August 2025 Meeting of the Scientific Guidance Panel for Biomonitoring California

Summary of Input and Recommendations

The Scientific Guidance Panel (SGP) for the California Environmental Contaminant Biomonitoring Program (also known as Biomonitoring California) met in Sacramento on August 27, 2025. This document briefly summarizes input and recommendations received from the Panel, as well as the range of topics discussed with the audience. Visit the August 2025 SGP meeting page to access the presentations, transcript, and other meeting materials.

SGP Panel Members in Attendance

Lara Cushing, PhD, MPH, Acting Chair
Timur S. Durrani, M.D., M.P.H., M.B.A.
Ulrike Luderer, MD, PhD
Thomas McKone, PhD
Amy Padula, PhD, MSc
Penelope (Jenny) Quintana, PhD, MPH
Oliver Fiehn, PhD, *attended remotely*

Program Update
Presentation: Nerissa Wu, PhD, California Department of Public Health (CDPH)

Panel members and the audience discussed the following topics with Program staff:

- Potential sources of elevated inorganic arsenic in participants in the California Regional Exposures Study in Los Angeles (CARE-LA)
  - Higher levels may be linked to diet, specifically rice consumption. California has a higher proportion of Asian and Hispanic populations who tend to eat more rice.
  - Public water systems in southwestern states, including California, may have higher arsenic concentrations in drinking water.
    - There are around 200 water systems in LA County, so it would be interesting to do something similar to what was done with PFASs, looking at arsenic levels in CARE-LA participants and arsenic levels by drinking water system.
- The analytical considerations when biomonitoring for micro- and nano-plastics.
  - While methods have been used to measure microplastics in fish and human tissue, they are not yet developed for large scale biomonitoring studies.
  - There are many different polymers and chemicals, such as flame retardants and plasticizers, that are associated with microplastics. The particle sizes are variable as well.
  - The target organs for microplastics also need to be understood to identify the appropriate biomatrix (e.g., blood, urine).
  - The Program would need to consider what chemicals are released through microplastics that are already on the Program’s designated list.

- The utility of micro-sampling devices to collect blood for biomonitoring studies.
  - Micro-samplers collects around 400 μL of blood, out of which 200 μL is serum. This would limit the number of analytes run on each sample.
    - PFAS and legacy pollutants such as hexachlorobenzene would be of interest to measure.
  - The Environmental Health Lab (EHL) is looking into the potential for metal contamination, and the Environmental Chemistry Lab (ECL) is looking into the potential for PFAS contamination from the micro-samplers.
  - The Program plans to conduct a pilot study comparing micro-samplers to traditional venipuncture. The study will also assess usability and acceptability by participants.
  - The logistics of micro-samplers in the field may be simpler than phlebotomy.
    - They would also be useful during emergency response biomonitoring, for instance, after a wildfire.
  - Researchers external to Biomonitoring California are also using or testing micro-samplers.
    - Most are being used to examine antibodies and proteins in blood.
    - They have reported issues with pain in some populations, such as young children.

- The evaluation of results return materials that study participants receive.
  - The Program has previously conducted a number of results return evaluations.
    - For example, in the CARE study, participants were asked to provide feedback on their results return packet.
    - Pre-results return evaluations are routinely done with community partners and other stakeholders to ensure cultural and linguistic appropriateness and accessibility to participants.
    - Currently, results return materials from the Biomonitoring component of the San Joquin Valley Pollution and Health Environmental Research Study (BiomSPHERE) study are being evaluated with the help of the Central California Asthma Collaborative (CCAC), a BiomSPHERE community partner, and UC Merced.
  - The Program has started to implement incremental changes to the materials, such as reducing the amount of text and introducing more graphics, based on prior feedback.
    - The use of an electronic platform, such as the Digital Exposure Report-Back Interface (DERBI) developed by the Silent Spring Institute, is also being explored.
  - Biomonitoring California was an author on a recent manuscript evaluating different results return formats and has led a National Biomonitoring Network workshop on best practices.

- Dr. Ahimsa Porter Sumchai provided a public comment that described how geospatial mapping identified arsenic, manganese, vanadium, and gadolinium in a population living and working close to Superfund sites in South San Francisco.

Results from the Biomonitoring component of the San Joaquin Valley Pollution and Health Environmental Research Study (BiomSPHERE)
Presentation: Aalekhya Reddam, PhD, OEHHA

Panel members and the audience discussed the following topics with Program staff:

- The higher levels of urinary 2-hydroxynaphthalene (2-naphthol), a metabolite of naphthalene, in BiomSPHERE participants compared to the levels reported in the general US population as part of the National Health and Nutritional Examination Survey (NHANES).
  - Research from other countries shows a general increase of 2-naphthol in urine in recent years, but not to the same magnitude as participants in the Central Valley.
  - The most recent NHANES cycle measuring 2-naphthol is 2015-2016. There are limited data on more recent levels of 2-naphthol in the United States.
  - Similar trends are being observed in another Biomonitoring California study (Farmworker women & Respiratory Exposure to Smoke from Swamp Cooler Air (FRESSCA–Mujeres)). These findings were presented at a FRESSCA-Mujeres community meeting held earlier this year.
    - Community members did not express concern regarding the elevated 2-naphthol levels.
    - Exposure reduction tips and uncertainties around exposures sources were communicated in the meeting.
  - Participants in California tend to have lower secondhand smoke exposure compared to other states, therefore NHANES participants with similar cotinine levels would be a more accurate comparison.

- Potential exposure sources of 2-naphthol in BiomSPHERE participants.
  - Cooking food with high heat can result in elevated levels of fine particulate matter and polycyclic aromatic hydrocarbons (PAHs).
    - Real-time air monitoring was not conducted, therefore exposure peaks of PAHs could not be captured.
    - There were no significant associations with cooking methods or grilled/fried food consumption and urinary 2-naphthol levels.
    - Cooking can result in exposures to other PAHs as well, but as they were not elevated or correlated with 2-naphthol, cooking may not be a primary source of exposure (small N might limit ability to see associations).
  - Traffic-related air pollution is a common source of PAH exposure.
    - There are significant correlations between air concentrations of black carbon and proximity to Highway 99, a major truck route.
    - Additional analyses need to be conducted to identify potential associations between nearby traffic and 2-naphthol levels.
  - Agricultural burning in the Central Valley may be a source of naphthalene exposure.
  - Naphthalene may be an ingredient in fragrances but not listed or disclosed on product labels.

  - New products may have been introduced since 2016 (the most recent NHANES data) that are contributing to the high levels of 2-naphthol in Central Valley residents.

- The development of a new method by EHL to characterize total naphthalene exposure.
  - EHL currently measures monohydroxylated metabolites of naphthalene (1- & 2-hydroxynaphthalene).
  - 1,2-dihydroxynaphthalene (1,2-DHN) is another metabolite of naphthalene that EHL is interested in developing methods to measure, as it has shown strong correlations with naphthalene exposures in air.

Science You Can Wear: The Silicone Wristband Journey from Bench to Biomonitoring
Presentation: Kim Anderson, PhD, Professor, Department of Environmental and Molecular Toxicology, Oregon State University

Using Silicone Wristbands to Assess the Personal Chemical Exposome: Strengths and Limitations
Presentation: Heather Stapleton, PhD, MS, Professor, Division of Environmental Natural Science and Department of Civil and Environmental Engineering, Duke University

Discussion: Use of Silicone Wristbands to Complement Biomonitoring Studies

Panel members, the audience, staff and guest speakers discussed the following topics:

- The utility of wristbands as passive air samplers compared to other methods of passive air monitoring.
  - There is no current method to calculate air concentrations from the concentrations in the wristbands; other passive air samplers may be preferred.
  - Wristbands cannot capture particulate matter.

- Examples of current applications of wristbands in different studies and by different countries and organizations.
  - Silicone wristbands are widely used in academia.
  - There are exposomic initiatives in the European Union that include wristbands in several studies.
    - Labs in the United States are collaborating and conducting harmonization studies that will allow the inclusion of wristbands in exposomic studies.

- Variables that might influence the concentrations of chemicals on the wristband.
  - There is a range of K_{oa} and K_{ow} for chemicals that are more stable on the wristband over time.
    - Very volatile chemicals may pose challenges due to potential losses during handling and shipping.
  - Field replicates have shown variability based on participants' activities and exposure (e.g., wearing the wristband on the dominant hand in certain occupational settings).
  - Research has shown variability depending on geographic region, temperatures, and over seasons.

        - Due to the temporal variability, longitudinal measures may be more appropriate than cross sectional measures.
    - Bathing does not appear to impact concentrations of chemicals on wristbands, likely due to the hydrophobic nature of target chemicals.
    - Impact of clothing types such as sleeve length and clothing treated with PFAS needs to be further studied.

- Best practices and ideal study design when deploying wristbands in the field.
    - If using wristbands as a screening tool, the longer participants wear wristbands, the higher the likelihood of the wristbands absorbing chemicals that are found in low concentrations in air.
        - If logistically feasible, it's recommended that participants wear their wristbands for at least 5-7 days.
        - In previous studies, participants needed to wear their wristbands for 7 days to capture exposure to volatile PFASs.
        - Inclusion of both a weekday and weekend in the study duration is important to capture the full range of a participant's exposure.
    - If using wristbands to directly compare to biomonitoring data for metabolites with half-lives of less than 24 hours, wristbands may be worn for 24 hours.
        - The time match will theoretically provide the strongest correlation between concentration of metabolites and chemicals on the wristband.
        - If the participants' behavior tied to exposure is relatively stable, the metabolites in the biological samples may be correlated with a 5-7 day wristband concentration.
    - If using wristbands to measure an acute exposure that is tied to a specific activity, such as firefighters that wear a wristband on duty, a shorter duration would be appropriate.
    - Consistent duration of wristband wear across all study participants allows for more accurate comparisons across participants.
        - Chemical-specific uptake rates may affect comparability. Fast-absorbing compounds require more precise timing across participants than slow-absorbing ones.
        - Uptake rate for certain classes of compounds appears to be linear. In these instances, chemical concentrations can be normalized to deployment period.
        - If there is variability in deployment length among participants, data should be reported as "nanogram per gram wristband per day" instead of "nanogram per gram wristband."
        - A forthcoming paper by the Anderson Lab on Performance Reference Compounds (PRCs) will support data normalization.

- The various Quality Assurance/Quality Control (QA/QC) procedures that are necessary to ensure accuracy of measurements of chemicals on wristbands.
    - Each batch of wristbands is tested for contamination, and some are archived in case of future contamination issues.
    - Researchers often collect field blanks from community settings or specific sites.
        - In addition to checking field blanks for contamination, they are also used to estimate detection limits.

    - Any potential influence of wristband color is accounted for in field blanks.
  - For laboratory analysis, a large number of samples run are for QC. The labs perform extraction blanks, preparation blanks, and instrument blanks for every batch of wristbands, and continuing calibration verification (CCV) for every 8 to 10 samples run.

- The difficulty in distinguishing between inhalation and dermal exposures from wristband chemical concentrations.
  - Silicone brooches may capture inhalation exposure better as they are located closer to the face, however participants may be more likely to remove the brooch when changing clothes.
  - For a majority of chemicals, it is unlikely that the concentrations on the wristbands are secreted from the skin.
    - There is limited research on metabolites that are excreted through sweat, and this should be explored further.
    - Past research has identified caffeine on the wristbands which is likely coming from the skin.

- Chemicals or chemical groups that are appropriate, or not appropriate, to measure using silicone wristbands.
  - Appropriate to measure in wristbands:
    - Plastic additives such as antioxidants, dyes, stabilizers, and vulcanizing agents
    - Flame retardants
    - Volatile and semi-volatile PFASs
    - Octylphenol and nonylphenol
    - PAHs
  - Less appropriate to measure in wristbands:
    - Chemicals that are specific to dietary exposures (e.g., certain pesticides)
    - Metals
    - Metabolites of pharmaceuticals and drugs of abuse as it may discourage participants from wearing the wristbands
    - Highly volatile compounds

- Participant perspectives on receiving wristband results.
  - Feedback has been generally positive from participants; they want to receive their results.
  - Results return materials should include:
    - Potential exposure sources to the chemicals measured in the wristbands
    - Ways to reduce exposures
    - Comparisons to other participants in the study
  - For studies that include a large volume of chemicals, Kim Anderson’s team provides a one-page summary, which includes background information on the study and highlights results for three chemicals/chemical groups, along with information on their sources and exposure reduction techniques.
    - They also include a larger, individual report which plots all the chemicals measured in the study and allows participants to see where they are relative to the rest of the group.

    - Concentrations on the wristbands are a combination of inhalation and dermal exposure as well as the absorptive capacity of the chemical which is difficult to communicate to participants.
        - There are no regulatory or health-based benchmarks for what levels of chemicals on wristbands are considered high or low.

- Issues the Biomonitoring California Program should consider before using silicone wristbands in future biomonitoring studies.
    - The overall goals of the Program, which are to identify chemical exposures in the Californian population and examine potential exposure sources.
        - Tools such as silicone wristbands can help with the interpretability of biomonitoring data.
        - Targeted analyses would be useful to help fill gaps in understanding exposure sources when complementing biomonitoring studies.
        - Non-targeted analyses can be used to identify novel chemicals that could aid in the process of designating chemicals, or prioritizing method development for identifying chemicals in urine or blood.
    - Ideal populations the program should consider for use of silicone wristbands.
        - Wristbands can be used in large scale studies across California, including in vulnerable populations such as children. Particularly when it would be logistically difficult to collect blood or urine samples.
        - Occupational exposures relevant to farmworkers and firefighters might also be an ideal setting for wristbands.
    - Example timelines and costs associated with silicone wristband studies.
        - Laboratory results from wristbands can generally be provided within 30-60 days.
        - The Stapleton lab provided example costs of some wristband analyses:
            - The basic panel is $250 per sample, and measures brominated flame retardants, PAHs, phthalates, pesticides, and other compounds on the electron impact (EI) mode.
                - Additional analysis for brominated flame retardants and furans using the negative chemical ionization (NCI) method and measuring volatile PFASs are an additional $50 per sample.
            - A combination of both targeted and non-targeted analysis is $500 per sample.
            - The cost of the wristband kits themselves is around $5 per kit.
    - The wristbands would not replace biomonitoring data but rather help complement biomonitoring results and identify novel exposures in Californians.