Derivation and Use of a New Discrete Growth Probability Distribution of Microbes in Environmental Samples and Associated Dose-Response Function

Dr. James D. Englehardt
Professor of Environmental Engineering
University of Miami
Coral Gables, Florida

Biosketch: Dr. James D. Englehardt is a Professor of Environmental Engineering at the University of Miami. Before receiving his Ph.D. in Civil/Environmental Engineering from the University of California, Davis, Dr. Englehardt led research projects in pollution prevention and mineral filter media development for the Manville Corporation. Prior to that, he supervised a laboratory and conducted product development and field service projects for the Western Filter Company, Denver, Colorado. His research group at the University of Miami works in the areas of risk analysis and physicochemical treatment process development. The group collaborates with the U.S. Environmental Protection Agency (EPA) and others to develop predictive Bayesian methods for rigorously assessing health risks of pathogens and chemicals from available information, based on principles of self-organization. Other projects include the development of models for locating sunken oil following spills and health and ecological risk analysis of alternatives for disposing cruise ship biosolids. In addition, the group is developing low energy, economical processes for oxidizing organics and the removal of inorganics from large wastewater flows. Methods include iron-mediated aeration (patent pending) and electrocatalytic processes. Applications of these methods include the potable reuse of municipal wastewater, and purification of water, wastewater, soil, sediment, and municipal solid waste. Awards include the Science Advisor's Award EPA, National Center for Environmental Assessment, Cincinnati; the Robert C. Barnard Environmental Science & Engineering Award (American Association for the Advancement of Science and EPA) and two University of Miami Eliahu I. Jury Awards for excellence in research.

Abstract: While pathogens in laboratory samples may be Poisson-distributed, the distribution of their counts in drinking water and, other low mean-count environmental media, is currently not well known, in part because most counts are zero. In addition, pathogen dose is proportional to the mean of the count distribution and, as the outcome of a complex system, the distribution potentially "scales" or ranges over orders of magnitude. Therefore, long-term dose may be governed by rare, high-count events not represented in available data. Also, current exponential and beta-Poisson-based dose-response assessments assume Poisson-distributed pathogens, thereby extrapolating response orders of magnitude downwards from tested doses to low doses. However, Gale et al. and others have shown that counts in drinking water samples are more disperse temporally and spatially than the Poisson and negative binomial distributions. In this seminar, a new discrete scaling distribution (DSD) will be derived for environmental microbial counts observed over time and evaluated versus the Poisson lognormal (PLN) distribution. The discrete growth distribution (DGD) will be verified versus simulated long-term data and available short-term microbial count data, in preference to the PLN. Further, a new beta-discrete growth dose-response function will be derived based on the DGD, analogous to the beta-Poisson. The proposed function will be verified for the illness endpoint by conceptual simulation of gastrointestinal pathogenesis. The new function has two parameters representing variability in host-pathogen infectivity and a third representing dispersion in the count distribution or, conceptually, the number of engineered or natural barriers to pathogen occurrence. Spectral analysis will be presented to explain the findings, and parameter estimation for these highly skewed scaling distributions will be described. A resulting assessment of unconditional illness and infection risk for *C. parvum* in drinking water, not considering secondary disease transmission and acquired immunity, will be presented for discussion.