

Wrapping Up:

What have we learned?

- Good Science is messy and takes time
 - Multiple paths (and dead ends...)
 - Understanding grows with the number of studies and different types of studies
 - Life is risky and we all die; some “causes” well understood, many are not
- Five Questions:
 - What we know about PM and premature mortality nationwide?
 - What do we know about PM and premature mortality in California?
 - What Study might we use?
 - How should uncertainties be included?
 - What do we know about the constituents and sources of PM, including diesel?

The Health Effects Institute

www.healtheffects.org

- Independent Non-profit Research Institute Since 1980
 - Impartial, high-quality science on health effects of air pollution
- Joint and Equal Core Funding
 - Government (U.S. EPA)
 - Industry (28 Worldwide Vehicle Manufacturers)
 - also other agencies and industries (US DOE, FHWA, CARB, oil, chemical, steel and other industries)
- Independent Board and Expert Science Committees
 - oversee and review competitively-selected research
- Over 200 studies
 - particulate matter, ozone, carbon monoxide, diesel exhaust, benzene, butadiene, methanol, others
 - Primarily new research; reanalysis when needed
 - Special Reports

PM and Premature Mortality Nationwide

- There are a number of larger epidemiology studies PM and mortality which generally find positive associations (with some exceptions)
- Some of the largest of these studies have been subjected to extensive reanalysis and extended analysis
- The US EPA and Global Burden of Disease project have reviewed these – and a range of relevant toxicology, as well as intervention studies:
 - and determined that PM exposure causes premature mortality
- There are, however, a number of remaining challenges:
 - Regional variability – variation in the estimates by region (e.g. Medicare cohort no effect in the West; NMMAPS stronger effects in So. Cal, NE, IND. MW; not elsewhere)
 - PM is not a single pollutant – need to know more about the individual components, and other pollutants (e.g. gases, toxics)
 - Residual confounding – although some of these have gone to extensive lengths to test confounders, there is always the possibility of some degree of remaining confounding
 - The rising age of the cohorts – and the likelihood that they become less useful as they age

PM and California

- There are several epidemiology studies that have tried to estimate PM mortality risks in California:
 - ACS in LA; Cal. Teachers (F), AHSMOG (F), CPS I (1982 follow-up) have found positive associations
 - CPS I (2002 follow-up) , AHSMOG (M?) did not find association
 - ACS in CA in development (not yet peer reviewed): found cause-specific associations but not for all cause mortality
- There are questions:
 - How does CA air differ from rest of US: some difference (e.g. sulfates) but carbonaceous species very similar
 - How does the fact that California is healthier factor in?
 - Is there a reason that all-cause mortality might not be positive in California (when it is elsewhere)?

Which Study to Use for Analysis?

- EPA and the Global Burden of Disease have reviewed the evidence and selected the Krewski (HEI 2009) as the basis for their work:
 - Most recent fully-peer-reviewed analysis
 - Based on a study with extensive individual characteristics and community characteristics
 - Had been subjected to extensive reanalysis
- Some other studies seem to have very high estimates (e.g. WHI, California Teachers)
- Is there good evidence that the risk in California is notably different from that found in the Krewski study?

Uncertainties

- Uncertainty in estimating associations is inevitable – and it is very important to try to estimate how these affect the results
- The Global Burden of Disease is quantifying uncertainty in all aspects: exposure measurement, geographic variation, and modeling approach
- US EPA is quantifying uncertainty through a number of different scenarios.
- A number of key uncertainties:
 - Model selection
 - Exposure metric/method used

PM Effects and The Mix of Pollutants

- PM is a complex mixture
 - and is part of an even more complex mixture with gases (which have their own “effects”)
- Each source has its own mix of emissions
 - And not always easy to specifically identify a source (e.g. for diesel)
- Studies of PM and other air pollutants (e.g. ozone, sulfur dioxide) are inevitably studies of a “marker” of some less well known set of components
- No single type of study – toxicology, occupational, epidemiology – is perfect for this
- Need for the future:
 - Systematic multi-disciplinary efforts (toxicology and epidemiology) to understand the toxicity of the PM components and the gases

A Few Concluding Thoughts

- Data Access is important to enhancing underlying confidence in results
- Civility is a good idea:
 - ARB officials, scientists, and critics are all trying to advance knowledge and the public good
- Twenty years of hard work has advanced knowledge, and led to beneficial decisions (e.g. much cleaner diesels), even as questions continue
- Remember, good science is messy...