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Teaching Wildlife Disease Outbreak Response Through a Collaborative One Health Workshop

Elliott S. Chiu [DVM/PhD Candidate], **Justin Lee [Research Scientist]**, **Jennifer Malmberg [PhD Candidate]**, **Anna Fagre [PhD Candidate]**
Microbiology, Immunology, and Pathology, Colorado State University, 1619 Campus Delivery, Fort Collins, CO 80523 USA.

Nicholas G. Dannemiller [DVM Candidate], **Margot Stuchin [DVM candidate]**
Colorado State University, 1619 Campus Delivery, Fort Collins, CO 80523 USA.

Ben Golas [PhD Candidate],
Graduate Degree Program in Ecology, Colorado State University, 1619 Campus Delivery, Fort Collins, CO 80523 USA.

Kathryn P. Huyvaert [Associate Professor]
Fish, Wildlife, and Conservation Biology, Colorado State University, 1474 Campus Delivery, Fort Collins, CO 80523 USA.

Abstract

Issues in the fields of wildlife disease and One Health are often difficult to address by single research groups because of the many disciplines and areas of expertise required to effectively solve complex problems. Although collaborations are becoming increasingly prevalent in the professional realm, many undergraduate, graduate, and professional students are merely introduced to the idea of collaboration without fully understanding how team-based approaches function. In this report, we describe the framework for a one-day workshop hosted by the Colorado State University student chapter of the Wildlife Disease Association (CSU WDA), where we gathered students and professionals to collectively investigate a simulated wildlife disease outbreak. CSU WDA student members designed the workshop and recruited professionals who are experts in their respective fields to run an outbreak simulation during the event. Based on pre- and post-event evaluation responses, this workshop was effective in increasing participants' knowledge of disease ecology, pathology, genetics, and microbiology, as well as the importance of collaboration among disciplines as it pertains to wildlife disease outbreaks.

Keywords

educational workshop; simulation; experiential learning; outbreak investigation

Elliott. chiu@colostate.edu.

INTRODUCTION

Collaboration among health care professionals and other scientists has become increasingly relevant in the face of wildlife disease spillover events,[1] pandemics,[2] anthropogenic catastrophes (e.g., oil spills),[3] and natural disasters (e.g., Hurricane Katrina).[4] Because of the unpredictable nature of these events, preparedness for mitigating negative consequences is important.[5] Based on pre-and post-workshop knowledge assessments,[6–8] hypothetical outbreak workshops, simulations, and tabletop exercises can increase participants' preparedness for such events.

Interdisciplinary training programs are becoming more common in postsecondary and graduate training programs (e.g., Master of Science [MS] in the Conservation Medicine Program at the Tufts Cummings School of Veterinary Medicine). However, developing and implementing a fully interdisciplinary academic program requires marked financial resources and expertise in multiple areas.[9,10] An interactive, problem-based workshop is an alternative approach to introducing students of various backgrounds to interdisciplinary practices requiring fewer resources and less time. Such workshops can be especially useful in promoting critical thinking within the framework of a collective response to outbreak scenarios, highlighting the need for prompt and adaptive approaches to disease mitigation.[11] To our knowledge, no published case studies exist that assess the efficacy of an interdisciplinary wildlife disease outbreak workshop for undergraduate, graduate, and veterinary students from multiple colleges and departments.

In this exercise hosted by Colorado State University's student chapter of the Wildlife Disease Association (CSU WDA), undergraduate students (Wildlife Biology; $n = 1$), graduate students (Department of Environmental Health and Radiological Sciences; Department of Microbiology, Immunology, and Pathology; $n = 5$), veterinary students (DVM years 1–3; $n = 10$), and professional veterinarians (Public Health, Pathology; $n = 3$) from a variety of educational backgrounds were presented with a hypothetical wildlife disease outbreak scenario. Working in small groups and with a limited amount of time, participants were provided with a budget for diagnostic tests and consultations with experts and were instructed to create a list of plausible differential diagnoses for the outbreak's cause. The envisioned learning outcomes for the workshop included participants being able to (a) articulate their findings following the simulation, (b) develop a response to the outbreak scenario based on their working hypotheses, and (c) discuss the importance of a multidisciplinary approach to wildlife disease outbreaks, underscoring the notion of a One Health framework. We administered pre- and post-workshop evaluations to participants to measure the efficacy of the simulation and associated lecture material. The use of evaluations was determined to be exempt by CSU's Institutional Review Board as described in 45 CFR 46.101(b).

WORKSHOP PREPARATION

Preparation for the wildlife disease outbreak workshop required a moderate amount of time (~80 person-hours) and planning, due to the nature of the event and the need to establish an immersive learning environment. We chose facilitators with relevant prior knowledge in wildlife disease and who expressed willingness to contribute both in the preparation and execution of the workshop. Workshop planners met with the selected facilitators to design the scenario, which emphasized the need for transdisciplinary collaboration. We merged information from two real-world cases to develop a simulated scenario of a major enzootic outbreak with a confounding minor plant toxicity issue (Figure 1). We developed a case description to provide enough detail for a self-guided, although not necessarily linear, path toward determining a small set of hypothetical case etiologies, contributing ecological factors, and potential management actions in response to the outbreak. Our case involved two populations of wild kangaroos in Australia; both populations suffered from a vector-borne disease,[12] with one population experiencing concurrent mortalities due to a plant toxicity.[13] The pathogen for the vector-borne disease, *Leishmaniaspp.*, was transmitted via a newly reported vector[14,15] to challenge previously accepted dogma.[16]

After planners defined the case, we established four disciplines to include in the simulation, each with a corresponding facilitator: (a) pathology (JM), (b) microbiology (AF), (c) molecular genetics (JL), and (d) disease ecology (KPH). As the disciplines were finalized, facilitators created a list of possible diagnostic tests and data collection strategies that workshop participants could use to garner more information about the case (Table 1). The list included extraneous tests to lend additional realism to the exercise. All diagnostic tests and data collection methods were associated with a monetary cost. Participants were allotted a $1,500 budget to emulate real-world financial constraints associated with outbreak investigation. Finally, facilitators generated simulated data for each test or type of sample collection.

WORKSHOP IMPLEMENTATION

We divided the workshop into two main sessions: didactic lectures and a practical simulation. Facilitators delivered presentations at the beginning of the event to provide a basic understanding of the various disciplines. The lectures were not intended to be comprehensive but rather were designed to orient participants to the case and the relevance of each discipline to a wildlife disease outbreak investigation. Each presentation lasted 40 minutes. Following these lectures, we briefed participants on details of the leishmaniasis outbreak in the kangaroo populations and other details of the case, and then proceeded with the practical simulation.

The simulation lasted approximately 4 hours. We assigned participants to predetermined teams of four people to promote a diversity of experience, expertise, and levels of study within each group. We provided participant groups a list of potential tests (average $150) and data types (Table 1) following the case briefing. Facilitators were stationed in appropriate departments within CSU’s Diagnostic Medical Center, and teams could visit any or all stations to request data or tests. Additionally, all facilitators offered more intensive wet labs (i.e., necropsy, histology, insect/plant collection and identification, bacterial culture, and phylogenetic analysis) to enhance the depth of the learning experience for participants.

The variety of tests within each discipline allowed teams to devise their avenue of inquiry while investigating the simulated outbreak. In principle, teams would use test results from different disciplines to corroborate or rule out their competing hypotheses on the etiology and ecology of the outbreak. However, the limited budget forced teams to be judicious in their decisions. The complexity of the case required teams to draw inferences about specific parts of the outbreak including the infectious agent, the novel vector, the phylogenetic identification of the causative agent, the confounding toxin, and associated ecological factors. If teams progressed quickly, they were asked to develop potential responses to the outbreak. Seldom were teams deliberately led to the answer at any discipline's station. One team believed they had uncovered everything the scenario had to offer until we queried the team about their results to encourage further inquiry.

WORKSHOP DEBRIEFING

Following the simulation, facilitators and teams gathered to debrief the case. Debriefing began with groups reporting their results. Groups consistently came up with the same themes, but no group was able to correctly identify all elements incorporated into the simulation. In particular, very few groups could identify the previously unreported vector for *Leishmania* spp., the identity of which was important for proposing effective control strategies. We then revealed all elements of the scenario and discussed possible control strategies to protect animal and human health. The session closed with a question and answer period.

WORKSHOP EVALUATION AND ANALYSIS

To quantify the impact of the simulation and associated lectures on learning outcomes, identical evaluation questions were given to participants before and after the workshop. Participants were asked to rate their perception of the importance of disease ecology, pathology, molecular phylogenetics, microbiology, and collaboration among multiple disciplines during a wildlife disease outbreak investigation using a scale of 1–10, with 1 indicating *little to no importance* and 10 indicating *very important*. Similarly, participants were asked to rate their current knowledge in disease ecology, pathology, molecular phylogenetics, microbiology, and collaboration among multiple disciplines as it pertains to wildlife disease outbreak investigations on a scale of 1–10, with 1 indicating *little to no knowledge* and 10 indicating *very knowledgeable* (Appendix). Out of the 18 participants who attended the workshop, 17 (94.4%) completed both the pre-and post-workshop evaluations.

After the workshop, completed evaluations were collated and we used Wilcoxon signed-rank tests using the package *coin*[17] implemented in R version 3.4.2[18] to evaluate whether participants' perception of the importance of the various disciplines changed and/or whether their discipline knowledge base changed over the course of the workshop. The Pratt method[19] was used in the event of ties (i.e., when the difference between pre-and post-workshop response as zero), and alpha = .05 was used to determine statistical significance.

We did not find a statistically significant change in the perceived importance of disease ecology, molecular phylogenetics, microbiology, and collaboration among multiple disciplines to a wildlife disease outbreak investigation. However, participants' perception of the importance of pathology to a wildlife disease outbreak was significantly higher after the workshop ($Z = -2.635$, $p < .05$). We also found a significant increase in participants' knowledge of disease ecology ($Z = -3.635$, $p < .05$), pathology ($Z = -3.504$, $p < .05$), molecular phylogenetics ($Z = -2.526$, $p < .05$), microbiology ($Z = -3.344$, $p < .05$), and collaboration among multiple disciplines ($Z = -3.321$, $p < .05$) after the workshop (Table 2).

PERCEIVED BENEFITS

We used an integrated approach to demonstrate how interdisciplinary collaboration is necessary for problem solving in an outbreak investigation, particularly one involving wildlife species where resources are often limited.[20] Through the lens of wildlife disease, participants integrated their understanding of pathology, diagnostic microbiology, genetics, and disease ecology to work toward a common goal promoting environmental, animal, and human health. The allotted budget and limited time frame allowed participants to consider how different assays, surveys, or diagnostics would inform their understanding of the scenario, thereby improving the learning experience.

Regardless of participants' background discipline and prior knowledge, the workshop significantly increased participants' knowledge in disease ecology, pathology, molecular phylogenetics, microbiology, and collaboration among multiple disciplines as it pertains to wildlife disease outbreak investigations. Students and established professionals alike reported that they benefited from the didactic lectures per personal communication. Lectures described established methods as well as newly developed techniques to provide cutting-edge information. The simulation teams were purposefully selected to include participants from a variety of disciplines (e.g., public health, epidemiology, wildlife biology, and veterinary medicine) and people at different career stages, ranging from undergraduate students to professional veterinarians. Intra-team diversity allowed for the added benefit of more experienced group members providing guidance to early-career counterparts throughout the simulation. Additionally, workshop planners specifically selected for a breadth of different disciplines addressed in the simulated outbreak investigation to ensure no one individual would be familiar with all disciplines.

This hypothesis-driven simulation required participants to work systematically through the scenario using reasoning skills, discipline-specific professional skills, and integration of newly acquired information. Because the outbreak scenario involved more than one disease process and a limited budget, careful consideration of differential diagnoses was necessary for hypothesis generation and effective decision making.

Finally, this workshop was planned and executed by the student members of CSU WDA working closely with their faculty advisors and professionals in the local and international wildlife health community, fostering a sense of collaboration centered on improving wildlife health. Despite the time investment, this simulation-based workshop was beneficial for both participants and organizers. For organizers, planning provided an opportunity for cooperation among professionals who may rarely cross paths. This interaction allowed for transfer of knowledge between disciplines; subsequently, organizers have taken this knowledge to their classrooms. For participants, involvement provided exposure to how multidisciplinary collaborations work and what opportunities future careers may hold.

SUMMARY

We encourage other groups to adopt similar education strategies focused on an interdisciplinary approach and collaborative mind-set. Our workshop required moderate commitment by eight student and faculty organizers to plan and design; yet, we found it to be a feasible undertaking for a student organization. We propose this event as a model for effective problem-based One Health education that could easily be integrated into formal graduate and veterinary medical curricula. The described activity was appropriate and was effectively executed for 19 participants with various backgrounds and interests.

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APPENDIX

WDA WILDLIFE DISEASE OUTBREAK INVESTIGATION WORKSHOP SURVEY

Name:

Area of study/department:

Level of study (undergraduate, graduate, vet student):

Please answer the following questions as they pertain to you, with 1 being “little to no importance” and 10 being “very important.”

1. How important do you believe the study of **disease ecology** is in working up a wildlife disease outbreak?

   1 2 3 4 5 6 7 8 9 10

2. How important do you believe the study of **pathology** is in working up a wildlife disease outbreak?

   1 2 3 4 5 6 7 8 9 10

3. How important do you believe the study of **genetic sequencing** is in working up a wildlife disease outbreak?

   1 2 3 4 5 6 7 8 9 10

4. How important do you believe the study of **microbiology** is in working up a wildlife disease outbreak?

1 2 3 4 5 6 7 8 9 10

5. How important do you believe the study of **collaboration of multiple disciplines** (e.g. veterinary medicine, wildlife biology, disease ecology, etc.) is in working up a wildlife disease outbreak?

1 2 3 4 5 6 7 8 9 10

6. Please answer the following questions as they pertain to you, with 1 being “little to no knowledge” and 10 being “very knowledgeable.”

1. How would you rate your current knowledge on the role of **disease ecology** is in working up a wildlife disease outbreak?

1 2 3 4 5 6 7 8 9 10

2. How would you rate your current knowledge on the role of **pathology** is in working up a wildlife disease outbreak?

1 2 3 4 5 6 7 8 9 10

3. How would you rate your current knowledge on the role of **genetic sequencing** is in working up a wildlife disease outbreak?

1 2 3 4 5 6 7 8 9 10

4. How would you rate your current knowledge on the role of **microbiology** is in working up a wildlife disease outbreak?

1 2 3 4 5 6 7 8 9 10

5. How would you rate your current knowledge on the role of **collaboration of multiple disciplines** (e.g. veterinary medicine, wildlife biology, disease ecology, etc.) is in working up a wildlife disease outbreak?

1 2 3 4 5 6 7 8 9 10

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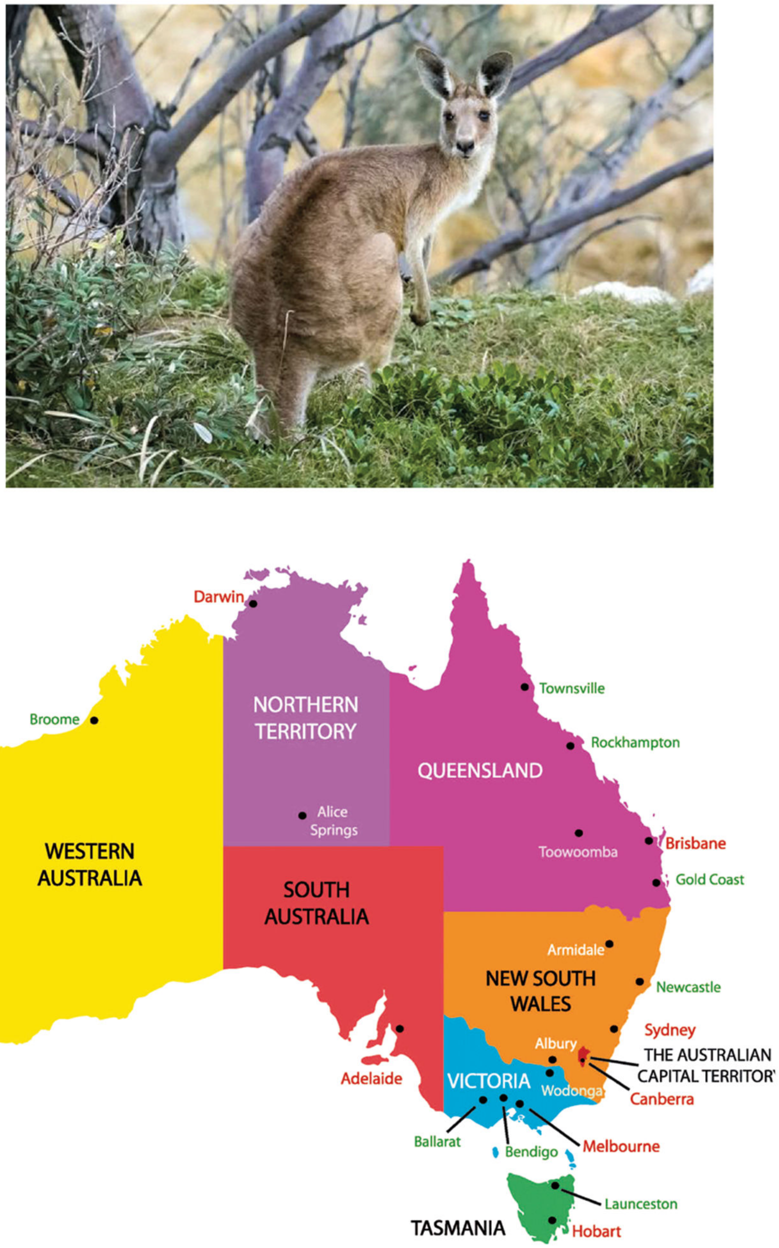

Figure 1:
Sample scenario briefing

Table 1:

List of available tests available for participants to generate data

Pathology	**Price**
Necropsy—gross only	80
Necropsy with histopathology	120
Impression smear (derm)	40
Blood smear	40
Special stain/IHC	40
Electron microscopy	400
GI contents	60
Tissue heavy metal quantification	60
CBC/Chem/UA	40
Molecular biology	
Real-time PCR	30/50
RT-PCR panel	60
Traditional PCR	50
NGS	800
Microbiology	
Aerobic bacterial culture	20
Anaerobic bacterial culture	20
Fungal culture	20
Fecal	10
Fine needle aspirate	40
Skin biopsy	80
Immunoflourescence	30
ELISA	15
Parasite identification	20
Disease ecology	
Trap rodents	100
Insect collection	100
Plant survey	100
Vector distribution maps	100
Live capture	50

Table 2:

Median reported scores following pre-and post-workshop evaluations

Question	**Pre-workshop median**	**Post-workshop median**	**Median change**	**Z score (*p*)**
Importance of disease ecology	10	10	0	−2.0 (.063)
Importance of pathology	10	10	0	−2.6 (.008)
Importance of genetic sequencing	8	9	0	−1.1 (.163)
Importance of microbiology	10	10	0	−1.4 (.156)
Importance of collaboration	10	10	0	0.0 (.75)
Knowledge of disease ecology	5	7	2	−3.6 (< .001)
Knowledge of pathology	5	7	2	−3.5 (< .001)
Knowledge of genetic sequencing	5	7	2	−2.5 (.006)
Knowledge of microbiology	5	7	2	−3.3 (< .001)
Knowledge of collaboration	6	9	2	−3.3 (< .001)

Note: Metrics in which significant changes in median were detected by the Wilcoxon signed-rank test are bolded.