The Mobile Exposure Device: a Personal Sampling Nexus for Exposure Monitoring

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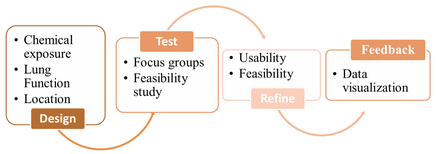
Abstract

Epidemiological studies linking environmental exposures to health outcomes have been criticized for the lack of personal exposure data. The mobile exposure device (MED) is integrated personal environmental exposure tools coupled with software which links health data to location and chemical exposure. The MED combines a wristband passive sampling device with a smart phone application and biometric equipment providing a holistic tool to capture uniquely linked environmental-health information. Silicone passive sampling wristbands sequester organic compounds while a cell phone application captures geographic location of study participants. Users were prompted to test lung function with a spirometer three times daily to identify variation in lung function throughout a typical daily routine. Wristbands were worn daily then mailed to the laboratory, extracted, and analyzed for over 1,300 organic compounds including PAHs, OPAHs, PCBs, pesticides, flame retardants and industrial chemicals. Data is transmitted securely from a laboratory information management system and the smart phone app to a secure server through web services and integrated in order to discover statistical relationships among air pollutants, locations, and lung function. The MED was developed and tested in two different exposure scenarios, one community in Oregon with proximity to intense industrial activity, and another community in Ohio near unconventional natural gas drilling operations. Focus group meetings were employed in both communities to further enhance and optimize the MED. The MED coupled with data integration and visualization techniques will enable researchers to gain new insights and investigate new connections, while allowing communities to see their data in more intuitive ways.

Development of Mobile Exposure Device (MED) through Community Partnerships



CarrollConcernedCitizens.org

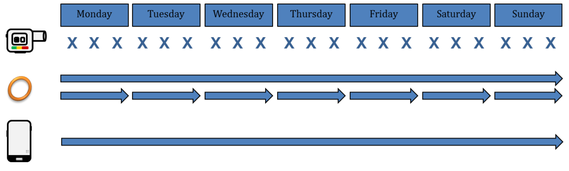
BEYOND TOXICS

Pilot Testing

- **2 Participants from West Eugene, OR**
  Concern: Pollution, respiratory health
- **2 Participants from Rural Appalachia, OH**
  Concern: Unconventional Natural Gas Drilling, air quality

Study Design

- Participants carried MED for one week
- Participants prompted to use spirometer three times daily
- One wristband worn daily and one wristband was worn for the entire week



The Mobile Exposure Device

Medical International Research; Spirotel® eHealth mini-Lab, v1 Spirometer
Measures FVC and FEV1

Photo from Medical International Research

Secure data transmission via bluetooth

Samsung Galaxy S3 Smartphone
Records GPS or network-based location. Transmits data to cloud and remove locally stored data.

Silicone Passive Sampling Wristband[1]
Sequesters freely dissolved organic contaminants to provide a time integrated average of exposure

Health endpoints integrated with exposure monitoring

Health endpoints integrated with location monitoring

Photo from Samsung

Exposure monitoring integrated with location monitoring

Wristband samplers mailed to laboratory for processing and analysis

Lung function and location data transmission Via SSL

Samples extracted and analyzed by Agilent GC-MS/MS for 62 polycyclic aromatic hydrocarbons

Pacific Northwest National Lab CLOUD

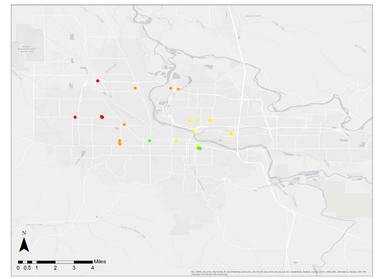
RESTful Web Services used to integrate data streams from OSU and PNNL. Evaluation of data analysis and visualization software in progress.

Data Integration & Visualization

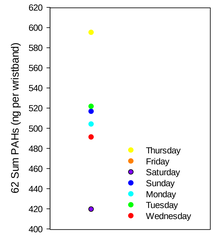
RESULTS

Example of the presentation of results provided to participants

1 Map of location within Eugene, OR

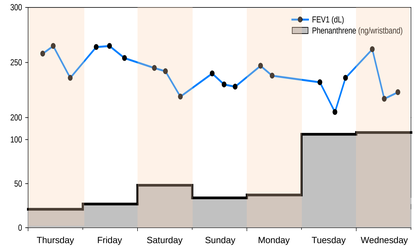


2 Total of all 62 PAH added together for each day



3 FEV1 values (morning, noon and night) for each day of the week of July 17, 2013. For reference, the average FEV1 for a white, 5'10" 45 year-old male is 409 dL.

Previous research by the west Eugenecommunity suggests they are disproportionately exposed to air pollution and exhibits increased asthma incidence[2]. Phenanthrene exposures have been associated with reduced lung function and wheezing in previous studies[3,4], therefore this graphic was generated for participants.



4 Concentration of phenanthrene (ng/wristband) detected in each daily wristband.

Conclusions

- The MED prototype and data visualization of results were significantly improved by community feedback
- Early beta testing resulted in a daily accumulation of over 600,000 data points including geographic location, lung function, and chemical observations for each participant
- Data transmission from mobile phone successful even in low network coverage areas of rural Ohio.
- Greater than 96% user compliance observed based on study design

Future Work

- Automation of data visualization and secure electronic delivery of results to participants
- Mobile application enhancements will include:
  - Capacity to deliver health surveys
  - iOS version of mobile app
- Integrate with outside data sources to locate potential sources of contaminants
- IT infrastructural scale up to support large epidemiologic studies that relate exposure and health effects

Acknowledgements

OSU NIEHS grant #P30 ES000210 **UC NIEHS grant** #P30ES006096
MED research team – Andres Cardenas, Gabriela Escutia, Dan Sudakin, Laura Syron, FSES Research Group
Community partners: Lisa Arkin (Beyond Toxics), Paul Feezel (Carroll Concerned Citizens)

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