Disease Emergence and Resurgence: The Wildlife-Human Connection

By Milton Friend
With contributions from James W. Hurley, Pauline Nol, and Katherine Wesenberg

Prepared by the USGS National Wildlife Health Center in cooperation with the U.S. Fish and Wildlife Service

Circular 1285

U.S. Department of the Interior
U.S. Geological Survey

U.S. Department of the Interior
Gale A. Norton, Secretary

U.S. Geological Survey
P. Patrick Leahy, Acting Director

U.S. Geological Survey, Reston, Virginia: 2006

Major funding support was provided by the U.S. Fish and Wildlife Service,
Division of Federal Assistance, Administrative Grant No. AP95-017.

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Suggested citation:
Friend, Milton, 2006, Disease Emergence and Resurgence: The Wildlife-Human Connection: Reston, Va., U.S. Geological Survey, Circular 1285, 400 p.

Library of Congress Cataloging-in-Publication Data

Friend, Milton
Disease emergence and resurgence : the wildlife-human connection / by Milton Friend and others ; prepared by the USGS National Wildlife Health Center in cooperation with the U.S. Fish and Wildlife Service. --1st ed.
p. cm. -- (Circular ; 1285)
Includes bibliographical references and index.
1. Zoonoses. 2. Wildlife diseases. 3. Animals as carriers of disease. 4. Communicable diseases--Transmission. 5. Emerging infectious diseases--Transmission. I. National Wildlife Health Center (U.S.) II. U.S. Fish and Wildlife Service. III. Title. IV. Series : U.S. Geological Survey Circular ; 1285.
[DNLM: 1. Zoonoses. 2. Communicable Diseases, Emerging--transmission. 3. Disease Reservoirs--veterinary. 4. Bioterrorism. 5. Disease Outbreaks--prevention & control.
WC 950 F911d 2005J
RA639.F75 2005
614.4'3--dc22
ISBN 1-411-30664-3 2005027017

Foreword

"Given the conspicuous role that diseases have played, and in many parts of the world continue to play, in human demography, it is surprising that ecologists have given so little attention to the way diseases may affect the distribution and abundance of other animals and plants." (May)[1]

In 2000, the Global Outbreak Alert and Response Network (GOARN) was organized as a global disease watchdog group to coordinate disease outbreak information and health crisis response. The World Health Organization (WHO) is the headquarters for this network.[2] Understandably, the primary focus for WHO is human health. However, diseases such as the H5N1 avian influenza epizootic in Asian bird populations demonstrate the need for integrating knowledge about disease emergence in animals and in humans.[3,4]

Aside from human disease concerns, H5N1 avian influenza has major economic consequences for the poultry industry worldwide.[5] Many other emerging diseases, such as severe acute respiratory syndrome (SARS), monkeypox, Ebola fever, and West Nile fever, also have an important wildlife component. Despite these wildlife associations, the true integration of the wildlife component in approaches towards disease emergence remains elusive. This separation between wildlife and other species' interests is counterproductive because the emergence of zoonotic viruses and other pathogens maintained by wildlife reservoir hosts is poorly understood.[6]

This book is about the wildlife component of emerging diseases. It is intended to enhance the reader's awareness of the role of wildlife in disease emergence. By doing so, perhaps a more holistic approach to disease prevention and control will emerge for the benefit of human, domestic animal, and free-ranging wildlife populations alike. The perspectives offered are influenced by more than four decades of my experiences as a wildlife disease practitioner. Although wildlife are victims to many of the same disease agents affecting humans and domestic animals, many aspects of disease in free-ranging wildlife require different approaches than those commonly applied to address disease in humans or domestic animals. Nevertheless, the broader community of disease investigators and health care professionals has largely pursued a separatist approach for human, domestic animal, and wildlife rather than embracing the periodically proposed concept of "one medicine."[7] We especially need to embrace this concept as the human population increases because there will be more contact, direct and indirect, among humans, domestic animals, and wildlife. An "Ecology for a Crowded Planet"[8] will be an even more pressing concern, and that includes increasing our understanding of disease ecology, especially that of the zoonoses.[9]

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Literature Cited

1. May, R.M., 1988, Conservation and disease: Conservation Biology, v. 2. p. 28–30.
2. Enserink, M., 2004, A global fire brigade response to disease outbreaks: Science, v. 303, p. 1605–1606.
3. Ferguson, N.M., Fraser, C., Donnelly, C.A., Ghani, A.C., Anderson, R.M., 2004, Public health risk from the avian H5N1 influenza epidemic: Science, v. 304, p. 968–969.
4. Webby, R.J. and Webster, R.G., 2001, Emergence of influenza A viruses: The Royal Society, v. 356, p. 1817–1828.
5. World Health Organization, 2004, Avian influenza—frequently asked questions, accessed August 16, 2004, at URL http://www.who.int/csr/disease/avian_influenza/avian_faqs/en/.
6. Childs, J.E., 2004, Zoonotic viruses of wildlife: hither from yon: Archives of Virology v.18, p. 1–11.
7. Zinsstag, J., and Weiss, M.G., 2001, Livestock and human health: Science, v. 294, p. 477.
8. Palmer, M., Bernhardt, E., Chornesky, E., Collins, S., Dobson, A., Duke, C., Gold, B., Jacobson, R., Kingsland, S., Kranz, R., Mappin, M., Martinez, M.L., Micheli, F., Morse, J., Pace, M., Pascual, M., Palumbi, S., Reichman, O.J., Simons, A., Townsend, A., and Turner, M., 2004, Ecology for a crowded planet, Science, v. 304, p. 1251–1252.
9. Marano, N., and Pappaioanou, M., 2004, Historical, new and reemerging links between human and animal health: Emerging Infectious Diseases, v. 10, p. 2065–2066.

Acknowledgments

This publication is the culmination of a fulfilling career far beyond anything I had envisioned. Contributions to my professional development by family and mentors deserve special recognition along with contributions by others because they have provided the foundation for me to undertake such a project. The encouragement, support, and sacrifices by my parents, Leo and Fannie, resulted in my transition from a laborer into the intriguing world of science. My wife, Jacki, enriches my life, provides the love, encouragement, and support that allowed me to experience a career that seems more like a wonderful "fairy tale" rather than reality.

Three of my many mentors also deserve special mention. Professor J. Franklin Witter (Animal Pathology, University of Maine), kindled my interests in diseases of wildlife and started me down the path that I would eventually follow. Dr. Donald J. Dean (Director, Division of Laboratories and Research, New York State Department of Health), introduced me to the challenges of zoonotic disease and encouraged my pursuit of advanced training. Professor Daniel O. Trainer, Jr. (University of Wisconsin) provided a highly stimulating advanced education and learning experience and greatly contributed to my professional development. Collectively, their friendship, guidance, and technical expertise enhanced my knowledge base, technical capabilities, perspectives, and vision. Their patience, understanding, and other traits made them excel as role models and I am forever grateful to have worked with and learned from these outstanding individuals.

I also am sincerely grateful to the many individuals who have contributed to the completion of this project through their time, efforts, and thoughtful comments. Ms. Danielle Lohaus and Ms. Melissa Lund typed the draft manuscripts, making countless adjustments to the drafts, organized some of the tables, and assisted in many other ways. A smile was always part of their efforts despite often trying conditions and frequent requests for rapid completion of material. Dr. Margaret Fleischli meticulously checked the numerous citations within the chapters and organized them into numerical lists, compiled the draft lists of scientific names and the glossary of technical terms, and drafted several of the Appendices. Her contributions were invaluable. Ms. Karen Cunningham and Ms. Kathryn Cleary provided searches and tabulations of information from the National Wildlife Health Center (NWHC) databases that were used in various graphics and tables. Ms. Kathy Wesenberg and Ms. Christine Marsh provided invaluable library support though searches and document acquisition that provide the foundation for much of the information presented in this publication. Ms. Carol Williams provided endless photocopy services needed for project operations and assisted with the library support efforts in other ways. Ms. Barbara Littlewood indexed the manual. Ms. Frances J. Bergmann, Ms. Jennifer Rodriguez, and Ms. Rosemary Stenback provided cartography and illustration support, and Ms. Kelly Conrad provided data and information search support. Many NWHC scientific staff and others also deserve special recognition: Dr. David E. Green for his contributions on infectious diseases of amphibians; Dr. Rebecca Cole for her counsel on parasitic diseases; Drs. Kathy Converse, Grace McLaughlin, Joshua Dein, and Rex Sohn for data and counsel involving wildlife mortality events and agency wildlife disease programs; Mr. Doug Docherty for assistance with the taxonomy of viruses; Dr. Frank Panek of the USGS Leetown Science Center for his information on emerging fish diseases; and Drs. Louis N. Locke (retired), David Blehert, Kathy Converse, Kimberly Miller, Bryan Richards, Mr. Bob Dusek, and Mr. Paul Gertler of the U.S. Fish and Wildlife Service also deserve special recognition for their laborious manuscript reviews and helpful comments. I am also greatly appreciative of the support, manuscript reviews, other assistance, and great patience and forbearance afforded me in the completion of this project by Dr. Leslie Dierauf, Director of the NWHC, and Deputy Director, Ms. Christine Bunck. I apologize for any omissions in acknowledgment of individual contributions that may have been made by others over the extended period of time required for project completion.

Milton Friend

Preface

"Scientists need to think beyond traditional disease research and consider the possible roles played by climate change, air travel, and the growth of cities…" (Dr. François-Xavier Meslin, World Health Organization)

Because of the increasing human population worldwide, and the greater number of people traveling globally, infectious diseases are spreading more rapidly than in previous decades. Nevertheless, any outbreak, whether zoonotic or another infectious disease, is a local event. Recently, a reporter contacted the National Wildlife Health Center (NWHC) and asked us to predict the next five deadliest diseases that could affect the nation. His urgent request asked us to provide him with every bit of information possible, so he could inform the public about how best to get ready for the next epidemic, be it in wildlife, domestic animals, or people. This is not the first time people or agencies inside or outside the federal government have asked scientists at the NWHC to predict what disease will next rear its ugly head. "What will be the next disease *du jour*?" "What do you see in your crystal ball?"

Even though many scientists worldwide are investigating emerging and resurging diseases, no one is able to predict the future, at least not at this time in the fields of wildlife and/or zoonotic diseases. We cannot yet say that on this date, in that location, at this time, disease X will break out in a particular species and from a specific source. Nevertheless, on several occasions NWHC scientists in the field have identified environmental situations prone to disease emergence prior to disease eruptions occurring in wildlife. They have also developed models of environmental factors associated with avian botulism.[1] Ecological investigations of diseases by NWHC scientists and others are enhancing our ability to "read the landscape" relative to disease risks. The time is coming soon though, when we will be able—at the very least—to forecast the next occurrence, perhaps based on climate change predictions, or changes in habitat, or other environmental or ecosystem factors. For example, the altitudinal spread of avian malaria and avian pox in Hawaiian forest birds is a possible outcome of increasing global temperatures.[2]

Enhanced understanding of the ecology of diseases of wildlife has direct importance for combating many infectious diseases of humans. According to Dr. Mark Woolhouse from the University of Edinburgh (Scotland), humans are plagued by 1,709 known pathogens, 832 of which are zoonotic (49 percent). Of the156 of these diseases that are considered "emerging," 114 are zoonotic (73 percent).[3] On the list of high-priority agents of concern for bioterrorism activities from the Centers for Disease Control and Prevention (CDC), nearly 80 percent are zoonoses (CDC A and B lists). Therefore, the wildlife-human-domestic animal connections are nearly impossible to ignore when investigating wildlife disease. Emerging diseases can be novel or exotic, with either expanded geographic range, emerging in species not previously considered susceptible or spreading in novel ways and to unusual locales and communities. For example, the National Center for Infectious Diseases states "Many emerging or reemerging diseases are acquired from animals or are transmitted by arthropods. Environmental changes can affect the incidence of these diseases by altering the habitats of disease vectors."[4]

Who are the players, and what are their roles in infectious, emerging, and resurging diseases? The short answer is everyone and everything. The long answer is those scientists who study/investigate wildlife, domestic animal, and vector-borne public health and disease, those with interests in conservation, environmental and ecosystem health, and those who believe that public education, politics, and science-based policy are essential components of any process or program related to public health and safety. For truly novel diseases, like SARS and Hendra virus infection, preventing establishment in new geographic areas and host populations should be a primary focus. Triage in each and every outbreak involves these steps:

1. Determine whether or not an outbreak is occurring;
2. Assess the risk level (high, medium, low) of that disease being caused by a zoonotic or other infectious agent;
3. Determine whether exposure to that disease agent will lead to catastrophic losses/impacts and/or mortality/morbidity;
4. Gather data on incidence and exposure routes and rates;
5. Understand prevalence of the particular disease outbreak agent;

6. Implement a consistent contingency response to prevent, control, treat and/or manage the risk of contracting that disease; and,

7. Ensure that science-based decisionmaking and policy development take place.

Due to the complex nature of information needed to address each of these steps, I believe the future of wildlife disease investigation and study, especially of zoonoses, lies in collaborative and coordinated efforts, undertaken by multi- and inter-disciplinary teams of highly motivated individuals, to promote and spread the word of scientific discovery. May this publication make a difference in all you do and motivate you to participate in studies involving the wildlife-human-domestic animal connections related to zoonotic and other infectious diseases.

Leslie A. Dierauf, V.M.D.
Director, National Wildlife Health Center
Madison, WI

Literature Cited

1. Rocke, T.E., and Samuel, M.D., 1999, Water and sediment characteristics associated with avian botulism outbreaks in wetlands: Journal of Wildlife Management, v. 63, p. 1249–1260
2. Benning, T.L., LaPointe, D., Atkinson, C.T., and Vitousek, P.M., 2002, Interactions of climate change with biological invasions and land use in the Hawaiian Islands—modeling the fate of endemic birds using a geographic information system: Proceedings of the National Academy of Sciences, v. 99, p. 14246–14249.
3. Enserink, M., 2000, Malaysian researchers trace Nipah virus outbreak to bats: Science, v. 289, p. 518–519.
4. Centers for Disease Control, 1998, National Center for Infectious Diseases: Preventing emerging infectious diseases—a strategy for the 21st Century, accessed December 2, 2004 at URL http://www.cdc.gov/ncidod/emergplan/.

Biographies

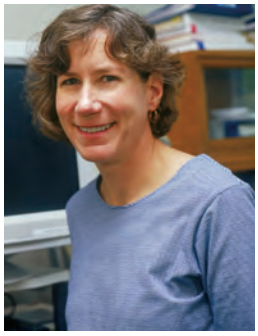
Milton Friend is an emeritus biologist at the U.S. Geological Survey's National Wildlife Health Center (NWHC) in Madison, Wisconsin. He developed the concept document for the Center and served as the director from its inception in 1975 until 1998. In 1999, he accepted an appointment by the Secretary of the Interior to develop and oversee a science program for the restoration of California's Salton Sea. He served as chief scientist for that program until early 2002, and then returned to the NWHC to work on this publication. Previous employment includes research on environmental contaminants for the U.S. Fish and Wildlife Service, serving as the wildlife disease specialist for the New York Department of Environmental Conservation, and positions with the Vermont and the Massachusetts Departments of Fish and Game. He received a B.S. in wildlife conservation from the University of Maine (forestry minor), M.S. in wildlife management from the University of Massachusetts (epidemiology minor), and joint Ph.Ds (veterinary science and wildlife ecology) from the University of Wisconsin (epidemiology minor) where he is an adjunct professor of Animal Health and Biomedical Sciences. His teaching at the University of Wisconsin is focused on diseases of wildlife. Among his numerous publications are the *Field Guide to Wildlife Diseases* published in 1987 and a greatly expanded and updated 1999 revision co-authored with J.C. Franson, *Field Manual of Wildlife Disease, General Field Procedures and Diseases of Birds.*

Dr. James W. Hurley is a family practice physician in Madison, Wisconsin. He received a B.S. in Zoology from the University of Wisconsin–Madison in 1965 and an M.D. degree from Tulane University in New Orleans in 1969. He completed his internship and residency in California (UC San Diego and UC Davis). For many years, Jim lived in California, where he practiced at the Truckee-Tahoe Medical Clinic in California. His appreciation of the outdoors, wilderness medicine, and domestic and foreign travel shapes his perspectives on zoonotic and infectious diseases. In working to help the public and other physicians become more aware of appropriate precautions, he believes that awareness leads to prevention.

Pauline Nol is a research scientist at the U.S. Department of Agriculture's National Wildlife Research Center in Fort Collins, Colorado, developing vaccines against brucellosis and bovine tuberculosis in wild ungulates. From 1999 to 2003, she worked at the U.S. Geological Survey's National Wildlife Health Center as a graduate student and a post-doctoral researcher, studying avian botulism in fish-eating birds and sylvatic plague in black-footed ferrets and black-tailed prairie dogs. She received a B.S. in Zoology and a D.V.M. from the University of Florida, and an M.S. in Veterinary Science at the University of Wisconsin.

Katherine Wesenberg is the librarian at the U.S. Geological Survey's National Wildlife Health Center. Previous to 1992, when she began at NWHC, she was the librarian for Anaquest Corporation, a pharmaceutical firm. In 1995, she produced a literature review concerning the investigation of avian mortality in the Playa Lakes region of New Mexico. In 1997, she authored a chapter titled "The Effects of Pollutants on Wildlife" in *Information Sources in Environmental Protection* (Bowker Saur, 1997). Between 1999 and the present, initiatives involving West Nile virus (WNV) and Chronic Wasting Disease (CWD) have been her major focus. She received her M.S. in Library Science and Information Studies from the University of Wisconsin.

John M. Evans is the graphics subunit chief and senior illustrator with USGS, Denver, Colorado. After attending Eastern New Mexico University, John served four years as a Navy Lithographer/Artist (1968–1972). John has worked in publications design, created artwork for textbooks, and has provided illustrations and design support to numerous agencies. While working as a supervisory visual information specialist with the Bureau of Reclamation (1979–1981), John received an Award of Excellence from the Society for Technical Communication for his scientific field guide illustrations. From 1981 to 1989, John developed course artwork and graphic design for the Office of Personnel Management. His work has appeared in many USGS publications including the National Ground Water Atlas, National Water Summary, and a State Department presentation for the Middle East Peace Process. He has also produced artwork for the Colorado Division of Wildlife, National Oceanic and Atmospheric Administration, and for numerous college geology textbooks.



Elizabeth Ciganovich is a technical editor with the U.S. Geological Survey, Water Resources Discipline, in Madison, Wisconsin. She served on the editorial and design teams for U.S. Fish and Wildlife Service wetland status publications and for the USGS technical report templates, the *Field Manual of Wildlife Diseases, General Field Procedures and Diseases of Birds*, the National Water Summary series, and the National Ground Water Atlas. She has a degree in journalism from the University of Wisconsin and is a member of the Association of Earth Science Editors.

Gail Moede Rogall is a technical editor and information specialist with the U.S. Geological Survey's National Wildlife Health Center. She has worked at the NWHC since December 1999. Previously, she worked as a technical editor for the USGS Water Resources Discipline in Wisconsin and Massachusetts. Gail received her B.S. in Landscape Architecture and her M.S. in Life Sciences Communication from the University of Wisconsin.

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