3 June 2010 Volume 1, Issue 2

CENTER FOR ADVANCING MICROBIAL RISK ASSESSMENT

ADVANCES IN QMRA

A QUARTERLY NEWSLETTER

INSIDE:

- Working to answer "How Safe is Safe Enough?"
- Advanced water distribution models to better predict sensor placement.
- Preview next issue
- CAMRA-wiki, making the most advanced information available to all.

WELCOME FROM THE CO-DIRECTOR

When thinking about a potential bioterror attack there are a number of difficult and urgent decisions which must be evaluated and made. This also of course follows for an unintentional release of pathogens into water systems or the food network.

We have decided to focus our second issue on the work progressing to further the decision support tools being developed by CAMRA.

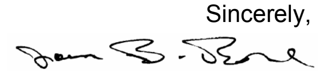
We have developed a direct decision support tool for a malicious release of a virulent pathogen, in this case *Bacillus anthracis*. The decision to be made is if and what type of medical treatments are most viable. This tool can be easily expanded to other medical options and other pathogens, now that the framework has been established.

We have also been developing and improving on AZRED a patch for a more realistic look at the hydraulics of contaminant transport in water distribution systems. This AZRED patch to widely implemented EPANET has been used successfully to make informed and risk-based decisions of sensor placement in the example water distribution system.

We are also pleased to announce the current development of the CAMRA-wiki. The CAMRA-wiki will be a main repository and instructional tool for those interested in QMRA, or those currently working or researching QMRA. Our wide range of classical and advanced dose response models are the current backbone of the CAMRA-wiki, but this is being built up to include pathogen safety data sheets (PSDS), and the application of QMRA such as these decision support tools.

We are currently looking forward to our future work and the future of CAMRA in general, as well as gaining more input from the QMRA community. Thank you again for reading our newsletter and we look forward to your input. If there are others who may be interested in the QMRA newsletter please send along the sign up information to them.

Sincerely,



Dr. Joan B. Rose

WE WANT TO WIDEN OUR ARTICLES: CONTRIBUTE TO THE QMRA NEWSLETTER

We greatly appreciate that the QMRA community is global and expands many disciplines.

Since this newsletter may help distribute news about the current state of QMRA science, as well as ideas about the next urgent needs, we welcome input from the entire QMRA community.

We are very interested in your input regarding the QMRA field and in what you are doing in your respective laboratories and offices.

Submitting to the newsletter is as simple as contacting the editors via the e-mail address or telephone number. We can discuss the material to be included and then it is a simple submission to the CAMRA e-mail address.

A full page article is typically between 600-650 words, this is dependant on the number and size of pictures/figures that may be included. For a small half-page article there is typically sufficient room for 250-300 words.

We will consider multi-page submissions as well, as this will be discussed with the editors. We hope that you will submit your work or ideas and interests in future articles to the QMRA newsletter.

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Editors:
Mark H. Weir, Rachel M. McNinch, and Joan B. Rose

HOW SAFE IS SAFE ENOUGH? USING RISK ASSESSMENT TO INFORM THE DEVELOPMENT OF ACTION LEVELS FOR ANTHRAX

It would be natural to assume that if you are exposed to *Bacillus anthracis*, you should seek medical treatment rather than run the risk of contracting anthrax. Jade Mitchell-Blackwood, doctoral researcher in risk assessment, sees things differently. From the perspective of a risk assessor, all options have risks. While medical treatment may reduce the risks of contracting anthrax, it involves its own risk of side effects as well as direct monetary costs. Jade, with her collaborators Dr. Patrick Gurian and recent MPH graduate Cara O'Donnell, developed a decision model that balances costs and risks of side effects of treatment for anthrax against the risk of death and disability from contracting anthrax (Figure A.) Their work, which has been accepted for publication in the Journal of Human and Ecological Risk Assessment: An International Journal [ISSN 1080 – 7039], suggests that at risks of contracting anthrax below the 1/10,000 level, the benefits of treatment may not be justified by the expected costs and health impacts from treatment. This type of analysis may help establish boundaries for where response actions are needed and where costs and side effects may outweigh the benefits of treatment.

Since 2001, a great deal of literature has been published to evaluate response strategies in the event of another anthrax attack. However, these studies have not addressed the question of "when?" action is warranted in terms of quantifiable risk. The decision model developed by Jade and her colleagues is the first attempt to address this question for two specific exposure scenarios. The results provide valuable information to responders who may be presented with decisions following an attack. The model takes into consideration that fact that a single release creates two related but distinct decision problems: (1) What action should be taken to protect those already exposed to this release? and (2) What actions should be taken to protect against future exposures that might result from residual environmental contamination associated with this release? The first decision is modeled using antibiotic therapy as the relevant option to treat people who may have been exposed. For the second decision, both vaccination and environmental decontamination are considered in order to reduce risk for future occupants of a contaminated space. These response actions are clearly justified for highly exposed individuals, but a real attack would probably also produce a very large number of individuals who receive very small exposures in areas outside of the immediate vicinity of the release. Through sensitivity analysis, the model establishes a risk level when response strategies are no longer justified. The results established non-negligible, non-zero risk thresholds. For the base case, the thresholds range from a risk of 1 in 33 (Figure B) for decontamination by fumigation to 1 in 6,547 for antibiotic prophylaxis (Figure D) and 1 in 7,108 for vaccination (Figure C). The switchover between action and non-action establishes a risk threshold above which action is warranted. If a measured environmental concentration is less than the number of spores which warrants action, then treatment may not be required. Non-zero cleanup levels are possible based on the actionable risk level. The framework established by CAMRA in this modeling effort provides a risk-based approach that speaks directly to the question "how clean is clean?"

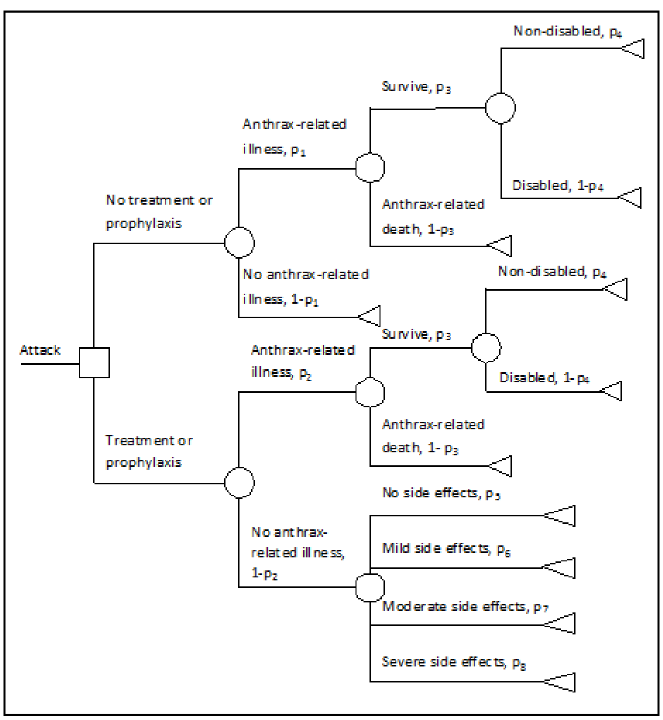

Figure 1. Plot Showing decision tree model for antibiotics and vaccination alternatives

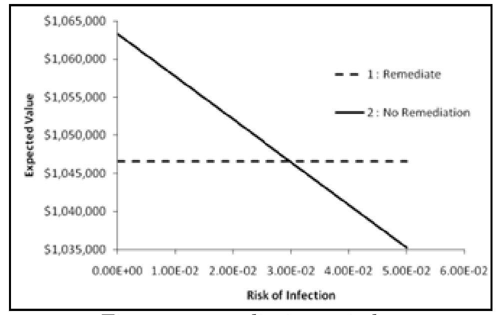

Figure 2. remediation switchover

The switchover between action and non-action establishes a risk threshold above which action is warranted. If a measured environmental concentration is less than the number of spores which warrants action, then treatment may not be required. Non-zero cleanup levels are possible based on the actionable risk level. The framework established by CAMRA in this modeling effort provides a risk-based approach that speaks directly to the question "how clean is clean?"

At the heart of this model is benefit-cost analysis, a well-established and useful tool for assessing trade-offs among alternative decision responses. Jade and her colleagues realize that analyses such as this cannot be the sole criterion in responding to bioterrorism incidents as this method has some limitations. But even with the limitations of the models, the fact that hundreds of millions of dollars and three years were required to decontaminate a handful of buildings warrants a consideration of how these decisions are made.

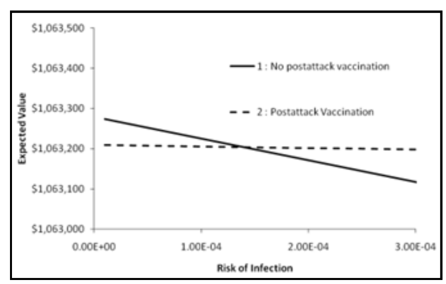

Figure 3. Vaccination switchover

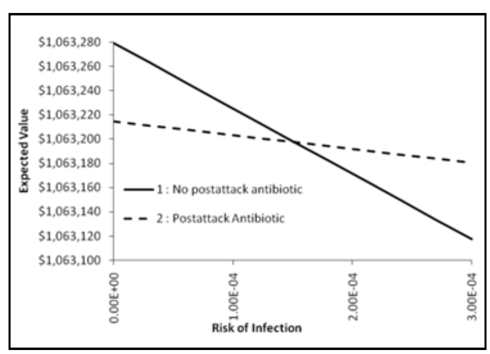

Figure 4. Vaccination switchover

Contributing Authors: Jade Mitchell-Blackwood and Patrick L. Gurian, Drexel University

WHERE DO WE PUT THE SENSORS: ADVANCED WATER DISTRUBTION MODELS INFORMING SENSOR PLACEMENT

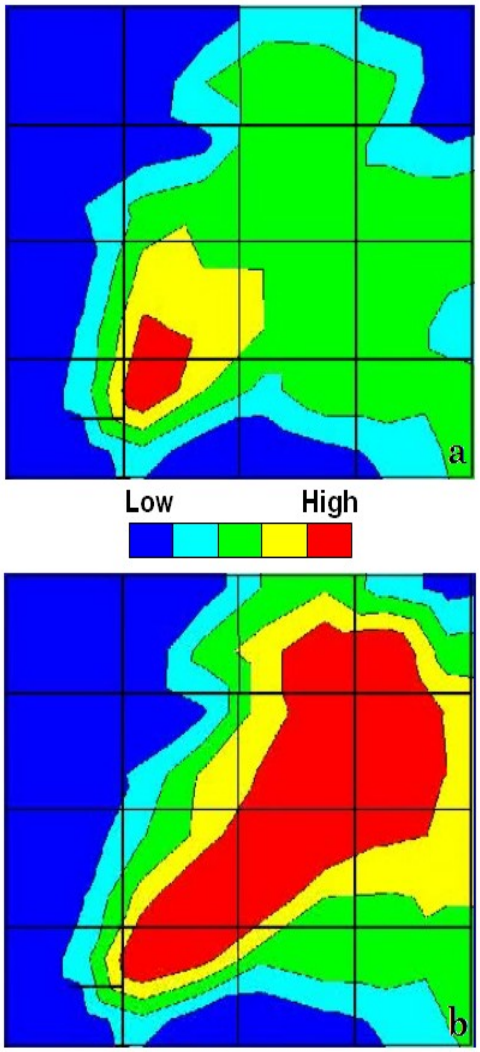

Figure 5. Plume development plots from EPANET with the complete mixing assumption in place (a), and AZRED removing this assumption (b)

CAMRA Investigator Dr. Christopher Choi and his PhD. students Pedro Romero-Gomez and Ryan Austin, have developed an adaptation to the widely used EPANET, making it more accurate.

The current EPANET as used assumes complete and even mixing (Figure 5a). CAMRA's work has shown that this assumption is erroneous in a cross junction. Therefore this erroneous assumption was removed, and extensive modeling (Figure 6a) and validation data gathering (Figure 6b) was used to develop a freely available patch for EPANET.

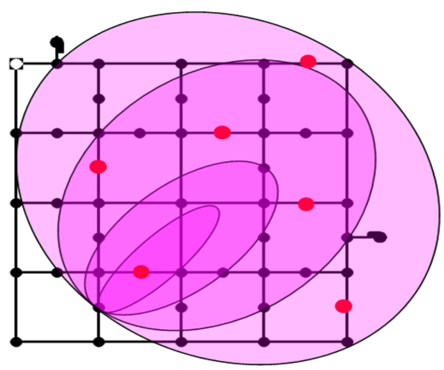

Figure 7. Conceptual example of risk levels showing differing risk levels for various different nodes, thereby, informing sensor location.

Titled AZRED, this patch counteracts the even mixing assumption replacing it with the results of the computational fluid dynamics model. As can be seen in the comparison of Figure 5a and 5b, where Figure 6b is from using AZRED.

This advancement can allow for a better understanding of how risks are delineated through the population. AZRED has been used to develop a strategy for optimal sensor placement in a water distribution network (Figure 7), the ovals representing different pathogen concentration levels.

This patch has been used to determine the optimal sensor locations for an example water distribution system. Figure 8 shows the example water distribution system which was optimized for an intentional release. This was also optimized for minimum detection levels and exposure level fro chemical contaminants.

AZRED is freeware and can be found at:

http://cals.arizona.edu/~cchoi/AZRED

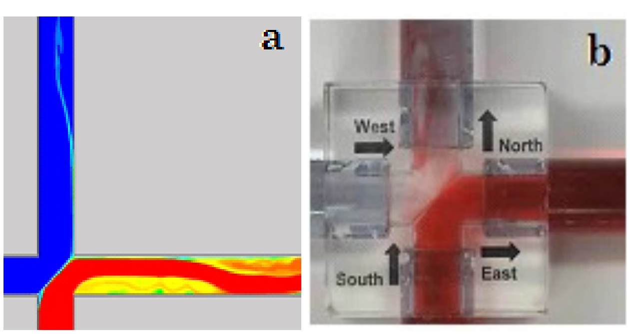

Figure 6. Computational fluid dynamics model representation of the uneven mixing modeled in a cross junction (a), and a picture from the validation experiments of this work (b).

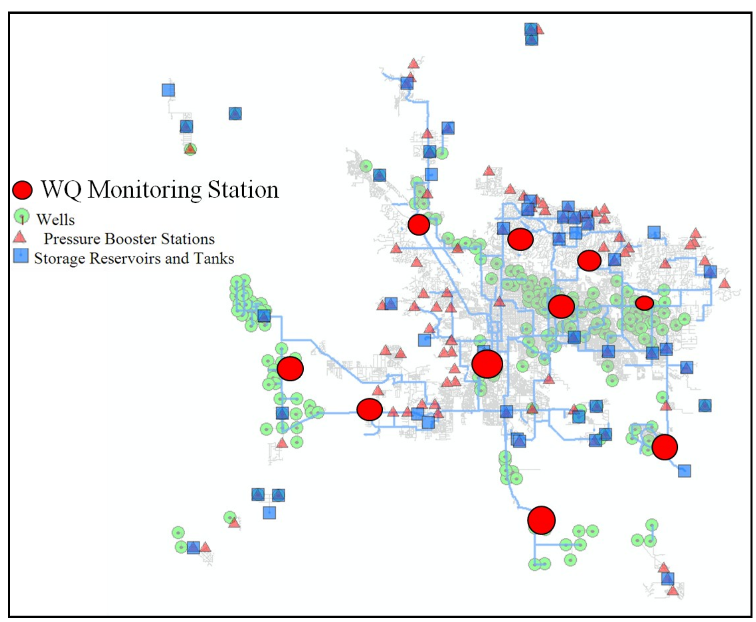

Figure 8. Example water distribution system with optimized sensor locations chosen using the AZRED patch for EPANET.

ANNOUNCING THE DEVELOPMENT OF THE CAMRA-WIKI. OPEN REPOSITORY OF QMRA DATA AND LEARNING TOOLS

While often we understand much about the microbial hazards, understand the potential impacts to the public health and have access to numerous web pages on pathogens to obtain information on symptoms and descriptions of the microbes, there is currently no one location for the quantitative data required to perform a QMRA.

CAMRA is closing this gap in knowledge for the public, researchers and decision makers with the CAMRA-wiki.

Currently in a beta stage, the CAMRA-wiki is an excellent means of disseminating vital work to interested parties. The CAMRA-wiki is being crafted as more than a repository of information and data, but also as a teaching tool.

It is envisioned that the CAMRA-wiki will act as a valuable teaching aid for QMRA self instruction and eventually classroom exercises. Not meant as a replacement to a textbook or the current main reference for QMRA (Haas *et al.,* 1999) but rather as an accompaniment and update to this book.

We are excited to begin to showcase the work and results of CAMRA as well as make these results more easily available to the QMRA community of researchers and users.

The CAMRA-wiki once fully established will accept submissions from other researchers and users in the QMRA community. These submissions will be subject to an internal review before official upload, in order to control quality, and ensure that copyright infringement will not be an concern.

We see this as an opportunity to continue to make available the most up-to-date information to researchers and decision makers, as well as an excellent means of expanding the QMRA community.

Rose, J.B., Haas, C.N., Gerba, C.P. Quantitative Microbial Risk Assessment John Wiley and Sons Inc., New

CAMRA-wiki beta version:

http://129.25.34.106/iswiki/index.php/Main_Page

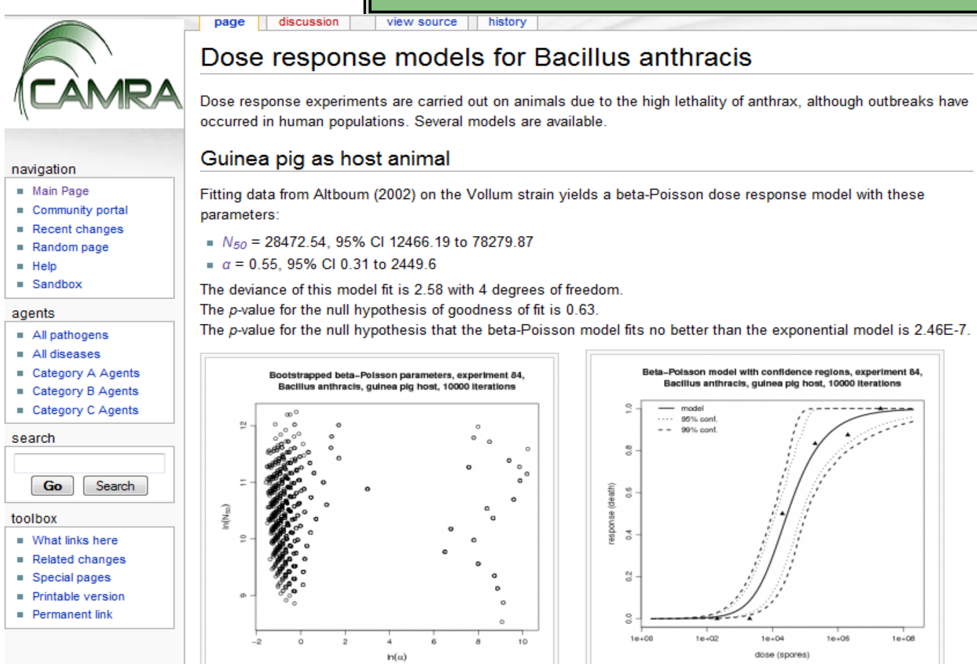

Figure 9. Screenshot of the dose response page for *Bacillus anthracis* (*B. anthracis*), the causative agent of anthrax. This page will show the available dose response model fits for different combinations of host animals and strains of *B. anthracis* along different exposure routes as well.

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