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ORACBA News

United States Department of Agriculture Office of Risk Assessment and Cost-Benefit Analysis

Sources of Variation and Uncertainty in the Estimation of Radiation D-10 Values for Foodborne Pathogens

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Introduction

Food irradiation is an effective method for inactivating foodborne pathogens. It can be defined as the treatment of food with ionizing radiation from the isotopic gamma ray sources cobalt-60 or cesium-137, and accelerated electrons with a maximum energy of 10 MeV (million electron volts), or x-rays with a maximum energy of 5 MeV generated by machine sources. D-values (absorbed radiation dose required to kill or inactivate 90% of the viable cells) are frequently used to provide estimates of the doses that may be needed to inactivate a desired level (e.g., 5 logs or 99.999% of viable cells) of a pathogen by ionizing irradiation of a food and such predictions may be incorporated into risk assessments. Appropriate use of D-values requires that the sources of variability for the determination be understood. The determination of the dose of ionizing radiation that is required to inactivate a foodborne pathogen, or for that matter of any other terminal treatment, is subject to many biological and physical variables. In addition, the many different methods used to calculate such values can produce different results. So one should not state a D-value without also providing an estimate of uncertainty as well as a description of both the biological and physical conditions under which the value was obtained. A D-value allows a dose to be estimated that will inactivate a desired level of a pathogen under defined conditions; however, the application of that desired dose in practice at the industrial level is itself subject to several sources of variability and uncertainty. The investigator, the regulator, the food industry, and anyone using such estimates for risk assessment must understand the sources of the variability and uncertainty involved in the application of the process of food irradiation if safety and quality are both to be obtained. Let's review each of the steps in the determination of a radiation D-value for the treatment of ground meat to inactivate *Escherichia coli* O157:H7 (as an example) and some of the sources of variability and uncertainty introduced at each step of the process.

Definitions

D-values for thermal inactivation are usually expressed as the number of minutes at a given temperature that are required to inactivate 90% of the cells of an organism. D-values for inactivation of bacteria by irradiation are normally expressed in terms of the dose of ionizing radiation that is actually absorbed. The absorbed dose is

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currently expressed in terms of the gray (Gy). A radiation dose of 1 Gy involves the absorption of 1 Joule of energy by each kilogram of matter through which the energy passes. A Gy is equal to 100 rad and 1 kGy would increase the temperature of a product by 0.24EC or 0.43EF. The current FDA regulations state the maximum doses for irradiation of meat or poultry in terms of the kilogray (kGy), which equals 1,000 Gy.

Choice of Cultures

The first source of variability is the choice of the isolate or isolates of *E. coli* O157:H7 that will be used to determine the D-value. Some of us prefer to select one or more isolates that have been associated with outbreaks of disease and may also choose to use a cocktail of 3 to 5 isolates, hoping that we will find in that mixture at least one that is at least as radiation resistant as the most resistant in nature. We can, of course, test each of several isolates separately to try to identify the most resistant among them, but this choice can be extremely time consuming. Even a mixture of isolates may not be representative of some isolates of this pathogen, and we cannot assume that the results obtained with *E. coli* O157:H7 can be extrapolated to other serotypes of *E. coli*. Unfortunately, the choice of the actual isolate or isolates is not the only source of variability. Several factors have been identified that may alter a pathogen's resistance to ionizing radiation.

Growth-Phase

The radiation resistance of bacteria is known to be affected by the phase of growth in which it was harvested. Thayer and Boyd (1993) determined that the D-value at 0EC, *in vacuo*, for the inactivation of stationary phase cells of *E. coli* O157:H7 on mechanically deboned chicken meat was 0.27 ± 0.01 kGy, whereas the equivalent D-value for log-phase cells was 0.16 ± 0.01 kGy. A 5-D value for stationary phase cells at 0EC, *in vacuo*, would be 1.35 kGy, but the 5-D dose for log-phase cells would be only 0.80 kGy. However, in most instances, the growth phase of food contaminants is unknown. The majority of cells will be in the stationary phase if the product has been properly refrigerated, but this might not be true for a psychrotroph like *Listeria monocytogenes*.

Past-History

The substrate upon which a bacterial culture is grown and environmental factors such as pH, temperature, and presence or absence of oxygen may alter its resistance to either radiation or thermal processing. An example of such adaptation is the growth of *E. coli* O157:H7 under acidic conditions in apple juice. Buchanan et al. (1998) induced a pH-dependent, stationary-phase acid resistance in *E. coli* O157:H7 cells by growing them in tryptic soy broth containing 1% glucose. When either non-acid-adapted or acid-adapted cells were inoculated into clarified apple juice and irradiated at 2EC, the D-value of the non-acid-adapted cells was 0.12 kGy whereas that of the acid-adapted cells was 0.22 kGy.

Naturally Contaminated and Biofilms

Some studies have suggested that only naturally contaminated products should be used to determine D-values because the cells have adapted themselves to the substrate and formed biofilms. This presumes that the formation of biofilms alters the resistance of the organism to radiation or any other stress. The first problem in addressing this hypothesis is that natural contamination of most foods by *E. coli* O157:H7 is often demonstrable only by enrichment culture. Even the level of contamination of poultry by *Salmonella* does not usually exceed 10^3 colony-forming units/cm^2. A study could require hundreds of samples to obtain statistically valid results. Contamination of meat or poultry usually takes place during processing and if it is held at proper temperatures during storage there will be little opportunity for non-psychrotrophic organisms such as *E. coli* O157:H7 to multiply. The very low populations of pathogens on naturally contaminated products make it very difficult to obtain sufficient points on an inactivation curve to allow the calculation of a D-value with a small variability. The assay of a low population of the pathogen in the presence of a much larger total population of normal flora requires the use of enrichment cultures and yes/no answers such as are used in an inoculated pack study for thermal processing. One can test the validity of studies with inoculated products by inoculating a

substrate such as irradiation-sterilized meat with *E. coli* O157:H7 and incubating the meat under abuse conditions that will allow the culture to multiply. The D-value obtained with that product then can be compared to that obtained with meat inoculated with high levels of the pathogen. In my laboratory such studies have not produced significantly different results.

Suspending Medium

The greater the size of the target, the greater the probability of radiation absorption. This means that it is far easier to inactivate metazoans than protozoa, bacteria, or viruses, in that order. It is also clear that most of the ionization events will occur within the substrate (most are about 70% water) and not the pathogen. Direct effects of radiation occur when the ionizing radiation is absorbed in the DNA molecule itself. Indirect effects occur when lethality results from interaction of the DNA with radiolytic (free radical) products of water. Competing reactions with the substrate may prevent free radicals from reaching the pathogen, and physical conditions such as water content and sub-freezing temperatures may reduce the mobility of the free radicals. It is unwise, therefore, to assume that D-values obtained with buffer or broth suspensions of bacteria will necessarily be the same for the inactivation of the bacteria on or in meat or poultry products. D-values obtained with either broth or buffer suspensions usually are much lower than those obtained with a meat product. For example, Thayer et al. (1990) reported the following D-values for the gamma radiation inactivation of *Salmonella typhimurium* at 2EC : 0.20±0.01, 0.22±0.02, and 0.53±0.03 kGy; respectively, in pH 7.0 phosphate buffer, brain heart infusion, and mechanically deboned chicken meat.

Sample Size and Packaging Conditions

Individual sample size influences assay sensitivity. It has been known since 1909 that cells irradiated under low oxygen (anoxic) are as much as three times less sensitive to ionizing radiation than cells irradiated in the presence of oxygen. Irradiation in the presence of oxygen also may induce adverse sensorial effects in the product. As a result, it is extremely important that the packaging conditions for each sample be carefully defined when a D-value is determined. If a commercial product is irradiated in the presence of air under a low dose rate, where oxygen diffusion into the product can occur, it may increase the number of pathogens inactivated at the expense of sensorial properties.

Culture-Media

The method by which the cells are enumerated following irradiation can dramatically alter the results. Any inactivation treatment injures many more cells than it inactivates. One of the common methods for identifying injured cells is to compare numbers of colonies formed on a selective medium to the number on a non-selective medium. We know that we may miss injured cells when we use such selective media, with the result that the associated D-value may be significantly lower than it should be. Further, the greater the dose, the greater the percentage of injury that will occur. The solutions to this problem are to use a sterile substrate or to use a non-selective media containing antibiotics and an antibiotic-resistant pathogen. Sometimes the addition of pyruvic acid and yeast extract to the plating medium increases recovery of injured cells. Sub-optimal incubation temperatures may promote injured cell recovery. In every case the petri plates should be incubated until maximal formation of colony-forming units has occurred.

Counting Colonies

The process of enumerating the number of colony-forming units is an estimation and is subject to several forms of bias and error. The simple process of counting the number of colonies at a given dilution is subject to variability. Jarvis (1989) estimates that the 95% confidence error for counting 30 colonies is ±37%, for 100 colonies ±20%, for 200 colonies ±14%, and for 320 colonies ±11%. So the estimate obtained by counting approximately 100 colonies on each of three plates and averaging the results will have an error of approximately ±11%. If only two plates are counted, the error would be approximately ±14%. This assumes that there are no pipetting errors or additional injuries introduced from the use of agar that is too hot when pour plate techniques are used.

Irradiation

Delivery of an accurate absorbed radiation dose to either a commercial or experimental sample requires an appropriate dosimetry system. A dosimetry system consists of dosimeters, measurement instruments, their associated reference standards, and established procedures for their use. In practice, there will always be a variability in the absorbed dose through the specimen or product because of the natural absorption of radiation by the sample. The absorption of radiation by food is primarily dependent upon its bulk density and the energy and type of incident radiation. On other than very small samples it is essential that the magnitude, location, and reproducibility of the maximum and minimum absorbed dose for a given set of experimental parameters be determined. With electron beam systems the shape of the product may alter the absorption of the radiation. The radiation produced by both electron beam and x-ray systems is not monoenergetic, which may introduce variability in the absorbed dose. Care must be taken that the dose is delivered to the specimen as uniformly as possible. To increase uniformity, experimental samples are sometimes placed on rotating tables. The dosimeter must be appropriate for both the dose range and the operating temperatures to which it will be exposed and should be referenced to National Standards (ASTM, 1999). Even with self-contained sources with fixed geometries, the estimate of the dose-rate for the source is subject to variability. We estimate the dose rate of our self-contained gamma source by the exposure of reference dosimeters supplied by the National Institute of Standards and Technology (NIST) to estimated doses of 10, 25, and 40 kGy. The measured doses were reported to have an error of 1.7%. Because subsequent measurements of absorbed dose start from the NIST measurement and then are subject to additional variability, in practice the measurement of the actual absorbed doses probably has a variability of at least 3%. Therefore it's necessary to report the variability of the absorbed dose along with the other variables of an irradiation study. To enable replication of experiments by others, the characteristics of the radiation source, including the type of incident radiation, dose rate, and environmental factors to which the sample is exposed during and after irradiation, such as temperature and atmosphere, must be stated. Irradiation temperature is very important because of indirect effects. The D-values *in vacuo* for inactivation of *E. coli* O157:H7 on mechanically deboned chicken meat are 0.28±0.02 and 0.44±0.03 kGy at irradiation temperatures of +5 and -5EC, respectively (Thayer and Boyd, 1993).

Calculation of D-value

Many authors estimate the D-value and its variability from the slope of the linear portion of the inactivation curve. Shoulder effects are eliminated by not including the zero dose in the least-squares analysis of the regression. The doses must be selected so as to provide at least five points in the regression, and replicate studies are performed. The variability of the regression estimate is influenced much more by the number of doses than by replication, and D-values should be compared by analysis of covariance rather than by comparisons of means. Obviously there are situations where it may be appropriate to consider tailing of the inactivation curve. D-values are not appropriate for that purpose and one needs to resort to extreme-value statistical methods such as are used in inoculated pack studies. In some cases, significant shoulders are discovered in the inactivation curves. A shoulder does not alter the D-value, but it must be taken into account for that particular organism and medium when estimates are made from the D-value of a dose that is necessary to inactivate, e.g., 5 logs; the value of the shoulder in kGy would be added to the estimate.

Commercial Irradiation

Everything said above for a research study applies to the irradiation of commercial products, except that the variability can be expected to be greater.

Food Preparation

During food preparation synergistic interactions between any surviving, but radiation-injured cells, and the process of cooking may occur.

Conclusion

The variances in the estimates of D-values for the inactivation of any pathogen must be included when

predicting the risk or benefit of the process to the consumer.

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The Acceptance of Irradiation of Meat and Poultry in the United States: What a long, strange trip it's been.

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It has only been in the last few years that irradiation has been approved as a final kill treatment for use on meat and poultry. This is surprising when you consider that the technology has been used for many decades by the Department of Defense and others. With the current public focus on the highest levels of food safety, it seems illogical that this technology has not been used earlier. What has slowed the acceptance of irradiation by the general U.S. public? There are two related reasons for this. The main reason is the reluctance of the U.S. public to accept new technology and to question the safety of novel technology. This has been the traditional reaction of consumers to many new technologies. The second reason is the enactment of the 1958 Delaney Clause, which designated irradiation as an additive rather than a treatment. Even though most reputable scientists then and now would agree that irradiation is a process and not an additive, the public was in an uproar and pushing for this designation. Since the approval of an additive is much more rigorous than that for a process, this designation has acted to greatly slow down the regulatory approval process.

The road to regulatory approval and public acceptance of irradiation has been slow over the last few decades. Recent activities suggest that there will be quicker regulatory approval in the near future. However, increased consumer acceptance may face greater challenges and may only be increased in response to a significant outbreak of foodborne illness.

The Early Years

The first experiments using irradiation occurred soon after the discovery of radium and the development of x-rays around the start of the 20th century. Unfortunately, these processes were very expensive and often caused degradation of taste and consistency. Since 1950, there has been much research into the use of ionizing irradiation to (1) inhibit post-harvest sprouting of potatoes and onions, (2) eliminate potential insect pests in fruits and vegetables, (3) delay ripening of fruits, (4) produce sterile flies for control programs, and (5) provide shelf-stable meat, poultry, and seafood products.

While the development of nuclear weapons provided a

greater and cheaper supply of ionizing radiation sources, the backlash against nuclear weapons transferred to the process of irradiation of foods. The introduction of irradiation as a treatment for foods in the 1950's proved an unfavorable confluence of events. During deliberations for the 1958 Food, Drug and Cosmetic Act many questions were raised about the safety of irradiation, most of them specious in the opinion of scientists. Still, the designation of irradiation as an additive in the Delaney Clause proved to have almost the same effect as an outright ban.

Further research by the Department of Defense during the early 1960's added support to the safety of irradiated foods. Based on this work, irradiation was approved for spices, dried fruit, nuts, fresh fruits, and meat.

Still, there was public resistance to the use of irradiation to assure the safety of the U.S. food supply. This resistance was similar to earlier times when arguments were raised against the introduction of milk pasteurization and food canning, also innovations in food safety. As with irradiation, it was argued that these processes caused degradation of nutrition and quality and caused risks to public health. Resistance to new technologies is a common factor of human behavior, especially when there is an outrage factor such as public health risks.

Recent Events

Although irradiation of spices and other minor ingredients has been approved by the U.S. since 1963, approval of irradiation for meat and poultry took a much longer course. Studies published in 1979 asserted that there was no hazard to mammals from consumption of irradiated poultry. Still, it was not until 1990 that Food and Drug Administration (FDA) approved the irradiation of raw packaged poultry. The U.S. Department of Agriculture's (USDA) Food Safety and Inspection Service (FSIS) approval took 2 additional years. FDA approved the use of irradiation to treat meat in 1997, but it wasn't until 1999 that USDA issued final rules to allow the use of irradiation of beef, pork, and mutton. This prolonged timeframe was the direct result of irradiation being declared an additive in the 1958 Delaney Clause. Since that time, USDA has worked with FDA to agree that any additive approved by FDA is also approved by USDA. This means that the approval process for new food applications will be more rapid than in the past.

The agreement to recognize FDA approval of additives is a great step forward, but it is only a partial response to the artificial designation of irradiation as an additive. Instead of challenging the Delaney Clause on its face, this rule provides an end to part of its impact. Many would argue that the real issue with the Delaney Clause remains to be addressed and should be addressed.

The Present and the Future

Since the approval of irradiation for meat and poultry, consumer acceptance has been inconsistent. Retail outlets in Florida and Illinois have met with limited success in the sale of irradiated poultry. The approval of irradiation of meat in 1999 has led to many attempts to provide irradiated beef to U.S. consumers. Recent reports have provided a mixed review of acceptance by U.S. consumers. Acceptance has been good in certain locales, especially in Minnesota and Iowa. At this point consumer backlash in certain minor markets seems to be an anomaly. A recent USDA Economic Research Service report shows that the level of consumer acceptance increased from 1990 to 1996 but that it has decreased in the past 4 years. Another study done by the University of California-Davis reports that consumer acceptance was estimated at 69% in 1996, declined slightly in 1997 and 1998, then plummeted to 28% in 2000. Opponents of irradiation, such as Public Citizen, have clearly gotten the attention of American consumers, already bombarded with scary food messages about genetically modified organisms, pesticide residues, and the alleged deficiencies of USDA's Hazard Analysis and Critical Control Points program.

What will it take to get U.S. consumer acceptance of irradiation as a food safety process? Perhaps it will take another episode similar to the 1993 outbreak of *E. coli* O157:H7 to capture the attention of consumers. Perhaps then the U.S. consumer will accept that there is a process that would render hamburger safe for consumption. U.S. consumers are continuing to demand safer food, yet are resistant to new processes and products such as

irradiation and genetically modified foods. At least for irradiation, it is likely that acceptance will come only in response to negative public health events.

Conclusions

The road to consumer acceptance of irradiation of meat and poultry has been a very long and strange trip. There are two remaining challenges: (1) the 1958 Delaney Clause which causes an extended regulatory review process, and (2) the reluctance of consumers to accept the process. While it seems unlikely that the Delaney Clause will be replaced in the near future, there is hope that the impediments toward consumer acceptance will be overcome. Recent test marketing in Minnesota and Iowa suggests that consumers are willing to accept this new technology. Real success will only come when school lunch programs and major fast-food companies buy into this process. Current events suggest that the USDA Agricultural Marketing Service may start buying irradiated beef for use in the school lunch program. This would be a significant step toward acceptance of irradiated beef. Purchase of irradiated beef by fast-food companies will probably occur only in response to a major outbreak of foodborne illness caused by ground beef sold in one of their establishments. This is a sad scenario but may be the only impetus that will advance the acceptance of food irradiation by the U.S. fast-food industry.

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Risk Assessor in Profile: Dr. Steve Anderson

Our featured risk assessor is Dr. Steve Anderson, currently an American Association for the Advancement of Science Risk Policy Fellow in the Health and Human Sciences Division of the U.S. Department Agriculture's (USDA) Food Safety and Inspection Service (FSIS). Steve works in the Risk Assessment Branch and is a member of the FSIS *Listeria monocytogenes* Risk Assessment Team and the USDA-Harvard University Bovine Spongiform Encephalopathy Risk Assessment Team.

Prior to Steve's association with USDA, he was a researcher at the Georgetown University Center for Food and Nutrition Policy (CFNP). While at the CFNP, he led the Georgetown risk assessment team for "Fluoroquinolone Usage and the Potential Emergence of Resistant *Campylobacter jejuni* in Cattle." Before coming to Washington in 1997, Steve was a laboratory researcher in the molecular biology of tropical and infectious diseases. As a visiting scientist at the University of Washington and Seattle Biomedical Research Institute, he identified unique protein targeting signals in the African trypanosomes (parasitic protozoans) that cause sleeping sickness. From 1990 to 1992, Steve was a post-doctoral researcher at the Howard Hughes Medical Institute in Iowa City, Iowa. While in Iowa, he characterized genetic mechanisms involved in the virulence of African trypanosomes.

Steve's academic background makes him a valuable addition to FSIS's Health and Human Science Division. His credentials include a B.S. in Zoology from Kent State University, an M.S. and a Ph.D. in Biology from the University of Cincinnati, and a Masters in Public Policy from Georgetown University.

Steve's early career was spent in the laboratory, which provided an exciting environment that focused on a few questions, and from his perspective, work progressed slowly. He used cutting-edge tools of biotechnology to clone, sequence, and introduce changes to a critical African trypanosome gene to understand its function. He also performed "gene knock-out" experiments to delete another group of important genes in African trypanosomes to understand their role in survival. While this work was very exciting, it took more than 4 years to complete. Steve made the move from the laboratory to the public policy arena 5 years ago. At the time, he was serving as a volunteer for a community-based AIDS education organization in Seattle and experienced how profoundly scientific knowledge and information could impact policies and people's lives. Steve finds the faster pace of policymaking and the involvement in many interesting questions and challenges very enjoyable.

When asked what he thought were the two biggest challenges facing risk assessors or risk assessment, Steve gave the following response. A major challenge is achieving clarity and harmonization among risk assessors, risk managers, and risk communicators against a political and policy backdrop that is constantly changing. That means all involved parties have to be forward thinking, and communicate with each other. Managers have to identify issues and assessors have to develop assessments that meet policy needs. It will be a major challenge to develop new strategies and risk assessments that are flexible enough to adapt to changes in policy direction. Risk communicators need to be included every step of the way and develop easily understood messages targeted at the general population or susceptible populations. The second challenge is dealing with dose response modeling. It is a struggle to model the sparse data available for many pathogens and to understand the underlying pathogen and host mechanisms involved. Steve finds it useful to establish links and involve the research community in data design and collection efforts. He is hopeful that further epidemiologic investigations and laboratory research will fill the data gaps.

News of ORACBA

In June, Dr. Nell Ahl left the Office of Risk Assessment and Cost-Benefit Analysis for a position as the U.S. Department of Agriculture Fellow to the Center for the Integrated Study of Food Animal and Plant Systems at Tuskegee University in Tuskegee, Alabama. Nell works at Tuskegee during the week and joins her husband, Jim, at home in Tennessee on the weekends. Nell is enjoying her new life at Tuskegee and is anxious to keep in touch with all of her friends and colleagues. Her E-mail address is asahl@tuck.edu. Please drop her a line, she would love to hear from you.

July Risk Forum: Dr. H. Christopher Frey

On July 12, Dr. H. Christopher Frey, Associate Professor in the Civil Engineering Department at North Carolina State University, presented the July Risk forum, entitled "Quantitative Analysis of Variability and Uncertainty in Exposure and Risk Assessment." Dr. Frey emphasized the need to distinguish between variability and uncertainty in risk assessment. Variability pertains to real differences among members of a population and reflects our certainty that different people will have different exposures or risk. Not only does variability occur at the

population level, but it has spatial and temporal dimensions as well. The susceptibility or exposure of an individual to a contaminant may vary, for example, over time. The concentration of a contaminant in the environment may vary geographically. In order to reduce variability, the system must be altered. Uncertainty, on the other hand, reflects our lack of knowledge regarding the true state of the system, such as the true value of a population parameter (e.g., mean exposure level) or the true distribution of inter-individual variability. Uncertainty can be considered as the probability that exposure or risk will be over- or under-estimated and can be reduced by gathering more or better information. Sources of uncertainty include: measurement error (either random or systematic), random sampling error, non-representativeness of data (due to the use of surrogates or biased sampling), or simply the lack of an empirical basis for drawing inferences. The output of one-dimensional probabilistic risk analysis, in which input distributions are simply propagated through a model, can be thought of as representing a randomly selected individual from the population. This commingling of uncertainty and variability may be appropriate (i.e., is safe to ignore) when either uncertainty or variability dominates. If both variability and uncertainty are substantial, however, two-dimensional probabilistic risk analysis methods can permit the analyst to separately characterize the variability for a given realization of the uncertain input variables and the uncertainty for a given realization of the variable inputs.

An unavoidable dimension of uncertainty in risk assessment is the role of judgment in any sort of data analysis, according to Dr. Frey. This is commonly recognized when the bases for risk assessment assumptions are explicitly subjective, such as professional opinion or a formal elicitation of expert judgment. Less commonly appreciated, however, is that quantitative data analysis is also subjective to a degree. Often viewed as purely objective, there may be subjective expert judgments—often consisting of very strong assumptions—implicit in quantitative analytical methods that can introduce bias that is difficult to quantify. Other important assumptions, such as determining the boundaries of the analysis, an appropriate model structure, representativeness of the available data, or the scenarios to be considered, are inherent to modeling and contain an element of subjectivity. Although it is useful to explore the sensitivity of the results to alternative assumption, systematic error is especially hard to estimate empirically. While they need to be constrained by scientific plausibility, extrapolations, adjustments, and expert judgment are unavoidable in risk assessment, whether or not probabilistic methods are to be employed. Probabilistic methods are, however, enjoying increased acceptance in the policy domain, and there is growing interest in and use of probabilistic methods in many fields of risk assessment.

September Risk Forum: Dr. Peter Cowen

The September13 presentation was given by Dr. Peter Cowen, Professor of Epidemiology and Public Health at the North Carolina State University College of Veterinary Medicine. The title of his presentation was “Epidemiologists and Risk Assessors: Do we speak the same language when it comes to food safety?” This presentation looked at similarities and differences between these sister disciplines.

Dr. Cowen first focused on the similarities, since he found many more of these than differences. Among these similarities are a common focus on the ultimate public health goals, use of the same knowledge base, use of integrative and quantitative disciplines, and grounding in the use of field data. He further noted that while the two disciplines started at very different times in very different places, they have been rapidly converging to a point where some scientists now may be both epidemiologist and risk assessor.

Among the differences noted by Dr. Cowen were the objectives of the two disciplines. Risk assessors are seeking to answer questions of what can happen, how likely it is, and what consequences will ensue. The

epidemiologist seeks answers to who, what, when, where, why, and how diseases (and health outcomes) occur in populations. Another major difference is that epidemiologists seek primary data while risk assessors rely on published information.

This presentation was very well received by the audience. A lively discussion at the end of the presentation had to be cut short due to time constraints.

Risk Calendar

October 2000

October 2 - 4 – Risk Communication Challenge, Harvard School of Public Health, Boston, MA. For more information, contact Harvard School of Public Health, Center for Continuing Professional Education, 677 Huntington, Ave., Boston, MA 02115-6096, telephone (617) 432-1171, fax (617) 432-1969, e-mail contedu@hsph.harvard.edu. For more information, see http://www.hsph.harvard.edu/ccpe.

October 10 - 13 – Ecological Toxicology and Environmental Risk Assessment, New Brunswick, NJ. Contact Environmental and Occupational Health Sciences Institute, Centers for Education and Training at (732) 235-9450, fax (732) 235-9460, E-mail cet@eohsi.rutgers.edu. For more information, see http://www.eohsi.rutgers.edu/cet.

October 11-13 – Second NSF International Conference on Food Safety: Preventing Foodborne Illness Through Science and Education, Hyatt Regency Hotel, Savannah, Georgia. For more information, contact Wendy Raeder at NSF Food Safety Conference, 789 Dixboro Rd., Ann Arbor, MI 48105 or call (734) 827-6888, fax (734) 827-6831, or E-mail raeder@nsf.org

October 11-13 – International Conference on Computer Simulation in Risk Analysis and Hazard Mitigation, Bologna, Italy. For further information, contact Karen Neal, Marketing Coordinator, Wessex Institute of Technology, Ashurst Lodge, Ashurst, Southampton. For more information, see http://www.wessex/ac/uk/conferences/2000/risk2000.

October 24 - 27 – International Society of Exposure Analysis - ISEA2000, Asilomar Conference Center, Monterey, CA. For more information, see http://www.iseaweb.org/isea2000.html.

October 30 – Methods in Quantitative Risk Assessment, Johns Hopkins University, School of Hygiene and Public Health, East Baltimore Campus. Course meets Mondays, Wednesdays, and Thursdays through December 22, 2000. For more information, call Johns Hopkins University, School of Hygiene and Public Health at (410) 614-6200.

November 2000

November 9 - 10 – Risk Based Decision for Environmental Applications, Thompson Conference Center, UT-Austin Campus. Contact Sharon Campos, telephone (512) 232-5168 or E-mail scampos@mail.utexas.edu. For more information, see http://lifelong.engr.utexas.edu.

December 2000

December 3 - 6 – 2000 Annual Meeting, Society for Risk Analysis, Crystal Gateway Marriott Hotel, Arlington, VA. For further information, contact John Ahearne at (919) 547-5213, fax (919) 549-0090, E-mail ahearne@sigmaxi.org or visit http://www.sra.org/events.htm.

January 2001

January 22 – Risk Policy, Johns Hopkins University, School of Hygiene and Public Health, East Baltimore Campus. Course meets Mondays and Wednesdays throught March 16, 2001. For more information, call Johns Hopkins University, School of Hygiene and Public Health at (410) 614-6200.

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