

# A history of One Health

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## Summary

One Health is not a new concept. It can be demonstrated that its origins and development literally run the gamut from A to Z, that is to say, from Aristotle to Zoobiquity. Indeed, the consequences of the interaction that occurs between ecosystems, animals and people have shaped, and continue to shape, the course of human events and history. A reasoned and evidence-based assessment of the history of One Health must first be founded on an agreed definition of the term, but, given the many disciplines and sciences involved, finding such a definition is no easy task. Furthermore, there is an extensive and growing list of visionary individuals who have, over the centuries, attempted to promote awareness and advance the concept to improve the management of the risks and consequences that arise at the interface between animal, human and ecosystem health. The One Health ideas of the 21st Century constitute a re-conceptualisation of health management in response to the accelerating environmental changes of the past 100 years, changes that are associated with the parallel exponential growth and concentration of the global human population. Consequently, the concept of One Health must recognise the constantly evolving relationship between animals and humans and the planet they share.

## Keywords

Animal health – Comparative medicine – Ecosystem health – Health management – Human health – One Health – Transdisciplinary.

## Introduction

The primary and daunting challenge of preparing a defensible and comprehensive historical account of One Health is the fact that there are numerous perspectives and interpretations of the term. In addition, an historical account is usually prepared in the context of a completed event. In the case of One Health, the concept, dimensions, awareness, acceptance and adoption continue to evolve.

## Defining One Health

Today's risk environment is one of complexity, interconnectedness and convergence, resulting from, among other factors, epidemiological globalisation, pathogen adaptation, food insecurity, changing human demographics, evolving animal production systems and climate change.

There is an increased awareness of the opportunity and the critical need to address health issues and to achieve health objectives by re-focusing more of health management on the interface between ecosystem health, animal health and human health. This change in thought towards the concept has been fuelled by a number of high-profile international infectious disease events over the past several decades. These include the emergence of zoonotic diseases such as Lassa fever, acquired immunodeficiency syndrome (AIDS) and Lyme disease, and viruses such as the highly pathogenic H1N1, H5N1 and H7N9 influenza viruses, Nipah and Hendra viruses, West Nile virus, Ebola and other filoviruses, and severe acute respiratory syndrome and Middle East respiratory syndrome coronaviruses. There are also continued threats from diseases such as rabies, Chagas disease, malaria, leptospirosis, human and bovine tuberculosis and foot and mouth disease and there has been a massive decline in wild animal populations as a result of diseases such as chytrid fungus in amphibians and white-

nose syndrome in bats. An important factor that is often overlooked is that zoonoses are in fact a two-way street, with humans infecting animals as well as the other way round. Indeed, the epidemiological investigations carried out in the majority of the 24 countries that reported detections of the novel re-assortment H1N1 influenza virus in domestic swine and turkey populations in 2010 concluded that sick humans were the primary source of infection for these domestic animal populations (1).

Other human and animal health concerns have also contributed to the urgent call for new approaches to global health management. These include antimicrobial resistance in human and animal pathogens, shortages of fresh potable water, pollution and environmental contaminants, food safety, food sufficiency and insecurity, and the universal global condition of rapid environmental change. All of these factors contribute to what many view as a crisis in global health management capacity and a demand for new mechanisms to address health threats in a horizontal, integrated and trans-disciplinary way, i.e. by tackling health threats at their origins at the ecosystem–animal–human health interface.

Different people with different perspectives define health differently. These same differences are brought to the definition of One Health and thus, there is, as yet, no universally accepted definition of One Health. The significant social, economic and political impacts of the events referred to above have understandably resulted in many choosing to define One Health in a very limited way, with the objective being solely the achievement of human health. For others, animal health and/or resilient, sustainable ecosystems are objectives of equal importance. The essence of the One Health concept is that these three objectives are interdependent and, in fact, constitute a single objective, because to achieve all three at once is the only means of achieving any one of them. In its Constitution of 1946, the World Health Organization (WHO) defined health as ‘a state of complete physical, mental and social well-being, not merely the absence of disease or infirmity’ (2). The interactions among human, animal and ecosystem health are implicit in this definition. Throughout history people have relied on domestic and wild animals (terrestrial and aquatic) for food through direct consumption. In addition, for centuries animal power has also been critical to cultivating, harvesting and transporting food. The inclusion of mental and social well-being in the WHO definition of health is very important when attempting to fully appreciate the contributions that animals and ecosystems make to human health.

In the case of animals, it recognises the wide range of benefits humans derive from their relationships with animals and the roles that animals play in everyday life and in society. It has been well demonstrated that the physical, emotional and mental well-being of an increasing number of people in

society is greatly improved through their interdependence with trained service animal companions (3) and pets. In addition, animals are sources of leisure activity and entertainment, as well as being critical sentinels that alert us to changes in the natural and workplace environment. With respect to ecosystems, the WHO definition of health brings into focus the broad scope of ecosystem services that play a crucial role in the physical well-being of humans and animals. These include photosynthesis, oxygen and water availability, soil fertility, nutrient cycling and detoxification. Moreover, many new drugs have a biological source and biodiversity serves an important role as a buffer against epidemics, pests and the consequences of catastrophic crop failures. Furthermore, ecosystem services can also be seen to have an impact on mental and social well-being, because of the cultural and spiritual value associated with nature, the opportunities it offers for eco-tourism and sustainable hunting and fishing, and the inspiration it provides for musicians, writers and painters (4). Additionally, diseases play important roles in ecosystem function, resiliency and evolution, thus, the absence of disease does not always indicate health.

However, a viable concept of One Health should also recognise the current capacity of humans and animals to have a negative impact on health objectives. Edward O. Wilson coined the acronym HIPPO to describe the key human activities that are most disruptive to ecosystems, thus reducing biodiversity and impeding achievement of One Health objectives. These are described as:

- Habitat destruction
- Invasive species
- Pollution
- Populations (human overpopulation)
- Overharvesting (5).

Consequently, to understand and effectively address the cause and effect that is inherent to many of the health issues that continue to emerge and re-emerge, a true One Health construct must incorporate both the human activities and the naturally occurring events that have an impact on water quality, biodiversity, genetic diversity and ecosystem health.

Therefore, it can be seen that One Health is concerned with more than just some critically important infectious and zoonotic diseases. One Health is a paradigm in which health is determined by a broad, inclusive and interdependent continuum of cause and effect across ecosystems and human and animal populations that fully embraces food security, biodiversity, economic prosperity, and emotional and mental well-being.

Indeed the word HEALTH itself can be interpreted as an acronym composed of:

- Humans
- Ecosystems
- Animals
- Living
- Together
- Harmoniously.

The One Health concept is undoubtedly a challenge to current collective human and institutional behaviours. It shines a spotlight on policies and decisions in human affairs that may often be made without due consideration or recognition of their negative impacts on health outcomes. It advocates new ways of incorporating health risk assessment into decisions made in a far wider array of private and public sectors than is the current general practice. The One Health concept insists that the responsibility for ecosystem health, animal health and human health must be accepted and shared across many different disciplines and sectors of human affairs.

## History of the One Health concept

The notion of One Health has no single origin in human thought. It is, rather, a basic condition of life on earth, repeatedly re-discovered and further explored throughout human history. From time immemorial, the health and well-being of humans has been intimately linked to animals and the planet they share. The interdependence of humans, animals and respect for land and water, which are the foundation of One Health, are an intrinsic part of the culture and spiritual beliefs of many ancient civilisations and modern aboriginal peoples. Since it is fundamentally a social, medical and ecological concept, it can also be glimpsed in various formulations in the historical record of Western thought. A notion of One Health can be found in the writings of the physician Hippocrates (460 BCE–367 BCE). In ‘On Airs, Waters and Places’, he identified the interdependence of public health and a clean environment. He is also credited with formulating the edict of ‘*Primum Non Nocere*’ – ‘above all, do no harm’, which all health practitioners agree to adhere to (6).

Shortly thereafter, Aristotle (384 BCE–322 BCE) introduced the concept of comparative medicine through his study of common characteristics among different species, including people and other mammals, which is reflected in his writings on the diseases of animals in the various books of his series ‘*Historia Animalium*’ (7). Almost 2,000 years later, the Italian physician Giovanni Maria Lancisi

(1654–1720), a pioneering epidemiologist, physician and veterinarian, wrote of the important role the environment plays in the spread of diseases to humans and animals. He is viewed as a pioneer in the management of rinderpest in cattle through his advocating of animal depopulation and quarantine strategies and it is suggested that he may have been the first to recommend the draining of swamps and the use of protection against biting flies in the prevention and management of human malaria (8).

The founding of the first veterinary faculty in Lyons, France, by Claude Bourgelat (1712–1779) established in Europe formal education in animal health and in its interactions with human health. The subsequent work of Louis-René Villerme (1782–1863) and Alexandre Parent-Duchatelet (1790–1835), also in France, led to the development of the veterinary specialty field of public hygiene (9).

The German physician and pathologist Rudolf Virchow (1821–1902) coined the term ‘zoonosis’ and is quoted as saying: ‘Between animal and human medicines there are no dividing lines – nor should there be. The object is different but the experience obtained constitutes the basis of all medicine’ (10). He insisted that health and disease in humans and animals differed only in detail and not in kind. He recognised that environmental factors were key determinants of health outcomes; for example, his prescription for ending a persistent epidemic of typhus, which he himself had investigated, was to provide the affected region with freedom, improved roads and good schools (11, 12).

The Canadian Sir William Osler (1849–1919), who studied under Virchow, further promoted the concepts of comparative medicine and comparative biology and the integration of human and animal health through his concurrent faculty appointments at both the Montreal veterinary college and the faculty of medicine at McGill University. He is often referred to as the father of modern medicine (13).

More recently, James Steele (1913–2013) and Calvin Schwabe (1927–2006) of the United States (USA) have been recognised for their visionary leadership in promoting the ecological nature of animal and human health. In 1947, Steele established the veterinary public health unit in what has become the Centers for Disease Control and Prevention in the USA and helped establish graduate education in public health as a new veterinary specialty. His warnings about the socio-economic consequences of zoonotic diseases led to the establishment of a veterinary public health unit by the WHO (7). Schwabe established a pioneering programme in veterinary preventive medicine at the School of Veterinary Medicine at the University of California, Davis. Moreover, in 1964, he published the textbook *Veterinary Medicine and*

*Human Health*, which called for integration among animal, human and environmental health in the management of veterinary and public health issues. In his book he referred to the importance of 'one medicine' and said that 'the critical needs of man include the combating of diseases, ensuring enough food, adequate environmental quality and a society in which human values prevail' (14). The most novel, and thus a defining, feature of the One Health concept of the 21st Century is its focus on ecological processes and environmental factors as key determinants of human and animal health. Thus, the concept rests as much on the intellectual history of the philosophy and science of ecology as on that of veterinary and human medicine. Like the notion of One Health itself, the interactions among the living and non-living elements of the earth's surface and human dependence and interference with these have been at the forefront of human thought and experience since the beginning of history. In the history of Western thought, they are already a central theme of the legends of Gilgamesh from about 2500 BCE (15) and of the many renditions of the story of the Garden of Eden. While all schools and movements in philosophy contemplated these fundamental relationships across the subsequent 4,500 years, ecology, as a science, emerged only in the early 20th Century. This was a time that saw the end of the great fragmentation of science into separate and disconnected fields in the 17th, 18th and 19th Centuries. Instead, science took a new turn toward convergence, stimulated primarily by the concept of species evolution articulated by Charles Darwin and the notion of selection forces shaping all living things, including people. The term 'ecology' was coined in 1866 by the multidimensional Ernst Haeckel (1834–1919), a German philosopher, physician, biologist, artist and professor (16).

Because ecology is a convergent science, it has many historic roots, far too many to recount here. Nonetheless, some of the more influential people along the path leading to the ecology of health and disease, and thus to the current concept of One Health, include Charles Elton (1900–1991) from England, who wrote a seminal textbook on animal ecology (17); Alfred Lotka (1880–1949) of the USA and Vito Volterra (1860–1940) of Italy, who laid the foundation for mathematical analysis and models of ecological processes (18); Aldo Leopold (1887–1948) of the USA, who wrote compellingly about the possibility, dimensions and consequences of human alterations of ecosystems (19, 20); and Robert MacArthur (1932–1972), also of the USA, who pioneered concepts in community and landscape ecology (21).

The successful application of the concepts of ecology to health and disease was further established in two seminal papers by Robert May and Roy Anderson in 1979 (22, 23). These papers proposed the new concept of the basic reproductive number ( $R_0$ ) of an infectious disease and

stimulated a flourishing new field of disease ecology which has established an environmental and ecological framework supporting the current concept of One Health.

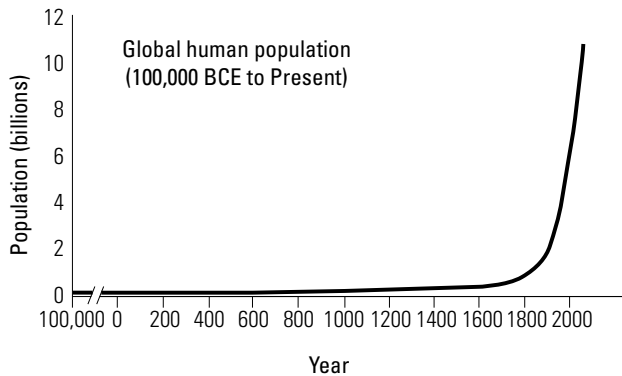
The relationships among human and animal health and their shared environment, of course, are not new. The molecular age and robust techniques in archaeology and anthropology have allowed us to see that infectious diseases emerging in human populations from animal sources triggered by changed environments have occurred repeatedly over the centuries. For example, measles virus, a scourge of humanity prior to modern vaccination, emerged from a cattle virus (rinderpest) that crossed the species barrier and became an autonomous human virus at the turn of the first millennium (1000–1200 CE). At that time, the rinderpest virus was a common virus of cattle to which humans had probably been constantly exposed since the domestication of wild cattle 9,000 years earlier. The new factor leading to the emergence of measles was large-scale urbanisation. Measles virus cannot persist in human populations of less than approximately 500,000 in-contact individuals. Clustered settlements and urbanisation created the environment in which rinderpest could become measles (24, 25). A similar scenario led to the emergence of the human immunodeficiency viruses (HIV 1 and 2) and the AIDS pandemic of the 20th Century. These viruses, which first emerged in urbanising Africa in the early 1900s, are thought to have evolved from a simian immunodeficiency virus that affected chimpanzees and Sooty Mangabey monkeys (26, 27).

## One Health in the 21st Century

The One Health ideas of today constitute a re-conceptualisation of health management in response to the exponentially accelerating environmental changes of the past 100 years associated with the parallel exponential growth of the global human population. The number of people on earth, the intensity of our activities and the pace and extent of environmental change have never been as great as they are today (28, 29). It took between 100,000 and 200,000 years for the human population to reach one billion people, in about 1800. By 1925, the population was two billion. Now, 90 years later, the population is seven billion and headed for nine or ten billion (Fig. 1).

Global populations of domestic animals and the use of all natural resources have risen in parallel with human numbers, at unprecedented rates and scales. All of the risk factors for the health of people, animals and our shared environment are the direct or indirect result of environmental changes that now so vastly exceed the biological pace of adaptation by people and animals. One Health is a hopeful, adaptive

approach to achieving health in a perturbed biosphere. It proposes to achieve human or animal or environmental health by achieving all three together in a form of integrated mutualism, and recognises that health in all three sectors must be achieved simultaneously and together, or not at all.



**Fig. 1**  
**Approximate growth of the global population since the evolution of modern humans**

In 2004, the Wildlife Conservation Society hosted a conference of international experts in multiple disciplines to discuss and respond to the reported and potential movements of diseases among human, domestic animal and wildlife populations. The symposium resulted in the publication of the 'Manhattan Principles on One World – One Health' whose title led to the coining of the term 'One Health' in its current context (30). This was followed by two additional international developments. In 2008, WHO, the World Organisation for Animal Health (OIE) and the Food and Agriculture Organization of the United Nations (FAO), with the support of the United Nations Children's Fund and the United Nations System Influenza Coordination, developed an unprecedented tripartite agreement to work more closely together to address the animal, human and ecosystem interface (31). Then, in June 2012, the World Bank published an assessment of the economic benefits of One Health (32). Over the past decade, multiple international meetings, symposia, publications, university programmes, health management measures and research projects have served to create an ever-expanding community of practice and an increasing number of networks advancing the use of the term and the tenets and principles captured by One Health. Perhaps One Health has truly come of age.

## Conclusion

In today's world of complexity, interconnectedness and what the literature describes as 'wicked' problems (those problems for which any proposed solution inherently creates other problems), the drivers and convergence of issues that impact on human, animal and ecosystem health are well entrenched.

The concept and principles of One Health are not new. Indeed, the threats and consequences that emerge from the interface between ecosystems, animal populations and human populations have been, and continue to be, the basis for many of the events that shape history. If there is one lesson that can be derived from a review of the history of One Health, it is that risk transfer is not risk management. Similarly, consequence transfer is not consequence management.

Despite the evidence of the enormous social and economic costs associated with the deteriorating capacity to achieve health objectives in all countries, collective and cohesive investment in addressing the emergence and consequences of health threats through an integrated, horizontal, trans-disciplinary approach, as advocated by the One Health concept, remains elusive.

One Health is a concept with a solid scientific basis and a rich heritage whose time has come. Surely so many highly regarded historic figures were not wrong. As former United States President Harry S. Truman once said, 'It is amazing what can be accomplished when you don't care who gets the credit.'

The value of history is in the learning and the opportunity to apply the learning for the betterment of all. In the book *Zoobiquity: what animals can teach us about health and the science of healing* (10), the authors remark, 'In a world where no creatures are truly isolated and diseases spread as fast as jets can fly, we are all canaries and the entire planet is our coal mine. Any species can be a sentinel of danger – but only if the widest array of health-care professionals is paying attention.'



# Histoire du concept « Une seule santé »

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## Résumé

Le concept « Une seule santé » n'est guère nouveau. Ses origines et ses évolutions se déploient sur une échelle qui va littéralement de A à Z, à savoir, d'Aristote à la notion toute récente de « zoobiquité ». Certes, les conséquences des interactions entre les écosystèmes, les animaux et l'homme ont façonné le cours de l'histoire et des événements humains par le passé et continueront de le faire. Une évaluation raisonnée et factuelle de l'histoire du concept « Une seule santé » doit reposer sur une définition de ce terme qui fasse l'unanimité, ce qui est assez difficile à obtenir compte tenu des nombreuses disciplines et domaines scientifiques concernés. De plus, au fil des siècles des personnalités visionnaires de plus en plus nombreuses ont tenté d'éveiller les consciences et de mettre ce concept en avant, afin de mieux gérer les risques survenant à l'interface entre la santé humaine, la santé animale et la santé des écosystèmes, ainsi que leurs conséquences. Au <sup>xxi</sup><sup>e</sup> siècle, la réflexion axée sur « Une seule santé » vise à reconceptualiser la gestion sanitaire afin de faire face à l'accélération des changements environnementaux survenus au cours des 100 dernières années, en lien avec la croissance et la concentration exponentielles de la population humaine dans le monde. En conséquence, le concept « Une seule santé » doit prendre en compte le caractère constamment évolutif des relations entre les animaux, les hommes et la planète qu'ils partagent.

## Mots-clés

Gestion de la santé – Médecine comparative – Santé animale – Santé des écosystèmes – Santé humaine – Transdisciplinarité – Une seule santé.



# Historia de «Una sola salud»

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## Resumen

El de «Una sola salud» no es un concepto nuevo. Se puede demostrar que sus orígenes y desarrollo abarcan literalmente desde la A hasta la Z, esto es, desde Aristóteles hasta la Zoobiciudad. En efecto, las consecuencias de la interacción que se produce entre ecosistemas, animales y personas han configurado, y lo siguen haciendo, el curso de la historia humana y sus avatares. Toda historia razonada y científicamente contrastada de «Una sola salud» debe reposar ante todo en una definición común de esta expresión, cosa que, dado el gran número de disciplinas y ciencias en las que incide, no resulta fácil. Además, existe una nutrida y creciente lista de personas visionarias que a lo largo de los siglos han tratado de dar a conocer y fomentar el concepto a fin de mejorar la gestión

de los riesgos y efectos que surgen en la interfaz entre sanidad animal, salud humana y salud ecosistémica. Las ideas que en el siglo XXI vehicula la expresión «Una sola salud» constituyen una renovada teorización de la gestión sanitaria como respuesta a los acelerados cambios que ha sufrido el medio ambiente en los últimos 100 años, cambios que son paralelos y vienen ligados al crecimiento exponencial y a la concentración de la población humana en el mundo. En consecuencia, el concepto de «Una sola salud» debe integrar las relaciones siempre cambiantes entre los animales, las personas y el planeta que comparten.

#### Palabras clave

Gestión sanitaria – Medicina comparada – Salud ecosistémica – Salud humana – Sanidad animal – Transdisciplinar – Una sola salud.



## References

- World Organisation for Animal Health (OIE) (2013). – World Animal Health Information System (WAHIS) disease reports. Available at: [www.oie.int/wahis\\_2/public/wahid.php/Diseaseinformation](http://www.oie.int/wahis_2/public/wahid.php/Diseaseinformation).
- World Health Organization (WHO) (1946). – Preamble to the Constitution of the World Health Organization as adopted by the International Health Conference, New York, 19–22 June 1946, signed on 22 July 1946 by representatives of 61 States (Official Records of the World Health Organization, no. 2, p. 100) and entered into force on 7 April 1948.
- Montalvan L.C. (2011). – *Until Tuesday*. Hyperion, New York.
- Cardinale B., Duffy E., Gonzalez A., Hooper D., Venail P., Narwani A., Mace G., Tilman D., Wardle D., Kinzig A., Daily G., Loreau M., Grace J., Larigauderie A., Srivastava D. & Naem S. (2012). – Biodiversity loss and its impact on humanity. *Nature*, **486**, 59–67.
- Anon. (2005). – HIPPO Dilemma. *In* Windows on the wild: science and sustainability – a book of environmental education studies. New Africa Books, Claremont, South Africa, 47–66.
- Wear A. (2008). – Place, health, and disease: the airs, waters, places tradition in early modern England and North America. *J. mediev. early mod. Stud.*, **38** (3), 443–465.
- Dunlop R.H. & Williams D.J. (1996). – *Veterinary medicine: an illustrated history*. Mosby-Year Book, St. Louis, Missouri.
- Lancisi G.M. (1964). – Giovanni Maria Lancisi: cardiologist, forensic physician, epidemiologist. *JAMA*, **189**, 375–376.
- Laberge A.F. (1992). – *Mission and method. The early nineteenth century French public health movement*. Cambridge University Press, Cambridge.
- Natterson-Horowitz B. & Bowers K. (2012). – *Zoobiquity: what animals can teach us about health and the science of healing*. Doubleday Canada, Toronto.
- Ackerknecht E.H. (1953). – *Rudolf Virchow: Virchow-Bibliographie 1843–1901*. Arno Press, New York.
- Virchow R. (1985). – *Collected essays on public health and epidemiology*. Science History Publications, Canton, Massachusetts.
- Cushing H. (1940). – *The life of Sir William Osler*. Oxford University Press, Oxford.
- Schwabe C. (1969). – *Veterinary medicine and human health*, 2nd Ed. Williams & Wilkins, Baltimore, Maryland.
- George A. (1999). – *The Epic of Gilgamesh*. Penguin Books, London.
- Anon. (2013). – Ernst Haeckel. Available at: [http://en.wikipedia.org/wiki/Ernst\\_Haeckel](http://en.wikipedia.org/wiki/Ernst_Haeckel) (accessed on 14 September 2013).
- Elton C.S. (1927). – *Animal ecology*. Sidgwick & Jackson, London.
- Begon M., Harper J.L. & Townsend C.R. (1996). – *Ecology: individuals, populations and communities*, 3rd Ed. Blackwell Science, Cambridge, Massachusetts.
- Leopold A. (1933). – *Game management*. Charles Scribner's Sons, New York.
- Leopold A. (1949). – *A Sand County almanac and sketches here and there*. Oxford University Press, New York.
- Fretwell S.D. (1975). – The impact of Robert MacArthur on ecology. *Ann. Rev. Ecol. Systematics*, **6**, 1–13.

22. Anderson R.M. & May R.M. (1979). – The population biology of infectious disease. Part I. *Nature*, **280**, 361–367.
  23. May R.M. & Anderson R.M. (1979). – The population biology of infectious disease. Part II. *Nature*, **280**, 455–461.
  24. Furuse Y., Suzuki A. & Oshitani H. (2010). – Origin of measles virus: divergence from rinderpest virus between the 11th and 12th centuries. *Viol. J.*, **7**, 52.
  25. Black F.L. (1966). – Measles endemicity in insular populations: critical community size and its evolutionary implication. *J. theor. Biol.*, **11**, 207–211.
  26. Grmek M.D. (1990). – History of AIDS: emergence and origin of a modern pandemic. Princeton University Press, Princeton, New Jersey.
  27. Hahn B.H., Shaw G.M., De Cock K.M. & Sharp P.M. (2000). – AIDS as a zoonosis: scientific and health implications. *Science*, **287**, 607–614.
  28. McNeill J.R. (2000). – Something new under the sun: an environmental history of the twentieth century world. W.W. Norton & Company, New York.
  29. Cohen J.E. (1995). – How many people can the earth support? W.W. Norton & Company, New York.
  30. Cook R.A., Karesh W.B. & Osofsky S.A. (2004). – The Manhattan Principles on 'One World, One Health'. Conference summary. One World, One Health: building interdisciplinary bridges to health in a globalized world, 29 September, New York. Wildlife Conservation Society, New York. Available at: [www.oneworldonehealth.org/sept2004/owoh\\_sept04.html](http://www.oneworldonehealth.org/sept2004/owoh_sept04.html) (accessed on 7 August 2013).
  31. Food & Agriculture Organization of the United Nations (FAO), World Organisation for Animal Health (OIE) & World Health Organization (WHO) (2010). – The FAO-OIE-WHO Collaboration. Sharing responsibilities and coordinating global activities to address health risks at the animal-human-ecosystems interfaces. A Tripartite Concept Note. Available at: [www.who.int/influenza/resources/documents/tripartite\\_concept\\_note\\_hanoi\\_en/](http://www.who.int/influenza/resources/documents/tripartite_concept_note_hanoi_en/) (accessed on 10 March 2014).
  32. World Bank (2012). – People, pathogens and our planet, Vol. 2: The economics of One Health. Report no. 69145-GLB. World Bank, Washington, DC.
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