**Ankur Singhal, MA**
**Senior Scientist (Analytics)**

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## Academic and Professional Profile

Mr. Ankur Singhal is an environmental health scientist specializing in quantitative exposure science. He uses his expertise in exposure assessment along with his unique skill set in data collection, data analytics and machine learning (ML) to provide end-to-end risk assessment solutions for his clients. He has experience conducting field studies, simulation studies and exposure reconstructions to generate data; developing mathematical models, including ML models, to characterize and predict exposures; and performing human health risk assessments. Recently, Mr. Ankur Singhal has been developing interactive software tools, e.g., web and mobile applications and dashboards, for his clients and has been a key promoter of new technology adoption at his current firm.

Mr. Singhal is an active participant in the academic and professional community publishing in peer-reviewed journals and presenting in conferences such as American Industrial Hygiene Association (AIHA), Society for Risk Analysis (SRA), International Society for Exposure Sciences (ISES), Society of Toxicology (SOT), and Product Stewardship Society.

## **Education and Degrees Earned**

- M.A., Endocrinology, University of California, Berkeley, 2011
- B.A., Molecular and Cell Biology, University of California, Berkeley, 2008

## **Current and Former Membership to Professional Societies**

- Society for Risk Analysis (SRA)
- American Industrial Hygiene Association (AIHA)
  - o Member of Risk Assessment Committee (2018 – 2020)
- Product Stewardship Society (PSS)
  - o Member of Credentialing Committee (2018 – 2020)
  - o Author on chapters for the Principal Practices of Product Stewardship (2019)
- Society of Toxicology (SOT)
- Society of Environmental Toxicology and Chemistry (SETAC)
- International Society of Exposure Science (ISES)

## <u>Experience Summary</u>

**Environmental Health & Engineering**
**Senior Scientist (Analytics group)**
**October 2020 – Present**

- Research, develop, and promote adoption of new technologies to further analytical capabilities within the firm and for the benefit of the client. Has included teaching and migrating of existing code to GitHub, adoption of cloud computing services, e.g., AWS and Kubernetes clusters, development of interactive web platforms and tools in Shiny (for R) and Flask (for Python). Have recently started using and promoting D3.js for creating interactive and versatile visualizations and graphs.
- Extensive litigation support in ongoing PFAS litigation. Has included data collection near water treatment facilities, detailed analysis of the data using traditional statistical models and advanced tools such as PCA, SVM, KNN, and other clustering methods to characterize source attributions. Developed interactive mapping tools using Shiny R for use by clients. Evaluated toxicology and epidemiology of PFAS and transport and fate (including fractionation issues); developed exposure profiles; have been on the pulse of regulatory developments including the latest proposed EPA MCL guidance. Intimately familiar with not only PFOA and PFOS but also other long-chained and short-chained PFAS.
- Proactive and reactive support for ethylene oxide (ETO) emissions compliance. Have evaluated the basis of EPA IRIS value along with the underlying NIOSH model. Familiar with ETO sterilization processes, controlled emissions, and sources of fugitives. Did analysis to predict point cancer risk in a census tract from newly reported emissions in TRI and NEI using prior NATA and AirToxScreen emissions without having to conduct extensive AERMOD and CMAQ modeling. Developed an interactive Shiny dashboard to visualize cancer risk near facilities. Code available in GitHub.
- Evaluated questions related to the COVID-19 pandemic such as transmission possibilities in airplanes and airports, in buildings, schools and other common indoor air spaces. Developed models to understand transmissions in indoor spaces along with creating dashboards in Tableau for the relevant communities to follow local statistics.
- Provided support in various other litigation projects from one-off analysis questions to immersive exposure assessments, report writing, expert critique, and responses to Daubert challenge. Projects have included evaluating exposures to hexavalent chromium, coal ash, formaldehyde in indoor air and to arsenic and lead in food.
- Continued Proposition 65 assessments for existing clients.
- Proficient in SQL, R, Python, Tableau including web development frameworks. Conversational in JavaScript and cloud computing tools.

**Paustenbach and Associates**
**Senior Analytics Scientist**
**April 2020 – October 2020**

- Conducted risk assessments and exposure assessments to support litigation for a CERCLA site related to widespread contamination of soil with radionuclides and potential exposures to the nearby community.
- Conducted evaluations for PFOA, PFOS, formaldehyde and asbestos.
- Provided continued support for Proposition 65 assessments for existing and new clients.

**Empirical Solutions Consulting, LLC**
**President and Founder**
**July 2019 – April 2020**

- Founded the company to provide support to consulting firms as a subcontractor focusing on litigation support and software development and data analysis needs. An immersive learning experience in marketing strategies.
- Provided litigation support for evaluating lead exposures to a nearby community from a smelter. Included use of air dispersion modeling and traditional statistical methods to predict the probability of exposures given space and time; conducted personalized exposure assessments.
- Supported existing Proposition 65 clients for conducting exposure assessments.
- Developed a web tool to predict exposures to formaldehyde in the indoor environment using previously published formaldehyde emissions model.
- Developed a recommendation tool similar to Netflix for rock climbers. First, developed a database of rock climbs from publicly available data using natural language processing (NLP) methods, e.g., bag of words, TF-IDW, sentiment analysis, to infer inherent parameters about routes (similar to a movie's parameters) from text descriptions and comments. Using this database, created a recommendation tool (content filtering, collaboration model, and neural networks) to predict a user's preference for a certain route. A fully functional API is publicly available, and a mobile app is currently in the process of being developed.

**Exponent, Inc.**
**Managing Scientist (Health Sciences group)**
**January 2013 – May 2019**

- Started as a junior level Scientist and within six years became a Managing Scientist. One of the youngest scientists in the Health Sciences group at Exponent to do so.
- Evaluated exposures to formaldehyde from laminate flooring. Managed and conducted an extensive sampling program to empirically determine formaldehyde emissions. Built a bi-exponential model to predict emissions over time in order to facilitate exposure assessment. Work published in peer-reviewed literature.

- Created quality control and quality management programs for Fortune 500 companies in order to maintain compliance with consumer product safety regulations around the country include CPSIA and California's Proposition 65.
- Consulted in the areas of risk assessment, environmental and occupational toxicology, and the scientific aspects of toxic tort cases. Provided advice on industry hygiene issues as well as remedial/feasibility studies.
- Provided expertise in consumer product safety matters, industrial and occupational toxicology, pharmacokinetics (PBPK modeling), environmental fate and transport, air pollution, odor abatement and ventilation engineering.
- Routinely involved in evaluation of health hazards posed by hazardous waste sites, landfills, contaminated soil, gaseous emissions, water, the workplace, pesticides and manufacturing processes.
- Managed projects involving the assessment of the health risks and significance of chemical contaminants present in water, sediment, ambient air, food, soil, the occupational environment, and in consumer products.
- Frequently interacted with local, regional, state and federal regulatory agencies.

### Key Projects (Partial List)

- **PFAS litigation:** Mr. Singhal has been actively involved in the ongoing PFAS litigation in multiple districts around the U.S. He has evaluated toxicology and epidemiology of various PFAS including PFOA and PFOS, is familiar with transport and fate (including fractionation issues) of these chemicals and has evaluated the basis of various regulatory values including the latest EPA MCL guidance for PFOA and PFOS. In addition, Mr. Singhal has managed sampling programs to assess levels of PFAS in water, soil, and sediment. He has analyzed those data using traditional statistical methods and with advanced tools such as PCA and supervised and unsupervised clustering methods to infer possible patters in source contributions. Mr. Singhal has created dashboards with interactive mapping tools and interactive graphs for visualization purposes and to aid in analysis during various litigation phases.

- **Ethylene oxide litigation:** Mr. Singhal has been actively involved in litigation surrounding ethylene oxide emissions and the potential cancer risks to the nearby communities. He has evaluated the basis of EPA's 2016 IRIS cancer potency factor for ethylene oxide, the NIOSH model that it relied upon, and the validity of the linear no-threshold assumption used by the EPA. In addition, Mr. Singhal has helped multiple clients assess their ethylene oxide emissions from their spice and medical device sterilization facilities in order to contextualize and forecast potential cancer risks to the nearby communities based on EPA's NATA and AirToxScreen evaluations. He has created an online interactive dashboard for the public to visualize cancer risks from ethylene oxide.

- **Coal ash exposure assessment**: Mr. Singhal evaluated exposures to community from a coal ash spill and to workers involved in the subsequent cleanup. He reviewed site health plans, individual exposure histories, and sampling plans and results to analyze each individual's exposures to lead, arsenic, and silica from coal ash.

- **An ML-based recommendation system for rock climbers:** Mr. Singhal developed a recommendation tool similar to Netflix for rock climbers with the idea that a model should be able to predict which routes a climber is likely to enjoy. He first developed a database of rock climbs from publicly available data, using natural language processing (NLP) methods, e.g., bag of words, TF-IDW, and sentiment analysis, to infer inherent parameters about routes (similar to a movie's parameters) from text descriptions and comments. Using this database, he developed a recommendation model (content filtering, collaboration model, and neural networks) to predict a user's preference for a certain route. The model is indeed able to learn over time and cross-reference climbers' preferences to routes' parameters and make highly relevant inferences. A fully functional API is publicly available and a mobile app is currently in the process of being developed.

- **COVID-19 transmission modeling**: Mr. Singhal helped develop deterministic and stochastic models to understand transmissions of SARS-CoV-2 (COVID-19) in various indoor air spaces such as grocery stores, restaurants, airplanes and airports. He developed online tools to track transmissions in the U.S. and also helped developed dashboards using Tableau for schools, universities and local communities to track local statistics.

- **Risk assessment for radionuclides:** Mr. Singhal conducted assessments to estimate potential health risks from widespread radionuclide contamination in groundwater and soil at a CERCLA site.
- **Formaldehyde exposures from laminate flooring**: Mr. Singhal led a team of several Exponent and non-Exponent scientists to assess formaldehyde exposures from laminate flooring installed in people's homes. He and his team collected the largest ever consumer product data set collected to date and developed novel mathematical models to estimate formaldehyde exposures from consumer products. This work was presented to US Consumer Product Safety Commission (CPSC) and has since then been published.
- **California Proposition 65 assessment**: Mr. Singhal has 10 years of experience performing California Prop 65 assessments for numerous chemicals including the most litigated ones – lead, cadmium, phthalates, bisphenol-A (BPA) and formaldehyde – in consumer products and food products.
- **Quality Assessment and Quality Control (QA/QC) programs**: Mr. Singhal has helped many of his consumer product clients develop Prop 65 screening programs as part of their Quality Control programs in order to proactively manage CPSIA and Prop 65 compliance internally.
- **Evaluation of claims that airborne dust from a former Naval site posed a cancer hazard to the community.** It was claimed that hundreds of persons who lived within ¼ mile of a former Naval base had been exposed to airborne dust (soil) from the facility and that it had entered their homes and was causing adverse health effects. Evaluated air and dust data in order to conduct an assessment.
- **Air quality assessments**: Mr. Singhal has conducted numerous indoor and ambient air quality assessments using low cost sensors, active sampling, exposure chambers, etc. to determine exposure to pollutants such as benzene, formaldehyde, volatile organic compounds (VOCs) and asbestos among others.
- **Predicting air quality using low cost sensors**: Mr. Singhal is actively researching the use of advanced data science methods such as deep learning to predict air quality. For example, he is currently building a deep neural network model to predict air quality at any geolocation based on features like weather patterns or even photos taken from someone's phone.
- **Biocompatibility assessment for consumer wearables:** Mr. Singhal has helped many of his clients in the tech industry assess dermal sensitization risk from their wearable products. Wearable products are unique in their composition and in how they are regulated and therefore, also require unique exposure assessment approaches. Mr. Singhal and his team at Exponent developed seminal methods for estimating allergic contact dermatitis (ACD) risk from wearable devices. This work has also been published.
- **PBPK model for malathion:** Mr. Singhal updated a PBPK model for malathion using *in vivo* human data. This work has been published in peer-reviewed literature.
- **Data analysis and data science:** Mr. Singhal has been helping these companies make the most out of their data by providing *ad hoc* data analysis services. His clients have included construction companies, utility companies and consumer products companies.

## **Publications**

- Bogen KT, Lewis RC, Singhal A, Sheehan P. 2020. Development of a Novel Method for Estimating Dermal Contact with Hand-Applied Cleaning Solutions. Environmental Monitoring and Assessment. Environ Monit Assess 2020; 192:157.

- Sheehan P, Singhal A, Bogen KT, MacIntosh D, Kalmes RM, McCarthy J. 2018. Potential Exposure and Cancer Risk from Formaldehyde Emissions from Installed Chinese Manufactured Laminate Flooring. Risk Anal 2017. doi:10.1111/risa.12926

- Singhal A, Posson M, Kalmes R, Gauthier A, Lewis R, Schenk J, Goswami E and Sheehan P. 2018. Proposition (Prop) 65 Risk Assessment. In: G Hart (Eds), Professional Practices of Product Stewardship (pp. 423-427). Falls Church, VA: Product Stewardship Society.

- Singhal A, Bogen KT, Sheehan P. 2018. Wearable Devices. In: G Hart (Eds), Professional Practices of Product Stewardship (pp. 428-433). Falls Church, VA: Product Stewardship Society.

- Bogen KT, Singhal A. Malathion dermal permeability in relation to dermal load: Assessment by PBPK modeling of in vivo human data. J Env Sci Health, Part B 2016; 0:1-9.

- Marconett CN, Singhal A, Sundar SN, Firestone GL. Indole-3-carbinol disrupts estrogen receptor-alpha dependent expression of insulin-like growth factor-1 receptor and insulin receptor substrate-1 and proliferation of human breast cancer cells. Molecular and Cellular Endocrinology 2012; 363:74-84.

- Marconett CN, Morgenstern TJ, San Ramon AK, Sundar SN, Singhal A, Firestone GL. BZL101, a phytochemical extract from Scutellaria barbata plant, disrupts proliferation of human breast and prostate cancer cells through distinct mechanisms dependent on the cancer cell phenotype. Cancer Biology and Therapy 2010; 10: 397-405.

## **Presentations and Posters**

- Schenk J, Singhal A, Scrafford C, Kalmes R. Emerging Regulatory Issues and Exposure Assessment of Furfuryl Alcohol (FFA). Presented at the Joint Annual ISES/ISEE Meeting, August 26-30, 2018, Ottawa, Canada.

- Singhal A, Kalmes R, Posson M. 2018. Addressing Chemical Exposure from Consumer Products: Lessons Learned. Presented at 2nd Annual Product Stewardship Society Conference Annual Meeting in Washington, DC, September 27-29, 2018.

- Singhal A, Kalmes R, Sheehan P. 2018. Lessons Learned from Formaldehyde Sampling Conducted in U.S. Homes. Presented at American Industrial Hygiene Conference and Exposition (AIHce) Annual Meeting in Philadelphia, PA, May 2018.

- Singhal A. 2018. Determining Compliance for Proposition 65 in Proposition 65 Update. Webinar presentation for International Society of Primerus Law Firms.

- Singhal A. 2017. Oral (non-food-mediated) exposure to plastic product additives. Presented at the European Chemicals Agency (ECHA) additives in plastics workshop, Brussels, Belgium, November 7-8, 2017.

- Singhal A and Sheehan PJ. 2017. Consumer Wearables: A New Product Stewardship challenge. Presented at the 1st Annual Meeting of Product Stewardship Society, Tampa, FL, November 2-4, 2017.

- Gauthier AM, Lewis RC, Bogen KT, Singhal A, Sheehan PJ. 2017. Wearable Technology Biocompatibility: A Unique Opportunity in Green Chemistry and Engineering. Presented at the 21st Annual Meeting of Green Chemistry and Engineering Conference, Reston, VA, June 13-15, 2017.

- Lewis RC, Winegar E, Posson M, Gauthier AM, Singhal A, Sheehan PJ. 2017. Exposure to an Ethanol-based Cleaning Product. Presented at American Industrial Hygiene Conference and Exposition Annual Meeting, Seattle, WA, June 4-7, 2017.

- Singhal A, Bogen KT, Lewis RC, Gauthier AM, Winegar E, Sheehan PJ. 2017. A Novel Approach to Estimating Dermal Contact with Hand-Applied Cleaning Solutions: A Simulation Study Involving Denatured Alcohol. Presented at the 56th Annual Meeting of the Society of Toxicology, Baltimore, MD, March 2017.

- Winegar E, Bogen KT, Lewis RC, Gauthier AM, Singhal A, Sheehan PJ. 2017. A Use-Simulation Study of a Denatured Alcohol Cleaning Product to Assess Potential Worker Exposure. Presented at the 56th Annual Meeting of Society of Toxicology, Baltimore, MD, March 10-16, 2017.

- Singhal A, Posson M, Jones A, Lewis RC, Gauthier A, Schenk J, Kalmes R, Sheehan PJ. Assessing Risk for Consumer Products Under California's Proposition 65 Regulations. 2016. Presented at the 37th Annual Meeting of Society of Environmental Toxicology And Chemistry, Orlando, FL, November 6-10, 2016.

- Sheehan P, Singhal A, Bogen KT, Kalmes R. Evaluating the Proposition 65 Health Significance of Formaldehyde Exposures from Chinese Manufactured Laminate Flooring. Presented at the 55th Annual Meeting of the Society of Toxicology, New Orleans, LA, March 13 - 17, 2016.

- Singhal A and Bogen KT. How Malathion Dermal Absorption Varies with Dermal Load, Based on Physiologically Based Pharmacokinetic Modeling of In Vivo Human Data. Presented at the 55th Annual Meeting of the Society of Toxicology, New Orleans, LA, March 13 - 17, 2016.

- Sheehan P, Lowney Y, Kalmes R, Bogen KT, Posson M, Glomski M, Singhal A, Volberg V, Beckerman B, Goswami E. Assessing User Exposure to Consumer Products: Methods Specific to Product Use and Exposure Route to Assess Consumer Health Risk. Presented

at the 36th Annaul Meeting of SETAC North America, Salt Lake City, UT, November 1 - 5, 2015.

- Kalmes R, Lowney Y, Sheehan P, Singhal A. Assessing Incidental Hand-to-Mouth Exposure to Lead from Consumer Products. Presented at the 36th Annaul Meeting of SETAC North America, Salt Lake City, UT, November 1 - 5, 2015.

- Sheehan P, Bogen KT, Singhal A, Kalmes R, Volberg V. Wearable technology products and allergic contact dermatitis: Chemical exposure and risk assessment challenges & developments. SETAC North America 36th Annual Meeting, Salt Lake City, UT, November 1-5, 2015.

- Sheehan P, Bogen KT, Singhal A, Kalmes R, Roberts M, Fedoruk MJ. Wearable products and allergic contact dermatitis: a new risk assessment challenge. Presented at the 54th Annual Meeting of the Society of Toxicology, San Diego, CA, March 22-26, 2015.

- Singhal A, Sheehan P, Turnham P, Bogen KT, Anderson E. Experimental comparison of dust concentrations from simulations in glove box and room chamber test environments. Presented at the American Industrial Hygiene Association Annual Meeting, San Antonio, TX, May 31-June 5, 2014.

- Singhal A, Sheehan P, Turnham P, Bogen KT, Anderson E. Experimental comparison of dust concentrations from simulations in glove box and room chamber test environments. Presented at the American Industrial Hygiene Association Annual Meeting, San Antonio, TX, May 31-June 5, 2014.

- Sheehan P, Posson M, Singhal A, Bogen KT, Hellerstein J. Assessing anthraquinone (AQ) exposure from food packaging: A product stewardship challenge in Europe. Presented at the American Industrial Hygiene Association Annual Meeting, San Antonio, TX, May 31-June 5, 2014.

- Singhal A, Bogen KT. Benchmark dose analysis of NTP data on tumors induced in rodents chronically exposed to dietary anthraquinone. Presented at the 53rd Annual Meeting of the Society of Toxicology, Phoenix, AZ, March 23-March 27, 2014.