Integrative approaches to disease control: the value of international collaborations

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Summary

One health and biodiversity issues are global and complex. As such, they require international collaboration if we hope to achieve the goal of minimising disease impacts on humans and animals, while maintaining biodiversity and ecosystem integrity. This will require motivated teams to overcome barriers to collaboration, by focusing on the proven keys to success and developing networks of biological, physical and social scientists as well as decision-makers and stakeholders. These collaborations will require facilitation by governments and international organisations.

Finally, we must move towards a more holistic, transdisciplinary approach to international collaborations. New forms of knowledge, institutional structure and problem-solving require a new dialogue between science and the humanities. Transdisciplinarity serves to ground the particular biodiversity or emerging disease issue in its ecological, social and health context, and enable decision-makers to reach across agencies and disciplines to strengthen the basis for sustainable ecosystems, health and development policies. We believe that future successes in addressing complex issues such as emerging infectious diseases, loss of biodiversity, and climate change will depend on international collaborations based on transdisciplinarity.

Keywords

Biodiversity – Collaboration – Complex problems – Emerging infectious disease – Environment – Interdisciplinary – International – Multidisciplinary – One Health – Transdisciplinary.

Introduction

The problems of a global society are increasingly complex and interdependent and, consequently, are not isolated to particular groups or disciplines. Many are unpredictable, emergent phenomena with non-linear dynamics whose effects have positive and negative feedbacks. As new problems develop, and strategies to address them are implemented, uncertainties continue to emerge and unexpected results occur, requiring not only a re-evaluation of one's strategies, but also of the problem itself. Social scientists term such complex issues, 'wicked problems' (6). Many of the environmental problems we face today are characterised by such complexity. Issues and phenomena such as climate change, maintenance of biodiversity, pollution and One Health are not only biologically complex, but are technically and socially complex on a global scale. Traditional, intra-disciplinary

scientific approaches are incapable of addressing complex environmental and health problems that transcend scientific, social and technological fields of study. A new approach to these complex problems is required.

One Health problems comprise several sub-problems that fall into the domains of different disciplines and social sectors, introducing a further level of complexity. An excellent example of this is the ecology of *Vibrio cholerae*, which requires elucidation by microbiologists, ichthyologists, entomologists, ecologists, epidemiologists, environmental engineers and sociologists, as well as medical professionals. There are wide variations in the preferences and values that decision-makers and stakeholders assign to the qualitative, quantitative and economic attributes of alternatives in a decision-making process, such as the one needed to address the management of cholera. By their very nature, these complex problems require numerous groups of scientists, decision-makers and stakeholders to collaborate on developing and implementing solutions.

Barriers and keys to successful collaborations

A number of internal and external factors can create barriers to successful collaboration. These include philosophical differences among individuals, organisations and agencies, as well as government policies, poor facilitation, inadequate leadership and project scope. Duplication of efforts can also be a barrier to collaboration. Many organisations often yield duplicated efforts, projects and expenses because traditional boundaries and biases often lead to views such as, 'we can do it better our way', and 'it will be more efficient if we do it ourselves'. Some of the most important barriers, though, are those that arise from methodological boundaries created by the culture of specific disciplines and organisations, such as poultry *versus* cattle health, or wildlife *versus* domestic animal health, or even human *versus* animal health. All of these barriers hinder transdisciplinary approaches to collaboration and problem-solving.

Active coordination and collaboration can overcome these barriers and produce results more rapidly and efficiently. Numerous researchers from a broad array of disciplines have analysed both successful and unsuccessful collaborations to identify the keys to success. Two of the most important factors identified from these efforts include: identification of the actual issue on which the group will collaborate and the purpose of the collective (8). This seems simple enough, but all too often committees are formed without clearly defined goals, leaving the group itself to struggle with its ultimate purpose. Regardless, once a collaborating group is formed, the participants must set goals and objectives, and have a clear vision of the desired outcomes.

An environment conducive to establishing beneficial working relationships is an integral component of effective collaboration. The ability to build relationships and create an environment of trust and respect is difficult, but essential for achieving the group's goals. Effective leadership and adequate support in terms of staff, funds and infrastructure are also essential.

Other keys to success are policy-level support and effective communication among all the collaborators and the stakeholders they represent. Indeed, communication has been linked to effective decision-making and consensus-building. For situations characterised by complexity, interdependence and equivocality, communication allows the pooling of individual knowledge, as well as the collective formulation of effective strategies for addressing issues. Information must be exchanged at many levels, including within the collaborative group, and at the policy and technical levels. However, it is also important that information is packaged and delivered in the right form, so it is usually best if provided sequentially and separately to the various target audiences.

Time is also a crucial factor in successful collaborations. It is not only important that a collaborative effort be given adequate time to complete its goals, but the timing of the effort itself is important. All too often, collaborations are under pressure to produce products quickly as a result of an emerging

issue. While a good team can overcome these time constraints, they can almost certainly produce a better product without the pressure of externally imposed deadlines. In other words, proactive collaboration is more effective than reactive collaboration.

Once the barriers and keys to successful collaborations are identified, the next step is to implement a collaborative process. Symposia are an effective way to jump-start communications and collaborations within and beyond the region. These symposia should identify regional priorities for building skills and projects, and identify intra-regional linkages. Such linkages ensure that a region draws from and builds upon existing resources instead of unnecessarily relying on support from outside the region, which can lead to duplication of resources. International support should foster these linkages, rather than weakening them, by focusing collaborations on building and enhancing government agencies that can address conservation and health issues. Without the support of local and national governments, enduring conservation programmes are difficult to maintain.

Some of the most important activities that governments, universities and international organisations, such as the World Organisation for Animal Health (OIE), Food and Agriculture Organization of the United Nations (FAO), EcoHealth Alliance and Wildlife Conservation Society, can undertake to encourage and enhance collaboration are the development of communication tools and training to close technological gaps. These activities also provide an opportunity to develop interpersonal relationships that are crucial to building trust and breaking down barriers. Another important activity that government agencies and organisations can facilitate is the creation and maintenance of rosters of expertise within regions. These rosters can be invaluable for regional scientists, decision-makers and other stakeholders to draw upon, as well as for the international agencies themselves. For example, last year the United States Department of Agriculture (USDA), the Chinese Academy of Sciences and the Chinese State Forestry Administration developed an Asia–Pacific Conference on Wildlife-Borne Diseases. Thirteen countries and five international organisations participated to promote collaboration in the field of wildlife diseases among countries and districts in the Asia-Pacific region; to share activities related to investigation, surveillance and research on wildlife diseases; and to coordinate the cooperation and communication of specialists across multiple disciplines. One of the outcomes of this conference was the creation of an Asia-Pacific communication network of scientists and decision-makers, interested in the ecology and management of diseases in wildlife.

Collaborations should foster an integrated approach to conservation, social, economic and political factors. These principles are embodied within the One Health approach to medicine, encouraging the ‘collaborative efforts of multiple disciplines working locally, nationally, and globally, to attain optimal health for people, animals, and our environment’ (1). This approach recognises that the physical, psychological and social health of people are inextricably linked with animal and ecosystem health. As collaborations develop, they should focus on providing science and tools to make informed decisions, rather than adopting the policy positions of donors. Country and regional policy decisions must incorporate socio-economic, cultural and political considerations. Collaborations should harness the complementarity of different institutional programmes. Too much focus is placed on the negative aspects of institutional differences, when it is these very differences that will be most productive in yielding solutions to complex problems.

Appreciating that the process of collaboration is more important than short-term products is a difficult step for product-oriented scientists and managers to make. These professionals are trained to focus on results and products, such as publications, management plans and changes in parameters, such as disease incidence and prevalence, species richness and demographics. While long-term products and solutions should remain the goal, the process of collaboration itself should be the short-term priority. International collaborations are difficult to implement and, once established, they are fragile. So focusing on collaboration should be the primary short-term goal.

Country and regional interdisciplinary start-up teams are initially the most important component of collaborations. These teams must be composed of key players that have expertise, motivation and the skills to build coalitions. They are vital in identifying other supporters and partners, organising meetings and activities, and developing a common vision. Start-up teams help partners to develop a base of common interests and concerns and to develop a consensus on a vision of a desired future.

Approaches to collaboration

When developing collaborations, focus should be placed on creating a network of networks. Global problems are too large and complex to be approached from a centralised perspective. If success is to be achieved, we have to accept that we cannot control the network or even know everything that is happening all the time, within every portion of the network. If we acknowledge that international collaborations are essentially networks, then we can apply network theory to understanding and facilitating them. A number of scientists have studied international collaborations in science (10). These studies suggest that collaborations are emergent, self-organising systems where the selection of a partner and the location of the research within disciplines rely upon choices made by individual scientists and not through specific national or international incentives or constraints. The numerous choices of scientists to collaborate are motivated by reward structures where authorships, citations and other forms of professional recognition lead to additional work and reputation (10). This multidisciplinary approach to collaboration is by far the most ubiquitous. While there may be a common problem or set of problems on which the group is engaged, each discipline works independently, and the results are usually brought together at the end of the effort (7). Much of the international community's efforts in addressing highly pathogenic avian influenza (HPAI) H5N1 have been from a multidisciplinary approach. While this kind of collaboration is not often conceptually innovative, it can provide insight on different aspects of a particular problem, leading to immediate but usually short-lived solutions. To be sure, the focused and refined multidisciplinary approach to science has been the cornerstone of our long-term evolution of knowledge. However, such specialisation also has the undesirable side-effect of fragmenting knowledge, which has been difficult to apply to realistic, complex problems (9). Multidisciplinary science has been essential in illuminating environmental problems, but has been incapable of integrating and synthesising knowledge of such issues into a larger ecological and social context, or guiding the development of policy to resolve them (2, 5).

Although multidisciplinarity is the most common form of collaboration in science, another approach, interdisciplinarity, is becoming more common in addressing complex problems. In interdisciplinary collaborations, scientists work jointly, using a shared conceptual framework which draws together discipline-specific theories, concepts and approaches (3, 7). This type of collaboration provides a more comprehensive organising principle by coalescing traditional fields of investigation. Interdisciplinary collaborations have been successfully used to address malaria control in Thailand and Brazil, diarrhoeal disease risk factors in Nigeria and, more recently, plague and tularemia in the United States of America. Although interdisciplinary collaborations provide new insights on complex problems, the results are often reported by individual disciplines within their traditional publication outlets.

Multidisciplinary and interdisciplinary methodologies provide the building blocks of knowledge within sub-disciplines and the capacity to understand those building blocks in the context of inter-related systems. However, they are generally incapable of understanding the whole ecosystem, including societal, cultural, economic and political, as well as biological and physical, factors. It is the integration of all these dimensions that is essential for resolving specific biodiversity and emerging infectious disease issues. A transdisciplinary approach is needed to ground complex issues in their ecological and social context, and enable decision-makers to reach across agencies and disciplines to work with

their counterparts in conservation, medicine, agriculture, education, economics and planning, to strengthen the basis for sustainable ecosystems, health and development policies. Transdisciplinarity recognises that complex problems are open and ill-defined, and that the reality being investigated consists of a nexus of phenomena which are not reducible to a single dimension (4, 5, 7). The very nature of complex problems is dependent on context and the relationship among the elements being investigated constitutes a core concept for complexity (6). Common ground and a more comprehensive understanding of such problems are not derived from an ideal model of how system function is a result of its constituent parts. Rather, the understanding emerges from the cross-fertilisation of multiple methods and perspectives that are adapted to the particular problem being investigated.

Also, investigation and problem-solving occur at several scales. At the scientific level, teams must learn to work in interdisciplinary and transdisciplinary settings that include multiple and non-traditional stakeholders. This requires time to learn about other disciplines and their terminology, develop a respect for a variety of perspectives on an issue, and learn to work in teams whose members have varying degrees of knowledge and work ethics. Scientists also need to develop skills in working with teams that are geographically separated; most multidisciplinary teams are composed of scientists within a specific country and institution. Complex biological problems, such as emerging infectious diseases and climate change, are global or regional by nature and require international collaborations where team members will not be able to meet physically on a regular basis. Technologically advanced communication tools, such as internet and video conferencing, in combination with traditional forms of communication (e.g. teleconferencing, conferences, physical meetings), along with other information-sharing technologies (e.g. cloud computing, social networking), can significantly improve communication and data-sharing among geographically dispersed teams and decision-makers.

At the institutional level, the scientific system must begin to transform itself and create appropriate curricula and institutional surroundings conducive to transdisciplinary approaches. Universities and agencies are arranged around scholarly disciplines, which promote individual or collaborative approaches within scientific fields. Scientists and professionals must be trained to think beyond the confines of their disciplines and to seek out expertise across multiple fields of study, as well as to embrace non-traditional sources of knowledge (e.g. cultural knowledge of local resources). Institutions must also remove professional impediments to successful transdisciplinary collaborations. Multidisciplinary approaches succeed because the disciplinary members of a team are encouraged to publish findings in their own journals. While numerous awards and promotions are bestowed on those who publish single-authored papers and books within disciplinary journals, relatively few are available to those who work on inter- and transdisciplinary teams. Environmental problems require transdisciplinary approaches, which the conventional knowledge institutions have been unable or slow to provide. Or, as Brewer (2) wrote, paraphrasing a popular axiom, ‘the world has problems, but universities (institutions, agencies) have departments’.

Finally, investigation and problem-solving occur at the political level. Here, policy transformations have effects on science and management systems. Governments, international organisations and donor agencies must play an active role in facilitating transdisciplinary approaches by providing funding, infrastructure, recognition and incentives to support collaboration networks across disciplines. While an increasing number of institutions are adopting transdisciplinary strategies, progress has been slow because organisations and agencies have long histories of multidisciplinary approaches shaped over periods when sustainability and the integrative demands that it requires were not priorities. Thus, many institutions reflect past problems, understanding and imperatives rather than emerging issues. However, progress is being made. The North American Interior Columbia River Basin Ecosystem Management Project, the National Cancer Institute’s Transdisciplinary Centers Initiatives, the Australian Cooperative Research Centres programme, the Intergovernmental Oceanographic Commission’s Integrated Coastal Area Management Project, the Gund Institute of Environmental

Economics, and the United Nations Environmental Science Programme's Science Initiative are examples of organisations, universities and governments that are addressing complex biological problems through transdisciplinarity.

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