BMDExpress2 Workflow

Inputs, Outputs and Best Model Selection

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BMDExpress2 Workflow

- Inputs
  - Hill
  - Power
  - Poly
  - Exponential
- Outputs
  - Hill
  - Power
  - Poly
  - Exponential
- Best Model Selection
  - Select best poly model
  - Select best non-poly
  - Deal with Hill and select best model

BMDExpress2 Workflow – Hill Input

```
Hill
BMDS MODEL RUN
827377983_1553221_at
Hill
0 20 0
250 1.0E-8 1.0E-8 1 1 1 0 0
1 1.349 1 0.95
-9999.0 0.0 -9999.0 -9999.0 -9999.0 -9999.0
0
-9999.0 0.0 -9999.0 -9999.0 -9999.0 -9999.0
DOSE RESPONSE
0.0 6.96377
0.0 7.05445
0.0 6.97254
0.0 7.09836
1.0E-6 7.17683
1.0E-6 7.12809
1.0E-6 7.17259
1.0E-6 7.04538
1.0E-4 7.09178
1.0E-4 7.12637
1.0E-4 6.82033
1.0E-4 7.30107
0.001 6.92979
0.001 7.15551
0.001 7.04346
0.001 7.2716
1.0 7.00026
1.0 6.75487
1.0 6.62335
1.0 6.77612
```

individual animal data	# observations	adverse direction
0	*20	0

Maximum iterations	rel function convergence	parameter convergence	BMDL curve calculation	restrict n> 1	BMD calculation	append or overwrite output file	smooth option
**250	1.08E-9	1.08E-9	1	1	1	0	0

BMR Type	BMR Level	Constant Variance	Confidence Level
1	**1.349	**1	**0.95

Alpha	Rho	Intercept	v	n	k
-9999.0	*0.0	-9999.0	-9999.0	-9999.0	-9999.0

Initialize Parameters
0

Alpha	Rho	Intercept	v	n	k
-9999.0	*0.0	-9999.0	-9999.0	-9999.0	-9999.0

** user supplied
* BMDExpress2 calculated based on user input

BMDExpress2 Workflow – Power Input

```
Power
BMDS MODEL RUN
539667114_1553221_at_power.(d)
539667114_1553221_at_power.out
0 20 0
250 1.0E-8 1.0E-8 1 1 1 0 0
1 1.349 1 0.95
-9999.0 0.0 -9999.0 -9999.0 -9999.0
0
-9999.0 0.0 -9999.0 -9999.0 -9999.0
DOSE RESPONSE
0.0 6.96377
0.0 7.05445
0.0 6.97254
0.0 7.09836
1.0E-6 7.17683
1.0E-6 7.12809
1.0E-6 7.17259
1.0E-6 7.04538
1.0E-4 7.09178
1.0E-4 7.12637
1.0E-4 6.82033
1.0E-4 7.30107
0.001 6.92979
0.001 7.15551
0.001 7.04346
0.001 7.2716
1.0 7.00026
1.0 6.75487
1.0 6.62335
1.0 6.77612
```

individual animal data	# observations	adverse direction
0	*20	0

Maximum iterations	rel function convergence	parameter convergence	BMDL curve calculation	restrict n> 1	BMD calculation	append or overwrite output file	smooth option
**250	1.08E-9	1.08E-9	1	**1	1	0	0

BMR Type	BMR Level	Constant Variance	Confidence Level
1	**1.349	**1	**0.95

Alpha	Rho	Intercept	v	k
-9999.0	*0.0	-9999.0	-9999.0	-9999.0

Initialize Parameters
0

Alpha	Rho	Intercept	v	k
-9999.0	*0.0	-9999.0	-9999.0	-9999.0

** user supplied
* BMDExpress2 calculated based on user input

BMDExpress2 Workflow – Linear Input

```
Polynomial
BMDS MODEL RUN
337982451_1553221_at_poly1.(d)
337982451_1553221_at_poly1.out
1
0 20 0
250 1.0E-8 1.0E-8 1 0 1 0 0
1 1.349 1 0.95
-9999.0 0.0  -9999 -9999
0
-9999.0 0.0  -9999 -9999
DOSE RESPONSE
0.0 6.96377
0.0 7.05445
0.0 6.97254
0.0 7.09836
1.0E-6 7.17683
1.0E-6 7.12809
1.0E-6 7.17259
1.0E-6 7.04538
1.0E-4 7.09178
1.0E-4 7.12637
1.0E-4 6.82033
1.0E-4 7.30107
0.001 6.92979
0.001 7.15551
0.001 7.04346
0.001 7.2716
1.0 7.00026
1.0 6.75487
1.0 6.62335
1.0 6.77612
```

Degree of polynomial
1

individual animal data	# observations	adverse direction
0	*20	0

Maximum iterations	rel function convergence	parameter convergence	BMDL curve calculation	restrict n> 1	BMD calculation	append or overwrite output file	smooth option
**250	1.08E-9	1.08E-9	1	**1	1	0	0

BMR Type	BMR Level	Constant Variance	Confidence Level
1	**1.349	**1	**0.95

Alpha	Rho	Intercept	beta0	beta1
-9999.0	*0.0	-9999.0	-9999.0	-9999.0

Initialize Parameters
0

Alpha	Rho	Intercept	beta0	beta1
-9999.0	*0.0	-9999.0	-9999.0	-9999.0

** user supplied

* BMDExpress2 calculated based on user input

BMDExpress2 Workflow – Poly 2 Input

```
Polynomial
BMDS MODEL RUN
337982451_1553221_at_poly1.(d)
337982451_1553221_at_poly1.out
1
0 20 0
250 1.0E-8 1.0E-8 1 0 1 0 0
1 1.349 1 0.95
-9999.0 0.0  -9999 -9999
0
-9999.0 0.0  -9999 -9999
DOSE RESPONSE
0.0 6.96377
0.0 7.05445
0.0 6.97254
0.0 7.09836
1.0E-6 7.17683
1.0E-6 7.12809
1.0E-6 7.17259
1.0E-6 7.04538
1.0E-4 7.09178
1.0E-4 7.12637
1.0E-4 6.82033
1.0E-4 7.30107
0.001 6.92979
0.001 7.15551
0.001 7.04346
0.001 7.2716
1.0 7.00026
1.0 6.75487
1.0 6.62335
1.0 6.77612
```

Degree of polynomial
2

individual animal data	# observations	adverse direction
0	*20	0

Maximum iterations	rel function convergence	parameter convergence	BMDL curve calculation	restrict n> 1	BMD calculation	append or overwrite output file	smooth option
**250	1.08E-9	1.08E-9	1	**1	1	0	0

BMR Type	BMR Level	Constant Variance	Confidence Level
1	**1.349	**1	**0.95

Alpha	Rho	Intercept	beta0	beta1
-9999.0	*0.0	-9999.0	-9999.0	-9999.0

Initialize Parameters
0

Alpha	Rho	Intercept	beta0	beta1
-9999.0	*0.0	-9999.0	-9999.0	-9999.0

** user supplied

* BMDExpress2 calculated based on user input

BMDExpress2 Workflow – Poly 3 Input

```
Polynomial
BMDS MODEL RUN
337982451_1553221_at_poly1.(d)
337982451_1553221_at_poly1.out
1
0 20 0
250 1.0E-8 1.0E-8 1 0 1 0 0
1 1.349 1 0.95
-9999.0 0.0  -9999 -9999
0
-9999.0 0.0  -9999 -9999
DOSE RESPONSE
0.0 6.96377
0.0 7.05445
0.0 6.97254
0.0 7.09836
1.0E-6 7.17683
1.0E-6 7.12809
1.0E-6 7.17259
1.0E-6 7.04538
1.0E-4 7.09178
1.0E-4 7.12637
1.0E-4 6.82033
1.0E-4 7.30107
0.001 6.92979
0.001 7.15551
0.001 7.04346
0.001 7.2716
1.0 7.00026
1.0 6.75487
1.0 6.62335
1.0 6.77612
```

Degree of polynomial
3

individual animal data	# observations	adverse direction
0	*20	0

Maximum iterations	rel function convergence	parameter convergence	BMDL curve calculation	restrict n> 1	BMD calculation	append or overwrite output file	smooth option
**250	1.08E-9	1.08E-9	1	**1	1	0	0

BMR Type	BMR Level	Constant Variance	Confidence Level
1	**1.349	**1	**0.95

Alpha	Rho	Intercept	beta0	beta1
-9999.0	*0.0	-9999.0	-9999.0	-9999.0

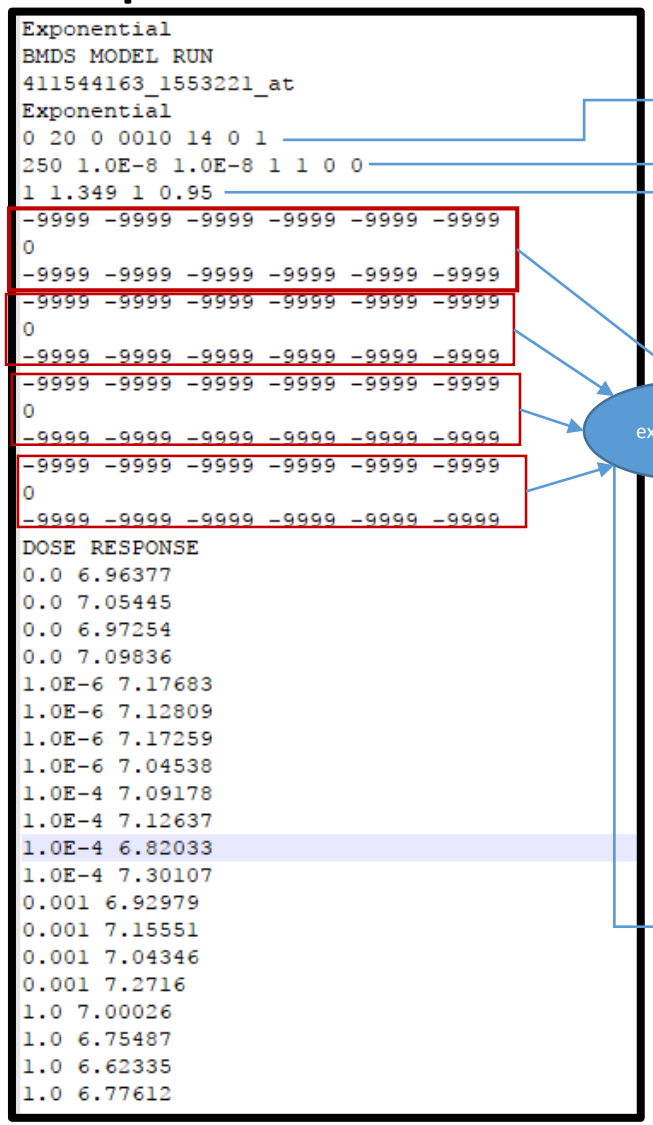
Initialize Parameters
0

Alpha	Rho	Intercept	beta0	beta1
-9999.0	*0.0	-9999.0	-9999.0	-9999.0

** user supplied

* BMDExpress2 calculated based on user input

BMDExpress2 Workflow – Exponential Model 2 Input



```
Exponential
BMDS MODEL RUN
411544163_1553221_at
Exponential
0 20 0 0010 14 0 1
250 1.0E-8 1.0E-8 1 1 0 0
1 1.349 1 0.95
-9999 -9999 -9999 -9999 -9999 -9999
0
-9999 -9999 -9999 -9999 -9999 -9999
-9999 -9999 -9999 -9999 -9999 -9999
0
-9999 -9999 -9999 -9999 -9999 -9999
-9999 -9999 -9999 -9999 -9999 -9999
0
-9999 -9999 -9999 -9999 -9999 -9999
-9999 -9999 -9999 -9999 -9999 -9999
0
-9999 -9999 -9999 -9999 -9999 -9999
DOSE RESPONSE
0.0 6.96377
0.0 7.05445
0.0 6.97254
0.0 7.09836
1.0E-6 7.17683
1.0E-6 7.12809
1.0E-6 7.17259
1.0E-6 7.04538
1.0E-4 7.09178
1.0E-4 7.12637
1.0E-4 6.82033
1.0E-4 7.30107
0.001 6.92979
0.001 7.15551
0.001 7.04346
0.001 7.2716
1.0 7.00026
1.0 6.75487
1.0 6.62335
1.0 6.77612
```

Per exponential model

individual animal data	# observations	adverse direction	Run Models	Span	Distribution Curve	MLE Solution
0	*20	0	***1000	11	0	0

Maximum iterations	rel function convergence	parameter convergence	BMDL curve calculation	BMD calculation	append or overwrite output file	smooth option
**250	1.08E-9	1.08E-9	1	1	0	0

BMR Type	BMR Level	Constant Variance	Confidence Level
1	**1.349	**1	**0.95

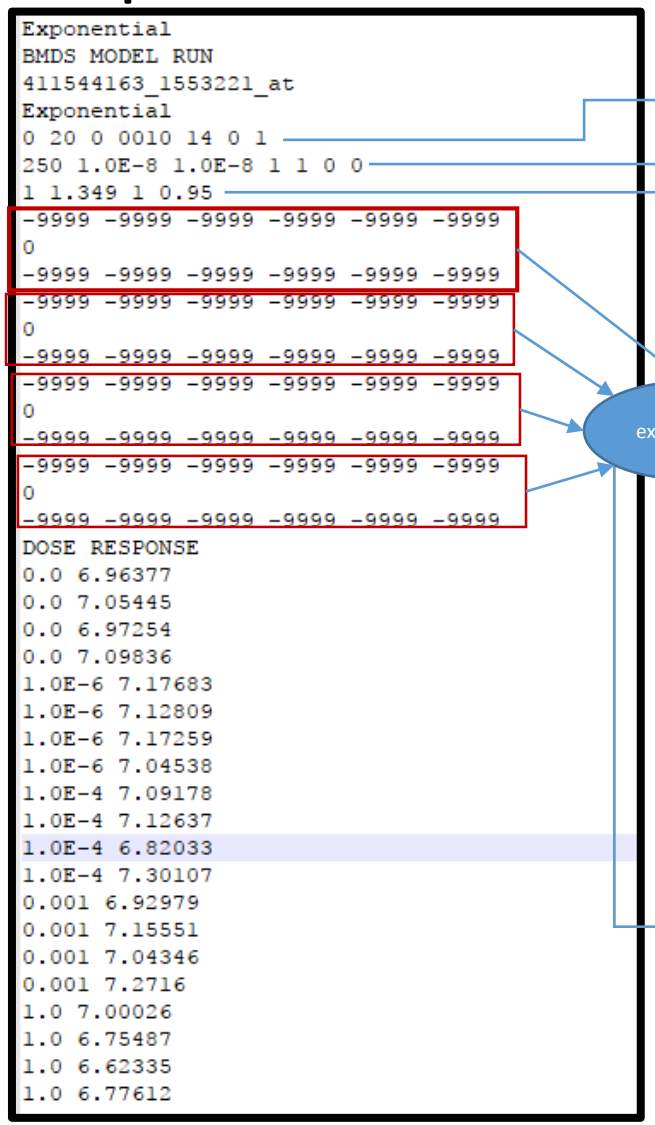
Alpha	Rho	a	b	c	d
-9999	-9999	-9999	-9999	-9999	-9999

Initialize Parameters
0

Alpha	Rho	a	b	c	d
-9999	-9999	-9999	-9999	-9999	-9999

*** select which exponential model to run
** user supplied
* BMDExpress2 calculated based on user input

BMDExpress2 Workflow – Exponential Model 3 Input



```
Exponential
BMDS MODEL RUN
411544163_1553221_at
Exponential
0 20 0 0010 14 0 1
250 1.0E-8 1.0E-8 1 1 0 0
1 1.349 1 0.95
-9999 -9999 -9999 -9999 -9999 -9999
0
-9999 -9999 -9999 -9999 -9999 -9999
-9999 -9999 -9999 -9999 -9999 -9999
0
-9999 -9999 -9999 -9999 -9999 -9999
-9999 -9999 -9999 -9999 -9999 -9999
0
-9999 -9999 -9999 -9999 -9999 -9999
-9999 -9999 -9999 -9999 -9999 -9999
0
-9999 -9999 -9999 -9999 -9999 -9999
DOSE RESPONSE
0.0 6.96377
0.0 7.05445
0.0 6.97254
0.0 7.09836
1.0E-6 7.17683
1.0E-6 7.12809
1.0E-6 7.17259
1.0E-6 7.04538
1.0E-4 7.09178
1.0E-4 7.12637
1.0E-4 6.82033
1.0E-4 7.30107
0.001 6.92979
0.001 7.15551
0.001 7.04346
0.001 7.2716
1.0 7.00026
1.0 6.75487
1.0 6.62335
1.0 6.77612
```

Per exponential model

individual animal data	# observations	adverse direction	Run Models	Span	Distribution Curve	MLE Solution
0	*20	0	***0100	22	0	0

Maximum iterations	rel function convergence	parameter convergence	BMDL curve calculation	BMD calculation	append or overwrite output file	smooth option
**250	1.08E-9	1.08E-9	1	1	0	0

BMR Type	BMR Level	Constant Variance	Confidence Level
1	**1.349	**1	**0.95

Alpha	Rho	a	b	c	d
-9999	-9999	-9999	-9999	-9999	-9999

Initialize Parameters
0

Alpha	Rho	a	b	c	d
-9999	-9999	-9999	-9999	-9999	-9999

*** select which exponential model to run
** user supplied
* BMDExpress2 calculated based on user input

BMDExpress2 Workflow – Exponential Model 4 Input

```
Exponential
BMDS MODEL RUN
411544163_1553221_at
Exponential
0 20 0 0010 14 0 1
250 1.0E-8 1.0E-8 1 1 0 0
1 1.349 1 0.95
-9999 -9999 -9999 -9999 -9999 -9999
0
-9999 -9999 -9999 -9999 -9999 -9999
-9999 -9999 -9999 -9999 -9999 -9999
0
-9999 -9999 -9999 -9999 -9999 -9999
-9999 -9999 -9999 -9999 -9999 -9999
0
-9999 -9999 -9999 -9999 -9999 -9999
-9999 -9999 -9999 -9999 -9999 -9999
0
-9999 -9999 -9999 -9999 -9999 -9999
DOSE RESPONSE
0.0 6.96377
0.0 7.05445
0.0 6.97254
0.0 7.09836
1.0E-6 7.17683
1.0E-6 7.12809
1.0E-6 7.17259
1.0E-6 7.04538
1.0E-4 7.09178
1.0E-4 7.12637
1.0E-4 6.82033
1.0E-4 7.30107
0.001 6.92979
0.001 7.15551
0.001 7.04346
0.001 7.2716
1.0 7.00026
1.0 6.75487
1.0 6.62335
1.0 6.77612
```

Per exponential model

individual animal data	# observations	adverse direction	Run Models	Span	Distribution Curve	MLE Solution
0	*20	0	***0010	33	0	0

Maximum iterations	rel function convergence	parameter convergence	BMDL curve calculation	BMD calculation	append or overwrite output file	smooth option
**250	1.08E-9	1.08E-9	1	1	0	0

BMR Type	BMR Level	Constant Variance	Confidence Level
1	**1.349	**1	**0.95

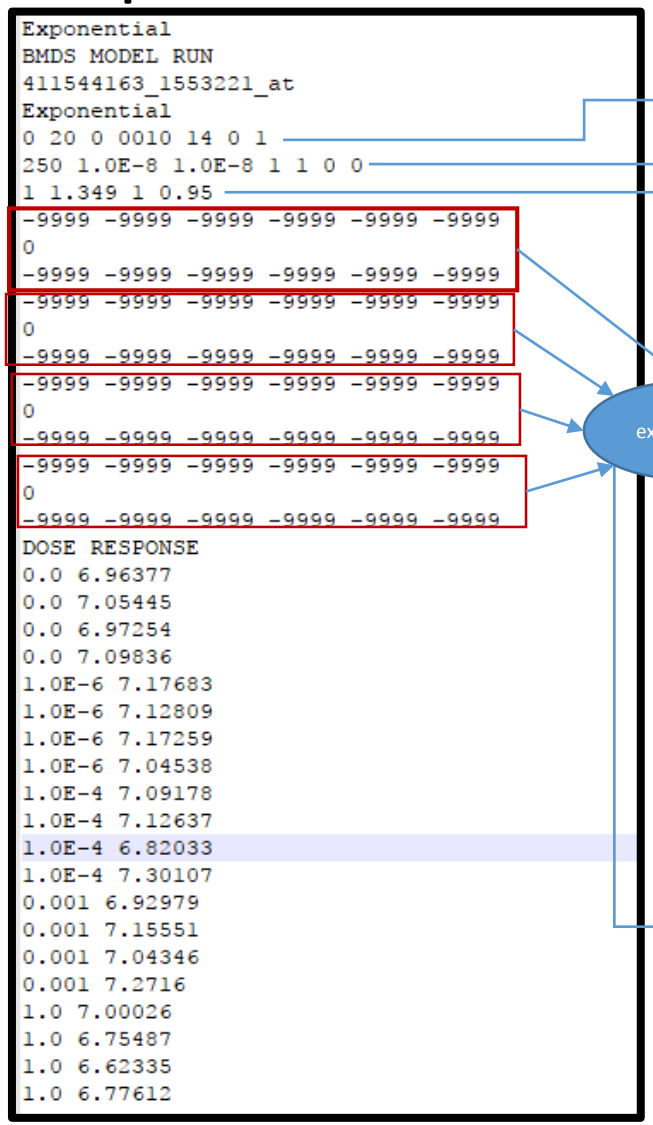
Alpha	Rho	a	b	c	d
-9999	-9999	-9999	-9999	-9999	-9999

Initialize Parameters
0

Alpha	Rho	a	b	c	d
-9999	-9999	-9999	-9999	-9999	-9999

*** select which exponential model to run
** user supplied
* BMDExpress2 calculated based on user input

BMDExpress2 Workflow – Exponential Model 5 Input



```
Exponential
BMDS MODEL RUN
411544163_1553221_at
Exponential
0 20 0 0010 14 0 1
250 1.0E-8 1.0E-8 1 1 0 0
1 1.349 1 0.95
-9999 -9999 -9999 -9999 -9999 -9999
0
-9999 -9999 -9999 -9999 -9999 -9999
-9999 -9999 -9999 -9999 -9999 -9999
0
-9999 -9999 -9999 -9999 -9999 -9999
-9999 -9999 -9999 -9999 -9999 -9999
0
-9999 -9999 -9999 -9999 -9999 -9999
-9999 -9999 -9999 -9999 -9999 -9999
0
-9999 -9999 -9999 -9999 -9999 -9999
DOSE RESPONSE
0.0 6.96377
0.0 7.05445
0.0 6.97254
0.0 7.09836
1.0E-6 7.17683
1.0E-6 7.12809
1.0E-6 7.17259
1.0E-6 7.04538
1.0E-4 7.09178
1.0E-4 7.12637
1.0E-4 6.82033
1.0E-4 7.30107
0.001 6.92979
0.001 7.15551
0.001 7.04346
0.001 7.2716
1.0 7.00026
1.0 6.75487
1.0 6.62335
1.0 6.77612
```

Per exponential model

individual animal data	# observations	adverse direction	Run Models	Span	Distribution Curve	MLE Solution
0	*20	0	***0001	44	0	0

Maximum iterations	rel function convergence	parameter convergence	BMDL curve calculation	BMD calculation	append or overwrite output file	smooth option
**250	1.08E-9	1.08E-9	1	1	0	0

BMR Type	BMR Level	Constant Variance	Confidence Level
1	**1.349	**1	**0.95

Alpha	Rho	a	b	c	d
-9999	-9999	-9999	-9999	-9999	-9999

Initialize Parameters
0

Alpha	Rho	a	b	c	d
-9999	-9999	-9999	-9999	-9999	-9999

*** select which exponential model to run
** user supplied
* BMDExpress2 calculated based on user input

BMDExpress2 Workflow – Hill Output

Parameter Estimates

Variable	Estimate	Std. Err.	95.0% Wald Confidence Interval Lower Conf. Limit	Upper Conf. Limit
alpha	0.0648651	0.0205122	0.024662	0.105068
intercept	6.55888	0.0636716	6.43408	6.68367
v	-1.77745	135.706	-267.757	264.202
n	3.06055	515.18	-1006.67	1012.8
k	0.739444	49.3537	-95.9921	97.471

Intercept	V	n	k
6.55888	-1.77745	3.06055	0.739444

Likelihoods of Interest

Model	Log(likelihood)	# Param's	AIC
A1	17.856850	6	-23.713700
A2	19.237895	10	-18.475789
A3	17.856850	6	-23.713700
fitted	17.354452	5	-24.708904
R	1.273745	2	1.452511

AIC	Log (likelihood)
24.708904	17.354452

Explanation of Tests

Test 1: Do responses and/or variances differ among Dose levels?
(A2 vs. R)
Test 2: Are Variances Homogeneous? (A1 vs A2)
Test 3: Are variances adequately modeled? (A2 vs. A3)
Test 4: Does the Model for the Mean Fit? (A3 vs. fitted)
(Note: When rho=0 the results of Test 3 and Test 2 will be the same.)

Adverse direction
-1 (if v < 0)

Tests of Interest

Test	-2*log(Likelihood Ratio)	Test df	p-value
Test 1	35.9283	8	<.0001
Test 2	2.76209	4	0.5984
Test 3	2.76209	4	0.5984
Test 4	1.0048	1	0.3162

Fit P-Value
0.3162

The p-value for Test 4 is greater than .1. The model chosen seems
to adequately describe the data

Benchmark Dose Computation

Specified effect = 1.349

Risk Type = Estimated standard deviations from the control mean

Confidence level = 0.95

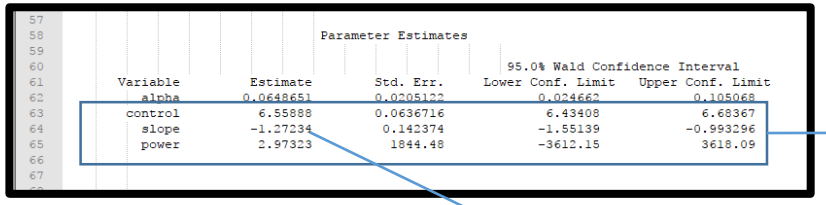
BMD = 0.463624

BMDL = 0.00117758

BMDU = 0.949156

BMD	BMDL	BMDU
0.463624	0.00117758	0.949156

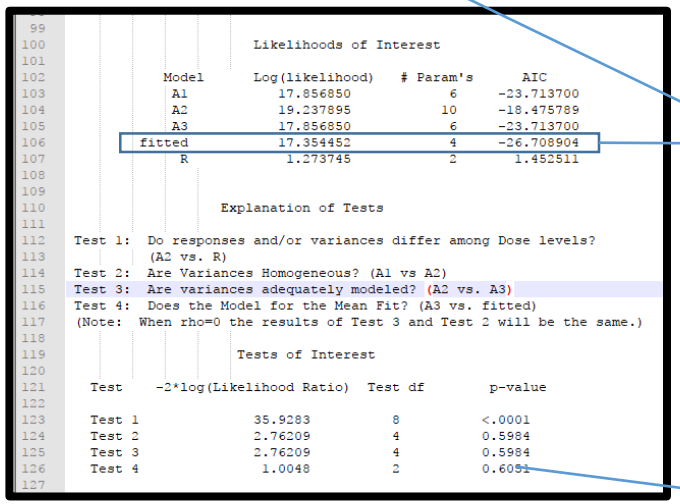
BMDExpress2 Workflow – Power Output



Parameter Estimates

Variable	Estimate	Std. Err.	95.0% Wald Confidence Interval Lower Conf. Limit	Upper Conf. Limit
alpha	0.0648651	0.0205122	0.024662	0.105068
control	6.55888	0.0636716	6.43408	6.68367
slope	-1.27234	0.142374	-1.55139	-0.993296
power	2.97323	1844.48	-3612.15	3618.09

control	Slope	Power
6.55888	-1.27234	2.97323



Likelihoods of Interest

Model	Log(likelihood)	# Param's	AIC
A1	17.856850	6	-23.713700
A2	19.237895	10	-18.475789
A3	17.856850	6	-23.713700
fitted	17.354452	4	-26.708904
R	1.273745	2	1.452511

Explanation of Tests

Test 1: Do responses and/or variances differ among Dose levels? (A2 vs. R)
Test 2: Are Variances Homogeneous? (A1 vs A2)
Test 3: Are variances adequately modeled? (A2 vs. A3)
Test 4: Does the Model for the Mean Fit? (A3 vs. fitted)
(Note: When rho=0 the results of Test 3 and Test 2 will be the same.)

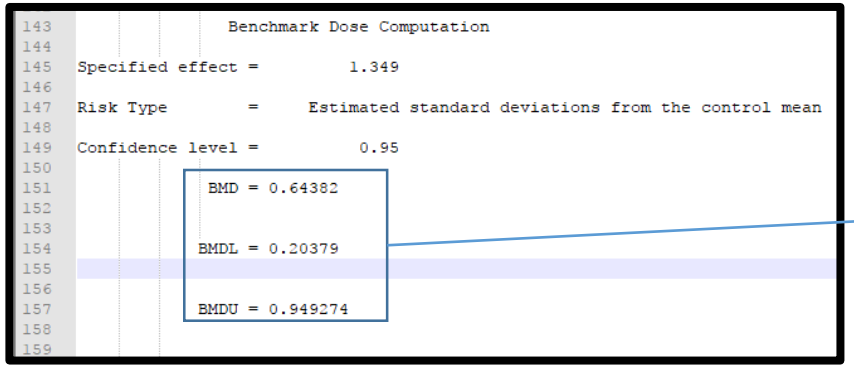
Tests of Interest

Test	-2*log(Likelihood Ratio)	Test df	p-value
Test 1	35.9283	8	<.0001
Test 2	2.76209	4	0.5984
Test 3	2.76209	4	0.5984
Test 4	1.0048	2	0.6051

AIC	Log (likelihood)
-26.708904	17.354452

Adverse direction
-1 (if slope < 0)

Fit P-Value
0.6051



Benchmark Dose Computation

Specified effect = 1.349

Risk Type = Estimated standard deviations from the control mean

Confidence level = 0.95

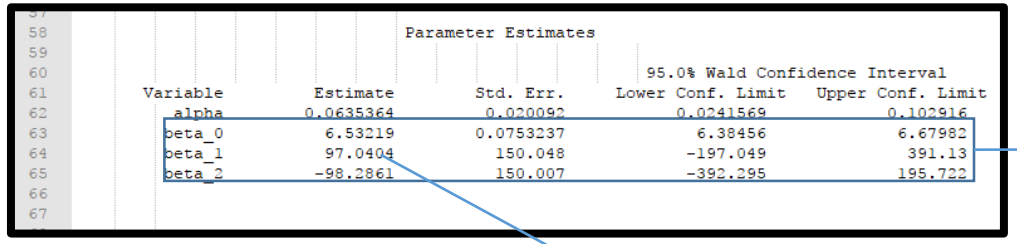
BMD = 0.64382

BMDL = 0.20379

BMDU = 0.949274

BMD	BMDL	BMDU
0.64382	0.20379	0.949274

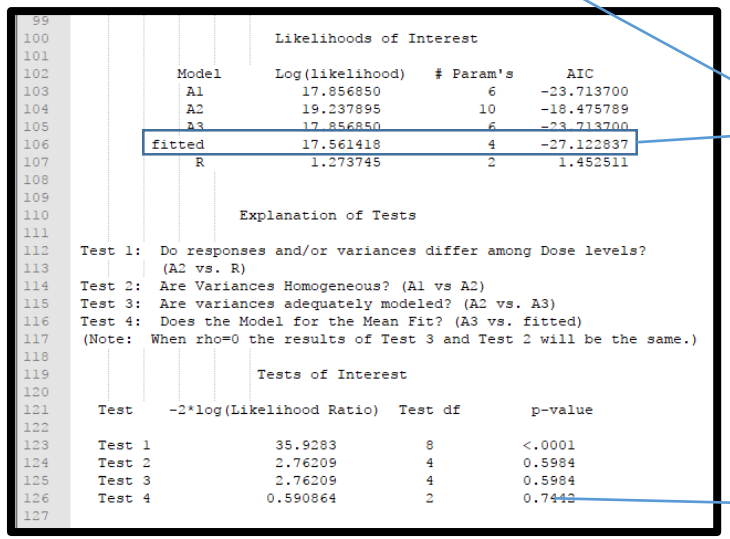
BMDExpress2 Workflow – Linear Output



Parameter Estimates

Variable	Estimate	Std. Err.	95.0% Wald Confidence Interval Lower Conf. Limit	Upper Conf. Limit
alpha	0.0635364	0.020092	0.0241569	0.102916
beta_0	6.53219	0.0753237	6.38456	6.67982
beta_1	97.0404	150.048	-197.049	391.13
beta_2	-98.2861	150.007	-392.295	195.722

Beta_0	Beta_1	Beta_2
6.53219	97.0404	-98.2861



Likelihoods of Interest

Model	Log(likelihood)	# Param's	AIC
A1	17.856850	6	-23.713700
A2	19.237895	10	-18.475789
A3	17.856850	6	-23.713700
fitted	17.561418	4	-27.122837
R	1.273745	2	1.452511

Explanation of Tests

Test 1: Do responses and/or variances differ among Dose levels? (A2 vs. R)
Test 2: Are Variances Homogeneous? (A1 vs A2)
Test 3: Are variances adequately modeled? (A2 vs. A3)
Test 4: Does the Model for the Mean Fit? (A3 vs. fitted)
(Note: When rho=0 the results of Test 3 and Test 2 will be the same.)

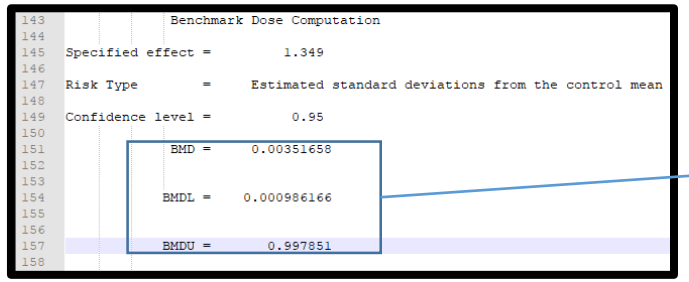
Tests of Interest

Test	-2*log(Likelihood Ratio)	Test df	p-value
Test 1	35.9283	8	<.0001
Test 2	2.76209	4	0.5984
Test 3	2.76209	4	0.5984
Test 4	0.590864	2	0.7442

AIC	Log (likelihood)
-27.122837	17.561418

Adverse direction
-1 (if beta_1 < 0) (beta_1 is used for all degrees of polynomial)

Fit P-Value
0.7442



Benchmark Dose Computation

Specified effect = 1.349

Risk Type = Estimated standard deviations from the control mean

Confidence level = 0.95

BMD = 0.00351658

BMDL = 0.000986166

BMDU = 0.997851

BMD	BMDL	BMDU
0.00351658	0.000986166	0.997851

BMDExpress2 Workflow – Poly 2 Output

```
                    Parameter Estimates

                                                  95.0% Wald Confidence Interval
      Variable        Estimate        Std. Err.     Lower Conf. Limit   Upper Conf. Limit
         alpha       0.0635364         0.020092           0.0241569           0.102916
        beta_0         6.53219        0.0753237             6.38456            6.67982
        beta_1         97.0404          150.048            -197.049             391.13
        beta_2        -98.2861          150.007            -392.295            195.722
```

Beta_0	Beta_1	Beta_2
6.53219	97.0404	-98.2861

```
                  Likelihoods of Interest

          Model      Log(likelihood)   # Param's      AIC
           A1           17.856850            6     -23.713700
           A2           19.237895           10     -18.475789
           A3           17.856850            6     -23.713700
       fitted           17.561418            4     -27.122837
            R            1.273745            2       1.452511


                 Explanation of Tests

 Test 1:  Do responses and/or variances differ among Dose levels?
          (A2 vs. R)
 Test 2:  Are Variances Homogeneous? (A1 vs A2)
 Test 3:  Are variances adequately modeled? (A2 vs. A3)
 Test 4:  Does the Model for the Mean Fit? (A3 vs. fitted)
 (Note:  When rho=0 the results of Test 3 and Test 2 will be the same.)

                  Tests of Interest

   Test    -2*log(Likelihood Ratio)  Test df        p-value

   Test 1              35.9283          8          <.0001
   Test 2              2.76209          4          0.5984
   Test 3              2.76209          4          0.5984
   Test 4             0.590864          2          0.7442
```

AIC	Log (likelihood)
-27.122837	17.561418

Adverse direction
-1 (if beta_1 < 0) (beta_1 is used for all degrees of polynomial)

Fit P-Value
0.7442

```
            Benchmark Dose Computation

Specified effect =         1.349

Risk Type        =     Estimated standard deviations from the control mean

Confidence level =          0.95

             BMD =     0.00351658


            BMDL =    0.000986166


            BMDU =       0.997851
```

BMD	BMDL	BMDU
0.00351658	0.000986166	0.997851

BMDExpress2 Workflow – Poly 3 Output

Parameter Estimates

Variable	Estimate	Std. Err.	95.0% Wald Confidence Interval Lower Conf. Limit	Upper Conf. Limit
alpha	0.0635364	0.020092	0.0241569	0.102916
beta_0	6.53219	0.0753237	6.38456	6.67982
beta_1	97.0404	150.048	-197.049	391.13
beta_2	-98.2861	150.007	-392.295	195.722

Beta_0	Beta_1	Beta_2
6.53219	97.0404	-98.2861

Likelihoods of Interest

Model	Log(likelihood)	# Param's	AIC
A1	17.856850	6	-23.713700
A2	19.237895	10	-18.475789
A3	17.856850	6	-23.713700
fitted	17.561418	4	-27.122837
R	1.273745	2	1.452511

AIC	Log (likelihood)
-27.122837	17.561418

Explanation of Tests

Test 1: Do responses and/or variances differ among Dose levels?
(A2 vs. R)
Test 2: Are Variances Homogeneous? (A1 vs A2)
Test 3: Are variances adequately modeled? (A2 vs. A3)
Test 4: Does the Model for the Mean Fit? (A3 vs. fitted)
(Note: When rho=0 the results of Test 3 and Test 2 will be the same.)

Adverse direction
-1 (if beta_1 < 0) (beta_1 is used for all degrees of polynomial)

Tests of Interest

Test	-2*log(Likelihood Ratio)	Test df	p-value
Test 1	35.9283	8	<.0001
Test 2	2.76209	4	0.5984
Test 3	2.76209	4	0.5984
Test 4	0.590864	2	0.7442

Fit P-Value
0.7442

Benchmark Dose Computation

Specified effect = 1.349

Risk Type = Estimated standard deviations from the control mean

Confidence level = 0.95

BMD = 0.00351658

BMDL = 0.000986166

BMDU = 0.997851

BMD	BMDL	BMDU
0.00351658	0.000986166	0.997851

BMDExpress2 Workflow – Exponential Model 2 Output

Parameter Estimates

Variable	Model 5	Std. Err.
lnalpha	-2.73545	0.0205122
a	6.55888	0.0636716
b	1.6131	33179
c	0.804078	633.024
d	3.19964	9306.47

a	b	c	d
6.55888	1.6131	0.804078	3.19964

Likelihoods of Interest

Model	Log(likelihood)	DF	AIC
A1	17.85685	6	-23.7137
A2	19.23789	10	-18.47579
A3	17.85685	6	-23.7137
R	1.273745	2	1.452511
5	17.35445	5	-24.7089

Additive constant for all log-likelihoods = -18.38. This constant added to the above values gives the log-likelihood including the term that does not depend on the model parameters.

AIC	Log (likelihood)
-24.7089	17.35445

Explanation of Tests

Test 1: Does response and/or variances differ among Dose levels? (A2 vs. R)
Test 2: Are Variances Homogeneous? (A2 vs. A1)
Test 3: Are variances adequately modeled? (A2 vs. A3)

Test 7a: Does Model 5 fit the data? (A3 vs 5)

Adverse direction
-1 (use trend test)

Estimated Values of Interest

Dose	Est Mean	Est Std	Scaled Residual
0	6.559	0.2547	-0.8053
1e-006	6.559	0.2547	0.03168
0.0001	6.559	0.2547	0.2616
0.001	6.559	0.2547	0.5119
1	5.287	0.2547	-7.734e-010

Tests of Interest

Test	-2*log(Likelihood Ratio)	D. F.	p-value
Test 1	35.93	8	< 0.0001
Test 2	2.762	4	0.5984
Test 3	2.762	4	0.5984
Test 7a	1.005	1	0.3162

Fit P-Value
0.3162

Benchmark Dose Computations:

Specified Effect = 1.349000

Risk Type = Estimated standard deviations from control

Confidence Level = 0.950000

BMD = 0.430382

BMDL = 0.00164527

BMDU = 0.946299

BMD	BMDL	BMDU
0.430382	0.00164527	0.946299

BMDExpress2 Workflow – Exponential Model 3 Output

Parameter Estimates

Variable	Model 5	Std. Err.
lnalpha	-2.73545	0.0205122
a	6.55888	0.0636716
b	1.6131	33179
c	0.804078	633.024
d	3.19964	9306.47

a	b	c	d
6.55888	1.6131	0.804078	3.19964

Likelihoods of Interest

Model	Log(likelihood)	DF	AIC
A1	17.85685	6	-23.7137
A2	19.23789	10	-18.47579
A3	17.85685	6	-23.7137
R	1.273745	2	1.452511
5	17.35445	5	-24.7089

Additive constant for all log-likelihoods = -18.38. This constant added to the above values gives the log-likelihood including the term that does not depend on the model parameters.

AIC	Log (likelihood)
-24.7089	17.35445

Explanation of Tests

Test 1: Does response and/or variances differ among Dose levels? (A2 vs. R)
Test 2: Are Variances Homogeneous? (A2 vs. A1)
Test 3: Are variances adequately modeled? (A2 vs. A3)

Test 7a: Does Model 5 fit the data? (A3 vs 5)

Adverse direction
-1 (use trend test)

Estimated Values of Interest

Dose	Est Mean	Est Std	Scaled Residual
0	6.559	0.2547	-0.8053
1e-006	6.559	0.2547	0.03168
0.0001	6.559	0.2547	0.2616
0.001	6.559	0.2547	0.5119
1	5.287	0.2547	-7.734e-010

Tests of Interest

Test	-2*log(Likelihood Ratio)	D. F.	p-value
Test 1	35.93	8	< 0.0001
Test 2	2.762	4	0.5984
Test 3	2.762	4	0.5984
Test 7a	1.005	1	0.3162

Fit P-Value
0.3162

Benchmark Dose Computations:

Specified Effect = 1.349000

Risk Type = Estimated standard deviations from control

Confidence Level = 0.950000

BMD = 0.430382

BMDL = 0.00164527

BMDU = 0.946299

BMD	BMDL	BMDU
0.430382	0.00164527	0.946299

BMDExpress2 Workflow – Exponential Model 4 Output

Parameter Estimates

Variable	Model 5	Std. Err.
lnalpha	-2.73545	0.0205122
a	6.55888	0.0636716
b	1.6131	33179
c	0.804078	633.024
d	3.19964	9306.47

a	b	c	d
6.55888	1.6131	0.804078	3.19964

Likelihoods of Interest

Model	Log(likelihood)	DF	AIC
A1	17.85685	6	-23.7137
A2	19.23789	10	-18.47579
A3	17.85685	6	-23.7137
R	1.273745	2	1.452511
5	17.35445	5	-24.7089

Additive constant for all log-likelihoods = -18.38. This constant added to the above values gives the log-likelihood including the term that does not depend on the model parameters.

AIC	Log (likelihood)
-24.7089	17.35445

Explanation of Tests

Test 1: Does response and/or variances differ among Dose levels? (A2 vs. R)
Test 2: Are Variances Homogeneous? (A2 vs. A1)
Test 3: Are variances adequately modeled? (A2 vs. A3)

Test 7a: Does Model 5 fit the data? (A3 vs 5)

Adverse direction
-1 (use trend test)

Estimated Values of Interest

Dose	Est Mean	Est Std	Scaled Residual
0	6.559	0.2547	-0.8053
1e-006	6.559	0.2547	0.03168
0.0001	6.559	0.2547	0.2616
0.001	6.559	0.2547	0.5119
1	5.287	0.2547	-7.734e-010

Tests of Interest

Test	-2*log(Likelihood Ratio)	D. F.	p-value
Test 1	35.93	8	< 0.0001
Test 2	2.762	4	0.5984
Test 3	2.762	4	0.5984
Test 7a	1.005	1	0.3162

Fit P-Value
0.3162

Benchmark Dose Computations:

Specified Effect = 1.349000

Risk Type = Estimated standard deviations from control

Confidence Level = 0.950000

BMD = 0.430382

BMDL = 0.00164527

BMDU = 0.946299

BMD	BMDL	BMDU
0.430382	0.00164527	0.946299

BMDExpress2 Workflow – Exponential Model 5 Output

Parameter Estimates

Variable	Model 5	Std. Err.
lnalpha	-2.73545	0.0205122
a	6.55888	0.0636716
b	1.6131	33179
c	0.804078	633.024
d	3.19964	9306.47

a	b	c	d
6.55888	1.6131	0.804078	3.19964

Likelihoods of Interest

Model	Log(likelihood)	DF	AIC
A1	17.85685	6	-23.7137
A2	19.23789	10	-18.47579
A3	17.85685	6	-23.7137
R	1.273745	2	1.452511
5	17.35445	5	-24.7089

Additive constant for all log-likelihoods = -18.38. This constant added to the above values gives the log-likelihood including the term that does not depend on the model parameters.

AIC	Log (likelihood)
-24.7089	17.35445

Explanation of Tests

Test 1: Does response and/or variances differ among Dose levels? (A2 vs. R)
Test 2: Are Variances Homogeneous? (A2 vs. A1)
Test 3: Are variances adequately modeled? (A2 vs. A3)

Test 7a: Does Model 5 fit the data? (A3 vs 5)

Adverse direction
-1 (use trend test)

Estimated Values of Interest

Dose	Est Mean	Est Std	Scaled Residual
0	6.559	0.2547	-0.8053
1e-006	6.559	0.2547	0.03168
0.0001	6.559	0.2547	0.2616
0.001	6.559	0.2547	0.5119
1	5.287	0.2547	-7.734e-010

Tests of Interest

Test	-2*log(Likelihood Ratio)	D. F.	p-value
Test 1	35.93	8	< 0.0001
Test 2	2.762	4	0.5984
Test 3	2.762	4	0.5984
Test 7a	1.005	1	0.3162

Fit P-Value
0.3162

Benchmark Dose Computations:

Specified Effect = 1.349000

Risk Type = Estimated standard deviations from control

Confidence Level = 0.950000

BMD = 0.430382

BMDL = 0.00164527

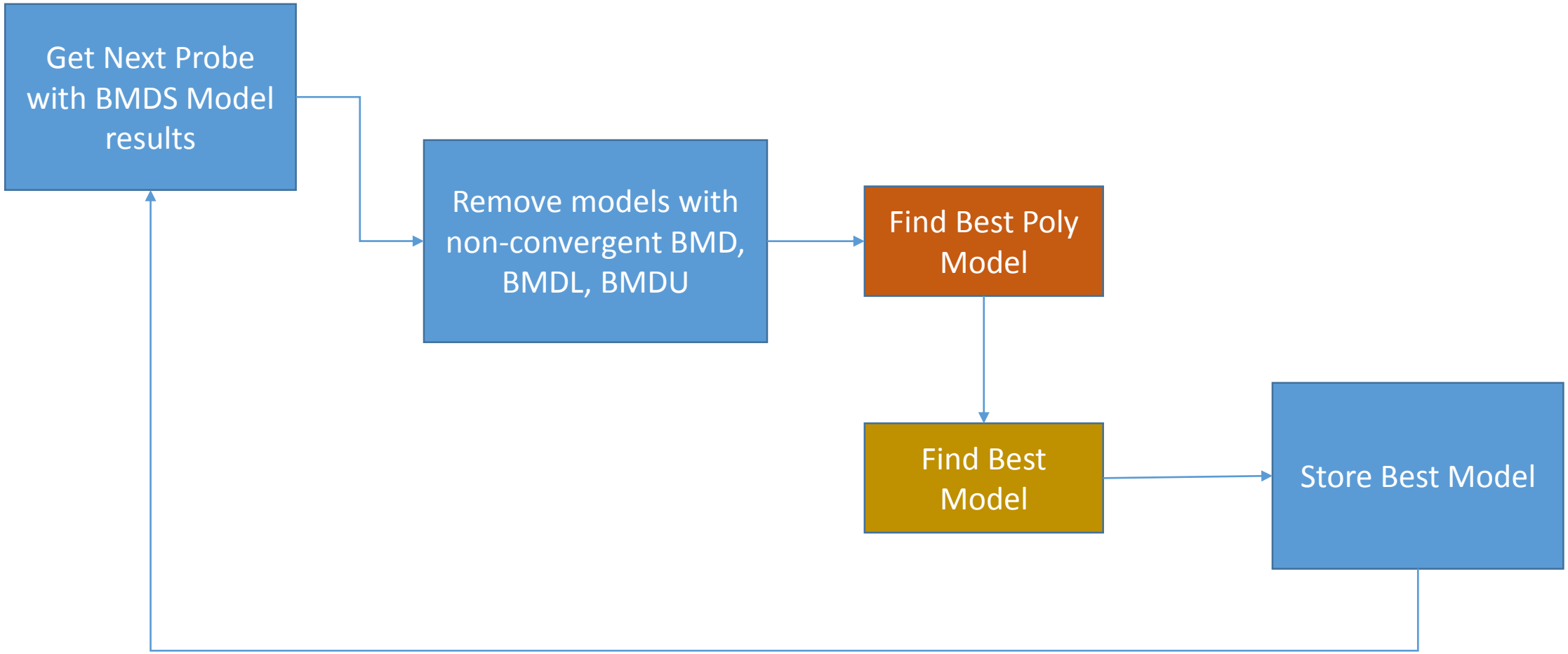
BMDU = 0.946299

BMD	BMDL	BMDU
0.430382	0.00164527	0.946299

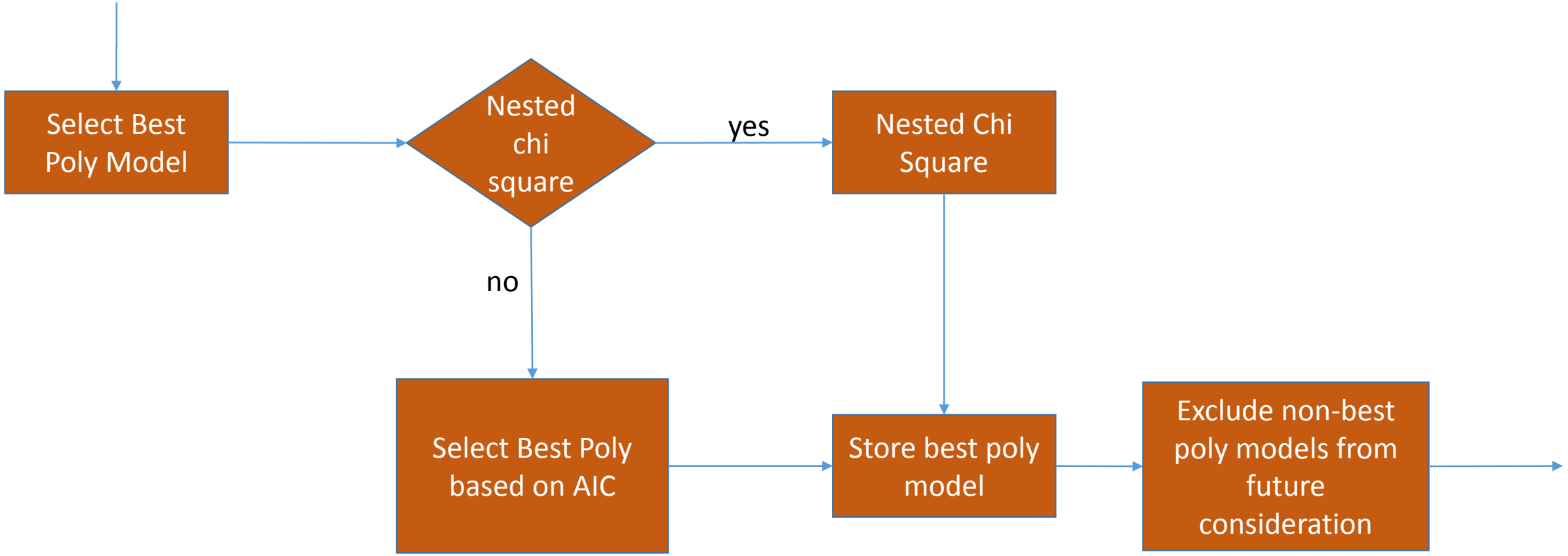
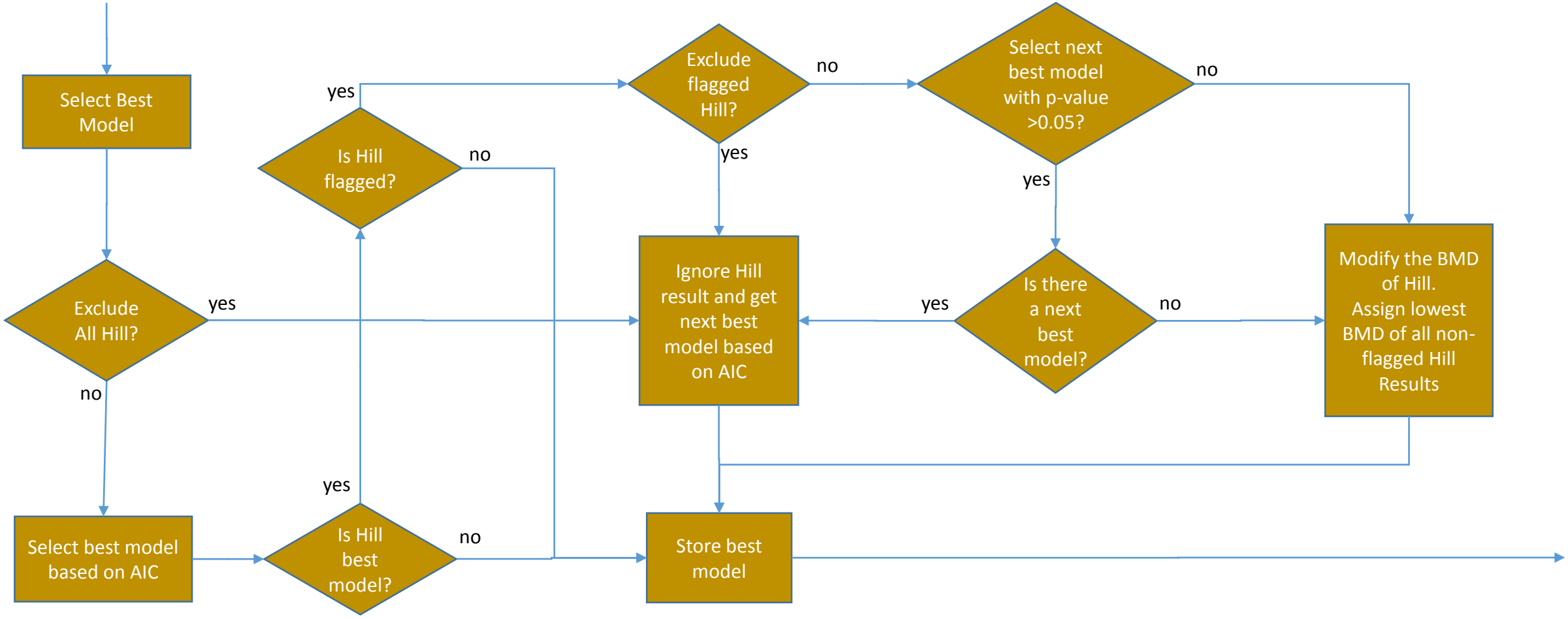
BMDExpress2 Workflow – Best Model Selection

- Best Model Selection
  - Select best poly
    - AIC
    - Nested Chi-squared
  - Select best non-poly
  - Select model from best poly and best non-poly
    - Not Flagged Hill
    - Is Flagged Hill
      - Exclude Flagged Hill from Best
      - Exclude All Hill
      - Modify BMD if Flagged Hill is Best
      - Select next best model with p-value greater than .005

BMDExpress2 Workflow – Select best poly



BMDExpress2 Workflow – Select best poly



BMDExpress2 Workflow – Select best model