

IVIVE Simulation Examples

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If you have not already read the *Introduction to the ToCS App* vignette, it is highly recommended to do so to get a general idea of the app's layout and obtain a detailed description of common user inputs across all output modules. Users should also review the ToCS README file to setup ToCS if they have not accessed the app yet. This vignette assumes that you have access the ToCS app GUI already.

Introduction

This vignette provides three examples that use the ToCS app to generate oral equivalent doses (OEDs) by in vitro in vivo extrapolation (IVIVE), each example with different parameters selected. Two of the three examples also incorporate chemical exposure data to generate bioactivity exposure ratios for chemical prioritization. To begin, open the app by using any of the methods described in the README file. You have correctly accessed the app if your screen looks like the image below.

The screenshot shows the initial interface of the ToCS app. At the top, there is a navigation bar with tabs: 'Toxicokinetic Chemical Simulator (ToCS)', 'General Parameters' (which is currently selected and underlined), 'Model Specifications', 'Compound Selection', 'Advanced (Optional) Parameters', and 'Run Simulation'. Below the navigation bar, there are three main sections: 'INSTRUCTIONS', 'OUTPUT', and 'SPECIES'. The 'INSTRUCTIONS' section contains text about the four outputs provided by ToCS and links to 'Vignettes (ToCS tutorials)', 'Report ToCS issues/suggestions', 'httk publication', and 'httk CRAN webpage'. The 'OUTPUT' section has a dropdown menu labeled 'Select' with the note 'Must not be equal to Select.' The 'SPECIES' section also has a dropdown menu labeled 'Select' with the note 'Must not be equal to Select.'

The opening interface to the ToCS app.

Example 1

Let's say we want to perform IVIVE for eight chemicals that we have bioactivity data for. Since the IVIVE produces an OED for each bioactive concentration, assume that we want to transform the nominal bioactivity data to a free concentration in vitro. When the solution is outputted, we want the 5th dose quantile human plasma OED calculated from the pbtk model. Assume that we also have chemical exposure estimates for all eight chemicals.

General Parameters Tab

Since we want to perform IVIVE, we select the *In vitro in vivo extrapolation (IVIVE)* option under the drop down menu from the *Output* card. Then under the *Species* card, we select *Human* for the first drop down. Thus, the completed *General Parameters* tab should look like the image below.

The screenshot shows the 'General Parameters' tab of the ToCS application. The top navigation bar includes links for 'General Parameters' (which is active), 'Model Specifications', 'Compound Selection', 'Advanced (Optional) Parameters', and 'Run Simulation'. The 'INSTRUCTIONS' section contains general usage information and links to 'Vignettes (ToCS tutorials)', 'Report ToCS issues/suggestions', 'httk publication', and 'httk CRAN webpage'. The 'OUTPUT' section has a dropdown menu set to 'In vitro in vivo extrapolation (IVIVE)'. The 'SPECIES' section has a dropdown menu set to 'Human'.

The completed General Parameters tab for example 1.

Model Specifications Tab

There are several user choices to be made under the *Model* card. Since we want to use the pbtk model for IVIVE, we select *pbtk* for the first drop down. For the second drop down we select *No* and decide to not make compounds with only in silico generated parameters for hepatic clearance or fraction unbound in plasma available for this example. Then, the third drop down menu asks the user whether they want to return a single OED per compound (a selected quantile) or all OED samples per compound. Since we only want the 5th OED quantile (95th steady state concentration quantile), we select *Only return a specified dose quantile (default)*. This prompts the appearance of an additional numeric input box where we want to enter the desired steady state concentration

quantile. Since we want the 95th steady state concentration quantile (5th OED quantile), we leave the input as 0.95. Under the *Dosing* card, we see that there are no user specifications to be made for this module. Thus, the completed *Model Specifications* tab should look like the image below.

Toxicokinetic Chemical Simulator (ToCS) General Parameters **Model Specifications** Compound Selection Advanced (Optional) Parameters Run Simulation

MODEL

Select the model to simulate. If a species other than 'Human' is selected, '3compartments' must be chosen.
pbtk

Select whether to use in silico generated parameters for compounds with missing in vitro data. These parameters will not overwrite existing in vitro data, and it will expand the number of compounds available.
No, do not load in silico parameters

Select whether to return all oral equivalent dose (OED) samples for each compound or a selected quantile.
Only return a specified dose quantile (default)

Enter the steady state concentration quantile (as a decimal) to be used in the OED calculation. Selecting the 95th concentration quantile will output the 5th OED quantile.
0.95

DOSING

No options for this category.

The completed model specifications tab for example 1 showing the model card.

Compound Selection Tab

Different from the other modules and vignettes, the first drop down menu under the *Preloaded Compounds* card has the user select a set of assumptions to implement regarding in vitro and in vivo bioactivity as well as metabolic clearance. The user can select from the following options:

- NULL:
 - Default assumptions applied (listed below) or customizable in the Advanced Parameters tab
 - Restrictive metabolic clearance (protein binding taken into account in liver clearance)
 - Treats the total specified concentration or tissue as bioactive in vivo
 - Treats the nominal concentration in vitro as bioactive
- Honda1:
 - Restrictive metabolic clearance (protein binding taken into account in liver clearance)
 - Treats the unbound (free) venous plasma concentration in vivo as bioactive
 - Treats the unbound (free) concentration in vitro as bioactive
- Honda2:
 - Restrictive metabolic clearance (protein binding taken into account in liver clearance)
 - Treats the unbound (free) venous plasma concentration in vivo as bioactive
 - Treats the nominal concentration in vitro as bioactive

- Honda3:
 - Restrictive metabolic clearance (protein binding taken into account in liver clearance)
 - Treats the total venous plasma concentration in vivo as bioactive
 - Treats the nominal concentration in vitro as bioactive
- Honda4:
 - Non-restrictive metabolic clearance (protein binding not taken into account in liver clearance)
 - Treats the total specified tissue concentration in vivo as bioactive
 - Treats the nominal concentration in vitro as bioactive

For more details, see the EPA's httk documentation and/or the following publication (<https://doi.org/10.1371/journal.pone.0217564> (<https://doi.org/10.1371/journal.pone.0217564>)). Since we want to use the unbound (free) concentration in vitro as bioactive instead of the nominal concentration, we select the *Honda1* assumption for the first drop down menu. We then keep the second drop menu in the *Preloaded Compounds* card on *Choose from all available chemicals*. Then, the box below asks for the user to specify the fraction fetal bovine serum. We apply the assumption that it is 0.1 for the bioactivity assays for our desired compounds and leave the box at 0.1. Another box below also appears and contains a list of preloaded compounds that we can select from. We search for the eight compounds that we would like to simulate and see that they are all present in the preloaded list. Thus, we select those compounds. On the *Uploaded Data* card on the right of the interface, there are three datasets that can be uploaded. The first one is if we need to upload any physical-chemical data for compounds we want to simulate that are not available under the preloaded compounds list. However, we do not need to upload anything here because all of the compounds we wanted were already available. The second spot to upload a file is required for IVIVE simulations. Here, we must upload a CSV file with bioactive concentrations (uM units) for each compound selected to simulate. Therefore, we upload the following csv table. Note that the table must have the following exact format.

A csv file with bioactivity data for all eight chemicals. All values were calculated as the 5th percentile of AC50s (active calls only) for each compound, where the list of AC50s was taken from the cHTS assay database from ICE (<https://ice.ntp.niehs.nih.gov/> (<https://ice.ntp.niehs.nih.gov/>)).

ChemicalName	CAS	BioactiveConcentration
Acetamiprid	135410-20-7	7.35400
2,4-db	94-82-6	13.46000
Acephate	30560-19-1	0.05875
Acetochlor	34256-82-1	1.34800
Alachlor	15972-60-8	1.61700
Aldicarb	116-06-3	0.09300
Ametryn	834-12-8	1.08200

ChemicalName	CAS	BioactiveConcentration
Amitraz	33089-61-1	27.49000

The third spot to upload a CSV file is for chemical exposure estimates, which is optional. Uploading this data will allow the user to visualize these exposure estimates against the model-outputted OEDs as well as generate bioactivity exposure ratios, which can guide chemical prioritization for potential risk. Suppose we have the following exposure data file:

A csv file with exposure data (mg/kg BW/day) for all eight chemicals. These exposure estimates were gathered from the EPA CompTox Dashboard. NHANES estimates were used if available. Otherwise, the EPA's SEEM3 model predictions were used.

ChemicalName	CAS	Upper	Median	Lower
Acetamiprid	135410-20-7	2.39e-04	5.99e-07	NA
2,4-db	94-82-6	1.29e-04	1.31e-06	NA
Acephate	30560-19-1	1.40e-06	3.37e-07	4.79e-08
Acetochlor	34256-82-1	2.00e-07	4.93e-08	4.74e-09
Alachlor	15972-60-8	1.40e-06	2.7e-07	NA
Aldicarb	116-06-3	2.39e-03	3.03e-06	NA
Ametryn	834-12-8	1.43e-03	2.23e-06	NA
Amitraz	33089-61-1	9.77e-04	1.24e-06	NA

For help with exposure file formatting, please refer to the *Introduction to ToCS* vignette and/or the *Exposure Data File Folder* under the left-side *Instructions* card on the interface. Following the selection of the compounds to simulate as well as uploading bioactivity and exposure data files, the completed *Compound Selection* page should look like the image below.

INSTRUCTIONS

Click on the appropriate link(s) below to download guidance on how to upload data under the 'Uploaded Data' card. Follow the 'Instructions' document in the downloaded folder to correctly format the file you want to upload.

[Uploaded Physical-Chemical Data File Folder](#)

[Bioactivity Data File Folder](#)

[Exposure Data File Folder](#)

PRELOADED COMPOUNDS

Select an IVIVE assumption to implement. For any input nominal bioactive concentration in vitro, the Honda1 assumption is recommended. Leave on 'NULL' if no assumptions are to be applied. See the 'IVIVE Simulation Examples' vignette for the description of the below assumption categories.

Honda1

Select the types of compounds you want to simulate.

Choose from all available chemicals

Enter the volume fraction of fetal bovine serum used in the in vitro assay.

0.1

Select any preloaded compounds. Search through the list by clicking on the box and scrolling or typing in a name. The list may not show all available compounds. Click on a compound to select it. You may select multiple.

94-82-6, 2,4-dl 30560-19-1, Acephate 135410-20-7, Acetamiprid
34256-82-1, Acetochlor 15972-60-8, Alachlor 116-06-3, Aldicarb
834-12-8, Ametryn 33089-61-1, Amitraz

UPLOADED DATA

Upload a CSV file of physical and chemical data for compounds not in the preloaded list (if desired). Download the 'Uploaded Physical-Chemical Data File Folder' under the 'Instructions' card for file formatting instructions.

Browse... No file selected

Upload a CSV file with in vitro bioactive concentrations (uM units) for all selected compounds. Download the 'Bioactivity Data File Folder' under the 'Instructions' card for file formatting instructions.

Browse... SampleBioData_8Chems.csv Upload complete

Upload a CSV file of exposure data for all selected compounds (optional). Download the 'Exposure Data File Folder' under the 'Instructions' card for file formatting instructions.

Browse... SampleExpData_8Chems.csv Upload complete

The completed compound selection tab for example 1.

Advanced (Optional) Parameters Tab

We will leave all options on this tab at their default values and proceed to the final *Run Simulation* tab. The *Advanced Parameters* tab should look like the image below.

MODEL CONDITIONS Enter the number of Monte Carlo samples generated for each compound. <input type="text" value="1000"/>	MODEL SOLVER No options for this category.	BIOAVAILABILITY Enter a default value for the Caco-2 apical-to-basal membrane permeability (denoted Caco2.Pab, 10^{-6} cm/s). <input type="text" value="1.6"/> Select whether to use the Caco2.Pab value set above to estimate F_abs (the in vivo measured fraction of an oral dose absorbed from the gut lumen into the gut) if bioavailability data is unavailable. <input type="button" value="Use the Caco2.Pab value selected above (default)"/>	OUTPUT SPECIFICATION Select the dose output units from either mg/kg BW/day (mgpkgday) (default) or umol/kg BW/day (umolkpgday). <input type="button" value="mpkpgday"/>
Select whether to adjust the chemical fraction unbound in presence of plasma proteins for lipid binding. <input type="button" value="Yes, adjust the fraction of unbound plasma (default)"/>		Select whether to use regressions when calculating partition coefficients. <input type="button" value="Use regressions (default)"/>	
Enter the p-value threshold for the in vitro intrinsic hepatic clearance rate where clearance assay results with p-values above this threshold are set to zero. <input type="text" value="0.05"/>		Select whether to use the Caco2.Pab value set above to calculate F_gut (the in vivo measured fraction of an oral dose that passes gut metabolism and clearance) if bioavailability data is unavailable. <input type="button" value="Use the Caco2.Pab value selected above (default)"/>	
Enter the minimum acceptable chemical fraction unbound in presence of plasma proteins. All values below this will be set to this value. <input type="text" value="0.0001"/>		Select whether to overwrite in vivo F_abs and F_gut data (if available). <input type="button" value="Do not overwrite in vivo values (default)"/>	
		Select whether to keep F_abs and F_gut at 100% availability (which overwrites all other bioavailability parameter settings above). <input type="button" value="Do not keep Fabs and Fgut at 100% availability (default)"/>	

The completed advanced parameters tab for example 1.

Run Simulation Tab

Now that all user parameter selections have been made and all compounds appear under the *Select Compounds* card, we click the *Run Simulation* button. Once the simulation is complete, the user's interface should look like the image below. The first tab shows a table of the OED for each compound. The table is available for download by the user if the user clicks the *Download Table 1* button. The user is also able to download all of the simulation parameters and chemical information used in the simulation by clicking the *Download OED Simulation Parameters* tab.

ACTIONS

Click on the 'Run Simulation' button when all information has been entered.

Run Simulation

Click on the button below to reset your session. This will clear all selections and any uploaded data, and is recommended to be done every time a new simulation is run.

Reset Session

Check the box to display plots with a log10 scale y-axis.

SELECTED COMPOUNDS

Selected_Compounds
2,4-db
Acephate
Acetamiprid
Acetochlor
Alachlor
Aldicarb
Ametryn
Amitraz

RESULTS

Oral Equivalent Dose Table

[Download Table 1](#) [Download OED Simulation Parameters](#)

Show 10 entries

Search:

CompoundName	CAS	OED
1 2,4-db	94-82-6	0.00225
2 Acephate	30560-19-1	0.003722
3 Acetamiprid	135410-20-7	0.2441
4 Acetochlor	34256-82-1	0.4636
5 Alachlor	15972-60-8	0.217
6 Aldicarb	116-06-3	0.005384
7 Ametryn	834-12-8	0.002732
8 Amitraz	33089-61-1	0.003962

Showing 1 to 8 of 8 entries

Table 1: Table of the IVIVE oral equivalent doses (OED) (mgpkgday) for each selected compound.

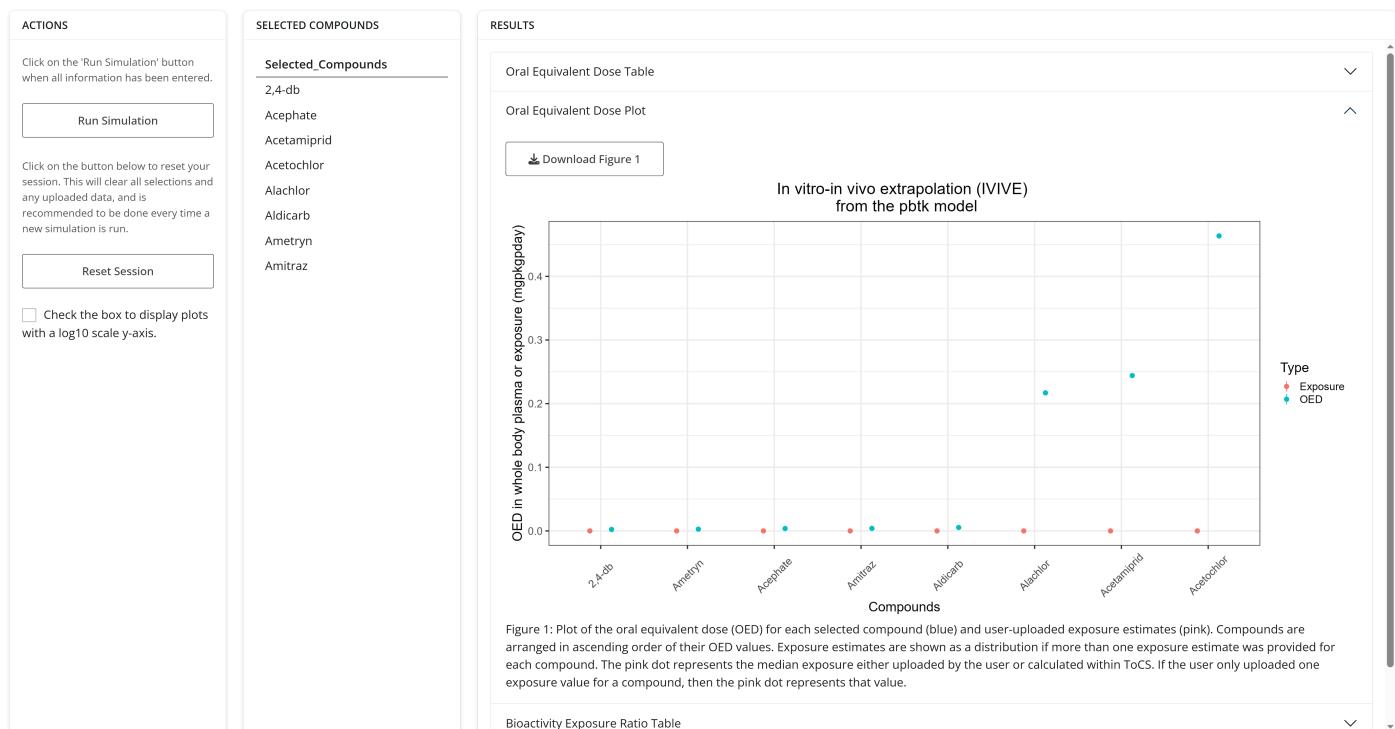
Oral Equivalent Dose Plot

Bioactivity Exposure Ratio Table

Bioactivity Exposure Ratio Plot

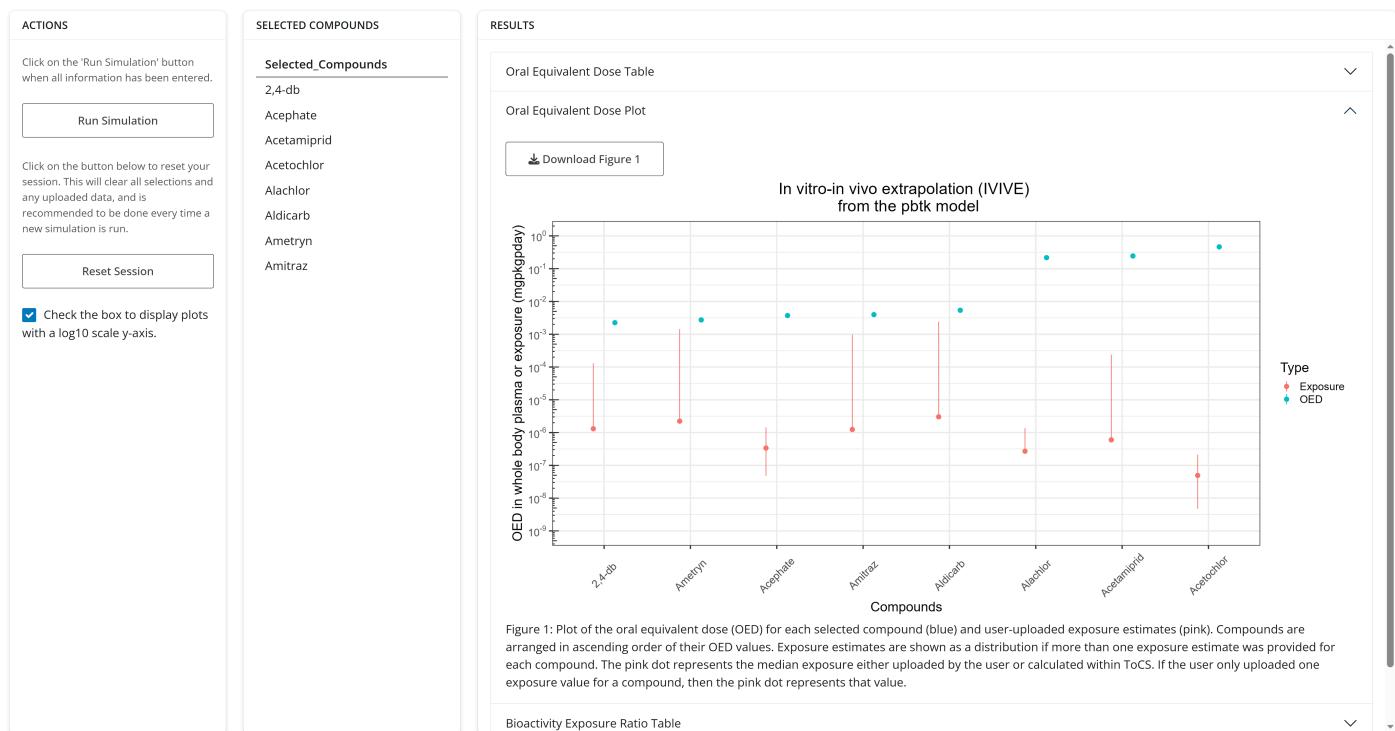
The completed run simulation tab for example 1 showing the expanded OED table tab.

The image below is the completed OED plot tab, which shows the OED (in blue) for the selected quantile for each compound plotted in ascending order. The plot also shows the exposure data estimates (in pink) from the uploaded exposure data file next to each respective chemical so users can compare the oral equivalent dose needed for bioactivity and the exposure estimate. The plot shown below uses a linear y-axis, but as we can see, this makes it challenging to visually see the difference between the smaller OEDs as well as the distribution for the exposure estimates.



The completed run simulation tab for example 1 showing the expanded OED plot tab where the plot has a linear scale y-axis.

Therefore, we can click the box under the *Actions* card to change the scale of the y-axis to a log10 scale. That then results in the image shown below, which allows the user to view the differences in magnitudes of all OEDs and exposure estimates. Two chemicals have three exposure estimates available (lower, median, and upper), which is clearly seen by the median pink dot with bars extending in both directions, while the remaining chemicals only have two exposure estimates uploaded (median and upper). Those chemicals show a pink dot which represents the median exposure and one bar which reaches the upper exposure limit. The user can download either the linear or log10 scale plot by clicking the *Download Figure 1* button.



The completed run simulation tab for example 1 showing the expanded OED plot tab where the plot has a log10 scale y-axis.

The image below shows the bioactivity exposure ratio (BER) table output for the calculated OEDs and uploaded exposure estimates. This is computed as the OED divided by the upper exposure estimate. As with Table 1, users can download this table by clicking the "Download Table 2" button.

ACTIONS

Click on the 'Run Simulation' button when all information has been entered.

Run Simulation

Click on the button below to reset your session. This will clear all selections and any uploaded data, and is recommended to be done every time a new simulation is run.

Reset Session

Check the box to display plots with a log10 scale y-axis.

SELECTED COMPOUNDS

Selected_Compounds
2,4-db
Acephate
Acetamiprid
Acetochlor
Alachlor
Aldicarb
Ametryn
Amitraz

RESULTS

Oral Equivalent Dose Table

Oral Equivalent Dose Plot

Bioactivity Exposure Ratio Table

Download Table 2

Show 10 entries

Search: _____

CompoundName	BER
1 2,4-db	17.44
2 Acephate	2585
3 Acetamiprid	1021
4 Acetochlor	2197000
5 Alachlor	158400
6 Aldicarb	2.253
7 Ametryn	1.91
8 Amitraz	4.055

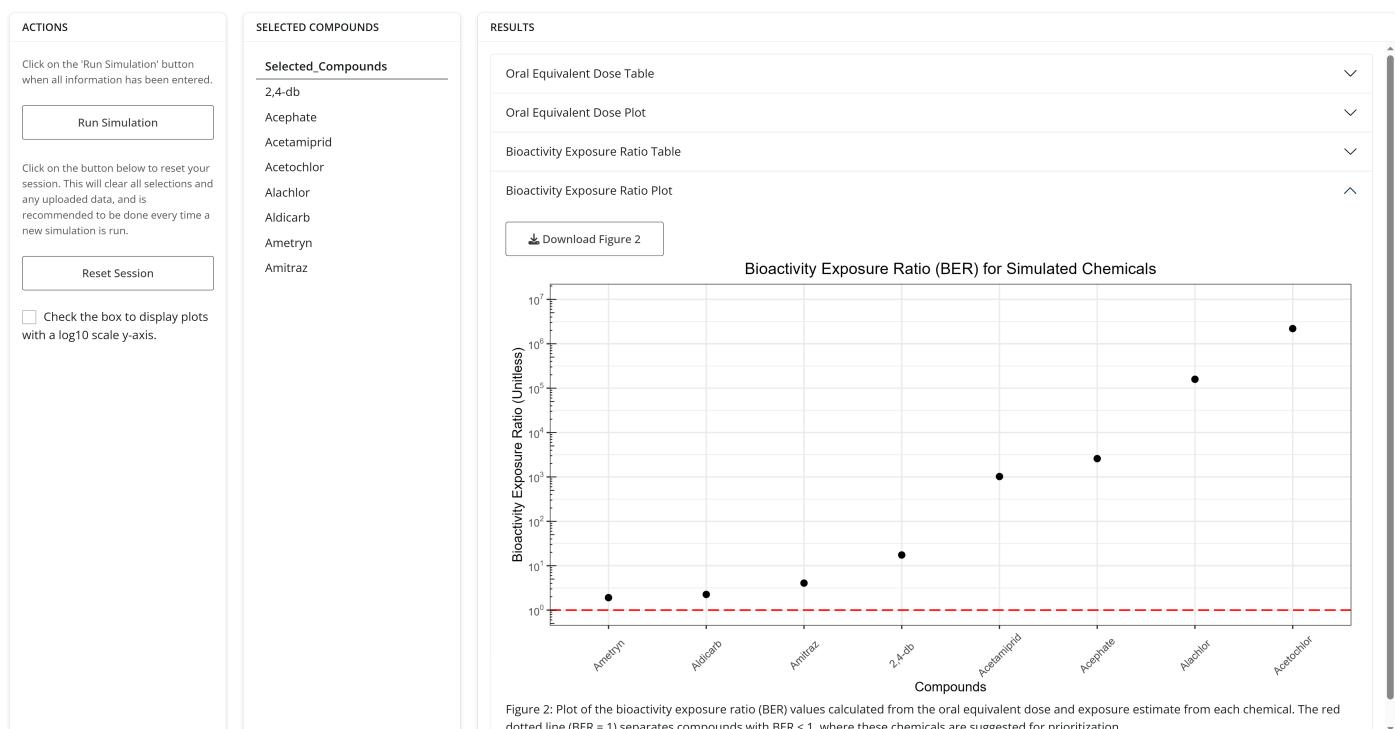
Showing 1 to 8 of 8 entries

Table 2: Table of the bioactivity exposure ratio (BER) for each selected compound.

Bioactivity Exposure Ratio Plot

The completed run simulation tab for example 1 showing the expanded bioactivity exposure ratio (BER) table tab.

The final output for the IVIVE module is given below and shows a plot of the BER for each chemical. The red dotted line on the plot indicates the threshold for chemical prioritization (BER = 1), where any chemicals that fall below that threshold should be prioritized for further assessment. In this simulation though, all BERs are greater than one. As with the previous plot, the user has the opportunity to download this plot by clicking the "Download Figure 2" button above the plot.



The completed run simulation tab for example 1 showing the expanded BER plot tab where the plot has a log10 scale y-axis.

If we wanted to run another simulation, we would click the *Reset Session* button under the *Actions* button, which would clear all parameter inputs and simulations and return the interface to the *General Parameters* tab.

Example 2

Let's say we want to perform human IVIVE for ten chemicals that we have bioactivity data for. Assume that we want to use the nominal plasma in vitro bioactivity data as the bioactive concentration instead of the free concentration in vitro, and we want to use restrictive clearance. When the solution is outputted, suppose that we want to view all generated plasma OED samples calculated from the 3compartments model. Also suppose that we have chemical exposure estimates for all ten chemicals and would like to use them for this analysis.

General Parameters Tab

Since we want to perform IVIVE, we select the *In vitro in vivo extrapolation (IVIVE)* option under the drop down menu from the *Output* card. Then under the *Species* card, we select *Human* for the first drop down. Thus, the completed *General Parameters* tab should look like the image below.

INSTRUCTIONS <p>Fill out the prompts on each of the above tabs moving left to right. Then, click the 'Run Simulation' tab to run the simulation or reset all selections.</p> <p>ToCS provides four outputs: 1) Concentration-time profiles (returns chemical concentrations in body compartments over time), 2) Steady state (SS) concentration (returns SS concentrations in body compartments from an oral infusion), 3) In vitro to in vivo extrapolation (IVIVE) (returns oral equivalent doses to in vitro bioactive concentrations), 4) Parameter calculations (returns elimination rates, volumes of distribution, tissue to unbound plasma partition coefficients, half-lives, and total plasma clearances).</p> <p>This application uses the U.S. EPA's R package 'httk'. For more information on ToCS and 'httk', please refer to the following links.</p> <p>Vignettes (ToCS tutorials)</p> <p>Report ToCS issues/suggestions</p> <p>httk publication</p> <p>httk CRAN webpage</p>	OUTPUT <p>Select the desired output.</p> <div style="border: 1px solid #ccc; padding: 2px; width: 100%;">In vitro in vivo extrapolation (IVIVE)</div>	SPECIES <p>Select the species to analyze.</p> <div style="border: 1px solid #ccc; padding: 2px; width: 100%;">Human</div>
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The completed General Parameters tab for example 2.

Model Specifications Tab

Under the *Model* card, we select **3compartments** for the first drop down. For the second drop down, we select **Yes** and decide to make compounds with only in silico generated parameters (hepatic clearance, fraction unbound in plasma) also available for this example. Then, the third drop down menu asks the user whether they want to return a single OED per compound (a selected quantile) or all OED samples per compound. Since we want to output all generated OED samples, we select **Return all OED samples (will also return the 5th dose quantile)**. Under the *Dosing* card, there are no options to select from. Thus, the completed *Model Specifications* tab should look like the image below.

MODEL

Select the model to simulate. If a species other than 'Human' is selected, '3compartments' must be chosen.

3compartments

Select whether to use in silico generated parameters for compounds with missing in vitro data. These parameters will not overwrite existing in vitro data, and it will expand the number of compounds available.

Yes, load in silico parameters

Select whether to return all oral equivalent dose (OED) samples for each compound or a selected quantile.

Return all OED samples (will also return the 5th dose quantile)

DOSING

No options for this category.

The completed model specifications tab for example 2.

Compound Selection Tab

As with the first example, the first drop down menu under the *Preloaded Compounds* card has the user select a set of simulations assumptions to implement. See example 1 above for descriptions of the assumptions. Since we want to use the nominal concentration in vitro as bioactive and restrictive clearance (protein binding taking into account in liver clearance), we select NULL for the first drop down menu (note that we could have also selected Honda3 for the same result). We keep the second drop menu in the *Preloaded Compounds* card on *Choose from all available chemicals* and then the box below contains a list of preloaded compounds that we can select from. We search for the ten compounds we want to simulate and see that they are all present in the preloaded list. Thus, we select those compounds. Under the *Uploaded Data* card, we ignore the first file selection option since all compounds to simulate were found in the preloaded compounds list. Then for the second file selection option, we are required to upload a CSV file with bioactivity data in it for each selected compound. Therefore, we upload the following csv table. The csv file must have the exact format as the table below.

A csv file with bioactivity data for all ten chemicals. All values were calculated as the 5th percentile of AC50s (active calls only) for each compound, where the list of AC50s was taken from the cHTS assay database from ICE. Abamectin did not have any AC50s, so one was entered to fill the data set.

ChemicalName	CAS	BioactiveConcentration
Acetamiprid	135410-20-7	7.35400

ChemicalName	CAS	BioactiveConcentration
2,4-db	94-82-6	13.46000
Acephate	30560-19-1	0.05875
Abamectin	71751-41-2	1.00000
Acetochlor	34256-82-1	1.34800
Alachlor	15972-60-8	1.61700
Aldicarb	116-06-3	0.09300
Ametryn	834-12-8	1.08200
Amitraz	33089-61-1	27.49000
Atrazine	1912-24-9	1.30200

For formatting instructions, please either download the *Bioactivity Data File Folder* on the left side of the page or consult the *Introduction to ToCS* vignette. The final file upload option under the *Uploaded Data* card provides the user the opportunity to upload chemical exposure data. Thus, we upload the following CSV file:

A csv file with exposure estimate data (mg/kg BW/day) for all ten chemicals. These exposure estimates were gathered from the EPA CompTox Dashboard. NHANES estimates were used if available. Otherwise, the EPA's SEEM3 and SEEM2 model predictions were used.

ChemicalName	CAS	Upper	Median	Lower
Acetamiprid	135410-20-7	2.39e-04	5.99e-07	NA
2,4-db	94-82-6	1.29e-04	1.31e-06	NA
Acephate	30560-19-1	1.40e-06	3.37e-07	4.79e-08
Acetochlor	34256-82-1	2.00e-07	4.93e-08	4.74e-09
Alachlor	15972-60-8	1.40e-06	2.7e-07	NA
Aldicarb	116-06-3	2.39e-03	3.03e-06	NA
Ametryn	834-12-8	1.43e-03	2.23e-06	NA

ChemicalName	CAS	Upper	Median	Lower
Amitraz	33089-61-1	9.77e-04	1.24e-06	NA
Abamectin	71751-41-2	1.24e-05	4.17e-08	NA
Atrazine	1912-24-9	4.00e-07	5.76e-08	2.81e-09

For more details on the format of this file, please review the *Introduction to ToCS* vignette and/or the Exposure Data File Folder below the upload area in the interface. The completed *Compound Selection* tab should look like the images below.

Toxicokinetic Chemical Simulator (ToCS) General Parameters Model Specifications **Compound Selection** Advanced (Optional) Parameters Run Simulation

INSTRUCTIONS
Click on the appropriate link(s) below to download guidance on how to upload data under the 'Uploaded Data' card. Follow the 'Instructions' document in the downloaded folder to correctly format the file you want to upload.

[Uploaded Physical-Chemical Data File Folder](#)
[Bioactivity Data File Folder](#)
[Exposure Data File Folder](#)

PRELOADED COMPOUNDS
Select an IVIVE assumption to implement. For any input nominal bioactive concentration *in vitro*, the Honda1 assumption is recommended. Leave on 'NULL' if no assumptions are to be applied. See the 'IVIVE Simulation Examples' vignette for the description of the below assumption categories.

NULL

Select the types of compounds you want to simulate.
Choose from all available chemicals

Select any preloaded compounds. Search through the list by clicking on the box and scrolling or typing in a name. The list may not show all available compounds. Click on a compound to select it. You may select multiple.

94-82-6, 2,4-db 71751-41-2, Abamectin 30560-19-1, Acephate 135410-20-7, Acetamiprid 34256-82-1, Acetochlor 15972-60-8, Alachlor 116-06-3, Aldicarb 834-12-8, Ametryn 33089-61-1, Amitraz 1912-24-9, Atrazine

UPLOADED DATA
Upload a CSV file of physical and chemical data for compounds not in the preloaded list (if desired). Download the 'Uploaded Physical-Chemical Data File Folder' under the 'Instructions' card for file formatting instructions.

Browse... No file selected

Upload a CSV file with *in vitro* bioactive concentrations (uM units) for all selected compounds. Download the 'Bioactivity Data File Folder' under the 'Instructions' card for file formatting instructions.

Browse... SampleBioData_10Chems.csv Upload complete

Upload a CSV file of exposure data for all selected compounds (optional). Download the 'Exposure Data File Folder' under the 'Instructions' card for file formatting instructions.

Browse... SampleExpData_10Chems.csv Upload complete

The completed compound selection tab for example 2.

Advanced (Optional) Parameters Tab

To speed up the computation time of the program, let's change the number of Monte Carlo samples generated for each compound (under the *Model Conditions* card) from 1000 to 500. Also, since we want to output the plasma OED, we keep the second drop down menu as *plasma* under the '*Output Specification*' card. Thus, the completed *Advanced Parameters* tab should look like the image below.

MODEL CONDITIONS Enter the number of Monte Carlo samples generated for each compound. <input type="text" value="500"/>	MODEL SOLVER No options for this category.	BIOAVAILABILITY Enter a default value for the Caco-2 apical-to-basal membrane permeability (denoted Caco2.Pab, 10^{-6} cm/s). <input type="text" value="1.6"/> Select whether to use the Caco2.Pab value set above to estimate F_abs (the in vivo measured fraction of an oral dose absorbed from the gut lumen into the gut) if bioavailability data is unavailable. <input type="checkbox"/> Use the Caco2.Pab value selected above (default)	OUTPUT SPECIFICATION Select the dose output units from either mg/kg BW/day (mgpkgday) (default) or umol/kg BW/day (umolpkgday). <input type="text" value="mpkgday"/> Select the output concentration type. <input type="text" value="plasma"/> Select a tissue you want the output concentration in. Leave on 'NULL' if the whole body concentration is desired. <input type="text" value="NULL"/>
Select which chemical concentration is treated as bioactive in vivo. <input type="text" value="Total chemical concentration (default)"/>	Select whether protein binding is taken into account in liver clearance. <input type="text" value="Yes, include protein binding (default)"/>	Select whether to adjust the chemical fraction unbound in presence of plasma proteins for lipid binding. <input type="text" value="Yes, adjust the fraction of unbound plasma (default)"/>	Select whether to use regressions when calculating partition coefficients. <input type="text" value="Use regressions (default)"/>
Select the p-value threshold for the in vitro intrinsic hepatic clearance rate where clearance assay results with p-values above this threshold are set to zero. <input type="text" value="0.05"/>	Select the minimum acceptable chemical fraction unbound in presence of plasma proteins. All values below this will be set to this value. <input type="text" value="0.0001"/>	Select whether to use the Caco2.Pab value set above to calculate F_gut (the in vivo measured fraction of an oral dose that passes gut metabolism and clearance) if bioavailability data is unavailable. <input type="checkbox"/> Use the Caco2.Pab value selected above (default) Select whether to overwrite in vivo F_abs and F_gut data (if available). <input type="checkbox"/> Do not overwrite in vivo values (default) Select whether to keep F_abs and F_gut at 100% availability (which overwrites all other bioavailability parameter settings above). <input type="checkbox"/> Do not keep Fabs and Fgut at 100% availability (default)	

The completed advanced parameters tab for example 2.

Run Simulation Tab

Now that all user parameter selections have been made and all compounds appear under the *Select Compounds* card, we click the *Run Simulation* button. Once the simulation is complete, the user's interface should look like the image below. The first tab shows a table of all generated OEDs for each compound (based on different steady state concentrations obtained from Monte Carlo simulations). The first row of the table contains the 5th quantile plasma OED, and then the rows below indicate the sample number and corresponding plasma OED from that sample. The user can view the various pages of samples by clicking the *Next* button at the bottom of the table. The table is available for download by the user if the user clicks the *Download Table 1* button. The user is also able to download all of the simulation parameters and chemical information used in the simulation by clicking the *Download OED Simulation Parameters* tab.

ACTIONS

Click on the 'Run Simulation' button when all information has been entered.

Run Simulation

Click on the button below to reset your session. This will clear all selections and any uploaded data, and is recommended to be done every time a new simulation is run.

Reset Session

Check the box to display plots with a log10 scale y-axis.

SELECTED COMPOUNDS

Selected_Compounds

2,4-db
Abamectin
Acephate
Acetamiprid
Acetochlor
Alachlor
Aldicarb
Ametryn
Amitraz
Atrazine

RESULTS

Oral Equivalent Dose Table

[Download Table 1](#)

[Download OED Simulation Parameters](#)

Show 10 entries

	2,4-db	Abamectin	Acephate	Acetamiprid	Acetochlor	Alachlor	Aldicarb	Ametryn	Amitraz	Atrazine
OED_5	0.008025	0.04854	0.003466	0.3011	1.182	0.5617	0.004157	0.005046	0.4637	0.01305
Samples										
1	0.1276	1.311	0.03361	3.27	16.11	1.702	0.04332	0.09272	7.202	0.1024
2	0.03722	0.2579	0.01065	0.8801	23.87	5.726	0.01645	0.007401	1.737	0.02804
3	0.03004	0.5247	0.04298	2.506	1.977	4.621	0.02394	0.007326	3.69	0.09782
4	0.005985	0.6309	0.0171	1.601	11.68	6.344	0.0034	0.09713	4.876	0.007193
5	0.03714	0.3282	0.02479	2.47	2.391	5.69	0.01132	0.01311	1.892	0.03947
6	0.02485	0.1578	0.003654	0.2998	10.71	0.9167	0.01667	0.01785	4.046	0.01686
7	0.01343	0.1501	0.01532	0.8448	4.173	2.818	0.01113	0.05037	55.01	0.02208
8	0.03993	0.1235	0.02661	1.932	4.421	2.702	0.01361	0.01878	0.8943	0.06439

Showing 1 to 10 of 502 entries

Table 1: Table of 500 IVIVE oral equivalent dose (OED) samples (mgpkg/day) for each selected compound. OED_5 represents the 5th OED quantile (using the 95th percentile steady state concentration).

[Previous](#) [1](#) [2](#) [3](#) [4](#) [5](#) ... [51](#) [Next](#)

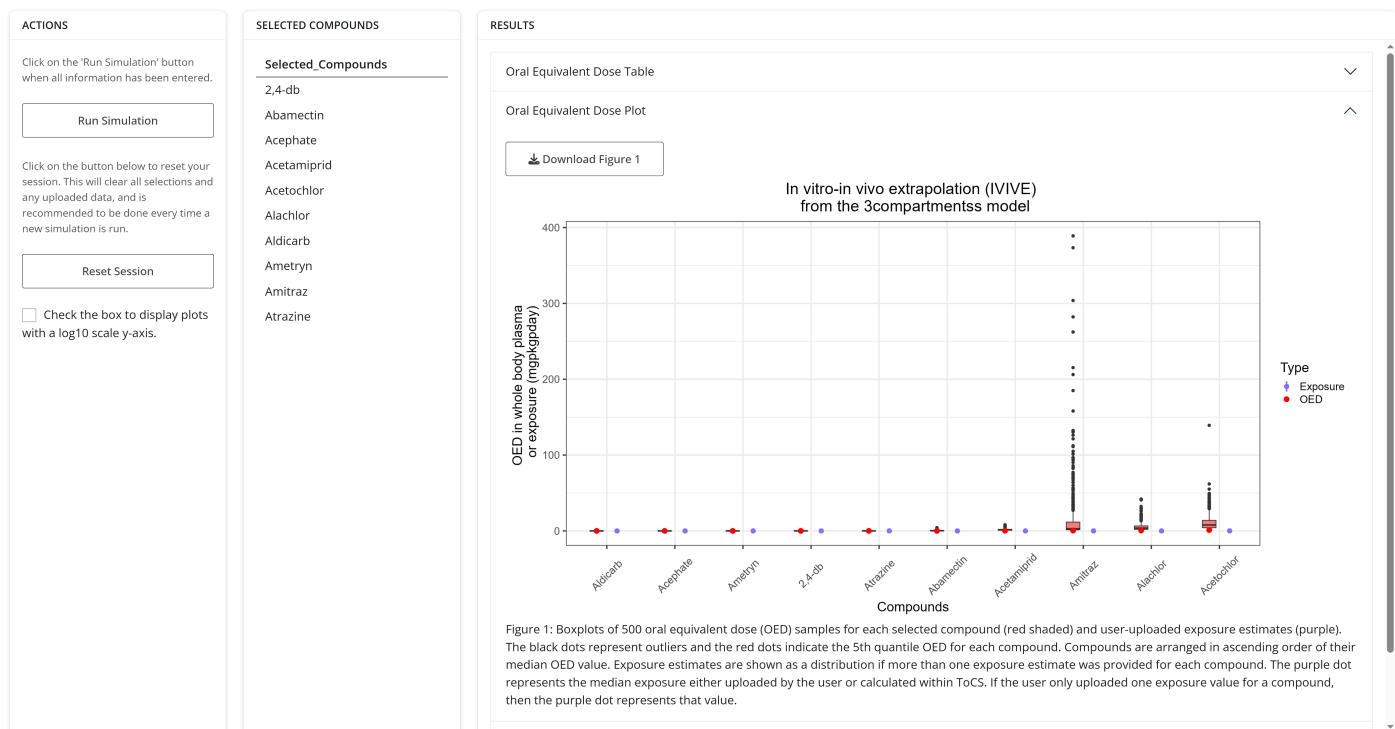
Oral Equivalent Dose Plot

Bioactivity Exposure Ratio Table

Bioactivity Exposure Ratio Plot

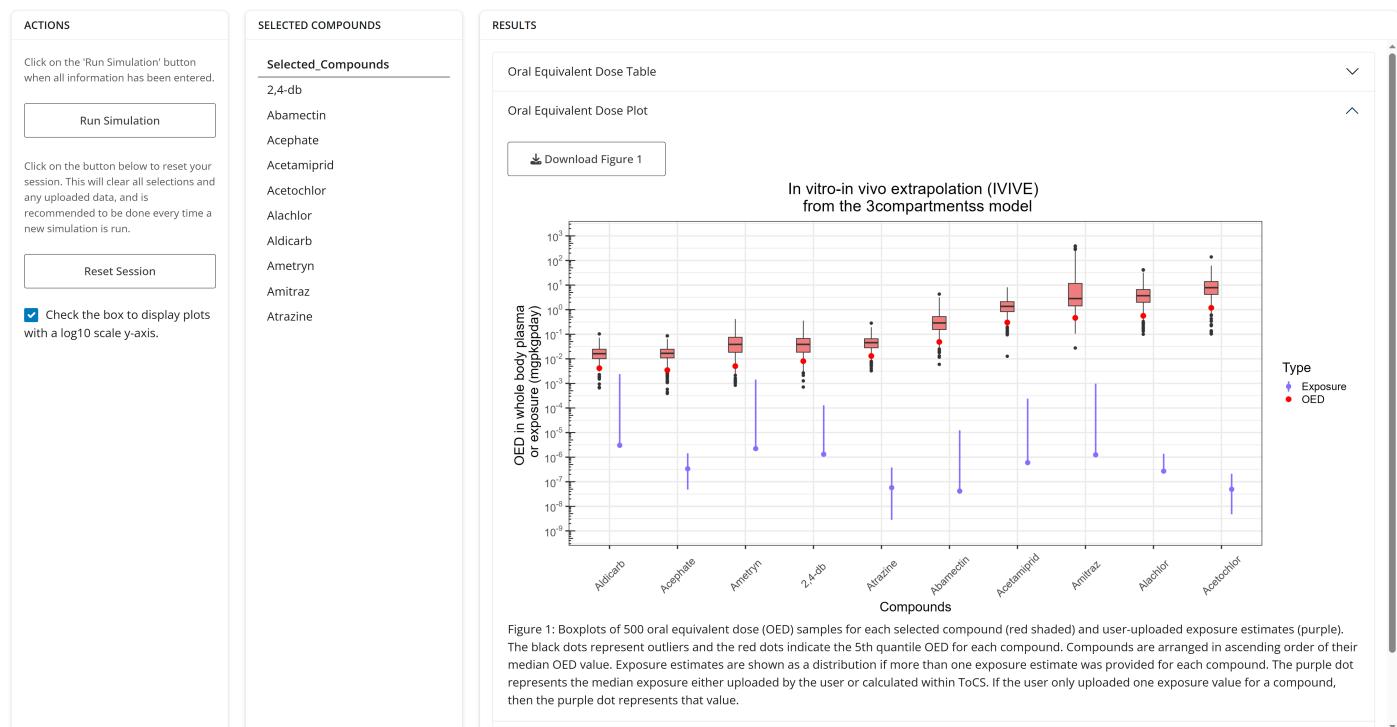
The completed run simulation tab for example 2 showing the expanded OED table tab.

The image below is the completed OED plot tab, which shows boxplots describing the distribution of all OED samples for each simulated compound with line ranges of exposure estimate distributions (in purple) next to each chemical (though they look like singular points due to the linear y-axis). The black dots are outlying samples, and the large red dots represent the 5th quantile OED from the OED table in the previous drop down tab. The plot shown below uses a linear y-axis, but as we can see, this makes it challenging to visually see the distribution of OED samples and all exposure estimates.



The completed run simulation tab for example 2 showing the expanded OED plot tab where the OED plot has a linear scale y-axis and showcases the OED distributions against the chemical exposure estimate distributions.

Therefore, we can click the box under the *Actions* card to change the scale of the y-axis to a log10 scale. That then results in the image shown below, which allows the user to clearly view and compare the OED sample distributions and exposure estimates of all compounds. The description of the exposure estimates is the same as in example 1. The user can download either the linear or log10 scale plot by clicking the *Download Figure 1* button.



The completed run simulation tab for example 2 showing the expanded OED plot tab where the plot has a log10 scale y-axis.

The table below shows the calculated bioactivity exposure ratios (BERs) for the chemicals included in the simulation with exposure data. The BER was calculated as the quotient of the 5th quantile OED (red dot from the OED plot) and the upper exposure estimate data point. Users can download the table by clicking the *Download Table 2* button above the table.

ACTIONS

Click on the 'Run Simulation' button when all information has been entered.

Run Simulation

Click on the button below to reset your session. This will clear all selections and any uploaded data, and is recommended to be done every time a new simulation is run.

Reset Session

Check the box to display plots with a log10 scale y-axis.

SELECTED COMPOUNDS

Selected_Compounds

- 2,4-db
- Abamectin
- Acephate
- Acetamiprid
- Acetochlor
- Alachlor
- Aldicarb
- Ametryn
- Amitraz
- Atrazine

RESULTS

Oral Equivalent Dose Table

Oral Equivalent Dose Plot

Bioactivity Exposure Ratio Table

Download Table 2

Show 10 entries

Search: _____

CompoundName	BER
1 2,4-db	62.21
2 Abamectin	3915
3 Acephate	2407
4 Acetamiprid	1260
5 Acetochlor	5602000
6 Alachlor	410000
7 Aldicarb	1.739
8 Ametryn	3.529
9 Amitraz	474.6
10 Atrazine	34250

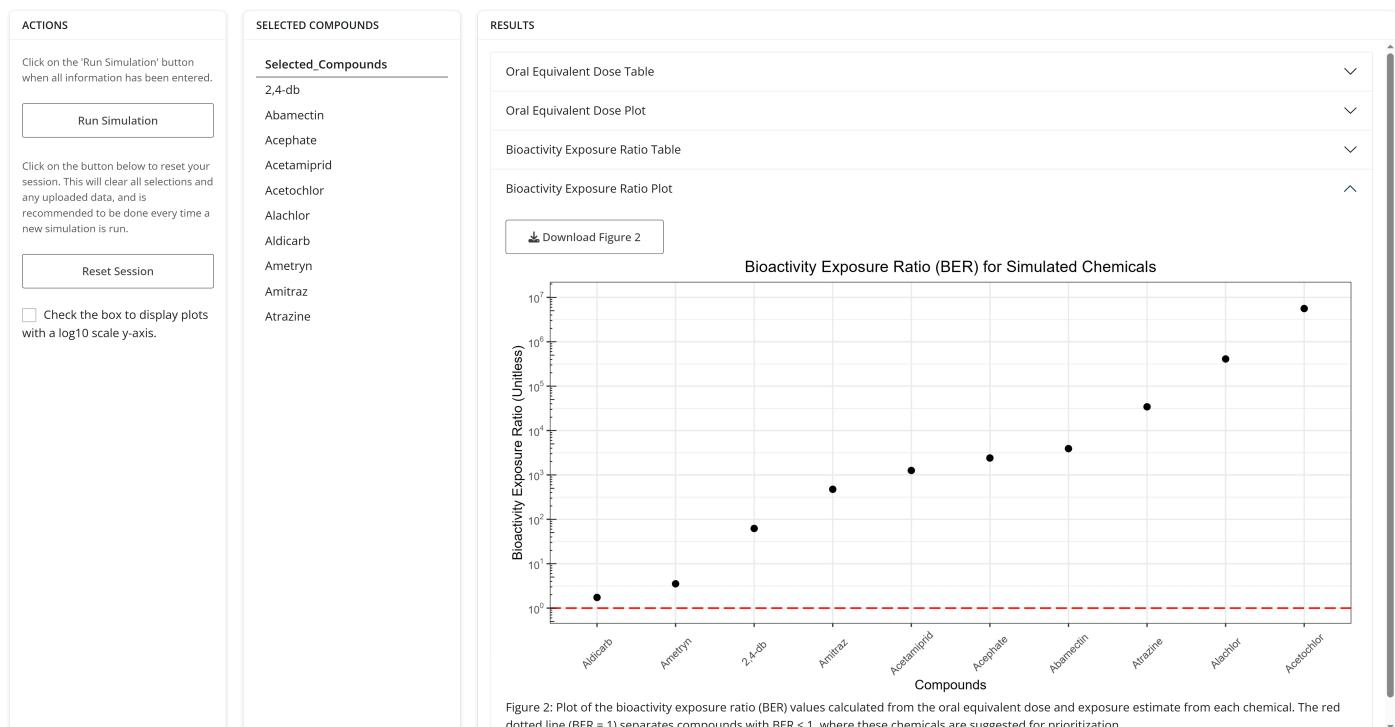
Showing 1 to 10 of 10 entries

Table 2: Table of the bioactivity exposure ratio (BER) for each selected compound.

Bioactivity Exposure Ratio Plot

The completed run simulation tab for example 2 showing the expanded BER table tab.

The image below shows the final output of the IVIVE module which is a plot of the bioactivity exposure ratio (BER) for each chemical. As we can see from the plot, all BERs in this simulation are > 1 (visually seen by the dotted red line), so they are not considered a risk with the current data used in the simulation. However, the user may want to use a different threshold for determining risk. Users can download this plot by clicking the *Download Figure 2* button above the plot.



The completed run simulation tab for example 2 showing the expanded BER plot tab where the plot has a log10 scale y-axis.

If we wanted to run another simulation, we would click the *Reset Session* button under the *Actions* button, which would clear all parameter inputs and simulations and return the interface to the *General Parameters* tab.

Example 3

Let's say that we want to perform human IVIVE to obtain 10th quantile liver OEDs using the 3compartment model. We will use the nominal bioactivity data for the eight compounds used in example 1, and want to include restrictive clearance in the model. We will not upload chemical exposure data for this example.

General Parameters Tab

Since we want to perform IVIVE, we select the *In vitro in vivo extrapolation (IVIVE)* option under the drop down menu from the *Output* card. Then under the *Species* card, we select *Human* for the first drop down. Thus, the completed *General Parameters* tab should look like the image below.

INSTRUCTIONS <p>Fill out the prompts on each of the above tabs moving left to right. Then, click the 'Run Simulation' tab to run the simulation or reset all selections.</p> <p>ToCS provides four outputs: 1) Concentration-time profiles (returns chemical concentrations in body compartments over time), 2) Steady state (SS) concentration (returns SS concentrations in body compartments from an oral infusion), 3) In vitro to in vivo extrapolation (IVIVE) (returns oral equivalent doses to in vitro bioactive concentrations), 4) Parameter calculations (returns elimination rates, volumes of distribution, tissue to unbound plasma partition coefficients, half-lives, and total plasma clearances).</p> <p>This application uses the U.S. EPA's R package 'httk'. For more information on ToCS and 'httk', please refer to the following links.</p> <p>Vignettes (ToCS tutorials)</p> <p>Report ToCS issues/suggestions</p> <p>httk publication</p> <p>httk CRAN webpage</p>	OUTPUT <p>Select the desired output.</p> <div style="border: 1px solid #ccc; padding: 2px; width: 100%;">In vitro in vivo extrapolation (IVIVE)</div>	SPECIES <p>Select the species to analyze.</p> <div style="border: 1px solid #ccc; padding: 2px; width: 100%;">Human</div>
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The completed General Parameters tab for example 3.

Model Specifications Tab

Under the *Model* card, we select **3compartment** for the first drop down. For the second drop down, we select **No** and decide to make compounds with only in vitro data available for this example. Then, the third drop down menu asks the user whether they want to return a single OED per compound (a selected quantile) or all OED samples per compound. Since we want to output the 10th quantile OED, we select **Only return a specified dose quantile (default)**. This results in the appearance of another input box. In this final box under the *Model* card, we enter the steady state concentration quantile that we desire to use in our OED calculation (0.90). This will return the 10th quantile OED in the simulation results. Under the *Dosing* card, there are no options to select from. Thus, the completed *Model Specifications* tab should look like the image below.

MODEL

Select the model to simulate. If a species other than 'Human' is selected, '3compartmentss' must be chosen.

3compartment

Select whether to use in silico generated parameters for compounds with missing in vitro data. These parameters will not overwrite existing in vitro data, and it will expand the number of compounds available.

No, do not load in silico parameters

Select whether to return all oral equivalent dose (OED) samples for each compound or a selected quantile.

Only return a specified dose quantile (default)

Enter the steady state concentration quantile (as a decimal) to be used in the OED calculation. Selecting the 95th concentration quantile will output the 5th OED quantile.

DOSING

No options for this category.

The completed model specifications tab for example 3.

Compound Selection Tab

As with the first example, the first drop down menu under the *Preloaded Compounds* card has the user select a set of simulations assumptions to implement. See example 1 for descriptions of the assumptions. As with example 2, we will select NULL for the first drop down menu since we wanted to use 1) the nominal in vitro concentration as bioactive, 2) restrictive clearance, and 3) liver tissue as bioactive in vivo. We keep the second drop menu in the *Preloaded Compounds* card on *Choose from all available chemicals* and then in the box below that, there's a list of preloaded compounds that we can select from. We search for the eight compounds that we want to select and see that they are all present in the preloaded list. Thus, we select those compounds. Under the *Uploaded Data* card, we ignore the first file upload option since all of the compounds we want to simulate are available under the preloaded list in the middle column. The second file upload for bioactivity data is required, and so we upload the following csv table of bioactive concentrations for all compounds:

A csv file with bioactivity data for all eight chemicals. All values were calculated as the 5th percentile of AC50s (active calls only) for each compound, where the list of AC50s was taken from the cHTS assay database from ICE.

ChemicalName	CAS	BioactiveConcentration
Acetamiprid	135410-20-7	7.35400
2,4-db	94-82-6	13.46000

ChemicalName	CAS	BioactiveConcentration
Acephate	30560-19-1	0.05875
Acetochlor	34256-82-1	1.34800
Alachlor	15972-60-8	1.61700
Aldicarb	116-06-3	0.09300
Ametryn	834-12-8	1.08200
Amitraz	33089-61-1	27.49000

For formatting instructions, please either download the *Bioactivity Data File Folder* on the left side of the page or consult the *Introduction to ToCS* vignette. The final file upload option under the *Uploaded Data* card provides the user the opportunity to upload chemical exposure data. However, suppose that we do not have chemical exposure data to upload for this simulation. Therefore, we leave that blank. The completed *Compound Selection* tab should look like the images below.

Toxicokinetic Chemical Simulator (ToCS) General Parameters Model Specifications Compound Selection Advanced (Optional) Parameters Run Simulation

INSTRUCTIONS

Click on the appropriate link(s) below to download guidance on how to upload data under the 'Uploaded Data' card. Follow the 'Instructions' document in the downloaded folder to correctly format the file you want to upload.

[Uploaded Physical-Chemical Data File Folder](#)

[Bioactivity Data File Folder](#)

[Exposure Data File Folder](#)

PRELOADED COMPOUNDS

Select an IVIVE assumption to implement. For any input nominal bioactive concentration in vitro, the Honda1 assumption is recommended. Leave on 'NULL' if no assumptions are to be applied. See the 'IVIVE Simulation Examples' vignette for the description of the below assumption categories.

NULL

Select the types of compounds you want to simulate.

Choose from all available chemicals

Select any preloaded compounds. Search through the list by clicking on the box and scrolling or typing in a name. The list may not show all available compounds. Click on a compound to select it. You may select multiple.

94-82-6, 2,4-db 30560-19-1, Acephate 135410-20-7, Acetamiprid
34256-82-1, Acetochlor 15972-60-8, Alachlor 116-06-3, Aldicarb
834-12-8, Ametryn 33089-61-1, Amitraz

UPLOADED DATA

Upload a CSV file of physical and chemical data for compounds not in the preloaded list (if desired). Download the 'Uploaded Physical-Chemical Data File Folder' under the 'Instructions' card for file formatting instructions.

No file selected

Upload a CSV file with in vitro bioactive concentrations (uM units) for all selected compounds. Download the 'Bioactivity Data File Folder' under the 'Instructions' card for file formatting instructions.

SampleBioData_8Chems.csv

Upload a CSV file of exposure data for all selected compounds (optional). Download the 'Exposure Data File Folder' under the 'Instructions' card for file formatting instructions.

No file selected

The completed compound selection tab for example 3.

Advanced (Optional) Parameters Tab

Since we want to output the plasma OED in the liver, we select *plasma* under the second drop down menu in the *Output Specification* card specifying the output concentration type. Then, we select *liver* under the third drop down since we want the liver OED. No changes to other parameters on this page should be made for this example. Thus, the completed *Advanced Parameters* tab should look like the image below.

Toxicokinetic Chemical Simulator (ToCS) General Parameters Model Specifications Compound Selection Advanced (Optional) Parameters Run Simulation

MODEL CONDITIONS Enter the number of Monte Carlo samples generated for each compound. <input type="text" value="1000"/> Select whether protein binding is taken into account in liver clearance. <input type="text" value="Yes, include protein binding (default)"/> Select whether to adjust the chemical fraction unbound in presence of plasma proteins for lipid binding. <input type="text" value="Yes, adjust the fraction of unbound plasma (default)"/> Select whether to use regressions when calculating partition coefficients. <input type="text" value="Use regressions (default)"/> Enter the p-value threshold for the in vitro intrinsic hepatic clearance rate where clearance assay results with p-values above this threshold are set to zero. <input type="text" value="0.05"/> Enter the minimum acceptable chemical fraction unbound in presence of plasma proteins. All values below this will be set to this value. <input type="text" value="0.0001"/>	MODEL SOLVER No options for this category.	BIOAVAILABILITY Enter a default value for the Caco2.apical-to-basal membrane permeability (denoted Caco2.Pab, 10^{-6} cm/s). <input type="text" value="1.6"/> Select whether to use the Caco2.Pab value set above to estimate F_abs (the in vivo measured fraction of an oral dose absorbed from the gut lumen into the gut) if bioavailability data is unavailable. <input type="text" value="Use the Caco2.Pab value selected above (default)"/> Select whether to use the Caco2.Pab value set above to calculate F_gut (the in vivo measured fraction of an oral dose that passes gut metabolism and clearance) if bioavailability data is unavailable. <input type="text" value="Use the Caco2.Pab value selected above (default)"/> Select whether to overwrite in vivo F_abs and F_gut data (if available). <input type="text" value="Do not overwrite in vivo values (default)"/> Select whether to keep F_abs and F_gut at 100% availability (which overwrites all other bioavailability parameter settings above). <input type="text" value="Do not keep Fabs and Fgut at 100% availability (default)"/>	OUTPUT SPECIFICATION Select the dose output units from either mg/kg BW/day (mgpkgsday) (default) or umol/kg BW/day (umolpkgsday). <input type="text" value="mgpkgsday"/> Select the output concentration type. <input type="text" value="plasma"/> Select a tissue you want the output concentration in. Leave on 'NULL' if the whole body concentration is desired. <input type="text" value="liver"/>
--	--	--	--

The completed advanced parameters tab for example 3.

Run Simulation Tab

Now that all user parameter selections have been made and all compounds appear under the *Select Compounds* card, we click the *Run Simulation* button. Once the simulation is complete, the user's interface should look like the image below. The first tab shows a table of the OED for each compound. The table is available for download by the user if the user clicks the *Download Table 1* button. The user is also able to download all of the simulation parameters and chemical information used in the simulation by clicking the *Download OED Simulation Parameters* tab.

ACTIONS

Click on the 'Run Simulation' button when all information has been entered.

Run Simulation

Click on the button below to reset your session. This will clear all selections and any uploaded data, and is recommended to be done every time a new simulation is run.

Reset Session

Check the box to display plots with a log10 scale y-axis.

SELECTED COMPOUNDS

Selected_Compounds

- 2,4-db
- Acephate
- Acetamiprid
- Acetochlor
- Alachlor
- Aldicarb
- Ametryn
- Amitraz

RESULTS

Oral Equivalent Dose Table

[Download Table 1](#)

[Download OED Simulation Parameters](#)

Show 10 entries

CompoundName	CAS	OED
1 2,4-db	94-82-6	0.03472
2 Acephate	30560-19-1	0.0004954
3 Acetamiprid	135410-20-7	0.03712
4 Acetochlor	34256-82-1	0.008898
5 Alachlor	15972-60-8	0.01157
6 Aldicarb	116-06-3	0.0005263
7 Ametryn	834-12-8	0.006534
8 Amitraz	33089-61-1	0.051

Showing 1 to 8 of 8 entries

Table 1: Table of the IVIVE oral equivalent doses (OED) (mgpkgday) for each selected compound.

Oral Equivalent Dose Plot

Bioactivity Exposure Ratio Table

Bioactivity Exposure Ratio Plot

The completed run simulation tab for example 3 showing the expanded OED table tab.

The image below is the completed OED plot tab, which shows a plot of the 10th quantile OEDs using the liver steady state concentration for OED calculation. The plot shown below uses a linear y-axis, but as we can see, this makes it challenging to visually notice the magnitude of smaller OEDs.

ACTIONS

Click on the 'Run Simulation' button when all information has been entered.

Run Simulation

Click on the button below to reset your session. This will clear all selections and any uploaded data, and is recommended to be done every time a new simulation is run.

Reset Session

Check the box to display plots with a log10 scale y-axis.

SELECTED COMPOUNDS

Selected_Compounds

- 2,4-db
- Acephate
- Acetamiprid
- Acetochlor
- Alachlor
- Aldicarb
- Ametryn
- Amitraz

RESULTS

Oral Equivalent Dose Table

Oral Equivalent Dose Plot

Download Figure 1

In vitro-in vivo extrapolation (IVIVE) from the 3compartment model

Compound	OED (mg/kg/day)
Acephate	~0.001
Aldicarb	~0.001
Ametryn	~0.007
Acetochlor	~0.009
Alachlor	~0.011
2,4-db	~0.035
Acetamiprid	~0.038
Amitraz	~0.055

Figure 1: Plot of the oral equivalent dose (OED) for each selected compound. Compounds are arranged in ascending order of their OED values.

Bioactivity Exposure Ratio Table

Bioactivity Exposure Ratio Plot

The completed run simulation tab for example 3 showing the expanded OED plot tab where the plot has a linear scale y-axis.

Therefore, we can click the box under the *Actions* card to change the scale of the y-axis to a log10 scale. That then results in the image shown below, which allows the user to view the differences in magnitudes of all OEDs. The user can download either the linear or log10 scale plot by clicking the *Download Figure 1* button.

ACTIONS

Click on the 'Run Simulation' button when all information has been entered.

Run Simulation

Click on the button below to reset your session. This will clear all selections and any uploaded data, and is recommended to be done every time a new simulation is run.

Reset Session

Check the box to display plots with a log10 scale y-axis.

SELECTED COMPOUNDS

Selected_Compounds

- 2,4-db
- Acephate
- Acetamiprid
- Acetochlor
- Alachlor
- Aldicarb
- Ametryn
- Amitraz

RESULTS

Oral Equivalent Dose Table

Oral Equivalent Dose Plot

[Download Figure 1](#)

In vitro-in vivo extrapolation (IVIVE) from the 3compartment model

Figure 1: Plot of the oral equivalent dose (OED) for each selected compound. Compounds are arranged in ascending order of their OED values.

Bioactivity Exposure Ratio Table

Bioactivity Exposure Ratio Plot

The completed run simulation tab for example 3 showing the expanded OED plot tab where the plot has a log10 scale y-axis.

The final two tabs on the IVIVE module exhibit the bioactivity exposure ratio (BER), if applicable for the simulation. Since no chemical exposure data was uploaded under the *Compound Selection* tab, no BERs were calculated for this simulation. If the user wanted to calculate BERs for this simulation, they would need to upload chemical exposure under the previous tab.

ACTIONS	SELECTED COMPOUNDS	RESULTS
Click on the 'Run Simulation' button when all information has been entered. Run Simulation	Selected Compounds 2,4-db Acephate Acetamiprid Acetochlor Alachlor Aldicarb Ametryn Amitraz	Oral Equivalent Dose Table Oral Equivalent Dose Plot Bioactivity Exposure Ratio Table Chemical exposure data was not uploaded under the 'Compound Selection' tab, so the bioactivity exposure ratio (BER) cannot be calculated. If the BER is desired, please upload exposure data on the 'Compound Selection' tab under the 'Output Specification' card. Bioactivity Exposure Ratio Plot Chemical exposure data was not uploaded under the 'Compound Selection' tab, so the bioactivity exposure ratio (BER) cannot be calculated. If the BER is desired, please upload exposure data on the 'Compound Selection' tab under the 'Output Specification' card.

The completed run simulation tab for example 3 showing the expanded BER table and plot tabs, which notifies the user that the calculations were not computed due to lack of exposure data.

If we wanted to run another simulation, we would click the *Reset Session* button under the *Actions* button, which would clear all parameter inputs and simulations and return the interface to the *General Parameters* tab.