Interpreting Epidemiologic Evidence: Optimal Use of Informative but Imperfect Research

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Challenge of Reconciling Policy Makers Needs with Epidemiology's Capability

- Goal is to make *optimal use* of *best available evidence,* not overstating or understating its quality and applicability
- Refine pathway for "demand-driven epidemiology" in which policy makers define needs from epidemiologists
- Recognize that assessment and integration of epidemiologic evidence reflects (informed) judgment
- Acknowledge that science does not dictate policy, it *informs policy judgments*

Ideal Scenario for Policy without Controversy

- Apply predefined, structured algorithms to integrate and judge available research
  - Objective, replicable, universally accepted
- Study quality of individual studies judged using standard and well-accepted criteria
  - Assignment to quality bins
- Integrated interpretation of cumulative study results
  - Does it support a causal effect of exposure at specified levels?
  - Does it identify a threshold for adverse health effects

Observational Studies and Causal Inference

- Research generates *measures of association* between exposure (air pollution) and disease
- Question is how closely the *measure of association* approximates the *causal effect*
- Assessment requires expertise in both epidemiologic methods and the subject matter (specific exposure, health outcome, potential confounders)
- Assessment falls along a continuum of certainty

Attainable Goals for Epidemiology's Contribution to Policy

- Comprehensive, accurate description of the relevant studies
- Unbiased evaluation of the quality of the research based on methods alone
- Description of the study results in relation to the methods used
- Integration and interpretation of epidemiologic evidence that is clearly communicated
  - Informed, balanced, clear
- Input to evaluation and integration of evidence across disciplines
  - Triangulation across lines of evidence to inform policy judgment

Inherent Nature of Epidemiologic Evidence

- Each study makes incremental contribution to overall level of knowledge, must be considered in context of other evidence
  - Complementary (or contradictory) to other epidemiologic studies
  - Interpretation influenced by other lines of evidence (mechanistic, toxicology)
  - The ideal “definitive study” is conceptually and logistically unattainable
  - Constellation of evidence must be woven together to inform decisions

Describing Quality of Epidemiologic Studies

- Study's quality falls on a continuum based on multiple dimensions of the study (exposure assessment, susceptibility to confounding, etc.)
  - Study attributes determine how closely measure of association reflects causal effect
  - Biases may lead to over- or underestimation of causal effect
  - Magnitude of potential error informed by prior studies, methodologic research, sensitivity analyses
  - Identify patterns: How do the methods influence the results?

Describing Quality of Epidemiologic Studies, cont.

- Examine key determinants of validity in detail
  - Typically a small number (2-4) primary influences on validity
  - For each of those, determine spectrum of quality across available studies
  - Empirically assess whether the methods and results support or argue against the hypothesized bias having an impact on results
  - If the bias appears to be influential, studies relatively free of the bias are more informative and warrant emphasis
  - If the bias does not appear to be influential, avoid downgrading studies based on susceptibility to that bias

Describing Quality of Epidemiologic Studies, cont.

- Assessment of validity is nuanced and requires expert judgment
  - Not a generic, universal algorithm
  - Taking into account what the study methods, what is known about the quality of those methods, and what was found (results)?
  - How closely does the measure of association approximate the causal effect?
  - Interpretation should be transparent, explicitly reasoned, and open to differing interpretation by other evaluators

Strengths and Limitations of Pooled Estimates from Meta-Analyses

- Understandable desire for integrated, quantitative product from a body of research
- Presumes results vary due to random error alone and weights them by size
- Question of whether studies can be sufficiently similar to combine them given varying methods
- Unclear that goal of universal measure of causal effect should be expected
- Pooled estimates can assist in assessing patterns – relationship between methods and results
- Illusion of certainty given multiple studies, precise result

Randomized Trials and Observational Studies

- For health care interventions (drugs, treatment algorithms, organization of care), randomized trials are extremely informative, may be definitive
- Only method to control confounding by unknown determinants of disease
- Limited opportunity and value in studies of environmental agents
  - Exposure is difficult to manipulate, short-term only
  - Magnitude of contrast is often modest relative to naturally occurring variation
- Susceptibility to confounding is a major concern but not the only determinant of quality

Distinctive Features of Air Pollution Epidemiology

- Requires expertise in air pollution exposure assessment and understanding of determinants of health outcomes
- Sources and levels of pollution argues against expectation of a universal measure of effect based on typical exposure metrics (e.g., PM2.5)
- Generally seeking subtle effect of air pollution in the context of much more powerful health determinants (socioeconomic, behavior)
- Statistical precision does not assure validity
- Need is not for replication of commonly used methods but opportunity to triangulate with novel settings, study designs, and other disciplines

Product of Synthesis of Epidemiologic Evidence

- Volume of informative studies
  - Assess likelihood of major shifts with new studies
- Overall effectiveness in addressing key methodologic challenges
- Apparent impact of methods on results
  - Identify key drivers of validity
- Explicit description of current state of evidence and certainty, including reasons for uncertainty, for policy application

Bridging Gap Between Epidemiologists and Policy Makers

- Ensure balanced, integrated, informed evaluation of evidence
  - Complementary expertise across disciplines
  - Minimize and balance biases among experts
- Explicit description of process for drawing conclusions
  - Systematic reviews to identify relevant studies and describe methods
  - Explain process and logic for final judgments
- Clear indication of where evidence ends and policy judgment begins
  - Evidence never dictates policy, just informs it

40 Years of Progress?

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SPECIAL ISSUE ON PARTICULATE AIR POLLUTION

HEALTH EFFECTS OF PARTICULATE POLLUTION: REAPPRAISING THE EVIDENCE

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Editor's Note

(George Comstock)

Epidemiologic science can give only general guidance to those who must decide upon acceptable limits of air pollutants. Judgment in this area depends much more on the art of epidemiology, the drawing of reasonable conclusions from imperfect data.