Integration of GPS Technology with Real-Time Particulate Matter Measurement

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1. Introduction
The purpose of this study was to develop an innovative exposure assessment tool by integrating real-time particulate matter (PM) monitors, global positioning system (GPS) receivers, and a geographical information system (GIS). These tools allow us to determine when and where hazardous exposures occur. By tracking exposure both spatially and temporally, we may gain a better understanding of the sources and factors that contribute to a workers’ total exposure budget. Such information may lead to more efficient control strategies, ensuring worker health while saving industrial hygiene resources.

2. Instruments and Methods

Nephelometer (pDR1200, ThermoElectron)
- Light-scattering device
- Measures PM concentration in real-time
- 880nm wavelength, 50-90°
- Uses a filter for gravimetric calibration

GPS (Geko 301, Garmin)
- Measures location via satellite in real-time
- Weight ~ 3.4 oz
- Position accuracy ~ 3 meters
- 9 hour battery life

Software (ArcGIS, ArcMap, MS Access)
- Real-time data loaded into Access database
- pDR and GPS data merged by timestamp
- Merged data loaded into ArcGIS software
- Exposure intensity color-coded

3. Results
Two cohorts from the City of Fort Collins, CO (Parking Enforcement Officers and Natural Areas Rangers) were repeatedly tracked over multiple work shifts. Each worker wore a portable GPS device and a personal nephelometer in conjunction with a pump. The pDR-1200 is capable of sampling PM₁₀ (and smaller) aerosol size distributions. Integrated and real-time outputs were logged on a 10-second basis and then merged onto a GIS map to visualize worker exposure as a function of location. Results from the Parking Enforcement tracks are shown.

4. Discussion
Advantages
- Exposure hotspots can be discovered using simple spatial analyses (and visualized on map).
- Real-time data provides exposure timing and intensity measurement

Disadvantages
- GPS battery life can be an issue for long exposure periods
- GPS receivers cannot operate indoors
- Real-time monitors have high initial costs, require calibration

5. Instrument Evaluation

6. Conclusions

7. Future Work
- Characterize PM exposure to young children with severe asthma over multiple 24-hour periods in Denver, CO (collaboration with researchers at National Jewish Medical Research Center)
- Asses exposure to organic grain dust for animal feedlot operators. This industry has a high prevalence of occupational asthma
- Adapt technology to indoor exposures
- Adapt technology to other exposure scenarios suited for real-time measurement (noise, radiation, gases, etc.)

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