Issues in the Development of Occupational Exposure Limits (OELs)

Paul A. Schulte, PhD

Relevance

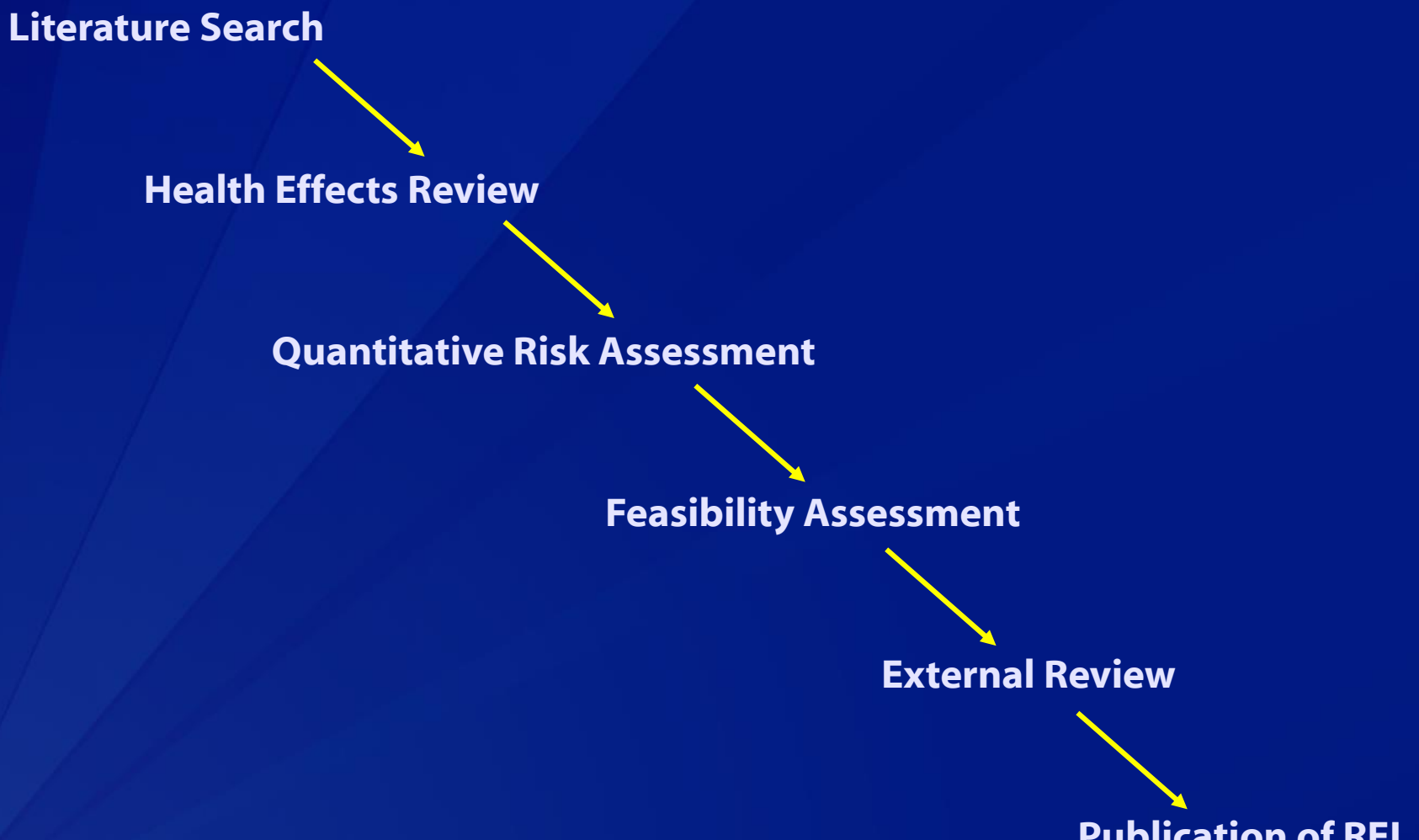
- NIOSH is mandated by the OSH Act (1970)

"…to develop criteria dealing with toxic materials and harmful physical agents and substances which will describe exposure levels that are safe for various periods of employment, including but not limited to the exposure levels at which no employee will suffer impaired health or functional capacities or diminished life expectancy as a result of his work experiences."

OSHA Act 20 USC 20 (a)(3)

Lentz [2013]

Development of a Recommended Exposure Limit (REL)



Lentz [2013]

Occupational Exposure Limits (OELs)

- Critical component of the risk management process
- Many organizations, world-wide develop OELs
  - Provide administrative procedures
  - Rationale
- Few organizations identify the underlying quantitative risk assessment employed in OEL development
- Paucity of written descriptions resulted in lack of transparency and inconsistent practices among organizations

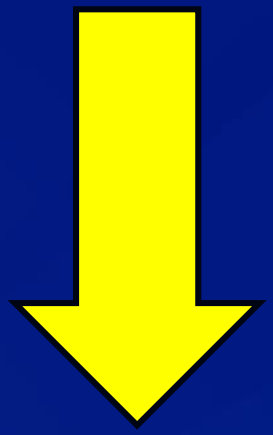
- NIOSH commissioned an effort to examine issues leading to OEL development
- Developing a dedicated issue of the Journal of Occupational and Environmental Hygiene (JOEH)
  - 10 papers
  - Range of authors

- Focus on the state-of-the-science in fields of:
  - Exposure science
  - Occupational hygiene
  - Risk assessment
  - Toxicology
  - Genomics and systems biology
- Goal: provide a clear description of how advances in these areas can be applied to OEL development

Related to OEL Development

- Consideration and interpretation of OELs in risk management

JOEH Issue



NIOSH guidance on how it conducts risk assessment and develops OELs

Manuscript 1

State-of-the-Science: The Evolution of Occupational Exposure Limit Derivation and Application

Authors: M.A. Maier (University of Cincinnati), T.J. Lentz (NIOSH), K. MacMahon (NIOSH), L. McKernan (NIOSH), C. Whittaker (NIOSH), P. Schulte (NIOSH)

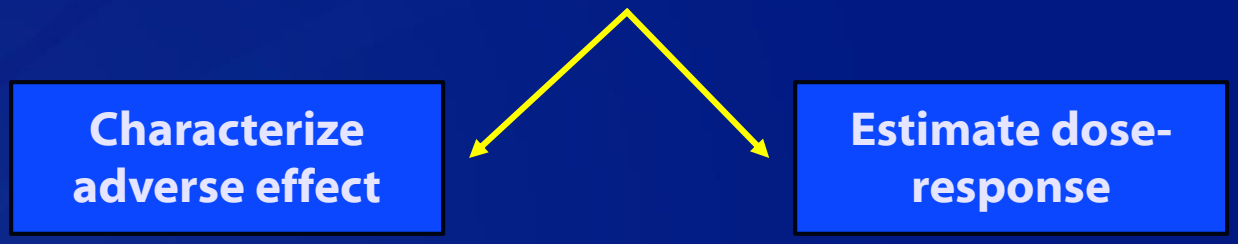
- Overview of the field and the papers in the issue
- Identification of critical issues in each paper

Manuscript 2

Advances in Dose-Response Assessment and Modeling for Deriving Occupational Exposure Limits

Authors: M.W. Wheeler (NIOSH), A.J. Bailer (Miami University), C. Whittaker (NIOSH)

- Describes and contrasts traditional and advanced practices in dose-response modeling from both toxicological and epidemiological perspective
- Initial step in developing an OEL



Manuscript 2 (cont'd)

- Need for more realistic models of dose-response
  - Biologically-based models
  - Semi-parametric models
- Describe new methods
  - Address statistical limitations
  - Make more complete use of growing knowledge on toxic mode of action

Manuscript 3

The Scientific Basis for Uncertainty, Safety, and Modifying Factors in OEL Setting

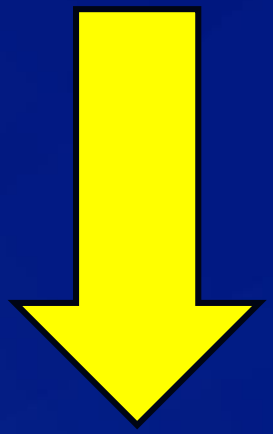
Authors: D.A. Dankovic (NIOSH), B.D. Naumann (Merck & Company), M.L. Dourson (Toxicology Excellence for Risk Assessment [TERA]), M.A. Maier (University of Cincinnati), L. Levy (University of Cranfield)

Manuscript 3 (cont'd)

- Need to account for interspecies, intraspecies, variability, and other sources of uncertainty
- Critical examination of historical use of uncertainty factors in the development of OEL
  - Practice goes back more than 60 years

Use of Uncertainty Factors Predicated on Assumption

Sufficient reduction in exposure from levels at the boundary for onset of adverse effects



Exposure level safe for majority of exposed population including vulnerable group

Variation in use of uncertainty factors

- Risk managers need to know sources of variability and uncertainty addressed in an OEL

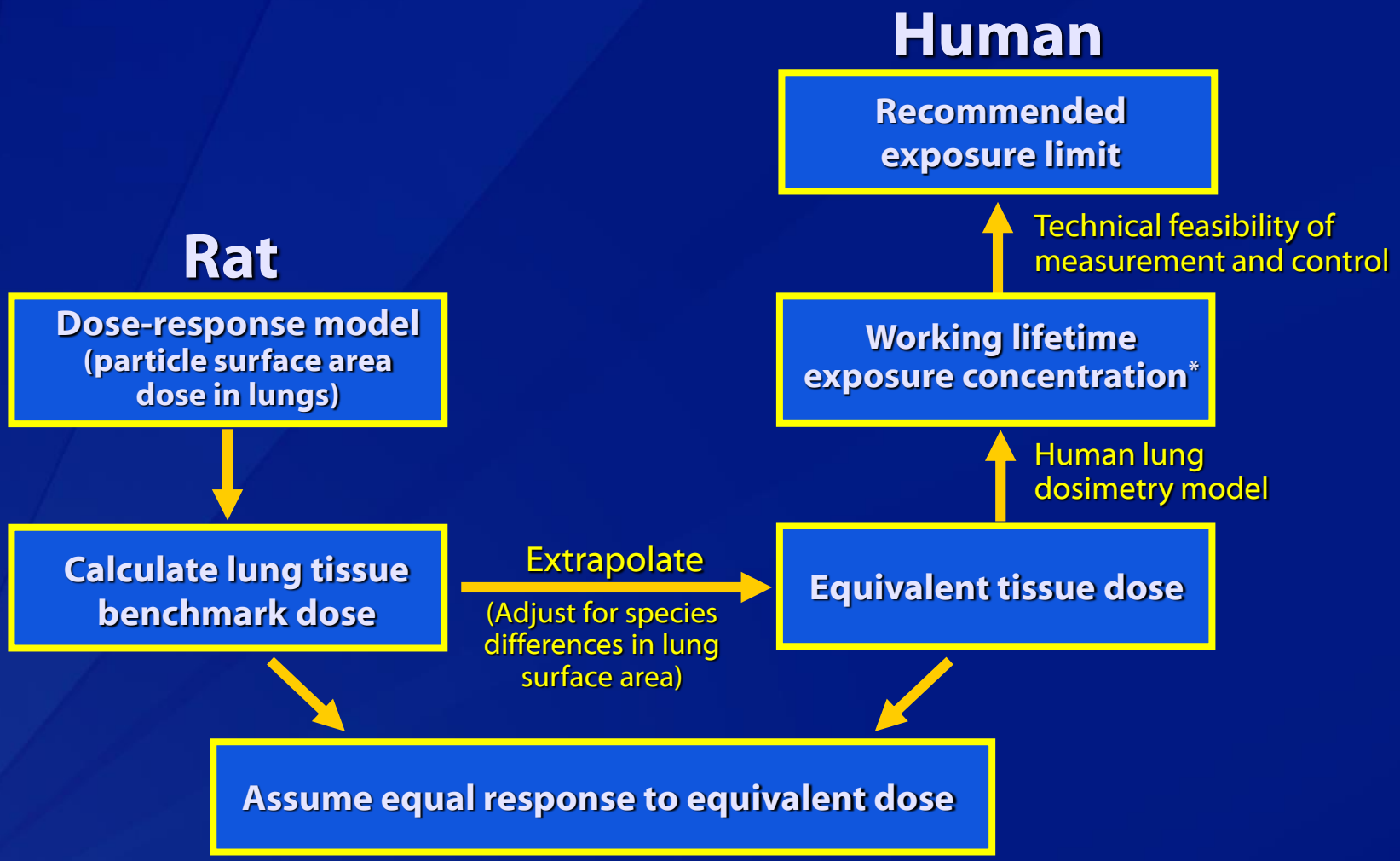
Manuscript 4

Advances in Inhalation Dosimetry Models and Methods for Occupational Risk Assessment and Exposure Limit Derivation

Authors: E. Kuempel (NIOSH), L. Sweeney (Henry Jackson Foundation), J. Morris (University of Connecticut), A. Jarabek (U.S. Environmental Protection Agency[EPA])

- Use of dosimetry concepts in risk assessment of OELs for inhaled substances
- Dosimetry is the measurement or estimate of inhaled dose
- Need to reduce uncertainty of inhaled dose estimates at the target tissue

Risk Assessment Approach for TiO_2



*Compare rat-based risk estimates with upper bound on risk from human studies

Manuscript 5

Systems Biology and Early Effects Dose-Response for OEL Setting

Authors: D.G. DeBord (NIOSH), L. Burgoon (EPA), S. Edwards (EPA), L.T. Haber (TERA), Helen Kanitz (NIOSH), E. Kuempel (NIOSH), R.S. Thomas (Hamner Institute for Health Sciences), B. Yucesoy (NIOSH)

- Dose-response estimation evolving more fully to incorporate new types of toxicity data
- Developments in physiological science

Manuscript 5 (cont'd)

- Utility of systems biology approach
  - Computational toxicology
  - Biomarkers of effect
  - Increased understanding of biological response at lower levels of exposure
  - Use of new screening data

Manuscript 6

The Role of Genetic and Epigenetic Information in Occupational Risk Assessment

Authors: P. Schulte (NIOSH), C. Whittaker (NIOSH), C. Curran (Northern Kentucky University)

- Challenge to characterize human variability in risk assessment
- Genetic and epigenetic data have not been widely used in risk assessment and REL development

Manuscript 6 (cont'd)

- Such data have potential utility
  - Endpoints in hazard identification
  - Indicators of exposure
  - Effect modifiers
  - Descriptors of mode of action

Manuscript 7

Understanding the Challenges of Setting Occupational Exposure Limits for Low Molecular Weight (LMW) Chemical Respiratory Allergens

Authors: G.S. Dotson (NIOSH), M.A. Maier (University of Cincinnati), P.D. Siegel (NIOSH), S. Anderson (NIOSH), B.J. Green (NIOSH), A. Stefaniak (NIOSH), I. Kimber (University of Manchester)

- Some toxicological effects present unique challenges to the OEL process
- Sensitization from chemical allergens (low molecular weight)
- Few OELs for sensitizers

Current Approaches

Future Research Need

Manuscript 8

Occupational Risk Probability and Interpretation of Traditional OELs—Enhanced Information for the Risk Manager

Authors: M. Waters (NIOSH), L. McKernan (NIOSH), M.A. Maier (University of Cincinnati), M. Jayjock (The Lifeline Group), L. Brosseau (University of Minnesota), V. Schaeffer (Occupational Safety and Health Administration)

- Since OELs are used by OSH professionals in the field
  - Interpretation
  - In context of exposure assessment

Manuscript 8 (cont'd)

- Focus on sources of variability and uncertainty in exposure assessment
- Characterize risk
  - In terms of a probability

    instead of
  - Binary: acceptable or unacceptable

Manuscript 9

International Perspectives and Global Harmonization of OEL Practices

Authors: M. Deveau (Health Canada), C.P. Chen (China Medical University), G. Johanson (Karolinski Instituet), D. Krewski (University of Ottawa), K. Niven (Shell Oil Co.), M.A. Maier (University of Cincinnati), S. Ripple (Dow Chemical Co.), P. Schulte (NIOSH), J. Silk (World Health Organization), J. Urbanus (Shell), D. Zalk (U.S. Army), R. Niemeier (NIOSH)

- Description of international practice
- Encourage coordination world-wide
- Make effective use of OEL resources

Manuscript 10

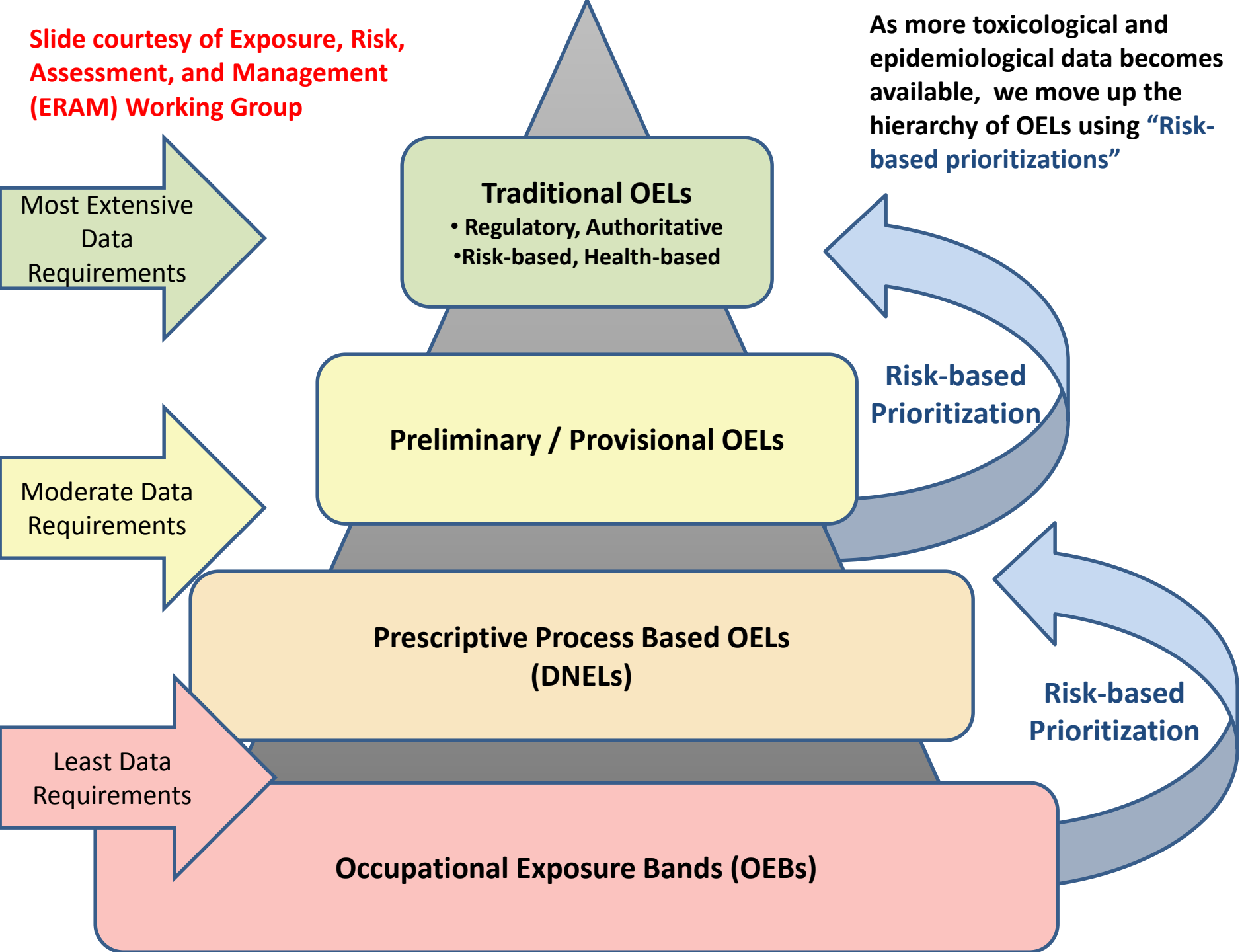
Aggregate Exposure and Cumulative Risk Assessment—Integrating Occupational and Non-occupational Risk Factors

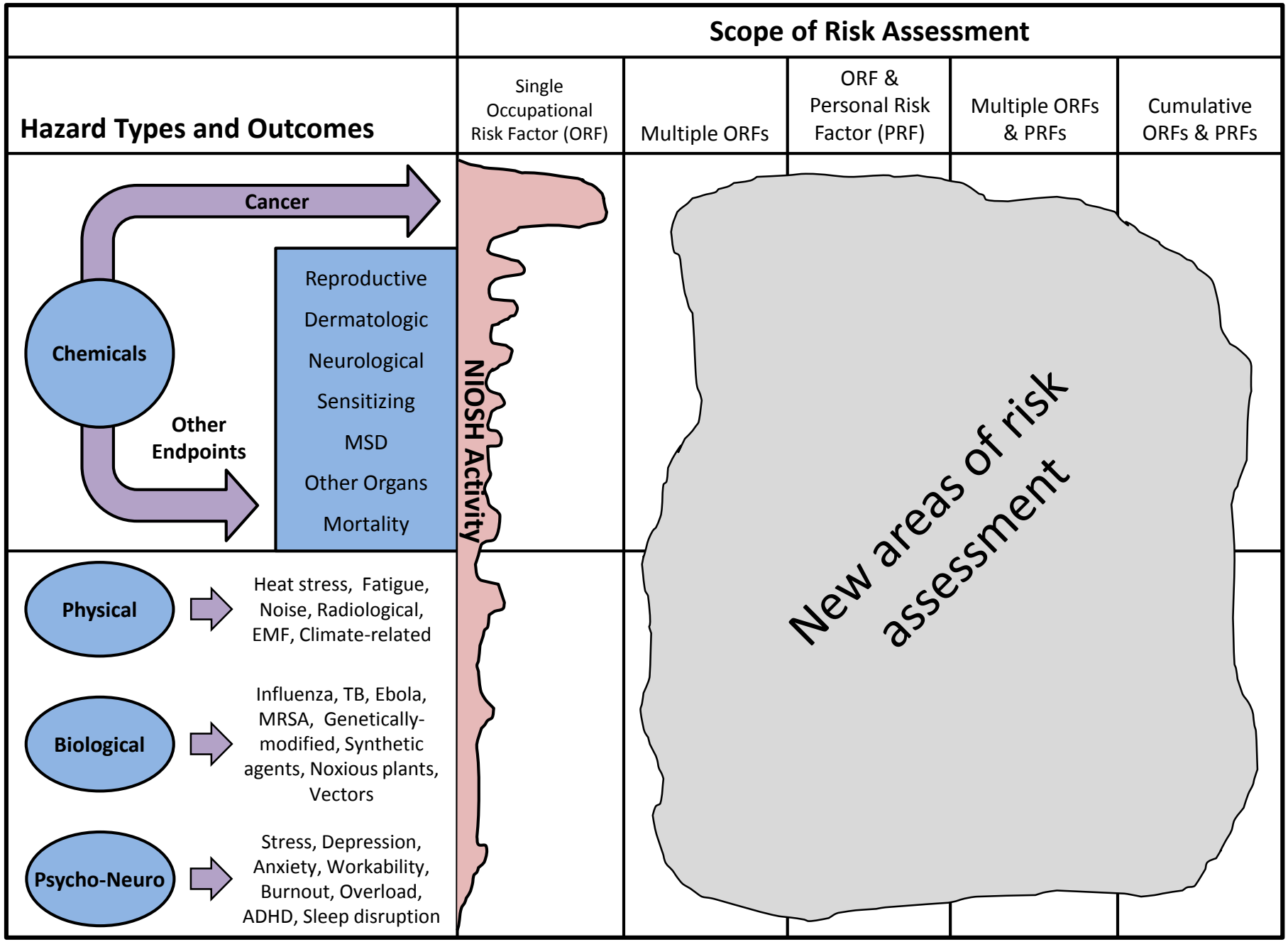
Authors: T.J. Lentz (NIOSH), G.S. Dotson (NIOSH), P.R.D. Williams (E Risk Sciences), M.A. Maier (University of Cincinnati), B. Gadagbui (TERA), S.P. Pandalai (NIOSH), A. Lamba (EPA), F. Hearl (NIOSH), M. Mumtaz (CDC)

- Reflects the broadening scope of risk assessment thinking in development of OELS
- Go beyond chemicals
- Assess complex exposures to chemicals and other stressors
  - By multiple pathways
  - Multiple sources

Slide courtesy of Exposure, Risk, Assessment, and Management (ERAM) Working Group

As more toxicological and epidemiological data becomes available, we move up the hierarchy of OELs using "Risk-based prioritizations"





Risk Assessment: Past, Present, and Future