
Review of Institute of Medicine and National Research Council Recommendations for One Health Initiative

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Human health is inextricably linked to the health of animals and the viability of ecosystems; this is a concept commonly known as One Health. Over the last 2 decades, the Institute of Medicine (IOM) and the National Research Council (NRC) have published consensus reports and workshop summaries addressing a variety of threats to animal, human, and ecosystem health. We reviewed a selection of these publications and identified recommendations from NRC and IOM/NRC consensus reports and from opinions expressed in workshop summaries that are relevant to implementation of the One Health paradigm shift. We grouped these recommendations and opinions into thematic categories to determine if sufficient attention has been given to various aspects of One Health. We conclude that although One Health themes have been included throughout numerous IOM and NRC publications, identified gaps remain that may warrant targeted studies related to the One Health approach.

Over the past decade, animal and human health leaders have begun to consider the benefit of collaboration, prompted by recognition that highly specialized practices of veterinary and human medicine are missing inextricable links between human health, animal health, and the viability of ecosystems. The 2008 Final Report of the American Veterinary Medical Association (AVMA) One Health

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Initiative Task Force defined One Health as the collaborative effort of multiple disciplines—working locally, nationally, and globally—to attain optimal health for people, animals and our environment. The report included the recommendation that the AVMA, the American Medical Association, and other interested parties should “plan a study on One Health to be conducted by the National Academy of Sciences and secure the necessary funding to underwrite this effort” (1). In 2009, the Institute of Medicine (IOM) and National Research Council (NRC) co-hosted the One Health Commission Summit, described as “a forerunner to an IOM study on One Health...[that will be] used to develop a strategic roadmap for public and private policies and initiatives that will, in turn, be instrumental in shaping the implementation of the One Health vision, both domestically and internationally” (2). The study was slated to begin in 2010; however, funding required to initiate it has not yet been committed.

A review of existing IOM publications for One Health–related consensus recommendations or individual opinions is a critical step in assessing whether to move forward with a general, or more refined, focus that will complement the existing body of IOM/NRC reports. We sought to complete such a review, and to fit the findings into a framework that would facilitate a data-driven assessment of how to move forward in possibly seeking an IOM/NRC review of One Health.

Methods

The National Academies and Their Reports

A primary function of the National Academies is to provide unbiased and timely expert advice to policy makers and the general public. The National Academies include the National Academy of Sciences, the IOM, the NRC, and

the National Academy of Engineering. Their operations are independent from the US federal government and not funded by direct appropriation, although studies are often mandated by Congress in the interest of seeking expert counsel. Studies can be requested by federal agencies or by independent organizations.

At the National Academies there is a vast difference in the weight ascribed to consensus committee recommendations, compared to the individual opinions that are collected in a workshop summary. A consensus committee, typically including 10–15 members, is carefully chosen to represent a range of specific disciplines and experiences. Consensus committees are carefully structured to ensure that all members are independent of the sponsoring agencies (3–5). The committees operate under a set of rigorous rules pertinent to Section 15 of the Federal Advisory Committee Act. Each committee member undergoes an extensive bias and conflict of interest review, and their names are posted online for public comment. The committee collects information from presentations, literature reviews, and other means; the committee's recommendations are then designed in a very structured way. When a draft report is compiled, it is submitted to a review committee with a similar mix of disciplinary expertise. The entire process is overseen by the overarching National Academies Report Review Committee (RRC).

In strict contrast, a workshop summary is not allowed to contain anything that could be interpreted as a consensus conclusion or recommendation. It is not reflective of a Federal Advisory Committee Act process and the RRC is minimally involved in most instances. To separate the workshop summary from the report of the persons who designed the workshop, the summary is always written by an appointed reporter rather than a workshop planning committee member. The goal is to ensure that the workshop report is not seen as the product of a committee process, but as a collection of opinions expressed by workshop participants. The standard of peer review for a workshop is very different from that described above for a consensus study. A much smaller group of reviewers is involved, and the objective of the review is to ensure that the report is an accurate and clear description of what happened, not what should have happened. Because there is some overlap in content between the IOM/NRC consensus reports and IOM workshop summaries in terms of coverage of health-related issues, we included both types of reports in this review.

Selection of Reports for Review

Titles and objectives of NRC/IOM reports during 1991–2013 were reviewed to identify content addressing interactions among humans, animals, and the environment. By using this process, 20 reports (Table) (6–25)

were judged most likely to contain multiple recommendations or opinions related to One Health concepts. Although it is likely that additional reports may contain One Health concepts, this review was constructed to provide a starting point to inform those considering how future studies of One Health by the National Academies could be constructed.

Defining One Health Concepts

For the purposes of this review, a consensus recommendation or workshop opinion was deemed related to One Health concepts if it included any aspect of the relationships between humans, animals, and the ecosystems in which they coexist and interact. Although this definition may be viewed as broad, it was chosen intentionally to prevent bias for or against any particular component of One Health.

Grouping of Recommendations

All consensus reports and some workshop summaries and workshop reports included summary or overview chapters containing an aggregated view of consensus report recommendations or themes emerging from the workshop. However, in cases in which reports lacked such an organized set of recommendations, the full report was reviewed to determine whether any pertinent information was conveyed within individual chapters. Recommendations or opinions found to be related to One Health were compiled for each individual report; then the aggregated list was reviewed to identify common themes. Finally, we sought to identify examples of completed or ongoing activities that address recommendations and opinions.

Results

Of the 20 publications that were reviewed in depth for this article, 8 were consensus reports. More than 50 recommendations and opinions were extracted, covering a broad array of topics ranging from a specific disease, system, or policy improvement, to general statements encouraging expansions of partnerships and broad investments in infrastructure for surveillance systems. As expected, the strongest and most specific recommendations were captured in consensus reports.

We grouped the recommendations and opinions into 7 topical categories: Surveillance and Response, Governance and Policy, Laboratory Networks, Training Needs, Research Needs, Communication Needs, and Partnerships. Online Technical Appendix Table 1 (wwwnc.cdc.gov/EID/article/19/12/12-1659-Techapp1.pdf) displays a paraphrased listing of the recommendations by category. The list of recommendations was circulated among the authors and other subject matter experts in an attempt to identify ongoing activities or programs that appear to address gaps identified in the IOM and NRC reports. Online Technical

Table. Listing of Institute of Medicine/National Research Council reports included in review, 1991–2013*

Date	Title	Type
1991	Animals as sentinels of environmental health	Report
1992	Emerging infectious diseases: Microbial threats to health in the United States	Report
1999	The use of drugs in food animals: Benefits and risks	Report
2001	Emerging infectious diseases: From the global to the local perspective	WS
2002	The emergence of zoonotic diseases: Understanding the impact on animal and human health	WS
2003	Microbial threats to health: Emergence, detection and response	Report
2005	Animal health at the crossroads: Preventing, detecting, and diagnosing animal diseases	Report
2005	Critical needs for research in veterinary science	Report
2006	Addressing foodborne threats to health: Policies, practices, and global coordination	WS
2006	The impact of globalization on infectious disease emergence and control	WS
2007	Global infectious disease surveillance and detection: Assessing the challenges – finding solutions	WS
2008	Vector-borne diseases: Understanding the environment, human health and ecologic consequences	WS
2009	Sustaining global surveillance and response to emerging zoonotic diseases	Report
2010	Antibiotic resistance: Implications for global health and novel intervention strategies	WS
2010	Infectious disease movement in a borderless world	WS
2011	Climate change, the indoor environment, and health	Report
2011	Critical needs and gaps in understanding prevention, amelioration, and resolution of Lyme and other tick-borne diseases	WS
2011	Fungal diseases: an emerging threat to animal, human and plant health	WS
2011	The causes and impacts of neglected tropical and zoonotic diseases: Opportunities for integrated intervention strategies	WS
2012	Improving food safety through a One Health approach	WS

* Report and bold text indicates recommendations from consensus reports, NRC committee reports, or IOM consensus reports; IOM, Institute of Medicine; NRC, National Research Council; WS, IOM workshop summary or workshop report.

Appendix Table 2 lists all of the recommendations, the exact references that support each recommendation, and examples of activities that appear to respond to specific recommendations.

Discussion

On the basis of the list compiled from the 20 reviewed reports, we found that the principles of One Health have, to varying extents, been included in many of the NRC/IOM recommendations and IOM workshop summaries. All of the reviewed reports had at least 1 recommendation related to an aspect of One Health. This sample was, admittedly, skewed toward those reports most likely to include recommendations, but we were impressed with the quantity identified in this review. Although even the earliest (1991) consensus report reviewed contained recommendations, a deeper review including reports from earlier dates would likely find additional recommendations linked to One Health concepts. As might be expected, One Health (or a related term) was not used in all instances as a descriptor for recommendations or opinions that fit within the definition of One Health activities used for this review; in fact, many recommendations that by today’s understanding are clearly related to One Health were not tagged as such.

The quantity of recommendations and workshop opinions related to One Health concepts suggests that a reasonable level of attention has been given to the One Health movement in the past 2 decades of IOM/NRC publications. However, level of coverage does not necessarily translate

into sufficient consideration of all aspects of a One Health approach, nor does it indicate adequate consideration of current understandings of One Health concepts. Apportioning our findings into thematic categories let us create a framework for evaluation of breadth of coverage. We found that some categories have received more attention than others. For example, the Surveillance and Response category had 16 recommendations or opinions that originated from 14 individual reports; and the Governance and Policy category had 10 recommendations or opinions from 8 reports. By contrast, 4 recommendations or opinions were identified in the Partnership category, and 3 were identified in the category of Communication Needs.

Most of the examples of implementation of One Health concepts that are described in the Technical Appendix are not directly associated with specific IOM or NRC recommendation. In contrast, recommendations from the United States Agency for International Development (USAID)-supported IOM report “Sustaining Global Surveillance and Response to Emerging Zoonotic Diseases” (2009) were translated into One Health activities under USAID’s Emerging Pandemic Threats (EPT) Program. Progress in One Health activities may be a result of explicit recommendations from IOM and NRC reports, or simply be occurring because of increasing awareness of One Health concepts.

Examples of Progress

In the Surveillance and Response category, there is good evidence that progress has been made in addressing

some of the One Health–related recommendations generated from IOM and NRC studies. Several recommendations in this category address the need for integrated surveillance systems that capture information from multiple sectors. An excellent example of such integrated surveillance is the National Antimicrobial Resistance Monitoring System, which became operational in 1996 as a collaborative effort of the Centers for Disease Control and Prevention (CDC), the US Food and Drug Administration, and the US Department of Agriculture. The National Antimicrobial Resistance Monitoring System tracks antimicrobial susceptibility among enteric bacteria from humans, retail meats, and food animals (26–28) and provides timely integrated surveillance information that has enhanced the effectiveness of response to outbreaks of enteric disease. Although many of the recommendations regarding surveillance and response have been addressed in part, this particular area may provide an opportunity for a more focused IOM study group to evaluate how existing systems could be linked or merged to provide a sustainable, integrated surveillance system that addresses the needs of multiple sectors.

Recommendations in the Governance and Policy category appear not to have been specifically addressed and may represent a gap that needs to receive more attention. However, a One Health website, www.onehealthglobal.net, was released in mid-April 2012. The portal is intended to be a network-of-networks that speaks to One Health governance and that may serve as a mechanism that facilitates the recommendations within the Governance and Policy category (29). The portal, *Operationalizing “One Health”: A Policy Perspective—Taking Stock and Shaping an Implementation Roadmap* is a product of the One Health Global Network Work Group that was formed as an outcome of the “Stone Mountain” meeting organized by CDC in collaboration with the World Organisation for Animal Health (OIE), the United Nations Food and Agriculture Organization (FAO), and the World Health Organization (WHO) (30).

Laboratory network recommendations have been addressed on several national fronts, including planning for a National Bio and Agro-Defense Facility (31) and the flourishing National Animal Health Laboratory Network (32). Internationally, OIE, FAO, and WHO have received USAID EPT funds to improve networking among human and animal laboratories (33). As mentioned previously, this EPT funding occurred after a 2009 Consensus Report, demonstrating direct actions to enhance laboratory capabilities in response to recommendations made within an IOM report (18).

Within the Training category, some recommendations are being addressed by the Stone Mountain Meeting Training Workgroup, grantees from 1 of 4 EPT projects named RESPOND, and the University of Minnesota with

Rockefeller Foundation funding (34). These 3 groups work independently and also collaboratively to define One Health Core Competencies for varying levels of practitioners. They also develop course catalogs that capture existing training opportunities and identify needed training materials. In April 2012, the University of Florida announced that it will offer 2 new One Health degree programs, including a PhD in Public Health with a One Health concentration. “The One Health concentration is a research-oriented health degree that emphasizes working across public health, veterinary health, and environmental health disciplines to tackle difficult health problems” (35).

Similar selected examples of programs and projects that address the IOM recommendations can be identified for the categories of Research Needs (e.g., National Institutes of Health [NIH] Centers of Excellence for Influenza Research and Surveillance program, EPT PREDICT projects and the NIH-NSF Ecology and Evolution of Infectious Diseases Program: A Joint Program for Multidisciplinary Research [36]), Communication Needs (e.g., formation of One Health Offices at USDA and CDC), and Partnerships (e.g., US Interagency One Health Working Group, inclusion of veterinarians in CDC Field Epidemiology and Laboratory Training Programs). Although these examples are excellent steps in the right direction, they do not respond to the majority of the recommendations. In particular, recommendations that point toward collaboration, resource sharing, coordinated research, and strengthened lines of communication deserve greater attention.

Conclusions

The quantity of recommendations found suggests that, on a relatively consistent basis, One Health concepts have been considered to be part of working group deliberations, and of IOM and NRC studies, although there is no single entity or process for tracking progress on the recommendations of the National Academies’ studies related to One Health. The examples we provide of completed, ongoing, and planned activities that address the recommendations are not intended to be comprehensive; however, the examples demonstrate that the One Health approach is making inroads. If additional IOM or NRC studies addressing One Health do go forward, we suggest that progress to date be considered and that the questions posed by the National Academies be carefully targeted to address remaining gaps.

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Review of Institute of Medicine and National Research Council Recommendations for One Health Initiative

Technical Appendix

Published Recommendations for One Health Activities, 1991–2013.

Technical Appendix Table 1. One Health Recommendations in Institute of Medicine and National Research Council Publications, 1991–2013*

Category	Abbreviated recommendations
Surveillance and Response	<p>Evaluate adequacy of global wildlife surveillance, inclusion in existing national systems, and sentinel value</p> <p>Make global surveillance networks sustainable</p> <p>Collaborate with other countries and international organizations to create global systems for preventing, detecting, and diagnosing diseases as they related to animal and human health</p> <p>Create independent audit and rating system for national surveillance systems with respect to emerging zoonotic disease outbreaks</p> <p>Evaluate value of domestic animals as sentinels and in disease surveillance and detection</p> <p>Implement surveillance on effect of outdoor and indoor conditions as well as building characteristics on occupant health</p> <p>Strengthen links between human, domestic animal, wildlife and vector surveillance systems</p> <p>Incorporate allied factors (climate, extreme weather, vegetation, etc.) into global surveillance systems</p> <p>Coordinate response from animal and public health authorities to foodborne outbreaks</p> <p>Evaluate if and how to incorporate syndromic surveillance</p> <p>Create tools for cost-effectiveness analysis of current surveillance systems</p> <p>Analyze feasibility and benefits of incentives for reporting to surveillance systems</p> <p>Ensure adequate systems for global surveillance and response, including engagement of all stakeholders</p> <p>Recognize human travelers as sentinels as well as agents of dispersal in the context of fungal diseases</p> <p>Increase capacity for early detection (and response) to fungal “invasions”</p> <p>Improved sharing of data internationally so that clusters of food-related enteric disease can be identified</p>
Governance and Policy	<p>Form expert committee to oversee development/use of antibiotics in human and food-animal medicine</p> <p>Develop and implement integrated and standardized regulations nationally to address exotic animal trade.</p> <p>Enhance World Organisation for Animal Health (OIE) authority to achieve compliance in reporting</p> <p>Establish coordinating body to facilitate development and implementation of integrated surveillance/response to zoonotic diseases (led by USAID and other stakeholders)</p> <p>Negotiate international agreement on trade in wildlife species</p> <p>Create interdisciplinary animal-public health programs</p> <p>Develop effective and comprehensive zoonoses management program with national leadership from the zoonosis community</p> <p>Expand U.S. rules to allow testing of animal specimens when needed for human therapy/outcome measures, and implement similar quality requirements as for human samples</p> <p>Reform legislation and regulations to address appropriate antibiotic use and incentivize novel antibiotics</p> <p>Focus on wildlife markets to reduce trade that threatens human, animal and ecosystem health</p>
Laboratory Networks	<p>Expand and strengthen animal health laboratory network to ensure capacity for routine and emergency needs; link all parties (federal, state, university and commercial) involved in animal and zoonotic diagnoses</p> <p>Strengthen veterinary diagnostic laboratories, and fund or reduce lab fees to encourage submissions</p> <p>Increase national lab capacity at BSL3/4 and veterinary BSL4</p> <p>Strengthen and integrate laboratory networks diagnosing food-borne and animal diseases</p>
Training Needs	<p>Develop interdisciplinary disease centers to promote multi-disciplinary approaches to microbial threats</p> <p>Build veterinary capacity to support public health, food systems, biomedical research, diagnostic laboratory investigations, pathology, epidemiology, ecosystem health and food animal practices</p> <p>Develop and strengthen linkages between public health training in medical and veterinary programs</p>

Category	Abbreviated recommendations
	<p>Improve understanding of cultural, infrastructure, and other issues affect improvement of surveillance, control and management of diseases</p> <p>Conduct training programs in food safety for public health officials, veterinarians and the animal health community in developing countries</p> <p>Support training of medical acarologists and tick biologists to ensure continuing progress on tick-borne diseases</p>
Research Needs	<p>Expand and coordinate NIH-supported research on agent, host, vector and environment factors leading to emergence of infectious diseases</p> <p>Increase funding for basic research on antibiotics, including development of more rapid and wide-screen diagnostics to improve tracking of emerging resistance and zoonotic diseases</p> <p>Climate change research should incorporate health issues associated with indoor environment</p> <p>Fund, sustainably, research in knowledge gaps in ecology, epidemiology, and pathogenesis of zoonotic diseases</p> <p>Investigate ecology of foodborne diseases to inform integration of animal and human health surveillance</p> <p>Define role of water as source of foodborne illness</p> <p>Provide evidence of economic benefit and value to investors to successfully solicit support for additional private or public research funding</p> <p>Integrate research efforts and findings on infectious diseases in humans, animals, and plants</p> <p>Develop comprehensive national databases that capture ecosystem, vector and patient data related to Lyme disease</p> <p>Develop bioeconomic models to assess economic impact of invasive species and evaluate prevention and mitigation</p> <p>Develop proof-of-concept prototypes for validation of One Health approach to food safety in developing world and to public-private partnerships</p>
Communication Needs	<p>Develop trust and communication pathways between industry, public sector, academia, NGOs, smallholder farmers and community representatives to achieve bi-directional flow of formal and informal information needed for evidence-based decision making and coordinated actions</p> <p>Educate public on complexities of antimicrobial resistance, especially related to use in food animals</p> <p>Develop public campaigns to address bush meat and exotic animal awareness</p>
Partnerships	<p>Develop/enhance EPA/CDC efforts to identify and mitigate health risks from degradation in indoor environmental quality associated with climate change</p> <p>Develop tripartite cooperative program within federal agencies to address infectious diseases in humans, domestic animals and wildlife, and to catalyze development of similar programs at state level that would network with the federal cooperative program</p> <p>Recognize the primacy of prevention and control of human disease, and improve collaboration between public health and agricultural agencies</p> <p>Establish prevention of invasive species spread as international public good and assist developing countries in establishing capacity for surveillance, detection and prevention of biologic (fungal) invasions</p>

*Bolded and shaded rows indicate recommendations from consensus reports

Technical Appendix Table 2. One Health-related recommendations identified in 17 Institute of Medicine or National Academies studies, divided into 7 thematic groups. Each recommendation is referenced to the original report(s) and examples of past, current or planned activities that address the recommendation are provided. A “Three Bears” review of One Health concepts in IOM studies: too much, too little, or just right?

Thematic group	Reference(s)	Examples of related activities
Surveillance and Response		
Evaluate whether global wildlife surveillance is adequate, include wildlife in existing national surveillance with links to agricultural intelligence, and evaluation of wildlife for value as sentinels	IOM CR 2009, NRC CR 1991; also discussed in IOM WS 2011 (Fungal Diseases) and IOM WS 2002	USAID Emerging Pandemic Threats Program (1)
Financial sustainability of global surveillance networks should be stabilized	IOM CR 2009; also discussed in IOM WS 2002	
“The United States should commit resources and develop new shared leadership roles with other countries and international organizations in creating global systems for preventing, detecting, and diagnosing known and emerging diseases, disease agents, and disease threats as they relate to animal and public health”	NRC CmR 2005 (Animal Health)	USAID Emerging Pandemic Threats Program (2)
Independent audit and rating is needed of “national surveillance system capacities for detecting and responding to emerging zoonotic disease outbreaks in humans and animals”	IOM CR 2009	
Evaluate domestic animals for value as sentinels and significance for disease	NCR CR 1991; also discussed in IOM WS 2011 (Fungal Diseases), IOM WS	World Small Animal Veterinary Association (WSAVA) (3)

Thematic group	Reference(s)	Examples of related activities
surveillance/detection	1992	
“The Environmental Protection Agency and other federal agencies should put into place a public-health surveillance system that uses existing environment and health survey instruments to gather information on how outdoor conditions, building characteristics, and indoor environmental conditions are affecting occupant health and on how these change over time.”	IOM CR 2011	
Strengthening links in human and animal surveillance: “Strengthening disease surveillance in humans and domestic animals. Priority areas include improving communication and information sharing between the medical and veterinary communities and designing integrated medical and veterinary disease surveillance systems at a regional level.” ²⁰⁰¹ and “...collaboration among practitioners of veterinary and human medicine, along with overlapping surveillance systems, would be highly beneficial to both people and animals” ²⁰¹¹ “Because many TBDs [tick borne diseases] are zoonotic, animal and human health experts urgently need to collaborate and to develop an integrated surveillance system that includes domestic animals, wildlife, ticks and people. Wider and more effective surveillance could allow animals to serve as sentinels and surrogates for human risk and exposure to TBDs.” ²⁰¹¹	IOM WS 2011 (Lyme and other TBD), IOM WS 2001	National Antimicrobial Monitoring System (NARMS): CDC (4) FDA (5) USDA 6) Global Foodborne Infections Network (7) Training materials developed by FDA/CDC/USDA to assess community readiness for food emergencies (8) ArboNET: National surveillance system for arboviral diseases in the United States (9) National Biosurveillance Integration Center (NBIC) (10)
Determine how to incorporate climate, extreme weather events, vegetation, insect vector distribution, etc. into global surveillance systems	IOM WS 2011 (Fungal Diseases), IOM WS 2008, IOM WS 2007, IOM WS 2002	National Ecologic Observatory Network (NEON) (11)
Coordination of responses to foodborne outbreaks from animal and public health authorities	IOM WS 2006 (Foodborne)	FREE-B Tool for Food-Emergency Readiness (12) Interagency Foodborne Outbreak Response Working Group (13) FDA’s CORE Network: Coordinated Outbreak Response & Evaluation (14)
Evaluate if/how to incorporate syndromic surveillance	IOM WS 2007	Pilot study to evaluate feasibility of syndromic surveillance for Ontario swine industry (15)
Tools for cost effectiveness analysis of current surveillance systems	IOM WS 2007	
Analysis of feasibility/benefit of incentives for reporting to surveillance systems	IOM WS 2007	
Advancement of OH will require “adequate systems and capacities to conduct global surveillance and respond to public health emergencies” and engagement “of all stakeholders, and particularly the private sector in global disease surveillance and response, recognizing that some key groups do not perceive such action to be in their best interest”	IOM WS 2010 (Infectious Disease Movement)	Incorporation of animal and human health in country-specific influenza response plans such as the 2012 North American Plan for Animal and Pandemic Influenza (NAPAPI) retains the key elements of the 2007 version, while incorporating the lessons learned from the North American response to Pandemic (H1N1) 2009, including recognizing that a pandemic influenza virus may emerge in our region and expanding the focus on animal influenza viruses to incorporate both avian and non-avian species. (16)
“Recognizing the importance of human travelers as disease couriers, transmitters,	IOM WS 2011 (Fungal Diseases)	

Thematic group	Reference(s)	Examples of related activities
and sentinels and, therefore, a critical target for infectious disease surveillance and detection”		
“Increasing capacity for the early detection of, and rapid response to, biological invasions”	IOM WS 2011 (Fungal Diseases)	Global Early Warning and Detection System (GLEWS) a joint system that builds on the added value of combining and coordinating the alert and disease intelligence mechanisms of OIE, FAO and WHO for the international community and stakeholders to assist in prediction, prevention and control of animal disease threats, including zoonoses, through sharing of information, epidemiologic analysis and joint risk assessment. (17)
Increased international exchange of molecular and epidemiologic data “to enable the sequence based linking of clusters of viral enteric disease, and thereby to track global food-borne outbreaks—outbreaks that threaten to produce more virulent viruses through recombination”	IOM WS 2012	
Governance and Policy		
“The committee recommends that further development and use of antibiotics in both human medicine and food-animal practices have oversight by an interdisciplinary panel of experts composed of representatives of the veterinary and animal health industry, the human medicine community, consumer advocacy, the animal production industry, research, epidemiology, and the regulatory agencies.”	NRC CmR 1999	A Public Health Action Plan to Combat Antimicrobial Resistance (18). Interagency Task Force participants include CDC, FDA, NIH, AHRQ, CMS, HRSA, USDA, DOD, VA and EPA.
“Integrated and standardized regulations should be developed and implemented nationally to address the import, sale, movement, and health of exotic, non-domesticated and wild-caught animals.”	NRC CmR 2005 (Animal Health)	
Enhance OIE authority to achieve compliance with existing reporting obligations	IOM CR 2009	
“USAID, in cooperation with the UN and other stakeholders from human and animal health sectors, should promote the establishment of a coordinating body to ensure progress toward development and implementation of harmonized, long-term strategies for integrated surveillance and response for zoonotic diseases.”	IOM CR 2009	
Review of current trade/import situations to quantify risk of bush meat import and wildlife trade (both legal and illicit), to be followed by negotiations on “a new international agreement on trade in wildlife species that improves international collaboration on reducing the threat that such trade presents to human and animal health.”	IOM CR 2009, IOM WS 2012	The Economics of Agricultural and Wildlife Smuggling, USDA, Economics Research Services Report Number 81, September 2009. (19)
“Create interdisciplinary animal-public health programs.”	IOM WS 2006 (Foodborne)	A Federal Interagency One Health Working Group was established in 2010 and expanded in 2012 with the intent of furthering such an interdisciplinary approach to animal-public health (and environmental health) programs.
National leadership from the zoonosis community behind an effective/comprehensive program to manage	IOM WS 2002	Coordinating Zoonotic Disease Surveillance: Partnering Agriculture and Public Health, NAHSS Outlook June

Thematic group	Reference(s)	Examples of related activities
zoonoses (with CDC's emerging disease plan as a possible model)		2005 (20)
Expanded (U.S.) government rules to allow for testing of animal specimens when results may affect human therapy/outcome, and requirements that labs performing such testing participate in proficiency testing/QA programs (CLIA) [note: rabies given as an example here, not certain of need for other diseases]	IOM WS 2002	
Policy makers should develop and support legislation/regulatory reforms to address appropriate use of antibiotics and incentivize development of novel antibiotics	IOM WS 2010 (Antibiotic Resistance)	
Focusing efforts on markets (e.g., wildlife markets) to regulate, reduce, or eliminate trade that threatens the health of humans, domestic animals, wildlife, and ecosystems.	IOM WS 2011 (Fungal Diseases)	
Laboratory Networks		
“The animal health laboratory network should be expanded and strengthened to ensure sufficient capability and capacity for both routine and emergency diagnostic needs and to ensure a robust linkage of all components (federal, state, university, and commercial laboratories) involved in the diagnosis of animal and zoonotic diseases.”	NRC CmR 2005 (Animal Health)	Integrated Consortium of Laboratory Networks (ICLN) – an operational system of laboratory networks coordinated by DHS for early detection and management of events requiring an integrated laboratory response (21) National Animal Health Laboratory Network (NAHLN) (22) OIE/FAO Network of Expertise on Animal Influenza – established jointly by OIE and FAO to support and coordinate global efforts to prevent, detect and control critical influenzas in animals (23) Swine Influenza Surveillance in the U.S. (24) CDC’s Laboratory Response Network – includes both public health and veterinary laboratories (25) FDA/USDA Food Emergency Response Network (26)
Strengthen veterinary diagnostic laboratories, and encourage submissions by funding/reducing lab fees	IOM WS 2002	National Animal Health Laboratory Network (NAHLN) (27)
Increased number/capacity of national laboratories with BSL3/4 and veterinary BSL4 capabilities, able to run multi-pronged research programs and scalable on outbreaks	IOM WS 2002	National Bio and Agro-Defense Facility (28) NIH National and Regional Biocontainment Laboratories (29)
“Strengthen and integrate laboratory networks that diagnose food-borne and animal diseases.	IOM WS 2006 (Foodborne)	
Training Needs		
“Interdisciplinary infectious disease centers should be developed to promote a multidisciplinary approach to addressing microbial threats to health.”	IOM CR 2003	
“Industry, producers, the American Veterinary Medical Association (AVMA), government agencies, and colleges of veterinary medicine should build veterinary capacity through both recruitment and preparation of additional veterinary graduates into careers in public health, food systems, biomedical research, diagnostic laboratory investigation, pathology, epidemiology, ecosystem health, and food animal practice.”	NRC CmR 2005 (Animal Health)	

Thematic group	Reference(s)	Examples of related activities
Linkages between and public health training in medical and veterinary programs	IOM WS 2006 (Globalization), IOM WS 2012	The Stone Mountain Meeting Training Working Group found 34 University efforts in One Health designed to establish formal linkages between medical and veterinary education. Below are just a few examples: -Triangle Global Health Consortium (30) -University of Wisconsin-Madison (31) -University of Illinois at Urbana-Champaign (32) -Yale School of Medicine (33) -University of Florida (34) -UC Davis School of Veterinary Medicine (35)
"...critical to improve our general understanding of the various cultural, infrastructure, and other issues that will affect how the United States can best work with the world community to improve the surveillance, control, and management of disease."	IOM WS 2002	
"Conduct training programs in food safety for public health officials in developing countries, veterinarians, and the animal health community."	IOM WS 2006 (Foodborne), IOM WS 2012	
"The number and training of medical acarologists and tick biologists are declining, and scientists who do investigate TBDs often focus only on Lyme disease-related questions. Support for the training of tick biologists with wide-ranging interests and broad research portfolios are essential to ensure continued progress on the full spectrum of TBDs."	IOM WS 2011	
Research Needs		
"The committee recommends the expansion and coordination of National Institutes of Health-supported research on the agent, host, vector, and environmental factors that lead to emergence of infectious diseases. Such research should include studies on the agents and their biology, pathogenesis, and evolution; vectors and their control; vaccines; and antimicrobial drugs."	IOM CR 1992	NIEHS-NIAID Workshop to examine the interactions between environmental exposures and infectious agents in the etiology of human diseases. Sept 8–9, 2011 (36) Centers for Oceans and Human Health Research Program, NIEHS and NSF (37) NIH-NSF Ecology and Evolution of Infectious Diseases Program: A Joint Program for Multidisciplinary Research (2011) (38)
"The committee recommends increased funding for basic research that explores and discovers new or novel antibiotics and mechanisms of their action, including the development of more rapid and wide-screen diagnostics to improve the tracking of emerging antibiotic resistance and zoonotic disease."	NRC CmR 1999	
EPA "should spearhead an effort...to make indoor environment and health issues an integral consideration in climate change research and action plans and, more broadly, to coordinate work on the indoor environment and health."	IOM CR 2011	
Knowledge gaps in ecology, epidemiology, and pathogenesis of zoonotic diseases (including vector borne) due to lack of sustained funding	IOM WS 2011 (Lyme and other TBD), IOM WS 2008, IOM WS 2002	NIH-NSF Ecology and Evolution of Infectious Diseases Program: A Joint Program for Multidisciplinary Research (2011) (38)
"Examine the ecology of foodborne diseases to inform the integration of animal and health surveillance"	IOM WS 2006 (Foodborne)	

Thematic group	Reference(s)	Examples of related activities
"Define the role of water as a source of foodborne illness"	IOM WS 2006 (Foodborne)	
To successfully solicit support for additional research funding from private and public partners, "researchers will need to provide evidence of economic benefit and opportunities for strategic investment."	IOM WS 2008	
"Integration of research efforts and findings on infectious diseases in humans, livestock, and wild animals, as well as in crop and wild plants"	IOM WS 2008	
"Informatics to create national databases that capture every aspect of the disease [Lyme] in the ecosystem, the vectors and the patients"	IOM WS 2011 (Lyme and other TBD)	
"Developing bioeconomic models to assess the economic impact of the introduction of invasive species and of alternatives for their prevention and mitigation"	IOM WS 2011 (Fungal Diseases)	
Design "research prototypes for proof-of-concept validation of One Health principles as applied to food safety in the developing world, and also to public-private partnerships between government and the food industry"	IOM WS 2012	
Communication Needs		
"In its work on zoonotic disease surveillance and response, USAID – in collaboration with WHO, FAO, and OIE – should convene representatives from industry, the public sector, academia, nongovernmental organizations (NGOs), as well as smallholder farmers and community representatives to determine how best to build trust and communication pathways among these communities in order to achieve the efficient bi-directional flow of both formal and informal information needed to support effective, evidence-based decision making and coordinated actions."	IOM CR 2009	
Need to educate public on complexities of antimicrobial resistance, especially given "polarized environment surrounding the issue of antimicrobial use in food animals"	IOM WS 2010 (Antibiotic Resistance)	
Public campaigns to address awareness of risks associated with bushmeat practices and with exotic animal importation	IOM WS 2010 (Infectious Disease Movement)	
Partnerships		
The EPA should collaborate with CDC "to assist state, territorial, and local health and emergency-management agencies in efforts...to identify populations at risk for health problems resulting from alterations in indoor environmental quality induced by climate change and to implement measures to prevent or lessen the problems."	IOM CR 2011	
"Federal agencies should develop a tripartite cooperative program to address infectious diseases in humans, in domestic animals, and in wildlife. This program should serve as a focus for regular communications through working groups to address information transfer; to improve response to disease emergencies; to establish priorities for collaborative, focused investigations; and to pursue other areas of mutual interest. The program also should serve as a model and catalyst to stimulate the development of	IOM WS 2002	NIH-NSF Ecology and Evolution of Infectious Diseases Program: A Joint Program for Multidisciplinary Research (2011) (38). A Federal Interagency One Health Working Group was established in 2010 and expanded in 2012 with the intent of furthering such an interdisciplinary approach to animal-public health (and environmental health) programs.

Thematic group	Reference(s)	Examples of related activities
similar cooperative programs between state agencies that would network with the federal program.”		
“Collaboration can be improved at the internal level as well. Although many international activities have succeeded, often via WHO, difficult circumstances have required the involvement of institutions outside the usual public health agency loop, such as agricultural agencies. This was true when the West Nile virus emerged in the United States in 1999, when the H5N1 influenza virus emerged in Hong Kong in 1997, and when the Hendra virus emerged in Australia in 1994. In each case, turf issues arose, and in some instances efforts to protect agricultural markets seemed to be deemed more important than efforts to protect the public health... The next step in solving such turf issues will involve recognizing the primacy of prevention and control of human disease.”	IOM WS 2002	Dedicated One Health Offices at CDC and USDA (39) Multi-Agency Federal Inter-Agency One Health Working Group The national One Health Commission (40)
“Establishing the prevention of the spread of invasive species as an international public good, which requires coordination among nation states... Because such a system is only as strong as the “weakest link,” efforts are also needed to assist developing nations in establishing capacity for surveillance, detection, and prevention of biologic invasions”	IOM WS 2011 (Fungal Diseases)	
*Bolded and shaded rows indicate recommendations from consensus reports;; IOM, Institute of Medicine; NRC, National Research Council; WS, workshop summary; WR, workshop report; CR, IOM consensus report; CmR = NRC committee report.		

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