

Paul Price, Ph.D.

Computational Exposure Scientist

National Exposure Research Laboratory, Office of Research and Development, U.S.
Environmental Protection Agency

EMPLOYMENT: 2015 – Present Computational Exposure Scientist USEPA National Exposure Research Lab

Dr. Paul Price is an exposure scientist where he provides support to EPA's Chemical Safety for Sustainability Research Program. His current areas of research include modeling exposures to chemicals that occurs from the use of consumer products, determining the role of exposure information in mixture risk assessments, and integration of mechanistic data on toxicity into mixture risk assessment process.

2014 - Present Adjunct Professor University of Michigan

2006 – 2015 Senior TERC Scientist, The Dow Chemical Company

At Dow Dr. Price performed research on technical issues related to mixture risk assessment, simulation modeling for exposure assessment, and biologically-based dose response modeling. He directed Dow's efforts in developing computational tools to support high throughput exposure and toxicity assessments. Dr. Price served on the design teams for two dietary exposure models, Flavorings Additives and food Contact materials Exposure Task (FACET) and on the technical committee for Cumulative and Aggregate Risk Evaluation System Next Generation (CARES-NG).

2000 – 2006 Director, The LifeLine Group Inc./ LINEA, Inc.

Dr. Price was the lead designer of the LifeLine dietary and residential exposure models. He co-developed COMET, a high-throughput exposure ranking tool, for Health Canada. Dr. Price also developed simulation models of exposure to and the effects of non-lethal weapons on combatants and the public.

1998 – 2000 Principal Scientist, AMEC Environmental and Energy Services

Developed simulation models for chronic exposure to carcinogens and non-carcinogens using simulation modeling. Projects included PCB exposures on the Hudson River from fishing and recreational use of the river and DDT exposure from recreational fishing near

the Palos Verde California and PCB exposures at the Oak Ridge National Labs.

1991 - 1998 Principle Scientist McLaren/Hart, Inc.

Developed simulation models for lifetime exposures to persistent compounds from fishing in the Hudson River, on the California coast, and the Tennessee River. Developed novel approaches for assessing uncertainty and bias in noncancer risk estimates.

1987 - 1991 American Petroleum Institute

Directed industry responses to technical aspects of regulatory initiatives. Major work was the dose reconstruction for an occupational cohort and developed models of long term residential exposures.

1979 - 1987 U.S. Environmental Protection Agency

Performed exposure and risk assessments in support of regulatory actions under Section 4 and 6 of TSCA and established drinking water standards under the SWDA.

1976 – 1978 Maryland Environmental Services

Analytical chemist

1974 - 1975 W.R. Grace Inc.

Analytical chemist

AWARDS AND HONORS

Society of Toxicology award for the outstanding paper in the field of risk assessment (2016)

Society of Toxicology award for the outstanding paper in the field of biological modeling (2011)

Society of Toxicology award for the outstanding paper in the field of risk assessment (1997)

Society of Toxicology awards for the outstanding presentation in risk assessment (1996) (Two awards)

EPA Bronze Medal awarded for development of fluoride drinking water standards, (1987)

EPA Bronze Medal awarded for meeting court-ordered deadlines for publication of regulations under Section 4 of Toxic Substances Control Act, (1982)

PROFESSIONAL AFFILIATIONS

Society for Risk Analysis (Charter member)

International Society for Exposure Science (Charter member)

Society for Toxicology (1996 - Present)

GOVERNMENT AND STATE ADVISORY PANELS

European Food Safety Authority Hearing Expert. Provided comments and suggestions to EFSA on a guidance document “*Guidance document on harmonised methodologies for human health, animal health and ecological risk assessment of combined exposure to multiple chemicals*”.

OECD Work group on cumulative exposures to chemicals. Part of EPA’s team for reviewing and commenting on the OECD initiative.

Technical Advisory Committee member EuroMix Project. Provide technical guidance on the role of exposure information in modeling risks from exposure to mixtures.

CARES technical advisory committee. Provided feedback on software design.

ILSI- HESI work group on TTC and antimicrobial chemicals. Part of a project to performed rigorous assessment of the applicability of the current TTC to antimicrobial active ingredients.

ILSI-HESI workgroup on mixtures, synergy, use of the TTC. Group performed major literature review of synergy and develop an approach for using the TTC in mixture risk assessments as a tier 0 approach.

EPA-ACE external peer review of the HARS risk assessment. This two-year appointment required a review of the human and ecological risks associated with the placement of remediation materials at the Historic Area Remediation Site (HARS) in New York Harbor. (2002-2003)

EPA-ACC Technical workshop on the Voluntary Children’s Chemical Evaluation Program (VCCEP) –Served on expert panel and made a presentation on relevance of exposure models to the assessment of Children’s Exposure, December, 2001

EPA external peer review of the report “Exposure Analysis for Dioxins, Dibenzofurans, and coplanar Polychlorinated Biphenyls in Sewage Sludge, December 2001

TERA Risk characterization of non-lethal weapons: workshop to develop framework (2001-2)

EPA external peer review of RAGS guidance on the use of probabilistic models (2000)
Served as chair of human health subcommittee of the external peer review panel for proposed guidance on the use of Monte Carlo modeling in the assessment of exposures at Superfund sites.

External peer reviewer of site-specific mercury reference dose (1997). Member of ITER peer review panel for establishing a safe intake level for mercury from the consumption of fish.

External peer reviewer of PCB carcinogenic potency assessment (1996). Member of EPA external peer review for revision of agency guidance document for PCB carcinogenicity.

Member of state of California risk assessment advisory committee (1996-7). Exposure assessment subcommittee. Reviewed and prepared written comments on all interim and final reports.

PUBLICATIONS

1. Dionisio, Kathie L., Katherine Phillips, Paul S. Price, Christopher M. Grulke, Antony Williams, Derya Biryol, Tao Hong, and Kristin K. Isaacs. "The Chemical and Products Database, a resource for exposure-relevant data on chemicals in consumer products." *Scientific data* 5 (2018): 180125.
2. Reyes, J. M., & Price, P. S. (2018). An analysis of cumulative risks based on biomonitoring data for six phthalates using the Maximum Cumulative Ratio. *Environment international*, 112, 77-84.
3. Bell, S. M., Chang, X., Wambaugh, J. F., Allen, D. G., Bartels, M., Brouwer, K. L., ... & Jarabek, A. M. (2017). In vitro to in vivo extrapolation for high throughput prioritization and decision making. *Toxicology in Vitro*.
4. Isaacs, K. K., Phillips, K. A., Biryol, D., Dionisio, K. L., & Price, P. S. (2018). Consumer product chemical weight fractions from ingredient lists. *Journal of Exposure Science and Environmental Epidemiology*, 28(3), 216.
5. Poet, T. S., Timchalk, C., Bartels, M. J., Smith, J. N., McDougal, R., Juberg, D. R., & Price, P. S. (2017). Use of a probabilistic PBPK/PD model to calculate Data Derived Extrapolation Factors for chlorpyrifos. *Regulatory Toxicology and Pharmacology*, 86, 59-73.
6. Vallotton, N., & Price, P. S. (2016). Use of the maximum cumulative ratio as an approach for prioritizing aquatic coexposure to plant protection products: a case study of a large surface water monitoring database. *Environmental science & technology*, 50(10), 5286-5293.
7. Driver, J. H., Price, P. S., Van Wesenbeeck, I., Ross, J. H., Gehen, S., Holden, L. R., ... & Rasoulpour, R. (2016). Evaluation of potential human health effects associated with the agricultural uses of 1, 3-D: Spatial and temporal stochastic risk analysis. *Science of the Total Environment*, 571, 410-415.
8. Driver, J., Price, P., Kaplan, W., Holden, L., Ross, J., & Landenberger, B. (2016). Modeling duration of time lived in a residence, a community and mobility in rural areas of Merced and Ventura, California to assess potential health risks to airborne contaminants. *Science of the Total Environment*, 569, 861-868.
9. Csiszar, S. A., Meyer, D. E., Dionisio, K. L., Egeghy, P., Isaacs, K. K., Price, P. S., ... & Bare, J. C. (2016). Conceptual Framework To Extend Life Cycle Assessment Using Near-Field Human Exposure Modeling and High-Throughput Tools for Chemicals. *Environmental science & technology*, 50(21), 11922-11934.
10. Bhatarai, B., Wilson, D. M., Price, P. S., Marty, S., Parks, A. K., & Carney, E. (2016). Evaluation of OASIS QSAR models using ToxCast™ in vitro estrogen and androgen receptor binding data and application in an integrated endocrine screening approach. *Environmental health perspectives*, 124(9), 1453.
11. Bhatarai, B., Wilson, D. M., Bartels, M. J., Chaudhuri, S., Price, P. S., & Carney, E. W. (2015). Acute toxicity prediction in multiple species by leveraging mechanistic ToxCast mitochondrial inhibition data and simulation of oral bioavailability. *Toxicological Sciences*, 147(2), 386-396.
12. Arnold, S. M., Morriss, A., Velovitch, J., Juberg, D., Burns, C. J., Bartels, M., ... & Price, P. (2015). Derivation of human Biomonitoring Guidance Values for chlorpyrifos using a physiologically based pharmacokinetic and pharmacodynamic

model of cholinesterase inhibition. *Regulatory Toxicology and Pharmacology*, 71(2), 235-243.

13. De Brouwere K, Cornelis C, Arvanitis A, Brown T, Crump D, Harrison P, Jantunen M, Price P, Torfs R. 2014. Application of the maximum cumulative ratio (MCR) as a screening tool for the evaluation of mixtures in residential indoor air. *Science of the Total Environment* 479–480 (2014) 267–276
14. Price PS, Zaleski R, Hollnagel HM, Ketelslegers H, Han X. 2014. Assessing the safety of co-exposure to food packaging migrants in food and water using the maximum cumulative ratio and an established decision tree, *Food Additives & Contaminants: Part A*, Published online: 16 Jan 2014
DOI:10.1080/19440049.2013.865145
15. Price PS, Ellen Dhein, Mick Hamer, Xianglu Han, Marjoke Heneweer, Marion Junghans, Petra Kunz, Csilla Magyar, Holger Penning and Carlos Rodriguez. 2012 A decision tree for assessing effects from exposures to multiple substances. *Environmental Sciences Europe* 2012, 24:26
16. Price PS, Xianglu Han, Marion Junghans, Petra Kunz, Chris Watts and Dean Leverett, 2012. An application of a decision tree for assessing effects from exposures to multiple substances to the assessment of human and ecological effects from combined exposures to chemicals observed in surface waters and waste water effluents. *Environmental Sciences Europe* 2012, 24:34
17. Han X, Price PS, 2012. Applying the maximum cumulative ratio methodology to biomonitoring data on dioxin-like compounds in the general public and two occupationally exposed populations. *Journal of Exposure Science and Environmental Epidemiology* , | doi:10.1038/jes.2012.7
18. Price PS, Rey TD, Fontaine D, Arnold SM, 2012. A reanalysis of the evidence for increased efficiency in benzene metabolism at airborne exposure levels below 3 ppm *Carcinogenesis* doi: 10.1093/carcin/bgs257
19. Saghir SA, McFadden LG, Bartels MJ, Rick DL, Price PS, Fontaine DD. 2012 Statistical methodology to determine kinetically derived maximum tolerated dose in repeat dose toxicity studies *Reg Tox Pharm* 63(2):344-51
20. McNally K, Cotton R, Cocker J, Jones K, Bartels MJ, Rick D, Price PS, and Loizou GD. 2012, Reconstruction of Exposure to m-Xylene From Human Biomonitoring Data Using PBPK Modelling, Bayesian Inference, and Markov Chain Monte Carlo Simulation, *Journal of Toxicology* 2012:760281
21. Rider CV, Dourson M, Hertzberg RC, Mumtaz MM, Price, and Simmons JE. 2012, Incorporating Nonchemical Stressors into Cumulative Risk Assessments. *Toxicol. Sci.* doi: 10.1093/toxsci/kfs088 First published online: February 17, 2012
22. Pottenger LH, Price PS, Gollapudi BB, 2012, Needed: Improved Dose Selection in Genetic Toxicology Studies, *Human and Ecological Risk Assessment: An International Journal*, Available online: January 13 2012
23. Han X and Price P. 2011. Determining the Maximum Cumulative Ratios for Mixtures Observed in Ground Water Wells Used as Drinking Water Supplies in the United State *Int. J. Environ. Res. Public Health* 2011, 8(12), 4729-4745;
doi:10.3390/ijerph8124729 (<http://www.mdpi.com/1660-4601/8/12/4729/>)
24. Price P and Han X. 2011. Maximum Cumulative Ratio (MCR) as a Tool for Assessing the Value of Performing a Cumulative Risk Assessment *Int. J. Environ.*

Res. Public Health 8, 2212-2225; doi: 10.3390/ijerph8062212
(<http://www.mdpi.com/1660-4601/8/6/2212/>)

25. Hinderliter PM, Price PS, Bartels MJ, Timchalk C, Poet TS. Development of a source-to-outcome model for dietary exposures to insecticide residues: An example using chlorpyrifos. *Regul Toxicol Pharmacol.* 61 (2011) 82–92
26. Price PS, Schnelle KD, Cleveland CB, Bartels MJ, Hinderliter PM, Timchalk C, Poet TS. Application of a source-to-outcome model for the assessment of health impacts from dietary exposures to insecticide residues. *Regul Toxicol Pharmacol.* 2011 61 (2011) 23–31
27. Boobis A, Budinsky R, Collie S, Crofton K, Embry M, Felter S, Hertzberg R, Kopp D, Mihlan G, Mumtaz M, Price P, Solomon K, Teuschler L, Yang R, Zaleski R. 2011. Critical analysis of literature on low-dose synergy for use in screening chemical mixtures for risk assessment. *Crit Rev Toxicol.* 2011 Feb 10.
28. Rhomberg LR, Goodman JE, Haber LT, Dourson M, Andersen ME, Klaunig JE, Meek B, Price PS, McClellan RO, Cohen SM. Linear low-dose extrapolation for noncancer health effects is the exception, not the rule. *Crit Rev Toxicol.* 2011 Jan;41(1):1-19.
29. Arnold SM, Price PS, Dryzga MD. Defining the contribution of non-benzene sources of benzene metabolites in urine: implications for biomonitoring and risk assessment. *Chem Biol Interact.* 2010 Mar 19;184(1-2):299-301. Epub 2010 Jan 21.
30. Price PS. Synergy a Risk Management Perspective. In *The Principles and Practice of Mixtures Toxicology*. Wiley-VCH. Ed. Moiz Mumtaz, 2010
31. Bogen KT, Cullen AC, Frey HC, and Price PS. 2009 Probabilistic Exposure Analysis for Chemical Risk Characterization, *Toxicological Sciences* 109(1), 4–17
32. Price PS, Hollnagel HM, Zabik JM. Characterizing the noncancer toxicity of mixtures using concepts from the TTC and quantitative models of uncertainty in mixture toxicity. *Risk Anal.* 2009 Nov;29(11):1534-48.
33. Price P, Wiltshire G. Modelling the chronic non-cancer effects of mixtures of migrants using Cramer classes and quantitative models of uncertainty. *Food Addit Contam Part A Chem Anal Control Expo Risk Assess.* 2009 Dec;26(12):1547-55.
34. Jayjock MA, Chaisson CF, Franklin C, Arnold C, and Price P. 2009. Using publicly available information to create exposure and risk-based ranking of chemicals used in the workplace and consumer products, *Journal of Exposure Science and Environmental Epidemiology* (2009) 19, 515–524
35. Price PS, Keenan RE, Swartout JC. 2009. Characterizing interspecies uncertainty using data from studies of anti-neoplastic agents in animals and humans. *Tox Appl Pharm* 2008 Apr 16
36. Price PS and Jayjock MA. 2008. Available data on naphthalene exposures: Strengths and limitations *Reg Tox & Pharm* Volume 51, Issue 2, Supplement 1, July 2008, Pg 15-21
37. Griego FY, Bogen KT, Price PS, and Weed DL. Exposure, epidemiology and human cancer incidence of naphthalene. *Reg Tox and Pharm* 51(2), Supplement 1, July 2008, Pages 22-26
38. Arnold, SF and Price PS, 2008 modeling mixtures resulting from concurrent exposures to multiple sources, *Toxicology and Applied Pharmacology* Volume 223, Issue 2, September 2007, Pages 121-124
39. Koontz M, Price P, Hamilton J, Daggett D, Sielken R, Bretzlaff R, Tyler T. 2006 Modeling aggregate exposures to glycol ethers from use of commercial floor products. *Int. J Toxicol.* 2006 Mar-Apr; 25(2):95-107.
40. Price PS, E. Mathis, D. Tedder, C. Chaisson, M. Jayjock, 2005. Human-effects Effectiveness Risk Characterization Model: Software for Simulating Human-Weapon Interaction with a

Graphic Interface. NATO Advanced Workshop Integrating Human Effectiveness and Risk Characterization of Non-Lethal Weapons

41. Price PS and Chaisson CF. A Conceptual Framework for Modeling Aggregate and Cumulative Exposures to Chemicals, 2005. *Journal of Exposure Analysis and Environmental Epidemiology* (2005) 15, 473–481
42. Price PS, Conolly RB, Chaisson CF, Young JS, Mathis ET, Tedder DT. 2003. Modeling Inter-individual Variation in Physiological Factors Used in PBPK Models of Humans, *Critical Reviews in Toxicology* Vol. 33, (5): 469-503
43. Dourson ML, Price PS, Unrine J, 2002 Health Risks from Eating Contaminated Fish Comments on Toxicology Vol. 8, Num 4-6 Pg. 399-419
44. Wilson ND, Craven V, Price PS, Paustenbach DJ. Analysis of Possible Health Risks to Recreational Fishers Due to Ingesting DDT and PCBs in Fish from Palos Verdes Shelf and Cabrillo Pier, Chapter 17, in *Human and Ecological Risk Assessment: Theory and Practice*, Ed. D. Paustenbach, 2002
45. Price PS, J. S. Young, C. F. Chaisson. 2001. Assessing Aggregate and Cumulative Pesticide Risks Using A Probabilistic Model, *Annals of Occupational Hygiene*, Vol 45 No. 1001, S131-S142
46. Wilson ND, Price PS, Paustenbach DJ. 2001. An Event-by Event Probabilistic Methodology for Assessing the Health Risks of Persistent Chemicals in Fish: A Case Study at the Palos Verdes Shelf, *Journal of Toxicology and Environmental Health*, 62:595-642
47. Price PS, Ginevan M., Barry, T., Qualitative and Quantitative Uncertainty Analysis, Chapter 12. *Residential Exposure Assessment*, 2001
48. Price PS, Keenan, R.E., Schwab B. 1999. Defining the Interindividual (Intraspecies) Uncertainty Factor. *HERA*, 5(5) p. 1023-1033
49. Carlson-Lynch, H., Price PS, J.C. Swartout, M.L. Dourson, and R.E. Keenan. 1999. Application of quantitative information on the uncertainty in the RfD to noncarcinogenic risk assessments. *HERA* 5(3) p. 527-547.
50. Price PS, P. K. Scott, N. D. Wilson, D.J. Paustenbach. 1998 An Empirical Approach for Deriving Information on Total Duration of Exposure from Information on Historical Exposures, *Risk Anal.* (18) 4
51. Swartout, J.C., Price PS, M.L. Dourson, H. Carlson-Lynch, and R.E. Keenan. 1998. A probabilistic framework for the reference dose, *Risk Anal.* (18) 3, 271-282
52. Price PS, R.E. Keenan, J.C. Swartout, C.A. Gillis, H. Carlson-Lynch, and M.L. Dourson. 1997. An approach for modeling noncancer dose responses with an emphasis on uncertainty. *Risk Anal.* Vol 17, No. 4.
53. Price PS and Stickney, J.A. 1997. The role of statistics, policy, and management issues in the decision to adopt linear non-threshold dose response models. *Comm. Toxicol.*, 6(2): 139-149.
54. Price PS, C.L. Curry, P.E. Goodrum, M.N. Gray, J.I. McCrodden, N.W. Harrington, H. Carlson-Lynch, and R. E. Keenan. 1996. Monte Carlo modeling of time-dependent exposures using a Microexposure event approach. *Risk Anal.* 16(3): 339-348.
55. Price PS, S.H. Su, J.R. Harrington, and R.E. Keenan. 1996. Uncertainty and variation in indirect exposure assessments: An analysis of exposure to tetrachlorodibenzo-p-dioxin from a beef consumption pathway. *Risk Anal.* 16(2): 263-277.
56. Curry CL., Price PS, D.G. Gunster, N.L. Bonnevie, and T. B. Abel. 1995. Interlake Variation in Polychlorinated Biphenyl Bioaccumulation Factors for the Great Lakes, Water Environment Federation, Annual meeting, May

57. Harrington NW, C.L. Curry, H.J. Carlson-Lynch, and Price PS. 1995. The Microexposure Event Modeling Approach to Probabilistic Exposure Assessment. Air and Waste Management Annual Meeting, San Antonio. Manuscript A443. May.
58. Ebert ES, Price PS, and R.E. Keenan. 1994. Selection of fish consumption estimates for use in the regulatory process. *J. Exp. Anal. Environ. Epid.* 4(3):373-394
59. Finley B, D. Proctor, P. Scott, P. Price, N. Harrington, and D. Paustenbach. 1994. Recommended distributions for exposure factors frequently used in health risk assessment. *Risk Anal.* 14(4):533-553
60. Keenan RE, B.L. Finley, and Price PS. 1994. Exposure assessment: then, now, and quantum leaps in the future. *Risk Anal.* 14(3):225-230.
61. Price PS, S.H. Su, and M.N. Gray. 1994. The effect of sampling bias on estimates of angler consumption rates in creel surveys. *J. Exp. Anal. Environ. Epid.* 4(2):355-372
62. Paustenbach DJ, R. Bass, and P. Price. 1993. Benzene toxicity and risk assessment (1972-1992): Implications for future regulations. *Environ. Health Perspect.*
63. Sherer RA and Price PS. 1993. The effect of cooking processes on PCB levels in edible fish tissue. *Qual. Assur: Good Practice, Reg. and Law* 2(4):396-407.
64. Paustenbach DJ, Price PS, Ollison W, Blank C, Jernigan J, Bass R, and Peterson HD. 1992. Reevaluation of benzene exposure for the Pliofilm (rubberworker) cohort (1936-1976). *J. Toxicol. Environ. Health* (36):177-231.
65. Price PS, J. Sample, and R. Strieter. 1991. PSEM a model of long term exposures to emissions of point sources. In: *Proceedings of the 84th Annual Meeting of Air and Waste Management Association*. June.
66. Price PS, J. Sample, and R. Strieter. 1991. Determination of less-than-lifetime exposures to point source emissions. *Risk Anal.* 12(3):367-382.
67. Price PS. 1988. Apportionment of reference doses. In: *Proceedings of the Society for Risk Analysis*.
68. Price PS. 1984. Acceptable levels of risk and standards. In: *Proceedings of the Society for Risk Analysis*.
69. Allman J and Price PS. 1980. A synopsis of perspectives on the innovative and alternative technology program. *Innovative and Alternative Treatment Technology program. J. Wat. Poll. Contrl. Fed.*