PUBHEHS 7375 Quantitative Microbial Risk Analysis Modeling (3 credits)

Spring, 2019

Course Director:

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Description and Content: The environments we inhabit present to us a suite of hazards with which our health can be affected. Pathogens make up a significant portion of these hazards and account for multiple millions of dollars in healthcare costs each year. Engineering controls are designed to remove pathogens and have developed large international industries to design and build these technologies. Microbial risk modeling and more specifically quantitative microbial risk assessment (QMRA) have been codified in law as a means of targeting and optimizing treatment methods and options. QMRA as a science is a coupling of public health, engineering, microbiology and mathematics (figure 1). This course will outline the fundamental sciences and their application in microbial risk modeling. Students will engage in lectures and project-based learning culminating in a functioning microbial risk model. It is preferable that the model can be used as a component of the graduate student's research or as a means of significantly improving the understanding of the research data the student has developed. Students will learn the microbiology necessary for hazard identification, mathematics of exposure and dose response modeling, and the mathematics, statistics and coding for risk characterization/management.

QMRA and microbial risk modeling in general is a growing scientific field with applications in engineering, public health, healthcare and policy. The growing impact of QMRA (figure 1) touches healthcare associate infections, engineering design, environmental and public health policy, and environmental regulations and laws. Therefore, the impact that learning the skills and science of QMRA will continue well into the future. The adapted QMRA paradigm (figure 2) will be used throughout the course and the course is organized to follow the flow of the paradigm. Each of the component parts describes a specific scientific step in QMRA, providing the scientific grounding of this evolving field.

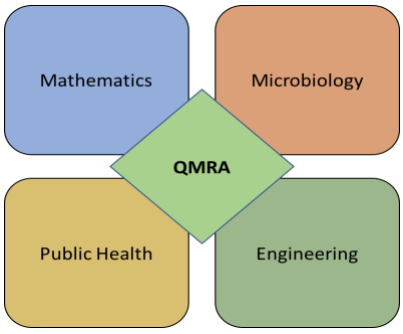

Figure 1. QMRA in a broader context as a translational science

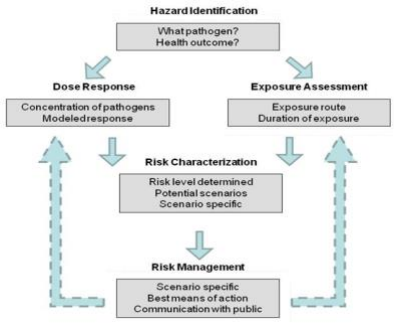

Figure 2. The QMRA paradigm

Prerequisites

Successful completion of graduate-level statistics course, or by permission of the instructor.

Carmen

I will be building the Carmen page as we move along through the semester, I will announce in class if we are using a component from this service.

Student Evaluation and Grading:

Quizzes:

To supplement the lecture materials additional reading and/or viewings will be assigned each week. This will expand on your knowledge and understanding via multiple means of instruction. To evaluate the knowledge retention and application of the materials you are being given and instructed a mixture of quizzes and exams will be used. The quizzes will cover the material on the prior Thursday and Tuesday, and be between 5 and 10 questions always equaling 10 points available. The quizzes will be proctored online using the Carmen interface for online learning (**LINK**). **Quizzes will be released online Wednesday at 16:00 and available until 17:00 Friday that week**. Quizzes are open book and notes, however, do not contact another person for assistance during the quiz, all quizzes are conducted independently.

Exams:

There will be two exams, midterm and final, which will be online assessed. They will be comprised of a mixture of multiple choice and short answer built around a specific public health scenario, either real or hypothetical. This is intended to test you **recall and application** of materials from the course. Exams are open book and notes, however, do not contact another person for assistance during the exam, all exams are conducted independently.

Project:

As can be seen in Table 1 the project is a significant portion of the course grade. This is because QMRA and the modeling needs to be enacted to learn more completely. The student's model will have the critical components of a QMRA model (bullet list below). Each of the milestone submissions outlined in the course schedule at the end of the syllabus will cover the materials for each of these critical components.

- Hazard Identification
- Exposure Assessment
- Dose Response
- Risk Characterization
- Risk Management
- Risk Communication

The models will be constructed in R. Code snippets for portions of each step will be provided by the instructor to start your process. The reason for using R is so that students see the working functions of a risk model not shadowed by a user interface, this will produce useable skills and a deeper understanding of the models themselves. The project will culminate at the end of the semester with a final report and presentation of the risk model. The operational status of the model as well as the milestones will build the final grade for the project.

Each of the milestones are components of the final report. Therefore, each milestone will be held to 2 – 4 pages maximum in equivalent to 10 – 12 point font, 1.5 spacing minimum. Extensive methods that require more than this should be discussed with the instructor with enough time to develop the text to try and achieve the page limit, or request a longer page length. Sweave, and RMarkdown are encouraged for report generation, but the learning curve is understood as well.

This project is structured to facilitate each student to be able to use their own data from either their dissertation or thesis research. Therefore, those students with their own data will learn whether their data is conducive to the type of models that they desire to develop, or QMRA in general. For those students without data, a QMRA model can be developed to assist in targeting data specificity for their experiments yet to be conducted. For those students with neither data nor experiments to target, you will work with your fellow students and the instructor to identify a hazard that is appropriate and interesting to your future work at OSU and career preparation.

Table 1. Details on course project

Broad Classification	Specific Requirements (what to communicate)	Due Date
Hazard Identification	1. What pathogen or biologically derived toxin have you chosen? a. Why did you choose this pathogen or toxin? 2. Microbiology a. Describe the microbiology of the pathogen or production of the toxin b. Quantify the impacts of microbiology on environmental survival	7 February

Broad Classification	Specific Requirements (what to communicate)	Due Date
	i. Is there a known persistence model? ii. What quantifiable persistence can be obtained c. Quantify the effects on pathogenesis if any 3. Epidemiology a. General disease burden b. Subpopulations with additional burden c. Transmission factors d. Symptomology e. Chronic carriers f. Information specific to pathogen chosen	
Exposure Pathway	1. Graphical representation of exposure pathway a. Impacts from and to transmission b. Define matrix of focus c. Describe how this exposure pathway will be modeled i. Method(s) decided upon or to decide from ii. Data needs for these methods iii. Data limitations thus far	14 February
Risk Characterization Method Proposal	1. Propose the modeling method and defend its choice a. What are the underlying principles of this method? b. What are the limitations from using this method? c. What are the data requirements for this method? d. How will this method be used?	21 February
Exposure Model	1. What is the modeling method for the exposure model 2. Is the entire pathway being modeled? a. What limitations does this decision cause? b. What limitations lead to this decision? 3. What are the data requirements and limitations of this method? 4. How have you addressed these limitations? 5. Quantify and describe your model functions and outputs 6. Provide visualizations for your model outputs	27 March
Dose-Response	1. What is the dose-response model you are using 2. Justify this choice 3. If modeling a biologically derived toxin, what is the RfD, RfC or other similar variable you are using? 4. Describe the underlying basis of the type of dose-response model you have chosen (mechanistic microbial; or threshold model)	3 April

Table 2. Grading matrix, demonstrating the appropriation and weighting of grades for the course.

Assessment	No. of points Each	Percent of Grade	Notes
Hazard ID Deliverable	20	14%	Address milestone questions and requests within the deliverables, maintain good grammar, and write sufficiently for replication of model, and deeper understanding.
Exposure Pathway Deliverable	10	7%	
Risk Characterization Method Proposal	10	7%	
Exposure Model Deliverable	20	14%	
Dose-Response Deliverable	20	14%	
Final Project Submission	40	29%	Culmination of risk model
Final Project Presentation	20	14%	
TOTAL – 15	140	100%	Cumulative assessment of learning achievement

Table 3. Grading assessment. Please remember that all students are capable of and A and I prefer assigning A's to all students.

Grade	Percentage	Meaning
A	100 – 93	Outstanding performance; consistent exceptional depth of understanding and/or creative application of concepts.
A-	92.9 – 90	Very strong performance with demonstrated depth of understanding and/or ability to apply course concepts
B+	89.9 – 87	Performance at an expected level; work is complete and shows solid understanding and application of course concepts
B	86.9 – 83	Adequate performance; work is complete but shows some limitations in grasp or ability to apply course concepts
B-	82.9 – 80	Marginally acceptable; work is conducted only to meet minimum course requirements
C+	79.9 – 77	Grades below B- indicate significant problems in understanding or applying course concepts and/or failure to meet stated course requirements.
C	76.9 – 73	
C-	72.9 – 70	
D+	69.9 – 67	
D	66.9 – 60	
E	<60	

Course Learning Objectives:

1. Apply an Environmental Health Science Model (figure 1) to public health scenarios
2. Categorize types of hazardous environmental agents
3. List sources and types of contaminants generated in and from various indoor and outdoor community settings.
4. Differentiate between environmental (indoor and outdoor) contamination, types of hazardous exposures, and related risks of disease.
5. Apply best practice concepts related to the prevention, planning and preparation for emerging and actual incidents involving community-based settings.
6. Interpret applied environmental health readings and case studies.

Applicable MPH Degree Core Competencies:

2. Select quantitative and qualitative data collection methods appropriate for a given public health context
3. Analyze quantitative and qualitative data using biostatistics, informatics, computer-based programming and software, as appropriate
4. Interpret results of data analysis for public health research, policy or practice
12. Discuss multiple dimensions of the policy-making process, including the roles of ethics and evidence
19. Communicate audience-appropriate public health content, both in writing and through oral presentation
6. Explain the critical importance of evidence in advancing public health knowledge
7. Explain effects of environmental factors on a population's health
8. Explain biological and genetic factors that affect a population's health
11. Explain how globalization affects global burdens of disease
12. Explain the ecological perspective on the connections among human, animal and ecosystem health (e.g., One Health)

Applicable Ph.D Degree Core Competencies:

1. Explain individual and community susceptibility and vulnerability factors that heighten the risk for populations for adverse health outcomes from environmental hazards – EHS
2. Critique general scientific research articles and assess the appropriateness of the statistical applications and methodology involved. – PH Biostats
3. Communicate the results of statistical analyses to statistical and non-statistical audiences. – PH Biostats
4. Carry out a research project that makes a contribution to biostatistical methodology and/or practice. – PH Biostats
5. Identify and address potential sources of bias, including selection bias, measurement error, and confounding, in both the design and analysis phases of epidemiological studies. – Epidemiology

EHS Specialization Competencies:

3. Explain the physiological factors that influence human exposure and the uptake of chemical and biological environmental agents.
4. Identify and explain individual (e.g., genetic, physiologic and psychosocial) and community (e.g., social, built, economic, race) susceptibility factors that heighten the risk for populations for adverse health outcomes from environmental hazards

5. Apply various risk assessment, risk management and risk communication approaches for environmental hazards
7. Describe federal and state regulatory programs, guidelines and authorities relevant to environmental and occupational health
8. Access State, Federal, and local resources for assessing environmental and occupational health.
9. Compare the principle components and influencing factors in the exposure continuum from source to disease.
10. Determine the role of exposure assessment in environmental and occupational health.

Attendance:
We are all adults; therefore, students are expected to attend all classes. Reasonable explanations for lack of attendance will be accepted, please do not abuse this policy.

Course Policies:
I will treat all students with the respect due to adults in professional development. Project updates and final project deliverables are due at 17:00 of the date posted. This can be extended with enough advance notice at least 3 days **minimum**. A new due date will be negotiated at the time of notice of late delivery of deliverables is given. If the deliverables are not submitted by the newly negotiated date, a zero will be given to the students in the group.

Special Note on Plagiarism:
Plagiarism is outlined below in Academic Integrity, however, I view plagiarism in its more intense definition, being **theft of intellectual property**. Any type of plagiarism will be referred to the appropriate chain of command for addressing academic misconduct and a zero for the assignment. If plagiarism is encountered more than once by any person or group it will result in failure of the course for the responsible party(ies).

Office of Student Life: Disability Services
Any student who feels s/he may need an accommodation based on the impact of a disability should contact me privately to discuss your specific needs. Please contact the Office of Student Life: Disability Services at 614-292-3307 in Room 098 Baker Hall 113 W. 12th Ave. to coordinate reasonable accommodations for students with documented disabilities (http://www.ods.ohio-state.edu/).

Mental Health Services
As a student you may experience a range of issues that can cause barriers to learning, such as strained relationships, increased anxiety, alcohol/drug problems, feeling down, difficulty concentrating and/or lack of motivationThe Ohio State University offers services to assist you with addressing these and other concerns you may be experiencing. If you or someone you know are suffering from any of the aforementioned conditions, you can learn more about the broad range of confidential mental health services available on campus via the Office of Student Life's Counseling and Consultation Service (CCS) by visiting ccs.osu.edu or calling 614-292-5766. CCS is located on the 4th Floor of the Younkin Success Center and 10th Floor of Lincoln Tower. You can reach an on-call counselor when CCS is closed at 614-292-5766 and 24 hour emergency help is also available through the 24/7 National Suicide Prevention Hotline at 1-800-273-TALK or at suicidepreventionlifeline.org.

Academic Integrity: Academic integrity is essential to maintaining an environment that fosters excellence in teaching, research, and other educational and scholarly activities. Thus, The Ohio State University, the College of Public Health, and the Committee on Academic Misconduct (COAM) expect that all students have read and understood the University's Code of Student Conduct and the School's Student Handbook, and that all students will complete all academic and scholarly assignments with fairness and honesty. The Code of Student Conduct and other information on academic integrity and academic misconduct can be found at the COAM web pages (http://oaa.osu.edu/coam/home.html). Students must recognize that failure to follow the rules and guidelines established in the University's Code of Student Conduct, the Student Handbook, and in the syllabi for their courses may constitute "Academic Misconduct."

The Ohio State University's Code of Student Conduct (Section 3335 -23-04) defines Academic misconduct as: *"Any activity that tends to compromise the academic integrity of the University, or subvert the educational process." Examples of academic misconduct include (but are not limited to) plagiarism, collusion (unauthorized collaboration), copying the work of another student, and possession of unauthorized materials during an examination. Please note that the use of material from the Internet without appropriate acknowledgement and complete citation is plagiarism just as it would be if*

the source were printed material. Further examples are found in the Student Handbook. Ignorance of the Code of Student Conduct and the Student Handbook is never considered an "excuse" for academic misconduct.

If COAM determines that the student has violated the University's Code of Student Conduct (i.e., committed academic misconduct), the sanctions for the misconduct could include a failing grade in the course and suspension or dismissal from the University. If you have any questions about the above policy or what constitutes academic misconduct in this course, please contact us.

Session & Theme	Session Numbers and Dates	Module Topics and Faculty Members	Readings & Due Dates for Milestones
Fundamentals	W1-Intro-1 8, 10 January	Fundamentals of Modeling ***Faculty: Dr. Weir***	Translating Research to Policy
		Fundamentals of Risk Modeling, and Statistics ***Faculty: Dr. Weir***	The Words of Risk
	W2-Intro-2 15, 17 January	Introduction to Modeling in R ***Faculty: Dr. Weir***	Cryptosporidium Spray Park
		Monte Carlo Programming and Graphics in R ***Faculty: Dr. Weir***	Choose 2 examples from Count Bayesie
Hazard ID	W3-HazID-1 22, 24 January	Fundamentals of Microbiology, and Infectious Disease Pathogenesis ***Faculty: Dr. Weir***	Legionella Uptake Microbiology
		Environmental Sampling Methods and Limits ***Faculty: Dr. Weir***	Effects of Detection Limits in QMRA
	W4- HazID-2 29, 31 January	Linkages of Human Health Mathematics and Microbiology ***Faculty: Dr. Weir***	Cryptosporidium Outbreak Related Risk Model Giardia in Drinking Water
		Hazard Identification – Hazard and Symptom ***Faculty: Dr. Weir***	Increasing Incidence of Legionella
Exposure Assessment	W5-Exp-1 5, 7 February	Exposure Pathways and Routes ***Faculty: Dr. Weir***	Flood and Infectious Disease Risks QMRA Urban Slums
		Exposure Modeling Methods ***Faculty: Dr. Weir***	**Hazard Identification Milestone Due**
	W6-Exp-2 12, 14 February	Markov Chain Modeling ***Faculty: Dr. Weir***	Opportunistic Pathogen Importance
		Fate and Transport Modeling – Water Exposure ***Faculty: Dr. Weir***	**Exposure Pathway Milestone Due**
	W7-Exp-3 19, 21 February	Environmentally Mediated Infectious Disease Transmission Modeling ***Faculty: Dr. Weir or Guest***	Environmentally Mediated Rotavirus Infections
		Fomites and Fomite Exposure Modeling ***Faculty: Dr. Weir***	**Risk Characterization Method Proposal Due**
Dose Response	W8-DR 26, 28 February	Dose Response: From Epi to Animal Models ***Faculty: Dr. Weir***	Development of First Gen Dose Response
		Dose Response Modeling, Optimization, and Bootstrapping ***Faculty: Dr. Weir***	Scanned Book Chapter on Carmen

Session & Theme	Session Numbers and Dates	Module Topics and Faculty Members	Readings & Due Dates for Milestones
From Exposure to Dose to Simple Risk	W9-ExpDR 4, 6 March	Coupling of Exposure to Risk Model ***Faculty: Dr. Weir***	Chapter 17 of Disease Control Priorities…
		Emerging Pathogens ***Faculty: Dr. Weir***	Chikungunya - Reemerging Infectious Disease
Broader Issues Risk Characterization	W10-Charac-1 18, 20 March	QALY/DALY ***Faculty: Dr Weir***	Chapter 2 of WHO GBD Estimates
		Risk Characterization – Excel and R ***Faculty: Dr. Weir***	
Risk Characterization Advanced Methods	W11-Charac-2 25, 27 March	Risk Characterization – 2D Simulations and Uncertainty characterization ***Faculty: Dr. Weir***	OPTIONAL – The Two-Dimensional Monte Carlo in Epidemiology
		Closing the Loop – Hazard to Characterization ***Faculty: Dr. Weir***	**Exposure Model Milestone Due**
Risk Perception and Communication	W12-Percep 1, 3 April	Perceiving Risks – Data Rich and Poor ***Faculty: Dr. Weir***	Risk Perception: It's Personal
		Risk Communication ***Faculty: Dr. Weir***	**Dose-Response Milestone Due**
Frontiers	W13-Front-1 8, 10 April	MDRO and AMR ***Faculty: Dr. Weir***	HHRA for Environmental Development of AMR
		Generations 2 and 3 Dose Response Models ***Faculty: Dr. Weir***	Scanned Book Chapter from Carmen
	W14-Front-2 15, 17 April	Incorporation of Social Behavioral Sciences ***Faculty: Dr. Weir or Guest***	
		Converged Dose-Response ***Faculty: Dr. Weir or Guest***	
Case Studies OR Project Work	W15-Case-1 22, 24 April	Fomites Risks and Influenza in Schools ***Faculty: Dr. Weir***	
		Cholera and Recreational Risks ***Faculty: Dr. Weir***	
Final Project Presentations	**Final Exam** 22 April 1000 – 1145	**Final Presentations – Final Reports Due 1 week before** **Room TBD**	