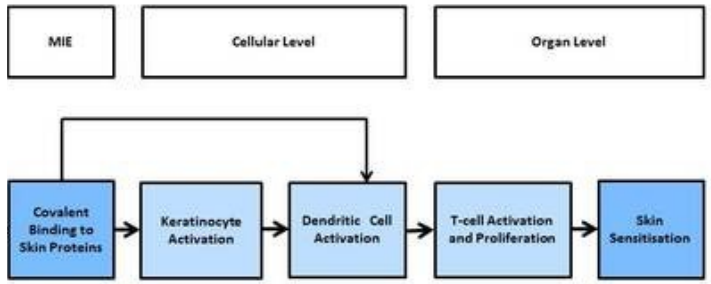
SARA-ICE, a Bayesian probabilistic model, gives a continuous measure of sensitiser potency: *ED_{01} (1% sensitising dose in human patch test).*

- A PoD (SARA-ICE DA)

Or

- GHS Classification (SARA-ICE Extended)

Integrated Chemical Environment



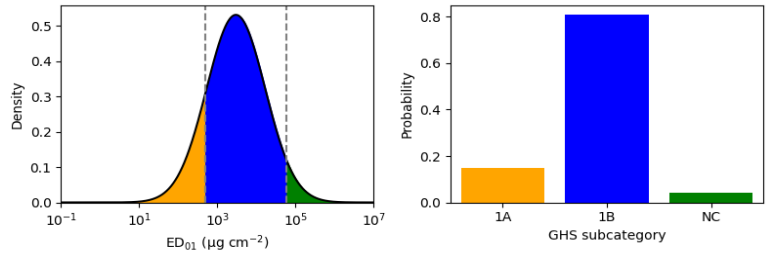
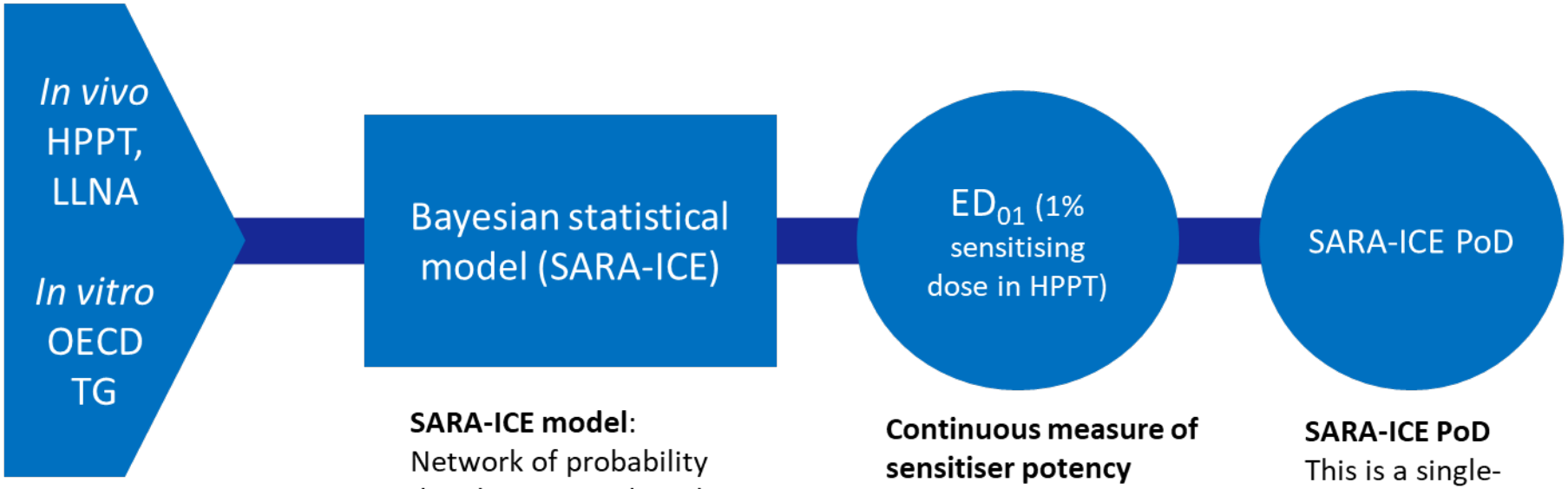


Figure (a) Example estimate of ED_{01} distribution with overlay of GHS subcategories 1A, 1B and NC defined thresholds, (b) probability of each GHS subcategory from ED_{01} distribution

SARA-ICE DA (OECD TG 497 Version)

Input



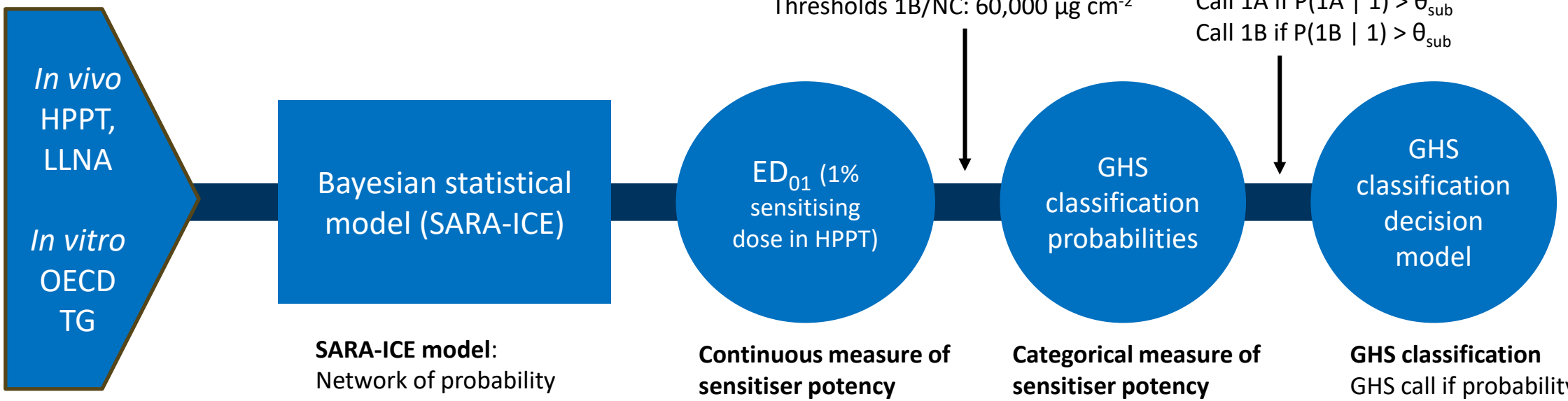
SARA-ICE database:
434 chemicals
1,407 *in vivo* studies
2,575 *in vitro* studies

SARA-ICE model:
Network of probability distributions to describe associations between all data types

Continuous measure of sensitiser potency
Probability distribution of a random variable defined as the dermal dose required to induce sensitisation in 1% of a HPPT-eligible population.

SARA-ICE PoD
This is a single-valued quantity at a physically possible dose that may serve as a suitable value for input into exposure-based risk assessment.

SARA-ICE DA – Extended Version



SARA-ICE database:
434 chemicals
1,407 *in vivo* studies
2,575 *in vitro* studies

SARA-ICE model:
Network of probability distributions to describe associations between all data types

Continuous measure of sensitiser potency
Probability distribution of a random variable defined as the dermal dose required to induce sensitisation in 1% of a HPPT-eligible population.

Categorical measure of sensitiser potency
Probability that chemical potency should be categorised as GHS 1A, 1B or NC.

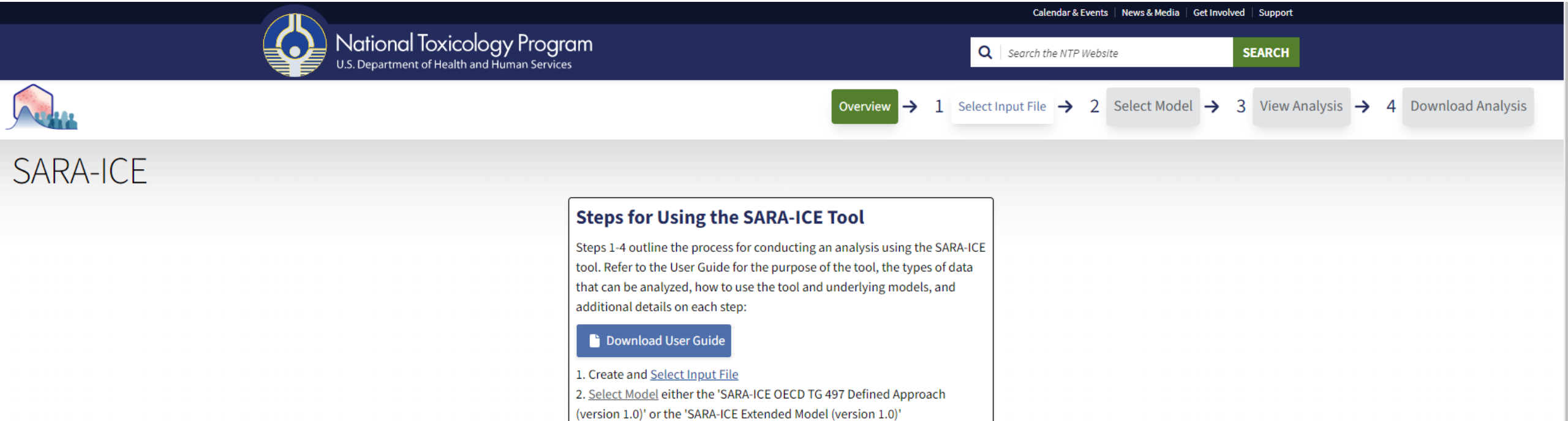
GHS classification
GHS call if probability passes thresholds chosen within the decision model

θ_{bin} = selected probability threshold for making a binary classification (1/NC)

θ_{sub} = selected threshold for making a sub-classification of 1A of 1B, contingent on class 1 being true

SARA-ICE Webapp

- User-friendly tool to run the model(s)
  - Two outputs
    - OECD Guideline 497 ED_{01} point-of-departure (static model)
    - Extended version (modifiable in future)



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SARA-ICE DA – Test Guideline 497 Version

National Toxicology Program
U.S. Department of Health and Human Services

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Search the NTP Website SEARCH

Overview → 1 Select Input File → 2 Select Model → 3 View Analysis → 4 Download Analysis

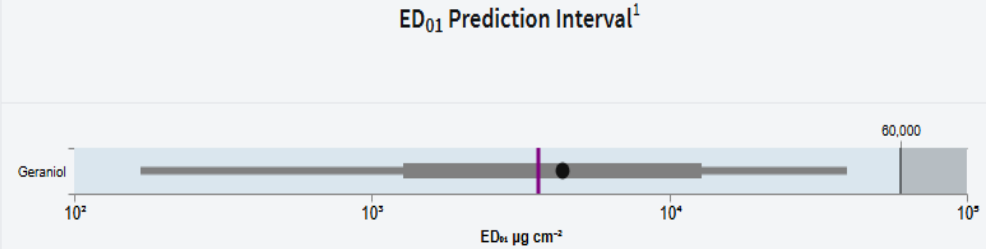
SARA-ICE

SARA-ICE DA OECD TG497 (v1.0) Results

Substance	CASRN	POD*	ED_{01} Percentiles (µg cm^{-2})		
			5th	50th	95th
Geraniol	8007-13-4	3,600	170	4,400	39,000

POD* - Point of departure - geometric mean of the ED_{01}, predicated on being a sensitizer

SARA-ICE DA OECD TG497 (v1.0) Prediction Intervals



[1] – ED01 estimates represented as centered 90% credible intervals (thin line), 50% credible intervals (thick line), and median (bullet). Point of Departure (vertical purple line).

Download Analysis ❯

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SARA-ICE DA – Extended Version

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U.S. Department of Health and Human Services

Search the NTP Website SEARCH

Overview → 1 Select Input File → 2 Select Model → 3 View Analysis → 4 Download Analysis

SARA-ICE

GHS Thresholds

Users can select Probability Thresholds for GHS Call for their own individual use requirements. Sliders are restricted to minimum allowable thresholds for predicting hazard or sub-category as defined in the evaluation found in Reinke et al., 2025. Evaluation of categorization performance was carried out using thresholds of 0.77 (hazard) and 0.62 (sub-category), as described in Supplementary Data 2: Performance of SARA-ICE against OECD benchmark GHS dataset.

GHS Hazard Probability Threshold
Category 1 vs Not Categorized (NC)
Minimum: 0.67
0.77

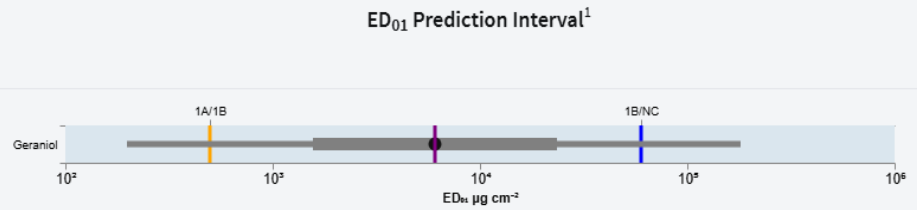
GHS Sub-Cat Probability Threshold
1A vs 1B (assuming Category 1)
Minimum: 0.5
0.62

SARA-ICE Extended Model (v1.0) Results

Substance	CASRN	Mean[1]	SPUR[2]	ED_{01} Percentiles (µg cm^{-2})			SARA-ICE Probability GHS Subcategory				GHS Call
				5th	50th	95th	1A	1B	1	NC	
Geraniol	8007-13-4	6,100	30	200	6,000	>60,000	0.11	0.76	0.87	0.13	1B

Mean[1] – Geometric Mean of the ED_{01} distribution
SPUR[2] – (SARA-ICE Prediction Uncertainty Ratio) fold-difference between the median (50th percentile) and the 5th percentile

SARA-ICE Extended Model (v1.0) Prediction Intervals



[1] – ED01 estimates represented as centered 90% credible intervals (thin line), 50% credible intervals (thick line), and median (bullet). Geometric Mean (vertical purple line).

Future development of SARA-ICE

- Guideline 497 model must remain static unless reviewed by OECD DASS EG
- Extended model can be updated/modified
  - Future plans:
    - Add new methods to database/input options
      - GARDskin/GARD Dose Response, EpiSensA, SENS-IS
      - In silico reactivity structural alert (OECD QSAR Toolbox)
    - Add new features
      - Addition of “EDx” – extrapolate the dose at which X% of the population will be sensitized
      - User input feature
      - Local version
  - Additional suggestions are always welcome

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HPPT App to Classify Human Data

2023

HPPT Database was created to support the development and evaluation of non-animal approaches for skin sensitization assessment.

Contains information for 1366 unique substances.

2024

Developed new GHS classification approach for hazard and potency classification.

Addresses borderline results.

Incorporates the number of sensitized subjects to better inform on potency.

2025

user-friendly, open-source R Shiny-based HPPT App was developed to facilitate public use of the modified classification approach.

Allows users to easily classify their HPPT data in a way that reflects human potency.

https://ntp.niehs.nih.gov/go/hppt

Integrated Chemical Environment

Home › Archives of Toxicology › Article

A database of human predictive patch test data for skin sensitization

Review Article | Open access | Published: 24 August 2023

Volume 97, pages 2825–2837, (2023) Cite this article

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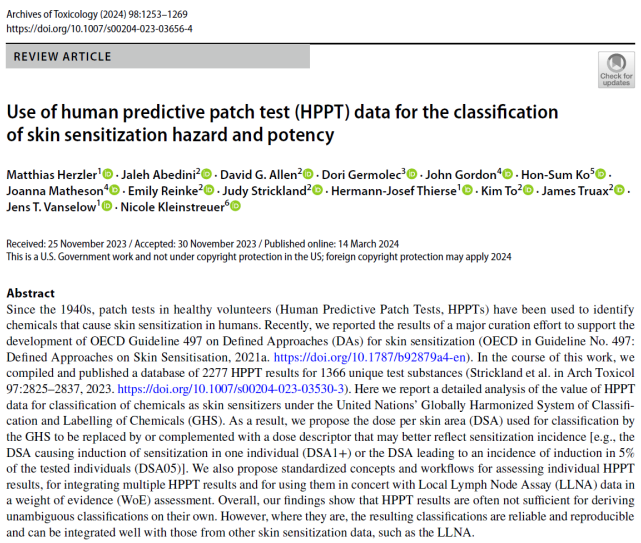
Judy Strickland, Jaleh Abedini, David G. Allen, John Gordon, Victoria Hull, Nicole C. Kleinstreuer, Hon-Sum Ko, Joanna Matheson, Hermann-Josef Thierse, James Truax, Jens T. Vanselow & Matthias Herzler

https://doi.org/10.1007/s00204-023-03530-3



Archives of Toxicology (2024) 98:1253–1269
https://doi.org/10.1007/s00204-023-03656-4

REVIEW ARTICLE

Use of human predictive patch test (HPPT) data for the classification of skin sensitization hazard and potency

Matthias Herzler[1] · Jaleh Abedini[2] · David G. Allen[2] · Dori Germolec[3] · John Gordon[4] · Hon-Sum Ko[5] · Joanna Matheson[4] · Emily Reinke[2] · Judy Strickland[2] · Hermann-Josef Thierse[1] · Kim To[2] · James Truax[2] · Jens T. Vanselow[1] · Nicole Kleinstreuer[6]

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Abstract

Since the 1940s, patch tests in healthy volunteers (Human Predictive Patch Tests, HPPTs) have been used to identify chemicals that cause skin sensitization in humans. Recently, we reported the results of a major curation effort to support the development of OECD Guideline 497 on Defined Approaches (DAs) for skin sensitization (OECD in Guideline No. 497: Defined Approaches on Skin Sensitisation, 2021a. https://doi.org/10.1787/b92879a4-en). In the course of this work, we compiled and published a database of 2277 HPPT results for 1366 unique test substances (Strickland et al. in Arch Toxicol 97:2825–2837, 2023. https://doi.org/10.1007/s00204-023-03530-3). Here we report a detailed analysis of the value of HPPT data for classification of chemicals as skin sensitizers under the United Nations' Globally Harmonized System of Classification and Labelling of Chemicals (GHS). As a result, we propose the dose per skin area (DSA) used for classification by the GHS to be replaced by or complemented with a dose descriptor that may better reflect sensitization incidence [e.g., the DSA causing induction of sensitization in one individual (DSA1+) or the DSA leading to an incidence of induction in 5% of the tested individuals (DSA05)]. We also propose standardized concepts and workflows for assessing individual HPPT results, for integrating multiple HPPT results and for using them in concert with Local Lymph Node Assay (LLNA) data in a weight of evidence (WoE) assessment. Overall, our findings show that HPPT results are often not sufficient for deriving unambiguous classifications on their own. However, where they are, the resulting classifications are reliable and reproducible and can be integrated well with those from other skin sensitization data, such as the LLNA.

Access the HPPT App
https://rstudio.niehs.nih.gov/hppt-app/

NICEATM and ICCVAM Presentations at WC13

https://ntp.niehs.nih.gov/go/niceatm-wc13

13th World Congress on Alternatives and Animal Use in the Life Sciences
August 31-September 4, 2025 – Rio de Janeiro, Brazil

Abstract 288: Web Application to Classify and Subcategorize Skin Sensitizers Using Human Data

Authors: Unnikrishnan A, To K, Herzler M, **Germolec D, Reinke E,** *Kleinstreuer N*

HPPT App

chemical_identifier	concentration_percent	dsa_ug_cm2	n_testsubjects	n_positive
10032-02-7	6	3888	25	0
DTXSID8039241	4	2700	25	1
Ammoniated mercur	2	1296	100	14
5870-93-9	12	8100	24	5
626-82-4	4	2700	30	2

HPPT User Input File

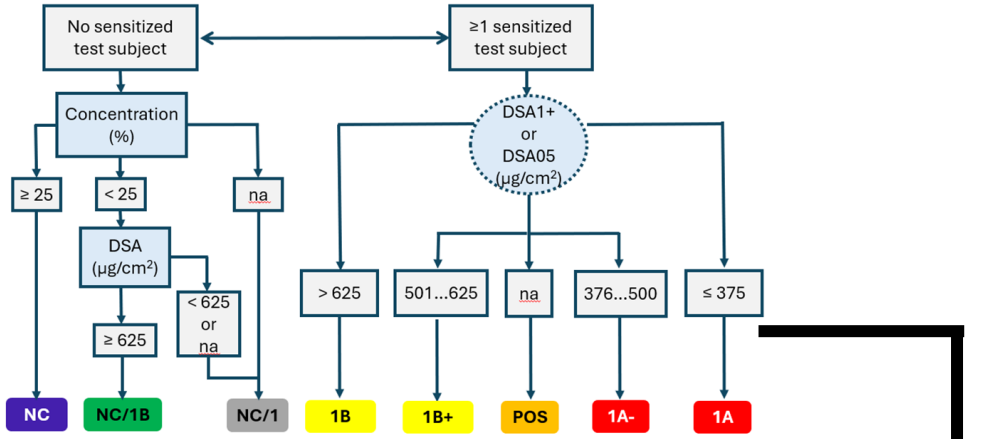
DSA1+

- Dose per skin area that sensitizes one test subject

DSA05

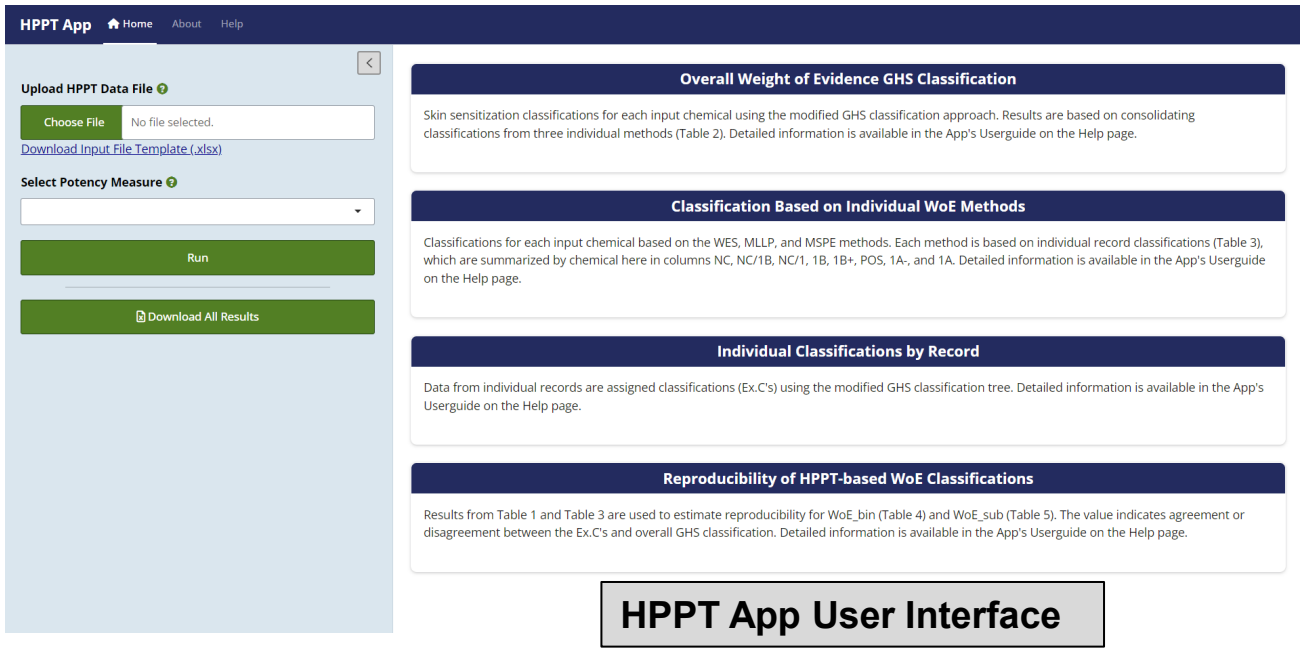
- Dose per skin area that sensitizes 5% of test subjects

Choose Potency Measure



* Figure adapted from Herzler et al. 2024

Modified Classification Approach



HPPT App User Interface

HPPT App

CSV Excel

Chemical Identifier	WoE_bin	WoE_sub	WoE_border	Total Tests
All	All	All	All	All
DTXSID8039241	1	1B	1B	1
Ammoniated mercury	1	1A	1A	1
626-82-4	1	1B	1B	1
5870-93-9	1	1B	1B	1
10032-02-7	NA	NA	NC/1B	1

WoE classification: Category 1 (sensitizer) or NC

Overall WoE GHS Classification

Chemical Identifier	Conc (%)	DSA (ug/cm2)	No. Test Subjects	No. Positive	Call	DSA1+	DSA5%	Ex.C	WES_indiv
All	All	All	All	All	All	All	All	All	All
DTXSID8039241	4	2700	25	1	Active	2700	3375	1B	1
Ammoniated mercury	2	1296	100	14	Active	93	463	1A	2
626-82-4	4	2700	30	2	Active	1350	2025	1B	1
5870-93-9	12	8100	24	5	Active	1620	1944	1B	1
10032-02-7	6	3888	25	0	Inactive	NA	NA	NC/1B	0.5

Individual Classifications by Record

Chemical Identifier	WES	WES_GHS_bin	WES_GHS_sub	WES_GHS_border	MLLP_bin	MLLP_sub	MLLP_GHS_bin	MLLP_GHS_sub	MLLP_GHS_border	MSPE	MSPE_GHS_bin	MSPE_GHS_sub	MSPE_GHS_border	NC	NC/1B	NC/1	1B	1B+	POS	1A-	1A
All	All	All	All	All	All	All	All	All	All	All	All	All	All	All	All	All	All	All	All	All	All
DTXSID8039241	1	1	1B	1B	1B	1	1	1B	1B	2700	1	1B	1B	0	0	0	1	0	0	0	0
Ammoniated mercury	2	1	1A	1A	1A	1	1	1A	1A	93	1	1A	1A	0	0	0	0	0	0	0	1
626-82-4	1	1	1B	1B	1B	1	1	1B	1B	1350	1	1B	1B	0	0	0	1	0	0	0	0

Classification Based on Individual WoE Methods

Chemical Identifier	WoE_sub	WoE_sub Reproducibility	Total Tests (Reproducibility)
All	All	All	All
10124-43-3	1B	100	3
10124-48-8	1B	77.78	18
103-16-2	1B	62.5	24
104-21-2	1B	100	2

Reproducibility of HPPT-based WoE Classifications

- Potency classifications generated can serve as reference data for the evaluation of non-animal skin sensitization tests.
- Providing individual classifications along with overall weight of evidence results can help users characterize uncertainty in the overall result.
- App also estimates classification reproducibility for chemicals, indicating agreement or disagreement with overall classification outcome.

Conclusion

- NICEATM has developed a suite of user-friendly tools to assess skin sensitization hazard and potency
  - Usable for risk assessment and screening
  - Streamlines decision process
- NICEATM will continue to focus on development of computational or other tools to help make regulatory decisions or complex models more available to stakeholders

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The NICEATM Group

UNITED STATES ICCVAM Advancing Alternatives to Animal Testing

Unilever

ICF

inotiv analyze. answer. advance.

Made Monkey, LLC

Integrated Chemical Environment

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