A Review of the Metrics for One Health benefits

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Summary

One Health as a concept has been with us for many years, yet it is only recently that it is actively being discussed as a way of mitigating risks in society. The initiatives in the use of the concept require methods to monitor the benefits gain from a holistic approach to health, yet there is an absence of adequate frameworks to measure One Health benefits. The paper explores this problem with a review of the available literature and an examination of other potential methods. It concludes that most published work on One Health describes how this concept is valuable without trying to estimate the size or the type of value. A framework for measuring the benefits of a One Health approach is needed and through a process of an international workshop and the development of a One Health business case the authors are working towards its development.

Keyword: Benefits – Economics – One Health – Review.

Introduction

The conjectured importance of zoonoses has prompted the scientific community and decision makers to look for holistic initiatives that incorporate the health and ecosystem sectors in order to improve understanding of the complex health relationships and to reduce national and global health risks. One Health recognises that the health of humans, animals and ecosystems are connected and advocates for coordinated, collaborative, interdisciplinary and cross-sectoral approaches. A harmonised and integrated approach – One Health – to mitigate health risks is appealing.

However, global recognition of One Health approaches, for more effective protection of the global community from health threats, has not led to systematic resource allocation for integrated disease mitigation programmes. We argue that in part this is due to a lack of studies that assess the economic efficiency of One Health approaches and therefore a business case for such a change is poorly substantiated. While costs for One Health initiatives are easier to document, there is a lack of standardised and established methods for measuring the benefits of integrated programmes.

Definitions

Several definitions of One Health have been presented since the term "One Medicine" was considered inadequate because it did not reflect the interactions between human and animal health that reach beyond individual clinical issues (1) and there is ongoing debate about what constitutes One Health. In the past it was mainly related to the interdependence of animal and human health, with the addition of environmental health. More recent definitions expand this to include other aspects that impact on health and well-being, in particular food security and poverty. For example, the Food and Agriculture Organisation of the United Nations (FAO) sees One Health as "a holistic vision to address complex challenges that threaten human and animal health, food security, poverty and the environments where diseases flourish" (2). Another definition of One Health requests that it demonstrates an added value to what human and animal health working in a disciplinary way can achieve: "added value in terms of human and animal health, financial savings or social and environmental benefits from closer cooperation of professionals in the health, animal and environment sectors at all levels of organisation" (3). The European Union (EU) uses a definition of One Health that refers to health hazards: "the improvement of health and wellbeing through:

a) the prevention of risks and the mitigation of effects of crises that originate at the interface between humans, animals and their various environments,

b) promoting a cross-sectoral, collaborative, 'whole of society' approach to health hazards, as a systemic change of perspective in the management of risks". Similar to the previous definition it implies that One Health has a value, i.e. it refers to the *improvement* of health and wellbeing in comparison to a status quo (which is most likely a non-integrated, uni-sectoral or disciplinary approach). Other definitions do not refer to an added value, but rather describe the concept. For example, the American Veterinary Medical Association defines One Health as "the integrative effort of multiple disciplines working locally, nationally, and globally to attain optimal health for people, animals, and the environment" (4). As a working definition for the purpose of this paper, we suggest the following broad definition:

One Health is a concept that addresses complex challenges to promote the health and well-being of all species through the integration of relevant sciences at systems level (based on (5)).

The problem

During the last five years there has been a growing momentum, particularly from the international community, requesting that health research, systems and services implement a One Health approach (6). Several projects and activities have been developed and are now working within this concept at the national, regional and global level (7) based on the expectation that a more holistic management of microbial health hazards would result in a more efficient use of the scarce resources available for mitigation of zoonotic disease risk.

However, such a paradigm shift is not supported by systematic allocation of resources to integrated national or multinational programmes. At national level Ministries of Health and Agriculture (or Animal Health) remain largely separated with individual budgets and agendas (6). This is partly due to lack of convincing economic arguments in support of the approach, the

inertia of existing sectoral systems (6), information sharing and reporting barriers within and across institutions (8), lack of agreements of leadership, resource allocation and distribution of tasks among partners (9), (10), and insufficient indicators and measures of health (11) . There is also a lack of studies to estimate the costs of such a change.

The examples where efficiency gains and the generation of net benefits to society have been demonstrated, are mainly single projects or small-scale modifications of health systems, because no country has taken a decision towards major funding of institutions whose main activity is One Health (6). To further the One Health cause and promote adoption globally, studies demonstrating the added value of One Health (in comparison to disciplinary, uni-sectoral or non-integrated) approaches are needed (12). Another challenge identified is that One Health initiatives have a strong disease focus, but often fail to address ecosystem components, malnutrition (both under- and overnutrition), or poverty (12).

Some economic evidence for One Health benefits exists, in particular referring to cost-savings and risk mitigation programmes for endemic zoonotic diseases, where strategic higher level budgetary and resource allocation provides sufficient financing to control disease along the livestock value chain leading to benefits in humans (6), (13–15). However, there is very sparse economic evidence about the economic efficiency of One Health surveillance systems, either analysed as independent strategies or incrementally; or the prevention of disease emergence (6). Economic analyses of One Health benefits resulting from strategies to reduce poverty or address malnutrition are hard to find.

We argue that the underlying problem of limited and partial economic evidence on One Health lies in **the absence of standardised methods to fully capture the complexity of benefits from taking a more holistic health approach**. This is largely due to the disconnect between disciplines in the past, which has resulted in specific disciplinary metrics that fail to appreciate other disciplines. To date, health impact assessments, environmental impact assessments, agricultural impact evaluations and socio-economic impact analyses are performed. While some overlap exists across these approaches, there is no systematic methodology brought together to reflect the intertwined nature of health impacts across animal and human health sectors, environment and agriculture. For example, in agriculture and animal husbandry space, productivity is commonly used. Databases such as the Global Livestock Impact Mapping System (GLIMS), hosted by FAO, provides background data on biophysical, livestock population and production, socio-economic, animal health and trade parameters, but it does not explicitly link productivity losses to disease incidence nor human health impacts. Similar problems are seen in human health in which Disability Adjusted Life Years (DALYs) are used to rank disease impacts, but do not take into account impacts on livestock production, health and welfare, or the impact of a zoonotic disease in livestock or the threat of its emergence on people's livelihoods and the wider societal aspects due to constraints in livestock sector development and food supply. DALYs also provide no information on the expenditure due to the presence or risk of disease or the lost opportunities in markets or the use of sub-optimal technologies in food systems (compare with animal disease impact assessments). This disciplinary isolation constrains the development of integrated data collection protocols and databases, and limits information on the priority of problems to be tackled and intervention points.

Consequently, there is a lack of combined metrics in complex systems that allow assessing the benefits of One Health initiatives in terms of their health (human and animal), economic, social, biological, environmental, and cultural benefits. The development of such metrics is not only a pre-requisite to assess whether One Health adds value compared to traditional approaches, but it also provides an important tool to assess the impact of multiple ongoing One Health initiatives at various levels.

Aim

One Health advocates for integrative health risk management at systems level to provide a comprehensive, strategic approach to future health challenges. Current impact assessment approaches do not cover the continuum of human through to animal health problems, and those which exist are often led by prioritisation processes dominated by expert opinion, which results in a stubborn institutionalization of programmes and preferential treatment of certain types of health problems. Questions need to be posed, therefore, about how we can estimate benefits from One Health in a standardised way to provide the economic evidence decision-makers need to allocate resources effectively (16).

Commonly mentioned benefits of One Health to mitigate zoonotic disease risks include

- increasing the benefit gained per resource unit used by sharing resources in the field
- larger societal benefits through integrated valuation of the impact of disease mitigation on human and animal health
- reduction of the likelihood of zoonotic disease emergence and establishment
- reduction of uncertainty in disease mitigation decisions
- improved information, data, knowledge and collaboration

Our long term aim is to develop a framework that explicitly incorporates the heterogeneity of One Health and allows measurement of all dimensions of One Health benefits in a standardised and consistent way allowing for adequate comparisons or even meta-analyses in the future. As a first step towards this aim, a literature review has been conducted to identify metrics and associated methods presented so far in the scientific literature for assessing the benefits of One Health activities.

Methodology

A literature review was conducted in the scientific and grey literature to create an inventory of One Health benefits and the metrics used to measure those benefits. For the scientific literature search we used Scopus, PubMed and Web of Science, using a Title and Abstract search without any restrictions in terms of language, year, or similar. The search terms used were (["One health" OR ecohealth] AND [effectiv* OR efficien* OR useful* OR benef* OR profit OR utility OR gain OR advantage OR value OR "losses avoid*" OR "cost avoid*" OR "costs avoid*" OR "cost sav*" OR "costs sav*"]). All references were extracted into Mendeley reference manager and screened independently by two researchers using primary exclusion criteria. When no abstract was available, the title was used to take a decision for inclusion or exclusion. The exclusion criteria were:

1) the reference did not refer to Ecohealth or One Health as a concept, and

2) the reference did not refer to any kind of benefit or value.

No secondary screening was considered necessary and all the articles were downloaded for a full text review and extracting of the information of interest. The same search terms were used in Google, where result pages were screened for relevant publications of any type (e.g. web presentations, reports, peer-reviewed publications) until three subsequent pages did not produce any further relevant results. These publications were added to the list of papers for full text review. Any other relevant publications found while reading the full text were added to the review. In addition to the publication details, the following information (where applicable) was extracted in the full text review:

a. Output (e.g. intervention, programme, database, collaboration etc.)
b. Benefits: type of benefit (free text), plus categorisation into economic, social, environmental, human health, animal health, or other benefit
c. Type of article: conceptual, applied or other
d. Metric used to measure benefit: yes/no
e. If metric used: study objective, method/technique, target groups, data used, software, limitations, advantages

Results

In Scopus, 513 articles were found, in Pubmed 411 and in Web of Science 80 (a total of 621 articles, of which 9 were duplicates). Of those 111 were kept for the full text screening. Thirty-three additional publications were added from Google search, and 10 from the full text review.

One Health benefits

The different One Health benefits described in the publications reviewed are described in Table . Economic, social, technical, animal and human health, environmental and information benefits were listed. The majority of benefits described fell into the groups of more effective disease control and/or biosecurity measures (often related to infectious disease), improvement in both animal and human health and well-being as well as economic benefits.

Table I
Benefits described in the publications found in the literature search

Benefit described	Observation	References
Early detection of threat and timely, effective or rapid response, for example • Pets as sentinels (e.g. lead) poisoning • Use of mobile technology for integrated data collection • Prevent, detect, and combat future pandemics based on experience from H1N1 • Improved understanding of health problem emergence and re-emergence in order to respond in a proportionate and timely manner	Mostly intermediary benefit, with an expectation that early detection leads to rapid and effective response and therefore smaller outbreaks with smaller outbreak costs	(17–26)
Better/improved/more effective disease control and/or biosecurity measures (often related to infectious disease), e.g. • Improved understanding of the virulence mechanism and disease pathogenesis and disease epidemiology • Coordinated risk assessment • Tackle infectious disease problems in the system where is it most effective • Enhanced knowledge to efficaciously address public health aspects of emerging and re-emerging infectious diseases • More effective policies • Integrated study designs investigating health status in humans and animals simultaneously allow an instantaneous identification of the source of a zoonotic disease • Shared veterinary laboratory to diagnose brucellosis in febrile patients has brought the collaborating physician in to include brucellosis testing as a differential diagnosis to malaria and typhoid fever in an area where raw milk consumption is still prevalent. • (Improved) management or control of diseases in animals and/or humans • Effective understanding and prevention of disease evolution require a multidisciplinary or One Health approach	The benefits described are largely referring to a technical intermediary outputs, without describing the final outcome, which would for example be less mortality or morbidity, higher productivity, etc.	(1), (3), (9), (16), (17), (19), (25–39)
Economic benefit / increase in economic efficiency, e.g. • Cost-effective reduction in disease transmission and incidence • Cost-savings by sharing resources (e.g. Reduction of logistic cost by 15%) • Human and animal health investigated as a single social system makes control more cost-effective (e.g. rabies, brucellosis – in comparison to looking at economic efficiency in one sector only) • Improved vaccination coverage at same or less costs • Efficient animal and human health systems • Economic growth	Few studies report a demonstrated increase in economic efficiency due to One Health and these are referenced in the various publications many times.	(1), (3), (5), (13–16), (25–27), (36), (38), (40–50)
Improvement in human or animal health or well-being, e.g. • Reduction of disease risk in humans and/or animals • Reduction in pandemic risk • Improved public health globally • Improved well-being because of human-animal bond • Increased physical activity resulting from dog ownership • Stronger motivation to quit smoking because endangers health of pet	These are final benefits or outcomes that can be measured directly.	(14), (26), (28), (29), (38), (42), (51–56)

Benefit described	Observation	References
• Improved food safety		
Higher quality or quantity of information, data; better knowledge, skills, e.g. • More information and insights (e.g. through knowledge exchange and transfer) • Improved knowledge • Comparative medicine – cross-fertilisation • New skills and experience • Capacity building	These are mainly intermediary outputs that are of limited value if not used to do things in a better way (e.g. better knowledge or data are only of benefit if they are used in some way). Measurement of final outcome often lacking	(1), (3), (13), (15), (26), (29), (36), (57–59)
Ecosystem benefit, e.g. • Ecosystem resilience • Wildlife conservation • Environmentally friendly approaches • Inclusion of wider habitat, e.g. community based approach	No studies that described a more concrete outcome, e.g. increase in animal populations	(60–62)
Personal or social benefits, e.g. • Increasing professional opportunities • Greater individual responsibility • Reduction in poverty and health related inequalities • Food security • Evidence-based decisions • Greater social cohesion • Empowerment of local communities • Trust	Benefits that increase the well-being of people through various pathways, such as feelings of trust, pride or safety, bonds or nutrition	(10), (27), (38), (62–65)
Other • Foster new ideas and innovation through collaboration and exchange		(29), (66), (67)

The benefits described range from rather specific measures focusing on one type of output (e.g. 15% reduction in costs) to all-inclusive expected benefits referring to one or more hazards that could be disaggregated into their respective outcomes (e.g. Prevent, detect, and combat future pandemics of H1N1) and very broad aspects that are difficult to disaggregate (e.g. ecosystem resilience). Also, many of the benefits described are intermediaries (e.g. improved coordination, knowledge, skills, capacity, and management) that contribute to final benefits of improved health or economic efficiency.

Metrics and associated methods used

In the majority of studies, the expected or perceived benefits stemming from One Health were listed in a descriptive or conceptual way, and only a small number of studies reported a benefit *measured* either in non-monetary or monetary terms. These exceptions are listed in Table .

Table II
Summary of measured One Health benefits

Benefit	Metric	Method	Outcome	References
Cost-sharing initiative between medical and veterinary vaccination campaigns in rural Chad. Mobile veterinary vaccination teams already visited pastoral livestock keepers in this area to administer veterinary vaccines	Monetary unit	Cost evaluation	15 % reduction in operational costs compared with separate vaccination campaigns; cost per vaccinated child reduced from €30.3 to €11.9	(46)
Chad: a joint vaccination programme for humans and cattle had a higher human uptake particularly among women and children when animal vaccination was being offered concurrently	Technical measure	Measure vaccination rate	A mean of 140 people were vaccinated a day during joint vaccination rounds compared with 100 people a day when veterinarians were absent	(45)
Reduction in vector density; greater individual responsibility of dengue control actions.	Pupae per person index. Perception: who is responsible for dengue control	Measurement of pupae per person; survey questionnaire	The mean pupae per person index was significantly different in treatment and control areas, i.e. 0.19 vs. 0.73 (p=0.024), and 0.05 vs. 0.26 (p=0.019), more people in control area felt that dengue control was shared responsibility	(30)
Demonstrated benefit of vaccinating livestock for brucellosis on human and animal health	Disability-adjusted life years, cost of programme per DALY averted	Cost-benefit and cost-effectiveness analysis	Cost-benefit analysis indicated that as an animal health intervention brucellosis vaccination of animals was not efficient. Looking at public health sector too, brucellosis control in livestock was a highly efficient intervention with a cost of less than $25 per disability-adjusted life year gained.	(14)
Echinococcosis mitigation in Spain achieved by education on disease risk in the human population, chemotherapy of all owned dogs in the area, euthanasia of stray dogs, sanitary disposal of offal from slaughterhouses and safe disposal of dead sheep by the construction of pits	Monetary units for programme costs and benefits from the prevention of human cases and the improvement of sheep production	Cost-benefit analysis	By year 8 of the programme, the cumulative benefit-cost ratio had exceeded 1, indicating costs had been recouped	(15)
A new mitigation programme for Schistosomiasis in China integrating case detection and morbidity control in humans, molluscicide treatment, health education, surveillance, environmental management and livestock control initiatives resulted in effective disease control	Monetary units for programme costs and benefits from the prevention of human cases averted	Cost-benefit analysis	The integrated programme created a net benefit for society of US $6.20 per US $1 invested	(13)
Rabies control in Chad through vaccination of dog population to avoid human cases and post-	Monetary units for programme costs and non-	Cost-effectiveness analysis;	Costs 50 USD per DALY averted; an effective dog mass-vaccination campaign, capable of interrupting	(48)

Benefit	Metric	Method	Outcome	References
exposure treatment	monetary units (number of exposures averted, number of cases averted)	estimation of break-even point	transmission, becomes cost-effective after 6 years, reaching 32 USD per DALY.	
Early detection of E. coli O157:H7 outbreak leads to societal benefits	Monetary units	Cost-benefit analysis	Early detection of a single outbreak and averting at least 15 human cases through the recall of 25 million pounds of potentially contaminated beef, the surveillance and response system would recover all costs for the 5 years of start-up and operation.	(49)
Investment in One Health systems for prevention and control of zoonotic diseases offers high expected benefits, with high rates of return	Monetary units	Cost-benefit analysis	Estimates efficiency gains at global level between US$184 million and US$506 million per year, or 10–16% if cooperation between the sectors through One Health is established	(25)
Use of an Escherichia coli O157:H7 cattle vaccine to prevent human illness caused by consuming beef	Monetary units	Cost-benefit analysis	Vaccinating the entire U.S. herd at a cost of between $2.29 and $9.14 per unit (depending on overall effectiveness of the vaccine) would be a cost-effective intervention for preventing E. coli O157:H7 illness in humans	(50)

Discussion

The problem identified for the presented study was not addressed through a systematic review of information on One Health and its benefits. The authors recognize that this may in part relate to structure of how the search was carried out. In particular, by explicitly searching for the terms “One Health” or “Ecohealth”, some initiatives that would fall under the One Health definition, but were not labelled as such will have been missed, and in turn the measurement of the benefits of such activities. Nevertheless, previous (non-systematic) reviews reporting on the economics of One Health failed to identify additional studies. Consequently, there seems to be a real lack of studies reporting on the added value of One Health and its measurement.

While there seems to be broad consensus in the published studies about the value of One Health, there is an evident lack of metrics and associated methods to estimate One Health benefits in a systematic way. There are slightly different needs in this regard. A large scale change in the level of government resource allocation needs clearly defined metrics on the cost of inputs to One Health and also measurable and comparable outcomes. This requires shifts in how governments carry out data collection and also the use of econometric methods to define the productivity gains from such a major shift in policy.

At grassroots level the needs are different and only a few studies use a scientific approach to measure and demonstrate the value of One Health. However, there are no studies that use randomized control trials or a case-control study design to actively investigate whether there is in fact an added value resulting from One Health. From a strictly scientific point of view, such studies would be needed to create the necessary evidence and basis for larger investments into One Health. This would require some element of comparison as used for example in case – control study designs or modelling approaches comparing the scenario of interest to a counterfactual. Because multiple One Health initiatives are already ongoing both at small and large scale, relevant data collection protocols should be established now to be able to make use of the data being generated during the change to a more comprehensive disease management approach.

Due to its holistic nature One Health activities can result in a wide range of benefits spanning from social (e.g. empowerment, poverty reduction) to economic (e.g. cost reduction, economic growth), environmental (e.g. ecosystem resilience, wildlife conservation), and health aspects (e.g. improved well-being and public health). From the literature review, five large groups of benefits crystallise:

1) protection of the environment and healthier ecosystems,

2) enhanced social and cultural values,

3) improvement in human and animal health and well-being and animal welfare,

4) better/improved/more effective/more rapid disease control and/or biosecurity measures

5) higher quality or quantity of information and data; better knowledge and skills.

Consequently, metrics from many different disciplines are needed to measure the resulting outputs and/or outcomes. Disciplinary approaches and methods for measurement are manifold; there is a wide range of methods used for economic impact assessment (e.g. cost-benefit analysis, economic surplus analysis, mathematical programming, general or partial equilibrium models), economic evaluation of health and health care health economics (e.g. cost of illness, cost-minimisation analysis, cost-effectiveness analysis, cost-utility analysis, cost-benefit analysis) or to value ecosystem services (e.g. market price method, productivity method, hedonic pricing, travel cost method, substitute cost method, benefit transfer method). Further, there are disciplines that offer a multitude of validated metrics and approaches, but that are usually not considered in One Health assessments, such as nutrition science. Yet, another complication arises through the fact that some benefits are realised quickly, while other benefits of a One Health approach may only manifest in the long term and thereby requiring the use of discounting of different values. This can be problematic when trying to compare natural and monetary units for example.

Consequently, the key task does not seem to focus on the development of new metrics, but rather finding ways of integrating the established disciplinary metrics that are standardised and commonly used as well as combining qualitative and quantitative datasets. Only with a standardised approach accepted and applied by the scientific community can the necessary evidence base be created to assess the real value of One Health.

In summary, three key challenges follow from the above considerations that need to be addressed urgently by the scientific community:

- The development of protocols to capture ongoing change
- Integration of available disciplinary metrics
- Data collection that captures One Health inputs and outcomes

To address the scarcity of metrics and associated methods to estimate One Health benefits identified in the literature review and the shortcomings described above, the authors organized a workshop of international experts in public health, zoonotic diseases and economists who work on health issues. The findings of this workshop which was held in London in September 2013, will be published shortly, focusing on how frameworks to capture benefits can be developed and applied. There is an urgent need for such work in the development of a One Health business case.

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