n. 1

Quaderni della Società Italiana di

MEDICINA TROPICALE *e* SALUTE GLOBALE

COOPERAZIONE VETERINARIA INTERNAZIONALE E SALUTE GLOBALE

a cura di:
Patrizia Parodi, Michele Dottori, Luciano Venturi

Edito a cura della
Società Italiana di Medicina Tropicale e Salute Globale (SIMET)

ISBN 978-88-900025-0-2

Società Italiana di Medicina Tropicale e Salute Globale (SIMET)

c/o Dipartimento di Malattie Infettive, Parassitarie e Immunomediate, Reparto di Malattie trasmesse da Vettori e Sanità Internazionale; Istituto Superiore di Sanità, Viale Regina Elena, 299 - 00161 Roma
Tel. +39 06 49906102 - Fax +39 06 49903561 - www.simetweb.eu/

Composizione ed impaginazione: Maria Grazia Bedetti; E-mail: mariagrazia.bedetti@iss.it

ISBN 978-88-900025-0-2

Tipografia: De Vittoria Srl, Via degli Aurunci, 19 - 00185 Roma - 2016

COOPERAZIONE VETERINARIA INTERNAZIONALE E SALUTE GLOBALE

A cura di:
Patrizia Parodi (Teramo), Michele Dottori (Reggio Emilia), Luciano Venturi (Bologna)

SANITA' ANIMALE

SICUREZZA ALIMENTARE

PRESENTAZIONE

Il presente volume dedicato alla *Cooperazione veterinaria internazionale e salute globale*, costituisce il primo numero di una nuova linea editoriale (I "Quaderni" della SIMET), voluta dal Consiglio Direttivo della Società Italiana di Medicina Tropicale e Salute Globale, dedicata a temi monografici e linee guida che possano fornire un contributo, di facile trasferibilità, nella pratica degli operatori di sanità pubblica internazionale.
Nel Quaderno n. 1 viene resa disponibile una raccolta di contributi, volutamente non omogenei tra di loro per le tematiche affrontate, in cui è rappresentato l'impegno espresso e l'apporto prodotto da alcuni cultori della Sanità Pubblica Veterinaria (SPV) applicata all'aiuto allo sviluppo internazionale e alla gestione delle emergenze.

Al crescente numero di situazioni di crisi umanitarie – inondazioni, siccità, perdita di produzione alimentare, depauperamento della biodiversità e del patrimonio animale - provocate dall'impatto delle attività umane sugli ecosistemi, occorre sommare un consistente numero di episodi ed allarmi riferiti alle malattie trasmissibili: dal 1970 a oggi sono state identificate circa 40 nuove patologie infettive che non erano conosciute dalle generazioni precedenti, mentre negli ultimi 10 anni sono stati registrati ben oltre 1100 focolai epidemici di varia natura, in tutto il mondo.
Tra le cause di tale tumultuosa evoluzione rientrano, incontestabilmente, i cambiamenti climatici connessi al riscaldamento del pianeta, colpevoli di alcune delle emergenze umanitarie più importanti registrate, ma anche la movimentazione di merci e animali legata alla globalizzazione dei mercati.
Alcune zoonosi "neglette", inoltre, sono endemiche in molti Paesi in via di sviluppo e la loro incidenza è sconosciuta o molto sottostimata. Per questo motivo la loro importanza per le comunità che ne sono affette è poco riconosciuta. Il controllo delle zoonosi "neglette" salva vite e assicura i mezzi di sussistenza offrendo opportunità realistiche ed economicamente efficaci per alleviare la povertà di comunità rurali periurbane ed emarginate.

L'Organizzazione Mondiale della Sanità, nel suo Rapporto: *A Safer Future - Global Public Health Security in the 21st Century* raccomanda, per affrontare le sfide che si presentano sul percorso collettivo volto a perseguire una sicurezza sanitaria globale, di mobilitare le necessarie competenze tecniche e sostenere la collaborazione interprofessionale per far fronte alle emergenze.

La SPV, d'altro canto, non ha un impatto solo sulla salute, ma anche sul commercio e lo sviluppo che, a loro volta, rappresentano alcuni dei fondamentali "*determinanti di salute"*. Nell'inarrestabile e rapido processo di globalizzazione, l'Organizzazione Mondiale del Commercio, al fine di facilitare l'accesso ai mercati internazionali ed estenderne i benefici a tutti i Paesi membri, anche i meno sviluppati, sin dall'inizio, ma in maniera crescente negli ultimi anni, ha previsto una serie di misure, fra cui periodi di adeguamento più lunghi, programmi di assistenza tecnica e formazione, che hanno avuto un impatto notevole in ampie aree del Pianeta, facilitando l'adozione di standard internazionali, l'armonizzazione delle norme e procedure di equivalenza che riducano gli ostacoli al commercio internazionale.

Facendo propri tali principi e raccomandazioni alcuni dei migliori specialisti della interdisciplinarietà in Sanità Pubblica hanno affrontato temi, a loro congeniali, con l'intento di contribuire al complessivo processo di promozione di una salute internazionale che deve confrontarsi con crescenti sfide globali.

La scelta di dedicare questo numero alla SPV è motivo di orgoglio per i coordinatori editoriali e indica quanto sia ormai profondamente radicato in Italia il concetto di Salute Unica (One Health) e l'approccio multidisciplinare che considera i temi di salute in tutte le politiche.

Per facilitare la consultazione, sono state predisposte quattro sezioni tematiche dedicate rispettivamente al contributo della SPV alle politiche internazionali; all'approccio "One Health"; ed a temi più tradizionali come la sanità animale e la sicurezza alimentare. Quest'ultima, è stata l'argomento di EXPO Milano 2015 "Nutrire il Pianeta, Energia per la Vita", l'Esposizione Universale ospitata dall'Italia, per dare una risposta concreta al bisogno di garantire cibo sano e sufficiente per tutti i popoli, nel rispetto del Pianeta e dei suoi equilibri. Il crescente ruolo assunto dai consumatori a livello mondiale costituisce un presupposto positivo per garantire la democraticità delle scelte assunte dai diversi Paesi e per assicurare la partecipazione delle popolazioni a tutti i livelli.

Agli autori vanno i ringraziamenti dei coordinatori editoriali che hanno la soddisfazione di presentare ai lettori una raccolta di contributi, sui vari temi della SPV internazionale, di assoluto rilievo.

Patrizia Parodi, Michele Dottori e Luciano Venturi

Looking forward, Veterinary Public Health contribution to meeting the global development challenges

M. GHIROTTI

Co-Chair, Global Donor Platform for Rural Development

Summary - The scenario emerged after World War II is gradually but radically mutating, driven by demographic, environmental and political changes and influenced by scientific progress. The results of the post 2015 debate on sustainable development set the agenda for the coming 15 years, stressing the centrality of environmental, social and food issues. The current livestock revolution and the need to meet in a more sustainable way the increasing demand for meat and other animal products, the debate on the proper use of natural resources, the risk of contaminating the environment and the food chain, the possible contribution to economic growth and job creation, the recrudescence of zoonotic epidemics that poses a serious hazard on public health could put the animal resources at the centre of the development agenda. Veterinary public health could validly contribute to safeguarde our planet and to society advancement by evolving its scope and practice to food security and nutrition, socio-economic and environmental issues. Managing animal resources, it should expand actions beyond livestock health adopting with conviction the One Health approach.

Key words: veterinary services, food security and nutrition, public health, planet boundaries, sustainable development goals

Riassunto - Lo scenario emerso dopo la seconda guerra mondiale sta gradualmente ma radicalmente mutando, indotto da cambiamenti demografici, ambientali e politici e influenzato dal progresso scientifico. I risultati del dibattito post 2015 sullo Sviluppo sostenibile hanno definito l'agenda dei prossimi 15 anni, sottolineando la centralità delle questioni ambientali, sociali e alimentari. La rivoluzione zootecnica e la necessità di soddisfare in modo più sostenibile la crescente domanda di carne e di altri prodotti di origine animale, il dibattito sul corretto uso delle risorse naturali, il rischio di contaminare l'ambiente e la catena alimentare, il possibile contributo al progresso economico e creazione di posti di lavoro, la recrudescenza di epizoozie che costituiscono un serio pericolo per la salute pubblica potrebbero porre le risorse animali al centro dell'agenda per lo sviluppo. La sanità pubblica veterinaria potrebbe validamente contribuire alla tutela del nostro pianeta e al progresso sociale evolvendo il campo di applicazione e prassi nella sicurezza alimentare e nutrizione, nelle questioni socio-economiche e ambientali. Nel gestire le risorse animali, dovrebbe andare oltre la salute del bestiame adottando un convinto approccio One Health.

Parole chiave: servizi veterinari, sicurezza alimentare e nutrizione, salute pubblica, confini planetari, obiettivi di sviluppo sostenibile

It is the "most uncanny" since, as unconditional will, it aims at rootlessness as such. This is why it is of no avail to show it the door: since long it has been roaming around invisibly inside the house. The task is to catch sight of and to face up to this guest.
(Martin Heidegger, *Zur Seinsfrage*)

Well, maybe it is just the time of year
Or maybe it's the time of man
I don't know who l am
But you know life is for learning
(Joni Mitchell, *Woodstock*)

INTRODUCTION

We are experiencing a period of transition. It could be argued that the present situation is not something new if seen from different points of view, also geographical. In the northern hemisphere, it may be perceived more distinctly because the European and North American economic and geopolitical centrality is under increasing pressure. Furthermore, several natural and human history theories indicate a cyclic pattern where growth is followed by stagnation. However, the magnitude and rapidity of the environmental, demographic, economic, social hence cultural changes taking place confirm such transition and the need to adapt ourselves, our societies, our professions. The urge for innovation should be encouraged by realising that there have always been periods of transformation albeit not probably at the present rapid pace. Calvin Schwabe, in his seminal book "Epidemiology in Veterinary

Corresponding author: Dr Mauro Ghirotti,
E mail: mauro.ghirotti@esteri.it

Practice", quotes John Gardner: "*A system that isn't innovating is a system that is dying*" [1]. Young countries, businesses and people, Gardner argues, are flexible, eager, open, curious, unafraid and willing to take risks: all ingredients needed for success. As time passes, complacency, apathy and rigidity are likely to prevail while motivation drops probably also because *status quo* and settled interests prevail. Social regeneration requires to face and look beyond imminent threats and problems while valuing the legacy of the past [2].

This imperative should also be of concern of Veterinary Public Health (VPH) and the broader veterinary profession that customarily preserve and enhance the health, wellbeing and productivity of animals, especially domesticated. The two terms are not synonymous, considering the marked public goods nature of the former, but they will be considered as such for the purposes of this paper given their common main focus on animal health. WHO defines VPH as the "*the sum of all contributions to the physical, mental and social well-being of humans through an understanding and application of veterinary science*" [3]. This definition should be considered quite anthropocentric, unable to recognise the multifaceted ecological and socio-economic functions of the different biotic components of a system and their relations. Moreover, it is inconsistent with the One Health (OH) approach that considers animal, human and environmental health as absolutely interweaved. This unbalanced vision has influenced and is influencing VPH practice. As discussed in the 1980's during meetings on the reform of livestock services, the veterinarian should be rather perceived as "the manager of animal resources" that include synanthropic and wild animals as well as fisheries. Too often, relationships between humans and animals are seen under a negative connotation. Problem identification eases activity targeting and solution finding but our profession should rather enhance the positive sides of the association [4]. The key questions should be: Why domestic and wild animal are important? How can we improve relationships with them increasing benefits and reducing inconveniences? Is it just a matter of disease prevention and control?

In a previous paper, it was pointed out that to be concrete, effective and therefore to provide valuable services, a VPH system, as any development activity, should take into account not only the specific local and national conditions and needs but also the main global challenges in our case related to food, health and the environment, paying particular attention to hygiene, including nutrition, coherently with the Mediterranean tradition. An understanding of the "political ecology" in which we operate allows to intervene more coherently and consistently in the policy dialogue and in service delivery and to appreciate the implications of being part of a broader international community, both in terms of obligations and opportunities [5]. Hereby, analysed the main changes taking place globally, some proposals will be formulated on how VPH should adapt its vision and the veterinary profession could tackle the challenges ahead.

The Global Development Agenda (GDA)

The theory and practice of international development, which in the last half century can claim significant results as shown in Figure 1, received a further impulse by the Millennium Development Goals (MDGs) process.

Figura 1 - Major global development progress in the last 40 years. Source: Wikipedia https://en.wikipedia.org/wiki/international_development, accessed Nov 23rd 2015.

In September 2000, world leaders met in New York to adopt the United Nations Millennium Declaration that committed single nations to a global partnership aimed at reducing extreme poverty and set out eight goals to be accomplished, mostly, within 2015. These priorities catalysed the concerted efforts of national governments, the international community, civil society and the private sector leading to a significant set of actions and investments. It is to be noted that the first MDG linked poverty reduction with fighting hunger and unemployment. After 15 years, some global results can be considered accomplished:

- the number of people living in extreme poverty has declined by more than half;
- the proportion of undernourished people in developing countries has almost halved;
- primary school enrolment in these countries has reached 90% and many more girls are in school compared to 15 years ago;
- control of HIV/AIDS, malaria and tuberculosis recorded significant progress;
- under-five mortality rate declined by more than half and maternal mortality by 45%;

- the percentage of people without access to safe water sources was halved [6].

As we approached the deadline to achieving MDGs, realising the value of adopting a unified agenda structured into clear goals and targets, a new post-2015 GDA has been finalised through the definition and adoption of the Sustainable Development Goals (SDGs). These will replace the MDGs, continuing in the coming 15 years the job started, and will not concern developing countries only. Their targets will be the new focus of international actions. The process was launched at the Rio de Janeiro UN Conference held in June 2012 (Rio + 20) during which it was recognised that sustainable development is based on three pillars: economic, social and environmental. The following discussion pointed out that the institutional set up (i.e., good governance) should be considered the forth pillar of sustainability.

The SDGs are expected to be "*action-oriented, concise and easy to communicate, limited in number, aspirational, global in nature and universally applicable to all countries while taking into account different national realities, capacities and levels of development and respecting national policies and priorities*" [6]. Some of these expectations are unlikely to be fulfilled. To achieve 17 SDGs and 169 different targets in 2030, as agreed at the end of a lengthy process that involved the whole UN system, will be a quite daunting task. Moreover, their pursue will retain a voluntary nature, differently from most agreements, commitments and regulations dealing, for example, with international trade. Those are compulsory, as in the WTO case. A review of the SDGs targets carried out by the International Council for Science and the International Social Science Council points out that, in the case of both food security and public health, a good proportion of the selected targets should be more specific, realistic and grounded on current scientific knowledge.

Altering the Planet Homeostasis

For millennia, technology has been the most powerful tool to harness nature and for progress. In recent years, a new term has been proposed by geologists, chemists and ecologists to emphasise the radical structural changes that human activities are posing on the whole Planet: Anthropocene [7]. Since the end of World War II, mankind is rapidly modifying the Earth alike the great forces of nature. There is strong evidence to support this theory of a new geological era. The best-known example is given by the consequences notably on global climate of the massive and rapid use of fossil fuel, formed by the decay of huge biomasses. Probably, atmospheric carbon dioxide is at its highest level in 15 million years. Human industry assisted in speeding up by over 150% the nitrogen cycle, which converts the pure element from the air into chemicals needed to ensure higher agricultural productivity. 30 billion tons of soil, moved in a year by a single mine at the Athabasca tar sands in Canada, corresponds to the double of the sediments flowing down all the rivers in the world. On the other hand, over the past half century, 50,000 large dams have shrunk by a fifth the flow of such sediments. As a consequence river deltas, where hundreds of millions of people live, are eroding away faster than they can be replenished. If we also consider that 90% of global plants is found in ecosystems affected by our species and that the vaster amount of large animal biomass is made by humans and domestic animals, the human capacity to upset the Planet is evident [8].

Therefore, we are approaching several Earth physiological thresholds. Nine boundaries have been identified and quantified. Crossing them could generate abrupt or irreversible environmental changes. Respecting these boundaries reduces the risks of dramatic consequences not only on human societies but on the whole Planet. They are the object of international agreements, such as the Kyoto protocol on greenhouse gases (GHG) emission, some of which find difficult application because of the limited support provided by leading economies.

1. **Stratospheric ozone depletion.** The ozone layer in the atmosphere filters out ultraviolet radiations from the sun. If this layer deplete, higher amounts of radiations will reach the ground with an increased incidence of skin cancer, genome alterations, damage to terrestrial and marine biotopes and to soil fertility.
2. **Loss of biosphere integrity.** Human-made changes were more rapid in the last 50 years than at any time in human history, increasing the risks of abrupt and irreversible biodiversity loss. One quarter of mammal species are at risk of extinction. The main driver is the demand for food, water and natural resources, leading to reduced ecosystem services.
3. **Chemical pollution and release of novel entities.** Toxic and long-lived substances such as synthetic organic pollutants, heavy metal compounds and radioactive materials are some of the key human-induced contaminations. They can have potentially irreversible effects on living organisms, causing diseases and mutations, and on the physical environment.
4. **Climate Change.** This boundary was already transgressed since more than 390 ppmv CO_2 are found in the atmosphere. The loss of summer polar sea-ice is most probably irreversible and

glaciers are rapidly shrinking. Through the destruction of the rainforests, climate-carbon cycle feedbacks accelerate Earth warming and the impact on climate.

5. **Ocean acidification.** A quarter of the CO_2 that we emit into the atmosphere is ultimately dissolved in the oceans forming carbonic acid, altering their chemistry and decreasing the pH of surface water. Compared to pre-industrial times, surface acidity has already increased by 30%. Beyond a threshold concentration, corals, some shellfish and plankton species do not find suitable conditions to grow and survive.
6. **Freshwater consumption and the global hydrological cycle.** Also this cycle is closely linked to climate yet human pressure, notably through land use, is the main determinant. The consequences from global-scale river and vapour flows can be abrupt and irreversible. Water is becoming increasingly scarce and by 2050 about half a billion people is likely to experience severe shortage, straining food systems and increasing the risk of conflicts.
7. **Land system change**. Agricultural intensification is a main driving force behind the serious reductions in biodiversity and effects climate, water flows and the biogeochemical cycling of carbon, nitrogen, phosphorus and other important elements. As pasture and cropland replace forests and wetlands, agricultural areas are converted to human settlements. The aggregated impact of local phenomena has global consequences. Forests are particularly important in controlling the combined dynamics and are the focus in monitoring systems. The emergence of zoonoses from wildlife, such as SARS, Nipah, Hendra, Ebola, rabies is often associated with deforestation, bush meat consumption and invasion of these biotopes.
8. **Nitrogen and phosphorus flows to the biosphere and oceans**. These cycles have been radically altered as a result of industrial and agricultural activities. Both elements are converted into fertilisers using huge quantities of energy. However, much of nitrogen is emitted to the atmosphere in various forms rather than taken up by crops. When rained out, it pollutes waterways or accumulates in the terrestrial biosphere. Similarly, most phosphorus applied in agriculture ends up in aquatic systems modifying life in rivers, lakes, oceans.
9. **Atmospheric aerosol loading.** Through their interaction with water vapour, aerosols influence the hydrological cycle of cloud formation and global or regional patterns of atmospheric circulation, such as monsoon formation in the tropics. They affect the quantity of solar radiations reflected or absorbed in the atmosphere. Humans alter such loading through pollution and release of dust and smoke [9].

Food production is a key driver in most of these changes. The agricultural sector consumes 70% of the Planet freshwater, more than twice that of industry (23%). Farming is directly responsible for 13% of human-generated GHG emissions, especially of two high-impact gases (i.e., nitrous oxide and methane). The contribution is up to 30% if all agricultural related activities are taken into account, including forest clearance. According to FAO, livestock generate 14.5% of human-induced GHG. Beef and dairy production contribute 41% and 20% of the sector's emissions, respectively, while pig 9% and poultry 8% [10]. At the same time, agriculture is severely affected by climate change. By 2050, 22% of the World regions under cultivation is expected to suffer. The negative impact will affect 56% and 21% of crops in Sub-Saharan Africa and Asia, respectively. It will have serious consequences on animal husbandry with productivity losses due to temperature increases and modifications in the availability, quality, and prices of inputs such as fodder, water, energy and infrastructures. Climate change is also leading to unpredictable patterns and extreme meteorological phenomena and influences the epidemiology of diseases and pests, modifying risk factors [11]. Higher temperatures will impact food hygiene.

Regarding fisheries, rising temperatures could boost marine communities in the northern Pacific, as their productivity increases [12]. However, over much of the oceans, higher temperatures and acidification will lead to disruption of complex food webs, coral bleaching, species loss, altered fish distribution and decline in stocks. As a consequence also of overexploitation, 85% of these stocks are already under stress. In 2030, to match the growing demand mainly from Eastern Asia, aquaculture will provide 60% of world fish consumption.

Empires rise, empires fall

The demographic issue has been excluded from the GDA despirte its dominance in the Planet future. As shown in Table 1, in the last 50 years the global human population more than doubled. It went from about 3.3 billion to 7.3 billion people, while cattle increased from 1 billion to about 1.5 billion heads. Converting different livestock into Tropical Units (TLUs), at present there are about 1.7 billion TLUs while less than 1 billion TL's were recorded in 1965. The respective annual growth for this period is thus 1.6%, 0.8% and 1%. The TLU per person ratio declined from 0.3 to 0.2 and livestock productivity soared to meet the rising demand for food of animal origin (FOAO). Only two domestic

Table 1 - Human and livestock population in the last 50 years, million heads. Source: FAOSTAT data, computed by the author.

Year	Human	Cattle	Sheep	Goats	Pigs	Chickens	Tropical Livestock Units
1965	3.329	1.009	1.031	367	496	4.349	989
2015	7.324	1.478	1.174	981	981	20.971	1.656
Difference	3.995	469	143	614	485	16.622	667
Annual growth rate	1.6	0.8	0.3	2.0	1.4	3.2	1.0

species showed higher fertility rates than people: the fast growing monogastric chicken (3.2%) and goats (2%) able to produce also under difficult conditions.
In 2050, the Planet will be inhabited by over 9 billion people. The larger increase will occur in Africa and Asia. 70% will be urbanised. Already half of the world population lives in cities that offer ample job and sociocultural opportunities. At the same time, urban poverty and environmental degradation are rising phenomena and blues, solitude and nihilism will be regular companions of town dwellers, not only in industrialised countries. Urbanisation, together with demographic and economic growth, are among the major determinants behind the expanding demand for FOAO and hence the present Livestock revolution that has changed the global agricultural scenario [13]. In rural areas the diet is higher in calories but less diversified, whereas in towns it is rich in animal proteins. A more harmonic integration between countryside and cities is a development priority that could assist in limiting the negative consequences of rapid urbanisation and rural depopulation. Ensuring food security, decent living conditions, employment and education, notably to the new generations, will be other major development challenges [4]. These factors, unbalanced demographic patterns among regions and conflicts are behind the huge migratory waves that are taking place. Pastoral communities are particularly instable.
In the middle of this century, 40% of population will be made of youth and children. Unemployment is now above 6% with a global job generating capacity of 61%. Agriculture is the largest provider, involving 40% of the global workforce and 60% of child labourers. Just livestock production employs 1.3 billion people and sustains 900 million of the world's poor [14]. According to IFPRI, population in the countryside is declining but until 2030 most employment will originate from the rural labour market. New jobs will be associated with processing and marketing since production, in order to be more efficient, has to maximise output per labour unit and surface. Women contribute to about 40-50% of agricultural labour force and production. Especially in some regions of the world, such as in bantu-speaking Africa or Central America, their role is even more relevant by innovating and expanding the entire food system. It is the case of street food that assists in diversifying the diet of many city people [4].
As mentioned, the MDG 1 target of halving poverty has been reached. Most of the progress is associated with the economic development of several Asian countries, where a high proportion of the world poor was found, and with their demand for raw products needed to booster manufacture. GDP is forecasted to rise annually by 3%, mainly in low and middle income countries. In this decade, it stagnated in Europe, USA, Russia and Japan but increased in China annually by around 10% whose income is expected to surpass that of United States in 2020. African lions are gradually prevailing on the Asian tigers (Tab. 2). Much of their growth is driven by agriculture but it could lead also to negative phenomena such as land grabbing, conflicts and natural resources depletion.

Table 2 - World's five fastest growing economies, annual average GDP. Source, Africa's impressive growth, the Economist online Jan 16th 2011.

2001-2010		2011-2015	
Angola	11.1	China	9.5
China	10.5	India	8.2
Myanmar	10.3	Ethiopia	8.1
Nigeria	8.9	Mozambique	7.7
Ethiopia	8.4	Tanzania	7.2

However, new patterns are emerging. In particular, gains from transactions will outnumber the ones from production. IMF data confirm that in 2012 the global value of financial products and instruments were fourfold the effective global economic output. According to some analysts, if we include the derivatives exchanged outside the standard markets, the estimated ratio is 13 to 1 and it keeps increasing. Huge quantities of virtual capital can be transferred at a finger snap from one region, commodity or group to another, upsetting the real economy and stability. This radical change is profoundly upsetting the structure and governance of our communities and states and the social achievements gained the last century.

The new gap

Some of the fast growing economies are still considered developing countries and, as such, are recipients of foreign aid. The division of the Planet between North and South is therefore anachronistic as well as between developed and developing countries. There is so much poverty in the former group, as the crisis of the Eurozone has clearly shown, and so much wealth in the latter. Global poverty has shifted from low-income countries towards that classified as middle-income that thus have resources to address their own major development constraints (Tab. 3).

Table 3 - Proportion of global poverty (less the USD 1.25 a day) in low and middle income countries. Source: Edward and Sumner, 2013 [16].

	1990	1995	2000	2005	2008
Low income	93.6	89	67.2	71.9	25.7
Middle income	6.3	11	32.8	28.1	74.3

For example, in Ethiopia, usually considered a low income country, GDP is growing annually by over 8% but between 8 and 12 million of its inhabitants (i.e., 9-13% of the entire population) are still chronically dependent on food aid, thus trapped in the worst form of poverty. Three quarters of the world's poor live in middle-income countries [15]. There, poverty has not fallen in absolute numbers but average incomes significantly soared. Moreover, one fifth of people living with on less than 1.25 USD a day are found in middle income fragile states such as Nigeria, Pakistan, Iraq, Syria, Yemen [16]. Governance and stability are at the top of their development concern.

Mounting and widespread inequality is thus characterising the global economy. The divide between rich and poor, linked to a constant erosion of middle classes, will not concern low income and emerging countries only. In Europe and USA since the 1980's, after over 50 years of strong reduction in income and wealth gaps, inequality is riding back to 19th century levels assisted by policies that encourage asset concentration. As shown by Piketty, the rate of return on capital is usually higher than the rate of economic growth. Both in the short and long term, property and finance bring more profits than economic investments [17]. In the 1950's, the salary of an industry executive was 30 or 40 times higher that his/her worker's. Nowadays, it is 400 or 500 times greater and seldom linked to productivity.

Broader development not only economic growth, poverty reduction and job creation will depend on the adopted economic model that will influence also our relationship with the Planet and will shape our communities. It is evident that the present one, based on taxation of creativity and added value (i.e., quality work) and on almost free exploitation of natural resources, is not sustainable. In order to reduce labour costs, this model favour unskilled, low paid workforces operating on a strictly vertical base and unable to address broader issues. As far as agriculture and animal husbandry are concerned, the dichotomy is between landless/high energy/specialised/low labour systems versus land based/low energy/integrated/high labour systems.

Long life to the King!

If the ongoing trends are confirmed, the rapid alterations in the production structure may have dramatic effects on our societies. Technology, which ensured greater efficiency and capacity of adapting the means of production to dynamic conditions, may not be as dominant as it was in the last five centuries since finance is less dependent from science. In fact, two key factors could be identified behind the evolution of modern western civilisation and, after World War II, of many other regions of the Globe: a) the centrality of science and its applications (i.e., technology) and b) the rationalisation and distribution of power through a system of checks and balances supported by a code of rights and duties. They are the pillars of a well functioning state and of the social contract we broadly call democracy. The organised application of science allowed, *inter alia*: a) to scale up agricultural efficiency and food availability transferring a vast proportion of the population to other productive sectors; b) to ensure higher returns to capital investments mainly through manufacture; c) to compete and possibly gain supremacy in regional and global markets; d) to organise effective services and to develop those infrastructures required to ensure proper living and educational standards, thus higher productivity. The redistribution of authority and wealth from the king and the supporting feudal structure to new political or technocratic elites or to the people was reflected in the state organisation and laws. It concerned the different powers (i.e., legislative, executive and judiciary) and competences (e.g., political, technical, administrative, operational) drawing a progressive division between individual and the state responsibilities as well as between public and private sector. In order to be effective, these powers and competences must be complementary. Where group interests and poor politics prevail, the system may generate instead repeated gridlocks.

The whole building is now under erosion with an increasing concentration of power and wealth, as already examined, in a critical period when we should instead improve governance and remove stalemates to address serious problems affecting the

community. Like in traditional societies, in order to recognise the structure of sovereignty in many modern nations and organisations, it is advisable to analyse kinship relationships. Finance is the key driver of national and global politics. It does not require such strong technical support and innovation as economic development and warfare instead do. While financial caucuses regulate global decision making, most intergovernmental institutions experience great difficulties in achieving effective delibe rations and common commitments on key development issues. Lengthy processes, lack of vision and leadership, emphasis on formal rather than substantial matters contribute in pre-empting these organisations. Similarly, the scientific and administrative professions risk of losing their influence in vigorous decision making. The contribution of the scientific community to the recent post 2015 Agenda was not as robust as in past major development processes, (e.g., the Alma Ata declaration on primary health care or the climate change debate) as it is difficult to recognise an OH influence in the choice of the targets associated to the health specific SDG 3.

In a global community where bounds among individuals, constituencies, representatives and institutions are becoming looser, ethical accountability is at stake and required levels of knowledge are scattered and vast, politics is probably no more that supreme art (*basiliké techné*), envisaged by Plato, "*able to ensure the supremacy of what is right by coordinating and governing all forms of knowledge, techniques and activities that take place in the polis*" [18]. Stuck in specialised expertise and far away from the field, rather than becoming an indispensable and constructive element in effective decision making, officials risk being the uncritical implementers of resolutions justified on the mere basis of a generic, supreme "political will". If not supported by proper ethics and governance, public servants may become merely bureaucrats hence servants of the establishment or group interest. The negative, sometimes disastrous, consequences particularly on ecosystems and public health of the short-sighted application of technology in modifying the environment and in warfare played a role in widespread scepticism towards science, in spite of its enormous and continuous contribution to human advancement. The mass perception is that politicians and scientists are unable to control the newly generate creatures, as pictured in many classics of Gothic literature and science fiction, thus to deliver what promised limiting the side effects. However, those countries holding a solid scientific tradition and desiring to maintain economic and political hegemony, as well as the private sector, still highly regard the huge advantages derived from mastering *techné*. New job prospects depend on greater levels of education, creativity, adaptation, capacity to perceive substantial changes. As Francis Bacon stated: *Scientia est potentia*.

The centrality of food

In order to feed the growing, mostly urbanised population, UN estimates that until 2050 we need to boost world food output by 60%, 70% according to previous calculations. This is an unrealistic target considering that, as observed, the whole Planet is under stress. 40% of agricultural land and pastures are already degraded and the availability of new areas for agro-pastoral purposes is very limited, augmenting the risk of extensive environmental disasters. Since the 60's, despite Africa's poor performance, food production coped steadily with the burgeoning human population (Fig. 2).

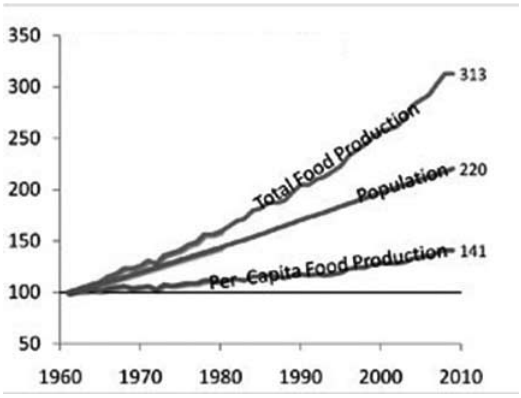


Figure 2 - World food production, total and per capita, compared with population growth (1961 = 100). Source: David Lam's Presidential Address, 2011.

However, in the last decade, productivity fell from 2.4% to 1.7% per year [19].

We should devise effective measures to sustain yields but also to solve some major contradictions of the existing global system. In spite of progress in fighting hunger, according to FAO, still 800 million people are undernourished globally. Better handling of severe emergencies allowed reducing hunger in most regions. At the same time, over nourished and obese people are steadily increasing also in low and middle income regions reaching almost 1.5 billion [14]. Meat consumption contributes to the phenomenon responsible of chronic diseases (e.g., cardiovascular and metabolic disorders, type 2 diabetes) and different forms of cancer. One third of the whole food production (i.e., about 1.3 million tons, enough to feed all the malnourished in the planet) is lost or wasted also because of biological or chemical contamination. Post-harvest losses are

recorded mainly in low income countries and in traditional farming, while food waste in the industrialised regions, although it is an emerging phenomenon in middle income countries, together with obesity. Also because of high market prices, effective veterinary services and technology advancement, losses and waste in FOAO are limited when comparing with other nutritional sorts but their elimination has higher environmental costs [20].

As mentioned, due to higher purchasing power, the demand for animal products is expanding notably in emerging countries. Large quantities of FOAO and live animals are thus shipped to meet this demand increasing the risk of spreading infectious diseases. In 2050, annual meat production has to reach 470 million tons, doubling the present output of 200-250 million tons per year [14]. In the next decade, in Asia it should increase by 60%. Since 2012, China became the main food market on the Planet. The ongoing Livestock revolution is contributing in rising the demand hence the cost of cereals too. It could be argued that, in rough terms, one third of world maize is used to feed notably monogastrics, another third for cars as biofuel and only the last third nourishes mankind. Already in 2006, livestock production accounted for 70% of all agricultural land and 30% of total land surface [14]. Small scale mixed farming and traditional pastoralism nevertheless prove to be efficient and sustainable in using limited natural resources, to provide occupation, to generate income, food and other products, to be flexible and resilient under often very difficult conditions. 70% of world food is produced by smallholder farmers.

Food is becoming more expensive than other major commodities, such as metals and energy. Moreover, biofuel production is linking cereal prices to petrol's increasing price volatility. Since the beginning of the new millennium, international costs for staples, which since the 1960's steadily declined, are on the increase (Fig. 3). Two major crises occurred in 2007 and 2010 upsetting the whole world economy. They

Figure 3 - Trend in world food prices. Source: World Bank, Food Outlook, 2013.

brought back to poverty millions of people in spite only 12% of maize and 18% of wheat are exchanged on the global market [19]. It should be noted that five multinationals control 90% of the global cereal trade, as 10 wholesale companies hold one third of the world food market and two main enterprises handle almost half of all improved seeds production and distribution. In spite of the mechanisms put in place by the international community after 2007, it is likely that further food price crises will occur.

As also mentioned, intensification is affecting agrobiodiversity, i.e., the result of millennia of patient and dedicated activity of farmers and pastoralists to select breeds and varieties most suitable to the different productive, environmental and socio-cultural conditions. FAO estimates that 30% of the 4,500 domestic breeds, naturally selected in the last 12,000 years, are at risk of extinction. Just 30 plants and 13 animal species provide 90% of consumed food [19].

It is evident that food is critical in addressing and linking main human rights and needs and in achieving broader development goal. Out of the 17 new SDGs, eleven are potentially associated with food and sustainable agriculture, as shown in Table 4. Food is deeply involved in vital dynamics such as access to land, inputs, services and markets and can be a powerful political weapon able to destabilise countries and regions, as occurred during the so-called Arab springs when high prices were the detonator of widespread protests. Moreover, it is becoming a clear social index as it is evident in several emerging economies and more recently in the Eurozone too. After decades of nutritional equity, when the high value of traditional food was recognised as in the case of the Mediterranean diet, consuming a proper meal is again a sign of wellbeing and status. While most of the current debate focuses on how to multiply farming output, a more balanced view should consider also quality issues [5]. According to the Committee on World Food Security, food security is in fact achieved when we ensure the physical, social and economic access to sufficient, safe and nutritious food that meets dietary needs and food preferences for an active and healthy life. Therefore, it is not limited merely to food safety, an established veterinary task, and it is inevitably related to equity [14]. As major diseases and contaminants constitute non-tariff barriers in the international trade of FOAO and live animals, poor quality standards keep small farmers and enterprises out from formal markets where better prices and contracts can be obtained. For example, the risk of aflatoxin excludes some tropical regions from the world trade of groundnut and maize, commodities widely used in livestock, fish and high value productions.

Food is thus an excellent business and provides ample opportunities for who is involved in the sector, particularly in the lower part of the value chain. Also in this case, benefits are gradually slipping from farmers to traders. Several financial products, such as futures and hedge funds, and many transactions in the stock markets refer to this commodity [5].

Respecting the social contract

An integral part of the social contract between the individual and the state in modern societies was the institution of effective services also to justify increasing taxation and to build up support and unity in post-independence conditions. The modern foundations were laid in 1942, during World War II when huge sacrifices were required to masses, by the Beveridge Report that identified squalor, ignorance, want, idleness and disease as the "Giant Evils" in society. Service provision is a significant ingredient of consensus and stability also in autocratic states, as the recent case of the Islamic State unmistakeably points out. VPH plays a relevant role, both under normal conditions and in emergencies, by preventing and controlling diseases (which can disrupt economies and societies, as the historical case of Rinderpest showed), ensuring food security, regulating relationships between human and animal populations [3]. Despite numerous constraints, every day veterinary and related public professions discretly provide their valuable contribution to reduce poverty by creating livelihoods, generating income and employment, assets and safety nets specially for pastoralists and women. The integration of animal husbandry with fishery, agriculture, forestry and other economic activities enhances productivity and allow a more sustainable use of natural resources and the evolution of farming and food systems. The prevalent model of veterinary services, generally under the Ministry of Agriculture, pays particular attention to animal production, hence in assisting farmers, and has strong agro-economic foundations. A negative consequence of such approach that may pay limited attention to hygiene is represented by the Bovine spongiform encephalopathy epizootic. To reduce feed production costs, standards were lowered. The almost antithetic model historically found in Italy and recently adopted by the European Directorate General for Health and Food Safety concentrates efforts on public health and to protect consumers. In this case, however, the farmer is merely considered an instrument, not a vital actor of the process. Regarding food, the former model focuses attention on the production phase while the latter on processing thus, respectively, on quantity and quality [5].

With the crisis of the welfare state in the 1980's, the public system has been criticised because of significant levels of spending associated with cases of inefficiency or modest performance. As a reaction, structural adjustment programmes, supported by international financial institutions, curbed national budgets and shifted several functions to private veterinarians, where available, or to auxiliaries and so called paravets. A consequence of the retrenchment or poor performance of public veterinary services is that supply does not always meet demand, with a concentration of services in peri-urban and in highly productive agricultural areas. There is shortage of veterinary staff not only in low income systems and in remote or marginal regions but also in industrialised countries [21]. In fragile states, because of conflicts, services cannot operate in the field. Another effect was the drastic reduction of essential activities for policy planning and implementation, like disease surveillance, data collection and reporting. After almost three decades, there are some doubts about the effective capacity of the private sector and civil society to deliver essential services and markets previously provided by the state [22]. However, it is also evident that the public sector cannot maintain service monopoly and that some activities would be better provided by practitioners. The latter, in charge of clinical services, can actively contribute to VPH carrying out food inspection and mass vaccination campaigns, through the diagnosis, control and reporting of serious zoonoses and communicable infections or detecting new disease patterns in specific clusters. In broad terms, the state should retain the normative, supervision and regulatory functions, with particular attention to policy analysis and formulation, perform major epidemic disease control, and support vulnerable groups or remote communities [5, 22].

Veterinary performance is not even among countries and do not depend on the availability of human and financial resources only. The increasing cost of direct and indirect expenses, such as salaries and equipment, have a negative impact in a prolonged phase of budget shortage and competition with other services and sectors. High professional and scientific standards and managerial skills are fundamental to ensure efficiency and quality. However, the delivery of effective services is also a matter of perspective and ethics. The Tragedy of commons, originally described by Hardin in pastoral communities [23], is nowadays a global issue that can be applied in urban areas, in preserving the biosphere, in the management of public services and goods and in understanding dysfunctional socioeconomic models. Where common resources,

such as pasture or funds, are shared within a weak regulatory arrangement, the benefits are personal since each one has interest to exploit these resources as much as possible while the costs of the improper use are borne by the whole community. Thus, what seems rational from an individual or clan perspective could impair long term wellbeing of the whole community. The Corruption Perceptions Index, monitored by the international NGO Transparency International, ranks countries on the "perceived levels of public sector corruption". Despite worldwide growing attention to this most harmful phenomenon and serious efforts to fight it, the Index showed few significant changes over the recent years and little overall improvement in transparency. In 2014, more than two-thirds of the 177 countries surveyed scored below average pointing out a serious worldwide problem. More advanced countries are well off because they are better organised, less corrupted and people participate directly in shaping their society. The same probably applies to public services that regulate important functions and interests, e.g., veterinarians with food production and trade. However, there are other "soft" forms of unethical behaviour when the regulatory authority is incorrectly or not performed or a bureaucratic and passive attitude prevails.

The way ahead

Our Planet has to face major challenges related to the respect of our ecological boundaries, the provision of food and essential services to satisfy main needs of a constantly growing population, the reduction of social and economic inequalities hence poverty, the effective participation also of remote communities and poor suburbs in the development process. We need to rapidly develop sustainable models at local, national and international level to address the different problems through concerted actions, since single interventions have often a limited impact. Because of its capacity to deal simultaneously with animal, human and environmental wellbeing, the veterinary profession could potentially contribute to address the many challenges of the GDA, acting as a bridge between sustainable agriculture and public health, economic development and preservation of our natural resources, particularly if regularly includes in its realm fisheries and wildlife, often neglected [4]. Table 4 could apply also to VPH. In order to do so, it has to undertake vigorously some basic steps, contributing actively to reposition science at the centre of our societies and of the development paradigm and considering that its ultimate scope and function is the organisation and delivery of efficient services. For Adriano Mantovani, one of the leading

Table 4 - The Sustainable Development Goals and their relevance regarding sustainable agriculture, food security and nutrition.

Goals		**Sustainable agriculture/ Food security related**
Goal 1	End poverty in all its forms everywhere	✓
Goal 2	End hunger, achieve food security and improved nutrition and promote sustainable agriculture	✓
Goal 3	Ensure healthy lives and promote well-being for all at all ages	✓
Goal 4	Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all	
Goal 5	Achieve gender equality and empower all women and girls	✓
Goal 6	Ensure availability and sustainable management of water and sanitation for all	✓
Goal 7	Ensure access to affordable, reliable, sustainable and modern energy for all	
Goal 8	Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all	✓
Goal 9	Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation	
Goal 10	Reduce inequality within and among countries	
Goal 11	Make cities and human settlements inclusive, safe, resilient and sustainable	
Goal 12	Ensure sustainable consumption and production patterns	✓
Goal 13	Take urgent action to combat climate change and its impacts	✓
Goal 14	Conserve and sustainably use the oceans, seas and marine resources for sustainable development	✓
Goal 15	Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss	✓
Goal 16	Promote peaceful and inclusive societies for sustainable development, provide access to justice for all and build effective, accountable and inclusive institutions at all levels	✓
Goal 17	Strengthen the means of implementation and revitalize the global partnership for sustainable development	

VPH mentors, VPH clearly consists in the actions that the community, consumers, public administrators expect from veterinary medicine to safeguard health, economy, environment, coexistence with animals [24]. As mentioned, the veterinarian, in close collaboration with other professions, should be the animal resource manager with a strong scientific, economic, social and environmental perspective. Updating a previous FAO/WHO Expert Committee definition [25], VPH has to be considered as: *the application of veterinary science to society advancement by improving human, animal and environmental health and the sustainable management of animal resources and food systems*.

Disease prevention and control remain the distinctive VPH focus. Limiting morbidity and mortality in animal populations is a fundamental task of veterinary services aiming to reduce economic and food losses and to preserve public health. While in the 1970's and 1980's most of the attention was placed to chemical contamination, emerging and re-emerging infectious diseases regained global significance [3]. According to the Centre for Disease Control and Prevention, one third of infectious diseases and emerging sicknesses in humans are zoonotic. While some bacteria are increasingly pathogenic (e.g., *Escherichia coli* and other *Enterobacteriaceae* or *Mycobacteria*) and several protozoal diseases are still difficult to control since their agents are vector-borne, endocellular or present a high degree of antigenic variations, the greater risks today derive from viruses because of their versatility and extremely high mutation and recombinant capacity. VPH has to adopt an effective OH approach and to show a strong vision and leadership by developing, in close collaboration with related expertises, a full corpus of knowledge, solutions, practices and procedures that enable to link tightly and systematically the proper use of animal and natural resources with human needs. In fact, it could be argued that, while the concept has been accepted by the scientific and development communities, OH is still a comprehensive analytical method rather than a solid and systematic discipline for effective policy planning and implementation. Moreover, although different other professions have largely contributed to the development of the concept, veterinarians still seems to be its main advocates and implementers [5]. It is time to cross the bridge, to develop a well-structured *modus operandi* involving directly our partners and to challenge the professional associations, the academia and ultimately decision makers to put into practice what agreed and deemed feasible, relevant and useful for the delivery of better services.

The full adoption of OH should induce our profession to expand more deeply and thoroughly its scope and practice beyond disease control and/ or the economic exploitation of livestock, areas already well managed. Last half century experience showed that the greatest results are achieved when, for example, animal health activities were part of a comprehensive livestock, public health or environmental strategy adapted to the specific agroecosystem. As analysed, to meet the new GDA challenges, a more comprehensive vision is needed to fight poverty, to reduce hunger and malnutrition, to create jobs, to ensure healthy lives and the sustainable use of Planet resources.

The other main area of VPH activity should concern the whole subject of food security and nutrition, not limited just to food safety and animal nutrition with particular attention to community dynamics [26]. In such regard, assistance should be provided both to producers and consumers because enhancing productivity is not always an antinomy or alternative to quality improvement. The knowledge, practices and procedures already successfully developed for FOAO could be expanded to all components of the diet adopting a food system approach [5]. This approach embraces the activities associated with production, processing, distribution, consumption and waste management, as suggested by the expression "from farm to fork". A food system operates within and is influenced by the social, political, economic and environmental setting. Therefore, it goes beyond the farming or production systems, takes into consideration the whole value chain and implies a deeper consideration of nutritional, public health, community development and cultural issues in order to achieve broader and longer lasting results in agriculture, economic and social development [27]. This implies a deep understanding of the implications of our actions also on the nutritional status of the population, income generation and livelihood of different groups.

Coherently with the OH vision, the veterinarian has to help in managing the complex interactions of the animal communities with people and the biosphere. So far, most of the attention on environment issues is pragmatically concentrated on the control of residues in the food chain and on the impact of contaminants on animal and human health. Instead, it should include a better understanding of Planet boundaries to be respected, the impact of the animal health and production on the different ecosystems and vice versa, the preservation and enhancement of biodiversity and agro-biodiversity, the proper management of wildlife and fisheries populations, the protection and promotion of terrestrial and marine biospheres to benefit of the huge ecosystem services and functions deriving from the proper and

sustainable use of natural resources [5, 10, 28].
Governance issues should be a fundamental part of VPH practice. In a complex and dynamic society dominated by technology, the Ethics of responsibili ty proposed by Max Weber it is still extremely valid. The professional conduct should be built on the understanding of the possible causal effect of our actions and on their calculated reorientation to achieve collective benefits while limiting the negative impact. Hence the relevance of a veterinary education based on even stronger scientific foundations integrated by a solid economic, social and ecological systemic expertise and by managerial skills. Subjects such as epidemiology, policy analysis, food security and nutrition, applied ecology contribute to effective decision making too. They provide an integrated and practical knowledge of the main issues to be addressed as well as professional tools ready to be used both at administrative and field level. The need for a rigorous, first class training is further motivated by the fact that the veterinarian profession is directly responsible of safeguarding human life and rights and community wellbeing as well as of the environment and its natural resources. A better understanding of future implications of urbanisation and rural transformation is required. Knowledge and technology must be employed to reduce serous problems such as food waste, pollution and land degradation, also during epizootics [5]. The gradual gender imbalance in the output of veterinary schools could be exploited to support more efficiently the role of women in animal husbandry, sustainable agriculture and food systems rather than to provide further clinical services for pets. The demand for companion animal care notably in cities, associated with middle class dynamics, does not always match the relatively high practitioners' supply. Informatics and other rapid technological advancements allow new organisational and educational solutions to increase service efficiency and to reduce transactions in our operations.

Conclusions

The veterinary profession has been historically characterised by a very practical attitude, a solid biological background and a deep knowledge of and interaction with rural communities. As long as it has been deeply field oriented and great masters showed the way ahead, the model has been quite successful, also occupationally. Key indicators and current patterns indicate that the post-World War II scenario is largely over, as probably the reality wittily represented by James Herriot. We have to adapt ourselves and to operate in a new global setting that is evolving rapidly and, for some aspects, could be quite unpredictable. The alternative, as far as VPH is concerned, is the progressive loss of relevance in an urbanised Planet where the environment is less prone to be manipulated without serious setbacks, food will be an even more important matter, contacts with domestic and wild animals highly regulated, professional competences change rapidly, inequality likely to be deeper, private interests increasingly dominant and taxpayers expect immediate returns to their contributions and delegation of authority.
In spite of the tremendous trials summarised in this paper, many positive changes are taking place in some regions of the Planet, not only in achieving the MDGs but also to reverse important dynamics such as demographic growth, deforestation, loss of biodiversity, new epidemics. Science advancement, increased community awareness and participation, better relations with the private sector, effective reforms and effective political support have been critical in promoting these changes. The demand for VPH actions within the GDA is potentially high. It is a huge opportunity and an ethical duty for the whole veterinary profession to meet this demand by evolving and adapting its scope and practice. However, as emphasised, it is not just a matter of resources and knowledge but of perspective, ethics and application.

Acknowledgements

This paper is dedicated to my late mother Agnese, a perennial link between earth and sky.

References

1. Schwabe CW, Riemann HP, Franti CE. Epidemiology in veterinary practice. Philadelphia: Lea & Febiger; 1977

2. Gardner JW. Self-Renewal: The Individual and the Innovative Society. W. W. Norton & Company; 1995

3. WHO. Future trends in Veterinary Public Health, Report of a Study Group. World Health Organization, Geneva, 2002. Technical Report Series No. 907.

4. Ghirotti M. Making better use of animal resources in a rapidly urbanizing world: a professional challenge, World Animal Review 1999; 92: 2-14.

5. Ghirotti M. Una medicina unica per le molteplici sfide dell'agenda globale di sviluppo. Annali dell'Istituto Superiore di Sanità 2014.

6. UNDP, 2015. http://www.undp.org/content/undp/en/home/mdgoverview/mdg_goals.html

7. Crutzen PJ, Stoermer EF. The Anthropocene. Global Change Newsletter 2010; 41: 17-18.

8. The Economist. Welcome to the Anthropocene. May 26th 2011 issue.

9. Stockholm Resilience Centre (2015). http://www.stockholmresilience.org/21/research/research-programmes/planetary-boundaries.html

10. FAO. Livestock's long shadow - Environmental issues and options, ed. by H. Steinfeld, P. J. Gerber, T. Wassenaar, V. Castel, M. Rosales, C. de Haan. FAO, Rome; 2006.

11. CTA, 2012. Promoting climate-smart agriculture in ACP countries. CTA Policy Brief. No 9.

12. FAO, 2009. Climate Change and Food Security in the Pacific. ftp://ftp.fao.org/docrep/fao/012/i1262e/i1262e00.pdf

13. Delgado C, Rosegrant M, Steinfeld H, Ehui S, Courbois C, 1999. Livestock to 2020: The next food revolution. Food, Agriculture, and the Environment Discussion Paper 28. IFPRI, Washington DC.

14. UN, Generaly Assembly, 2014. Report of the Special Rapporteur on the right to food, Olivier De Schutter. The transformative potential of the right to food. A/HRC/25/57. UN, New York.

15. Edward P, Sumner A."The Geography of Inequality: Where and by. How Much Has Income Distribution Changed since 1990." CGD Working Paper 341. Center for Global Development, Washington, DC; 2013

16. Chandy L, Gertz G. Poverty in Numbers: The Changing State of Global Poverty from 2005 to 2015. Brookings Global Policy Views, Brookings Institution, 2011-01.

17. Piketty T. Capital in the Twenty-First Century, Harvard University Press; 2014

18. Galimberti U. Psiche e techne. L'uomo nell'età della tecnica, Feltrinelli, Milano; 1999

19. De Castro P, Adinolfi F, Capitanio F, Di Falco S, and Di Mambro A. The Politics of Land and Food Scarcity. Routledge, London; 2013

20. FAO. Food Wastage Footprint: Impacts on Natural Resources. FAO, Rome; 2013

21. Mach A. Alarm over rural veterinarian shortage. ABC News, May 12, 2011.

22. Cheneau Y, El Idrissi, AH Ward D. An assessment of the strengths and weaknesses of current veterinary systems in the developing world. Revue scientifique et technique, Office international des Épizooties 2004; 23: 351-359.

23. Hardin G. The Tragedy of the Commons. Science, 1968; 162(No. 3859): 1243-1248.

24. Marabelli R, Mantovani A. La medicina veterinaria presentata ai pubblici amministratori. Istituto Superiore di Sanità, Roma; 1997

25. FAO/WHO. The Veterinary Contribution to Public Health Practice. FAO/ WHO Technical Report, FAO Agricultural Studies n. 96. Food and Agriculture Organization of the United Nations, Rome; 1975

26. UNICEF. Conceptual framework for analysing the causes of malnutrition, UNICEF, New York; 1997

27. Global Donor Platform for Rural Development, 2014. Food Systems and Gender. Florence Annual General Assembly, Concept Note. https://www.donorplatform.org/

28. Harold M, Neville L, Steinfeld H, and Schneider F. Livestock in a Changing Landscape. Island Press; 2010.

Contributo della Sanità Pubblica Veterinaria alle politiche internazionali di sviluppo sulla filiera alimentare dalla alimentazione animale al cibo sulla tavola intesa come ricchezza economica

R. C. LELLI

Istituto Zooprofilattico Sperimentale dell'Abruzzo e del Molise "G. Caporale", Teramo, Italia

Riassunto - La Sanità Pubblica Veterinaria in Italia (SPV), fondata sulla univocità delle problematiche sanitarie fra uomo-animali-ambiente, Cooperazione Internazionale e contributo all'economia dei Paesi, è un aspetto che la Medicina Veterinaria Italiana ha fatto proprio da sempre, e su cui si basano i *curricula* universitari, per la formazione dei medici veterinari. Il concetto di SPV, evolutosi nel tempo, oggi viene considerato come "*la somma dei contributi al benessere fisico, mentale e sociale delle persone attraverso la conoscenza e l'applicazione della scienza veterinaria*" (Organizzazione Mondiale della Salute – OMS, 1999).
A partire dal recente evento EXPO 2015, si considerano le attività delle Organizzazioni internazionali in tema di salute, come l'Organizzazione Mondiale della Sanità (OMS), la Food and Agriculture Organization (FAO) e l'Organizzazione Mondiale della Sanità Animale (OIE). Tutte interpretano il loro mandato centrato sulla difesa della Salute a livello mondiale, con la consapevolezza dell'interrelazione uomo-animale-ambiente e del perché proteggere la sanità pubblica e l'economia nei Paesi più poveri significa anche proteggere la salute e l'economia dei Paesi più sviluppati.
Si riporta una breve analisi delle attività che l'Istituto Zooprofilattico Sperimentale dell'Abruzzo e del Molise "G. Caporale" ha posto in essere per la salute unica (one health) e per la Cooperazione internazionale.

Parole Chiave: Sanità Pubblica, Cooperazione, sicurezza alimentare, zoonosi, ambiente

Veterinary Public Health: from healthy animals to healthy food, contribution to improve economy in developing countries
Summary - In Italy, the Veterinary Public Health concept, linked to "Human-animal-ecosystems interface", International Cooperation and contribution to the economy of countries, is connected with the history of the Veterinary Medicine Faculties' *curricula*, the veterinary services and their organization.
At international level, the concept of Veterinary Public Health has evolved over time, and today it is considered as "t*he sum of the contributions to the physical, mental and social development of people through the knowledge and application of veterinary science*" (WHO, 1999).
On the subject of Cooperation, Sustainability, Public Health, it is necessary to take into account the EXPO 2015 event, and the activities of international organizations such as the WHO, the FAO and the World Organization for Animal Health (OIE). These organizations are focusing their mandate on the defense of Health worldwide, on the interrelation Man-Animal-Environment, and on the aim to protect the public health and the economy in the poorest countries to also protect the health and the economy of the developed countries.
A brief analysis of the activities that the Istituto Zooprofilattico Sperimentale, Abruzzo e Molise "G. Caporale", Italy, has put in place for International Cooperation is offered.

Key words: Public Health, Cooperation, food safety, food security, zoonosis, environment

INTRODUZIONE

In seguito alle analisi effettuate dall'OMS, che indicano che nel 2050 la crescita della popolazione sulla Terra supererà i 9 miliardi di persone, la Food and Agricolture Organization (FAO) e le Nazioni Unite hanno stimato che per soddisfare i bisogni riguardo la domanda di cibo, le produzioni attuali dovranno essere più che raddoppiate, anche in considerazione dello sviluppo economico, soprattutto di alcuni Paesi e degli abitanti [1].
L'aumento della produzione di cibo, che ne consegue, dovrà avere necessariamente un impatto sostenibile sull'ambiente e sulla disponibilità di risorse naturali, pertanto è necessario essere pronti ad utilizzare un nuovo approccio riguardo la collaborazione

Corrispondenza: Dr. Rossella Colomba Lelli,
Via Campo Boario, 64100.
Tel. +39 348 7978794; Fax +39 0861 332251;
E mail: rossella.silmar@gmail.com; r.lelli@izs.it

fra i differenti attori e la ricaduta dei risultati a quanti ne debbono usufruire. All'aumento della popolazione si aggiunge l'impatto sull'ambiente di migrazioni, urbanizzazione, inquinamento, disponibilità di risorse naturali, cambiamenti climatici e tutto quanto ne può conseguire, fra cui problemi di ordine sanitario, come gli eventi legati alle malattie "emergenti e riemergenti", comprese le zoonosi e la garanzia della sicurezza alimentare. Negli ultimi anni, per quanto attiene a tali argomenti, si fa riferimento allo slogan "Un mondo, Una salute, Una medicina", che oggi sta evolvendo in: "Una medicina, Una scienza" [2].

In Italia, la Sanità Pubblica Veterinaria (SPV), legata al tema della Cooperazione Internazionale e di contributo all'economia dei Paesi, è un aspetto che la Medicina Veterinaria ha fatto proprio e su cui si basano i *curricula* universitari, per la formazione dei medici veterinari. Il concetto di Sanità Pubblica Veterinaria si è evoluto nel tempo, ed oggi l'Organizzazione Mondiale della Sanità (OMS) lo definisce come "*la somma dei contributi al benessere fisico, mentale e sociale delle persone attraverso la conoscenza e l'applicazione della scienza veterinaria*" [3].

Per quanto riguarda l'Italia, nel 1997, Marabelli e Mantovani hanno definito la SPV come l'insieme delle "*azioni che il pubblico (i consumatori) ed i pubblici amministratori si aspettano dalla Medicina Veterinaria (soprattutto dai Servizi Veterinari Pubblici) per la salvaguardia di salute, economia, ambiente, coesistenza con gli animali*" [4].

Il concetto italiano di SPV abbraccia quindi tutte le attività veterinarie di rilevanza pubblica e tutte le attività dei Servizi veterinari, di fatto, sono attività di SPV. A conferma di ciò, è bene considerare che i Servizi Veterinari Pubblici fanno capo all'Amministrazione sanitaria, sono strumento del Ministero della Salute e non del Ministero dell'Agricoltura. Nell'Unione Europea, l'Austria è l'unico Paese, oltre l'Italia, in cui i SV sono storicamente nell'ambito delle funzioni del Ministero della Salute.

Finalità principale della SPV è la prevenzione e le attività di Sanità Pubblica Veterinaria hanno lo scopo di salvaguardare e promuovere gli aspetti positivi del rapporto uomo-animale-ambiente, come la redditività, la produzione di alimenti e di altri prodotti di origine animale, il lavoro, la ricerca, il benessere psichico che inducono per il tramite delle attività di terapia assistita con gli animali, la zoofilia, ma anche di controllare gli aspetti negativi che ne potrebbero derivare [4].

Le attività legate alla Sanità Pubblica Veterinaria sono da considerarsi un indicatore dello stato di prosperità e di pace di una Nazione.

Oggi tale concetto è quanto mai evidente anche a livello internazionale, se si considera che le organizzazioni Internazionali, come l'Organizzazione Mondiale della Salute (OMS), l'Organizzazione delle Nazioni Unite per l'Alimentazione e l'Agricoltura (FAO) e l'Organizzazione Mondiale della Sanità Animale (OIE) hanno fatto proprio il concetto di Sanità Pubblica a livello globale.

EXPO – Milano - 2015

Il Tema che è stato individuato per Expo 2015 è stato: "Nutrire il Pianeta, Energia per la vita", e nella lettura della "Guida al Tema" si trovano molti argomenti che collocano il tema degli alimenti nel contesto della globalità e della sicurezza alimentare, che sono gli argomenti su cui la SPV si concentra e che ne costituiscono il *core*.

Di seguito si riporta quanto scritto nella Guida al Tema:

"Il contenuto della Guida al tema di EXPO, Milano 2015, è strettamente collegato ad alcuni degli Obiettivi del Millennio fissati dalle Nazione Unite:

- *Il primo: sradicare la povertà estrema e la fame, in modo particolare ridurre del 50% la popolazione mondiale che soffre la fame.*
- *Il quarto: ridurre di 2/3 la mortalità infantile dei bimbi al di sotto dei cinque anni.*
- *Il quinto: migliorare la salute materna, in modo particolare ridurre di 3/4 il tasso di mortalità materna.*
- *Il settimo: garantire la sostenibilità ambientale, in particolare stimolando politiche e programmi di sviluppo sostenibile per invertire l'attuale perdita di risorse ambientali, riducendo il processo di annullamento della biodiversità.*
- *L'ottavo: sviluppare un partenariato mondiale per lo sviluppo*

Fanno parte dello sviluppo del Tema tutte le riflessioni scientifiche, i processi produttivi, le politiche pubbliche, le regole che normano la sicurezza alimentare e la qualità degli alimenti per uno sviluppo equilibrato e sostenibile degli individui, dei sistemi di produzione agricolo-forestale, dell'allevamento, delle risorse marine, delle filiere produttive.

A partire da un'attenzione prioritaria ai sistemi agricoli, ma anche ai processi di trasformazione e distribuzione alimentare in tutte le loro dimensioni, soprattutto quelle industriali, si pone l'obiettivo anche di stimolare l'attenzione dei visitatori alle competenze professionali specifiche necessarie per rispondere al meglio alle sfide legate alla lotta alla fame e alla malnutrizione, alla sovralimentazione e alla cattiva alimentazione."

Nella stessa Guida viene preso in esame l'Universo della cooperazione per lo sviluppo:

"Costituiscono rappresentazione di questo approccio al Tema "Nutrire il Pianeta, Energia per la Vita" le declinazioni dei metodi e degli strumenti

della cooperazione finalizzate a ridurre la fame, la malnutrizione, gli squilibri sociali legati all'accesso al cibo, nonché ogni programma finalizzato a veicolare investimenti per ottenere risultati efficaci nello sviluppo delle aree rurali povere e in quelle urbane dei Paesi in via di Sviluppo. In questa logica assumono particolare rilevanza gli accordi di partenariato poiché essi tendono a essere rispettosi dei ruoli e delle peculiarità dei diversi attori" [5].

La SPV, la sicurezza alimentare, l'impatto sui paesi a livello globale

Tutti gli aspetti messi in evidenza dal Tema di EXPO, raccolgono in un unico argomento il ciclo del cibo, legato alla sicurezza degli alimenti e alla assicurazione degli alimenti a tutte le popolazioni e a tutti gli strati sociali delle popolazioni (in inglese: *Food safety* e *Food security*, che in italiano sono rappresentati dall'unica espressione: Sicurezza alimentare).

Ne risulta evidente il ruolo centrale che la Sanità Pubblica Veterinaria ricopre e il ruolo della Cooperazione internazionale finalizzata alla condivisione dello sviluppo tecnico scientifico ed economico fra i Paesi.

L'economia dei Paesi in Via di Sviluppo, è in funzione della salubrità degli alimenti, condizionata dalla salute degli animali. Infatti, la salute degli animali assicura una maggiore produzione di cibo - anche in quanto mezzi di trazione e lavoro - e permette l'accesso al mercato internazionale degli animali e dei loro prodotti che spesso costituiscono una parte rilevante del Prodotto Interno Lordo.

La sicurezza degli alimenti di origine animale, destinati all'alimentazione umana, è condizionata dalla salute degli animali e degli allevamenti da cui originano, in qualsiasi parte del mondo, e il concetto di economia dei Paesi legata alle produzioni agricole dipende dalla capacità di avere allevamenti che siano sani ed economicamente redditizi.

Nelle società ad economia agricola, nei Paesi più poveri al mondo, è evidente che anche la stabilità sociale e politica è influenzata dalla capacità di garantire alle popolazioni un reddito minimo e condizioni che risolvano il problema della fame.

In tali Paesi, le condizioni economiche di gran parte della popolazione sono legate al possesso di pochissimi animali, loro unica ricchezza e sostentamento. Nei nuclei familiari dove sono presenti bambini, essi costituiscono spesso anche l'unica fonte di alimentazione per gli stessi.

Nelle società ad economia agricola, nei Paesi più poveri al mondo, è evidente che anche la stabilità sociale e politica è influenzata dalla capacità di garantire alle popolazioni un reddito minimo e condizioni che risolvano il problema della fame.

Di conseguenza, unico rimedio alle guerre, in certe zone dell'Africa soprattutto, è garantire la disponibilità di acqua e di cibo alle popolazioni. E la garanzia del cibo alle popolazioni inizia dalla disponibilità di animali che forniscano carne, latte, uova, lana, lavoro nei campi e che per essere produttivi, godano di condizioni di salute buone. Altro aspetto da tenere in considerazione è la possibilità per i Paesi di esportare i loro animali o le loro produzioni agricole, contribuendo in modo sostanziale all'economia del Paese intero [6].

Come riportato nel sito della FAO [7]:

"*È di attualità il discorso che il Direttore Generale della FAO, Graziano Da Silva, ha pronunciato nel mese di Settembre 2015, sulla correlazione che c'è fra sicurezza alimentare e crisi migratoria.*

Le milioni di persone costrette a scappare dalla guerra, dalla povertà e da altre avversità ci ricordano tragicamente di quanto sia urgente il bisogno di soluzioni pacifiche basate sulla giustizia sociale e su migliori opportunità economiche per tutti. Cruciale per raggiungere tale scopo è proteggere ed investire nei mezzi di sussistenza rurali.

Sviluppo rurale e sicurezza alimentare sono centrali nella risposta globale alla crisi dei rifugiati. La guerra causa la fame e la fame, a sua volta, uccide e spinge le persone ad abbandonare le proprie case" ha affermato. "Sia che vivano nei campi sia che si stiano spostando, queste persone si trovano in una situazione di particolare vulnerabilità. Il mondo deve dare una risposta esaustiva che offra speranza e soluzioni concrete ai rifugiati. E questa risposta deve tenere in considerazione la loro sicurezza alimentare presente e futura e il ripristino dei loro mezzi di sussistenza rurali."

omissis

L'agricoltura continua a costituire la spina dorsale dei mezzi di sussistenza per la gran parte delle persone in situazioni di conflitto o post-conflitto.

omissis

Questo comprende la fornitura di sementi per permettere agli agricoltori siriani di avere un raccolto cerealicolo sufficiente a sfamare le proprie famiglie; programmi di denaro-contro-lavoro per creare opportunità di reddito ripristinando al tempo stesso le infrastrutture agricole fondamentali; supporto veterinario e campagne di vaccinazioni in Iraq, Giordania, Libano e Siria per preservare la salute del bestiame e le fonti essenziali di nutrimento; la distribuzione di kit per la produzione agricola casalinga che diano agli sfollati e alle famiglie ospitanti i mezzi per produrre cibi ricchi di nutrienti, come uova, latte e verdure" [7].

Da ciò ne deriva che sempre più, nell'immediato futuro, si assisterà al fenomeno migratorio su rotte ben definite, che originano dai Paesi dove c'è la presenza di crisi politiche, sociali, religiose, ambientali, verso Paesi che garantiscono o sembrano garantire

una vita migliore. Alla base di tali viaggi c'è un problema di base legato alla crisi alimentare, anche se ancora tale consapevolezza non c'è ed è ancora una percezione, non completamente compresa ed indagata.

"*Il fenomeno migratorio è sicuramente causato in gran parte per sfuggire alla fame. In uno scenario nel quale desertificazione, inquinamento e surriscaldamento dell'atmosfera minacciano la sopravvivenza delle popolazioni africane spingendole a un esodo biblico verso l'Europa, provocando una serie di preoccupazioni nel Vecchio Continente riguardo un'imminente ondata di immigrati. Ecosistema e insicurezza alimentare e il confronto-scontro tra culture diverse, sono temi che negli anni '90 non erano ancora prioritari nell'agenda politica globale, ma che sono divenuti di drammatica attualità. Le dimensioni e le dinamiche delle ultime crisi alimentari sono state ampiamente riportate dai media internazionali, così come i tentativi di individuarne le cause. Uno di questi ha riguardato il ruolo giocato dai prezzi agricoli e dalla loro volatilità. Secondo l'ultimo Rapporto FAO del 2014, oltre 805 milioni di persone, vale a dire una su nove, continuano a soffrire, per le cause più diverse, la fame cronica. Si tratta di un dato in diminuzione, ma pur sempre intollerabilmente alto*"[8].

Mentre non vi è alcuna soluzione univoca per assicurare cibo a tutta la popolazione mondiale, il rapporto "*The State of Food Insecurity in the World 2015 – SOFI*" [9] evidenzia diversi fattori che possono giocare un ruolo fondamentale nel raggiungimento dell'obiettivo di eliminare la fame nel mondo.

Al primo posto c'è il miglioramento delle produzioni agricole, in particolare nelle piccole aziende a conduzione familiare, nelle aree rurali. Ciò porta a migliorare notevolmente la condizione di povertà estrema. Limitarsi alla Assistenza sociale, legata alla disponibilità di risorse finanziarie che garantiscano almeno 1,5 US $ al giorno, considerato il limite della situazione di fame, non risolve il problema e sicuramente non in maniera durevole, per tutti quanti vivono al di sotto di tale soglia.

Solo fornendo gli strumenti per migliorare la redditività degli allevamenti e dei terreni sarà possibile raggiungere l'obiettivo di eradicare la Fame nel Mondo e di ridurre la povertà.

La Commissione Lancet

Nel 2009 è stata istituita la Prima Commissione *Lancet* sui Cambiamenti Climatici e la loro ripercussione sulla salute, al fine di mappare l'impatto dei Cambiamenti climatici e definire le necessarie risposte politiche per assicurare alla popolazione mondiale standard di salute i più elevati possibile. Ancora una volta ci si rende conto come solo operando a livello globale è possibile intervenire sulle popolazioni, siano esse umane o animali e sull'ambiente. I cambiamenti climatici inducono effetti diretti, sul territorio, ed effetti indiretti, come la qualità delle acque, l'inquinamento, le modifiche nell'uso delle terre, squilibri ecologici, ma inducono anche dinamiche sociali nuove, fra cui migrazioni e conflitti [10].

È evidente come, a livello internazionale, le fonti alimentari di derivazione animale necessitano della disponibilità di Servizi Veterinari preparati e competenti, e di risorse umane e strumentali indispensabili, al fine di verificare e garantire la salute degli animali e l'assistenza agli allevatori, per ottenere le necessarie condizioni igienico-sanitarie degli alimenti e anche per migliorare la redditività degli allevamenti e delle produzioni agricole in generale.

FAO/OIE/OMS "*Tripartite Alliance – Concept note*"

Al fine di ottenere una gestione più efficace anche delle malattie ad alto impatto zoonosico, vi è la necessità di migliorare le capacità diagnostiche a livello globale, di fare analisi dei dati e la valutazione del rischio, avere conoscenze di tipo epidemiologico, di scienze sociali e di comunicazione. C'è bisogno di reti di collaborazione fra istituzioni che si occupano di salute umana e veterinaria, c'è bisogno di sistemi informativi ed informatizzati che permettano lo scambio di conoscenze e di dati in tempo reale e che permettano di condividerli in modo trasversale e verticale. La creazione di reti tra i Paesi promuove la fiducia, la trasparenza e la cooperazione. OIE, FAO e OMS si sono impegnate a lavorare a più stretto contatto per allineare le attività relative all'interfaccia uomo-animale-ambiente, al fine di sostenere i Paesi membri. L'emergere di nuove patologie o il riemergere di malattie esistenti, comprese le zoonosi, la crescente minaccia delle malattie animali transfrontaliere, l'impatto dei cambiamenti ambientali e la globalizzazione, così come le nuove esigenze della società legate alla sicurezza alimentare, alla assicurazione degli alimenti a tutte le popolazioni, alla salute pubblica e al benessere degli animali, sottolinea la necessità della collaborazione tra le tre Organizzazioni Internazionali.

Nel quadro dell'accordo fra FAO, OIE e OMS sono state definite le rispettive responsabilità nella lotta contro le malattie, comprese le zoonosi, che possono avere un grave impatto sanitario ed economico sulle popolazioni umane ed animali. Le tre Organizzazioni hanno lavorato insieme per molti anni per prevenire, individuare, controllare ed eliminare i rischi di malattie per gli esseri umani trasmesse, in modo diretto o indiretto, dagli animali. Nel 2010, la "Triade FAO / OIE / OMS" ha riconosciuto ufficialmente questa stretta collaborazione, con stra-

tegie comuni da attuare in relazione alla consapevolezza dell'interfaccia uomo -animale- ambiente, per sostenere i Paesi membri nelle attività di prevenzione e controllo delle malattie (*Concept Note*, Aprile 2010) [11].
La prevenzione delle emergenze epidemiche e della diffusione delle malattie infettive umane e animali è riconosciuto come "bene pubblico", con ripercussioni sociali ed economiche a livello globale anche per il futuro, per cui OIE, FAO e OMS incoraggiano la solidarietà internazionale nel controllo delle malattie umane e animali, fornendo sostegno internazionale ai Paesi membri che chiedono assistenza per impostare Piani di controllo e di eradicazione delle malattie sia nell'uomo sia negli animali.
Nel 2010 sono state definite tre aree prioritarie di lavoro: influenza, rabbia e lotta alla resistenza antimicrobica

Concetto di "una salute" (One Health)
Attualmente i Paesi si trovano ad affrontare con maggiore frequenza la comparsa di malattie infettive, che si diffondono da un Paese all'altro, senza tenere conto dei confini politici e ciò costituisce una sfida per le istituzioni veterinarie pubbliche e per i servizi sanitari che debbono individuare nuovi e più olistici approcci di controllo.
Anche se lo slogan "*One World - One Health*" (*OWOH*) è stato utilizzato a partire dal 2004 [12], considerando unico l'ecosistema "animali (domestici e selvatici) – uomo", il concetto di "*One Medicine*" risale a Calvin Schwabe in "*Schwabe's Veterinary Medicine and Human Health"*. Fin dalla prima edizione era stigmatizzato il concetto di un unico approccio, umano ed animale alle zoonosi, e nella terza edizione tale enunciato divenne "*One Medicine*" [13-16]. Questo concetto ha guadagnato l'attenzione internazionale negli ultimi anni [17], con un approccio che riconosce come la salute degli esseri umani e degli altri animali è un'entità unica e l'uomo e gli animali non umani condividono lo stesso mondo e hanno un' influenza reciproca sull' ambiente in cui vivono [18].
Ciò ha focalizzato l'attenzione sul concetto di malattie emergenti-riemergenti, la gran parte delle quali sono zoonosi, che spesso causano un impatto devastante sull'uomo, sugli animali e sull'ambiente. La loro emergenza è influenzata da fattori socio-economici, ambientali ed ecologici. L'interazione tra gli esseri viventi, compresi gli agenti patogeni, che condividono lo stesso ambiente, deve essere visto come un sistema unico, dove diverse componenti possono svolgere un differente ruolo:

1. il commercio di animali e prodotti di origine animale a livello globale e la necessità di un approccio multidisciplinare e internazionale;
2. la fauna selvatica e i fattori ambientali per la diffusione e il mantenimento delle infezioni;
3. l'importanza fondamentale dell'integrazione dei trattamenti terapeutici umani e veterinari in una strategia "di medicina unica" e la necessità di operare in modo multidisciplinare;
4. la necessità di una visione completa su tutta la filiera produttiva, "dalla fattoria alla tavola";
5. i flussi migratori che conducono alla comparsa in territori nuovi, di agenti patogeni "antichi" e alla scoperta di "nuovi" patogeni quando l'uomo entra in ecosistemi nei quali era assente;
6. l'adattamento degli agenti patogeni a nuovi ospiti o in condizioni ecologiche differenti rispetto al passato;
7. la capacità dei vettori ad adattarsi a condizioni ambientali differenti rispetto ai luoghi di origine [19].

La sicurezza alimentare è una materia complessa, spesso tra le cause sottese a crisi geopolitiche ed essa rappresenta un valore primario, essenziale alla costruzione di un futuro sostenibile che, tuttavia, merita approfondimenti e incisivi interventi di coordinamento a livello comunitario e internazionale. Numerosi gli spunti di riflessione sulle strette connessioni e interdipendenze tra il settore alimentare - nei suoi vari aspetti - e i fattori sociali, culturali, geopolitici e strategici. Varie le tematiche oggetto di approfondimento: dall'accaparramento delle terre alla geopolitica dell'alimentazione, dalla gestione del territorio alla sicurezza, dagli aspetti economico-finanziari a casi specifici in Africa e in Asia, con riferimento al fenomeno della migrazione. Il tutto senza trascurare un approccio nuovo dell'*intelligence* che, nel campo alimentare, individua le frontiere di una minaccia integrata capace di sommare interessi spionistici, competizione economica e ambizioni geopolitiche [20].

L'unione Europea
L'approccio dell'Unione Europea alla garanzia del consumatore riguardo la sicurezza alimentare è quello di una regolamentazione sulla sicurezza "dai campi alla tavola", che affida un ruolo fondamentale ai vari operatori del settore, dalle autorità pubbliche ai produttori, che sono i responsabili delle proprie produzioni e devono garantirne l'igienicità e la sicurezza.
L'adozione di standard di controllo lungo la filiera può contemperare l'esigenza di tutela del consumatore con gli interessi delle aziende produttrici [21].

La medicina veterinaria in Italia: elemento essenziale della Sanità Pubblica
I Servizi Veterinari sono essenziali per garantire la salute e il benessere delle popolazioni umane ed animali, e per fare in modo che il rapporto uomo-animale–ambiente sia ottimale. Da quando si parla di

"Salute unica", di "Medicina unica", di "Un mondo una salute", di "Una Medicina una Scienza", tale concetto è condiviso a livello internazionale, ma, in alcuni Paesi, fra cui sicuramente l'Italia, la consapevolezza che la Sanità e l'interazione uomo-animale-ambiente siano un *unicum* è un concetto antico. In Italia, si può far risalire al Rinascimento, e, negli ultimi 60 anni, i Servizi Veterinari sono stati organizzati in coerenza con tale visione [22].

L'efficacia, l'efficienza e la sostenibilità dei servizi sanitari, sia nel settore veterinario sia per quanto riguarda la salute pubblica, aumentano fortemente se le azioni sono attuate congiuntamente e il concetto di gemellaggio fra Paesi e fra le organizzazioni sanitarie dei Paesi è parte della costruzione della infrastruttura a livello globale per la lotta alle malattie degli animali, comprese le zoonosi, e per garantire la sicurezza alimentare e la salute a livello mondiale, con un rapporto costo-beneficio positivo per la comunità internazionale

L'assenza di malattie, incluse le zoonosi, nonché l'igiene degli alimenti e la sicurezza, sono fattori primari per il benessere dell'uomo

Migliorare la salute e il benessere degli animali aumenta la disponibilità e la qualità delle proteine per la popolazione umana e contribuisce a preservare le terre coltivabili dall'abbandono, garantire la salute degli animali e la sicurezza dei prodotti di origine animale impedisce problemi sanitari per l'uomo, pertanto, la Comunità deve assicurare la funzione dei Servizi Veterinari ufficiali "dalla stalla al consumatore".

In Italia, riconoscendo la funzione del veterinario ufficiale come unica e con la consapevolezza che la salute e il benessere sia dell'uomo sia degli animali siano fra loro interdipendenti, sono stati istituiti gli Uffici Veterinari a livello di Comunità, finanziati sia con contributi pubblici, sia con contributi dei privati, fin dal 1930.

Risale al 1934 il Testo Unico delle Leggi Sanitarie [23] che, fra altro, obbligava i Comuni a:

- costruire un macello in quanto "infrastruttura di sanità pubblica" obbligatoria;
- assumere un veterinario comunale:
- prestare attenzione alla salute ed al benessere degli animali negli allevamenti;
- dirigere il mattatoio;
- effettuare l'ispezione degli alimenti negli esercizi di vendita e nelle strutture dove si distribuivano alimenti a qualsiasi titolo [24].

La Sanità pubblica veterinaria in Italia e gli Istituti Zooprofilattici Sperimentali

A partire dall'inizio del Ventesimo secolo in Italia vengono istituiti i 10 Istituti Zooprofilattici Sperimentali (IIZZSS), il *primum movens* nel 1907: la "Stazione Sperimentale per la Lotta all'Afta e per la Polizia Sanitaria pratica di Milano", oggi IZS Lombardia ed Emilia Romagna, e l'ultimo nel 1941, l'"Istituto Zooprofilattico Interprovinciale di Teramo ed Ascoli Piceno", oggi IZS Abruzzo e Molise. I 10 IIZZSS oggi presenti sul territorio nazionale, nel corso degli anni, dalle origini fino agli anni '70, hanno subito evoluzioni di tipo legislativo, organizzativo ed amministrativo ma proprio fin dagli anni '70 si tracciano le linee d'intervento dello Stato in materia veterinaria, che definiscono la strategia di lotta alle malattie degli animali in Italia. Questi provvedimenti, insieme ai provvedimenti assunti nel 1961 [25], sull'alimentazione animale e l'igiene degli alimenti, compongono un unico *corpus* legislativo e sanciscono la nascita della Sanità Pubblica Veterinaria contemporanea in Italia. Un modello culturale ed istituzionale che la maggioranza della professione veterinaria, in Italia e nel mondo, comincerà a capire e a condividere, solo cinquant'anni più tardi. La strategia si basava, per usare le stesse parole di Luigino Bellani, l'allora Capo dei Servizi Veterinari in Italia,

«...[omissis] sull'ammodernamento ed il potenziamento delle strutture tecniche del servizio veterinario, l'adeguamento degli indirizzi dell'azione profilattica a principi moderni e collaudati dall'esperienza, l'ampliamento e l'intensificazione delle possibilità operative nel settore del risanamento dalla tubercolosi bovina e dalle brucellosi, la possibilità di più consistenti provvidenze finanziarie per le aziende eventualmente colpite da alcune gravi malattie degli animali».

Un elemento che ebbe un grosso peso nella mutazione degli Istituti Zooprofilattici Sperimentali fu la promulgazione della Legge n. 101/1974 [26], che sottolineava il carattere pubblico degli Istituti e, per la prima volta, venivano attribuiti agli Istituti compiti internazionali attribuendo loro, previa autorizzazione del Ministero della Sanità, anche l'esercizio di attività di assistenza tecnica ai Paesi in via di sviluppo, a seguito degli accordi di cooperazione tecnico-scientifica nel settore veterinario tra l'Italia ed i Paesi esteri [27].

La consapevolezza, già a metà del secolo XX, che la salute dell'uomo e degli altri animali era una sola ed era più efficace ed efficiente prevenire l'insorgenza delle malattie negli animali, per poter proteggere la salute dell'uomo, ha portato a stabilire specifici Piani di lotta alle malattie e studi sperimentali per approfondirne le conoscenze.

Il riconoscimento del ruolo della Medicina Veterinaria in materia di sicurezza alimentare e per la sicurezza e la prevenzione delle malattie nell'uomo, ha fatto sì che la Direzione Generale dei Servizi Veterinari, fin dalla sua istituzione, nel 1946, sia stata annessa al Ministero della Salute italiano.

Ciò ha comportato la crescita di una cultura della

Sanità Pubblica Veterinaria che ha avuto dei maestri e dei precursori, nelle figure di Giuseppe Caporale, di Luigino Bellani, di Adriano Mantovani, di Vincenzo Caporale, che hanno segnato la Storia della Medicina Veterinaria in Italia, in relazione al concetto di interrelazione Uomo-Animale-Ambiente, con un approccio multidisciplinare ai problemi e con la consapevolezza che se l'ambiente è condiviso, è possibile tenere sotto controllo il bene sociale. Grazie a tali personaggi di elevata levatura scientifica, l'Italia è riconosciuta come uno dei Paesi di riferimento della SPV a livello mondiale.
La Leptospirosi, l'inquinamento da mercurio, la Schistosomiasi, la contaminazione da diossine, il Virus Ebola, le Pesti, l'inquinamento da Pesticidi, l'Antrace, l'Influenza, la *West Nile Disease*, la Rabbia, sono solo pochi esempi di problematiche di Sanità Pubblica che danno la chiara evidenza di come si possa intervenire al fine di prevenire e/o di controllarne l'insorgenza, solo tenendo in considerazione l'interrelazione "Uomo-Animale-Ambiente".
A livello internazionale, il vero sforzo è imparare a costruire e a condividere conoscenze comuni in modo sostenibile.

I 5 Capitoli del successo sostenibile dell'IZSAM "G. Caporale"

Un esempio di successo sostenibile per la Cooperazione, è la collaborazione tra l'IZSAM, il Ministero dell'Agricoltura della Namibia e il Laboratorio Centrale Veterinario (CVL) di Windhoek
Una storia vecchia di più di 20 anni per una collaborazione sostenibile e di successo, di cui si ripercorrono i passi più importanti:
1993-2004: risorse finanziarie, umane e strumentali, per lo studio delle malattie comuni ad entrambi i Paesi o di quelle presenti in un Paese e che rappresentano un rischio per l'altro
- studio, sviluppo e validazione di metodi diagnostici e di vaccini;
- produzione di reagenti diagnostici in maniera collaborativa.

2005: allestimento e gestione congiunta di un laboratorio di virologia, con condivisione dei costi per le spese correnti.
2009: collaborazione con Zambia, Angola, Botswana.
2010: ricerca e sperimentazione su: Pleuropolmonite Contagiosa Bovina, Peste Equina, Encefalosi Equina, Arterite Virale Equina, Febbre della Valle del Rift, *Lumpy Skin Disease*, *Hearthwater*, Afta Epizootica, Morbo Coitale Maligno, Brucellosi. Programmi e progetti che hanno riguardato anche la protezione degli animali selvatici.
2011: progetto sulla sicurezza alimentare, finanziato nell'ambito di un *Twinning* OIE [28].

Il *Twinning* o Gemellaggio OIE è uno strumento dell'OIE, che finanzia specifici progetti di collaborazione fra un Laboratorio o Centro di Collaborazione OIE ed un Laboratorio diagnostico in un Paese membro, per migliorare le capacità diagnostiche dello stesso nei confronti di determinate malattie o problematiche sanitarie di rilevanza internazionale.
È un rapporto importante per stabilire reti di collaborazione duratura nel tempo tra istituzioni e Paesi.
Nuovi capitoli sono stati nel frattempo scritti, con lo stesso successo e cioè le collaborazioni ed i *Twinning* OIE con:
- Botswana
- Cuba
- Eritrea
- Tunisia
- Siria
- Libano

Nuovi orizzonti si sono aperti, soprattutto in Medio Oriente dove malattie come brucellosi e tubercolosi dominano nelle popolazioni animali e umane.
Le attività dell'IZSAM si sono concretizzate nel coordinamento delle reti fra i Centri di Collaborazione OIE, i Laboratori di Referenza OIE, i Centri di Referenza Nazionali, i Laboratori e i Centri di ricerca della regione Mediterranea, nella definizione di nuovi progetti *Twinning*, nello scambio di esperienze e condivisione di programmi di ricerca su Progetti che hanno accomunato gli interessi scientifici ed economici del Bacino del Mediterraneo, nella formazione del personale nei laboratori, nell'adattamento dei Sistemi informativi alle realtà territoriali dei Paesi della Regione Sudafricana, nella formazione per quanto riguarda la Qualità e la Biosicurezza nei laboratori.
Sicuramente è stata sviluppata la cultura
- dell'inclusione rispetto a quella dell'esclusione e della supremazia;
- della condivisione della conoscenza rispetto alla proprietà della conoscenza;
- dell'organizzazione trasversale rispetto all'organizzazione gerarchica.

La collaborazione con i Paesi in via di sviluppo ha prodotto conoscenza basata su elevati standard scientifici e sul consenso. Lo scambio di dati, di materiale di campo, di campioni biologici e di reagenti diagnostici e di riferimento ha permesso la crescita del personale e dei livelli di competenza dei Laboratori sia in Italia, sia nei Paesi con cui la collaborazione e la Cooperazione era ed è in atto.
Sono stati sviluppati e validati nuovi metodi di laboratorio e nuovi vaccini per la prevenzione delle malattie negli animali, sono stati organizzati circuiti interlaboratorio per la valutazione delle competenze di tutto il personale.
Infine, la cooperazione in Africa è:

- una responsabilità
- un'opportunità
- una palestra e un banco di prova

e, in definitiva, i "*Twinning* OIE" costituiscono un ponte per costruire un'infrastruttura sostenibile per le attività dei Servizi veterinari a livello mondiale [24].

Essi sono solo una parte dei progetti OIE per costruire le basi per "Un pianeta - Una salute"

E lo sforzo è di costruire reti regionali di competenza veterinaria per affrontare la sfida per il controllo delle malattie animali e per garantire la sicurezza a livello globale per quanto attiene al paradigma "Uomo-Animale-Ambiente".

Conclusioni

Il ruolo dei Servizi veterinari assume sempre più un valore fondamentale per fornire un contributo adeguato alla Sanità Pubblica e alla riduzione della povertà nei Paesi in via di sviluppo, oltre che per garantire un futuro sostenibile quando la popolazione umana raggiungerà il traguardo dei 9 miliardi di persone sulla Terra.

Ciò presuppone la disponibilità di professionisti adeguati, l'adeguamento dei *Curricula* Universitari a livello mondiale, ed un approccio olistico per quanto riguarda la salute dell'uomo, degli animali e dell'ambiente [29].

Sarà necessario acquisire maggiori competenze sull'analisi dei costi/benefici per individuare la migliore risposta in caso di epidemie e l'acquisizione di tutti gli strumenti per prevenire, diagnosticare e combattere le malattie in tempi rapidissimi. Sarà necessario garantire il livello igienico sanitario degli alimenti, il miglioramento delle produzioni, la difesa dell'agricoltura familiare e delle produzioni rurali tradizionali, in quanto sono molto diffuse proprio nei territori che più necessitano di un contributo allo sviluppo dell'economia dei Paesi.

Bibliografia

1. United Nations. Economic and Social Affairs Population Division. World Population Prospects: The 2015 Revision Key Findings and Advanced Tables: ESA/P/WP.241; 2014

2. Travis DA, Sriramarao P, Cardona C, Steer CJ, Kennedy S, Sreevatsan S, Murtaugh MP. One Medicine One Science: a framework for exploring challenges at the intersection of animals, humans, and the environment. Ann. N. Y. Acad. Sci. 2014; 1334: 26-44.

3. World Health Organization. Future trends in veterinary public health. Gruppo di lavoro OMS: TE, Italy, 1999. Available from: http://www.who.int/zoonoses/vph/en/; Last visited 05/10/2015.

4. Baldelli R. Sanità Pubblica Veterinaria: dove? 2012. Available from: http://www2.vet.unibo.it/staff/Baldelli/Sanità%20Pubblica%20Veterinaria%202013.2014/PRESENTAZIONI/2.%20concetto%20di%20SANITA'%20PUBBLICA%20VETERINARIA.pdf; Last visited 05/10/2015.

5. EXPO, Milano 2015, Guida del Tema. A cura del gruppo di lavoro TEG Tema Coordinamento editoriale Direzione Thematic Spaces. Con il contributo di Marco Amato e Stefano Karadjov. Render a cura di Centro Sviluppo Realtà Virtuale S.r.l. Available from: http://www.expo2015.org/it/cose/il-tema; Last visited 05/10/2015.

6. Parodi P, Venturi L, Dlamini B, Mc Grath P. International trade and public health in Africa: the example of Swaziland. Giornale Italiano di Medicina Tropicale 2011; 16 (3-4):13-22.

7. Food and Agriculture Organization. Direttore Generale della FAO Sicurezza alimentare e crisi migratoria sono correlate; 2015. Available from: http://www.fao.org/news/story/it/item/332007/icode/; Last visited 05/10/2015.

8. Giordano A. Crisi alimentari, migrazioni e sicurezza. Gnosis rivista italiana di intelligence 2015; 1: 115-121.

9. Food and Agriculture Organization. Meeting the 2015 international hunger targets: taking stock of uneven progress. Hunger Report (The State of Food Insecurity in the World 2015 - SOFI); 2015. Available from: www.fao.org/hunger/en/; Last visited 05/10/2015.

10. Watts N, Adger WN, Agnolucci P, Blackstock J, Byass P, Cai W, Chaytor S, Colbourn T, Collins M, Cooper A, Cox PM, Depledge J, Drummond P, Ekins P, Galaz V, Grace d; Graham H, Grubb M, Haines A, Hamilton I, Hunter A, Jiang X, Li M, Kelman I, Liang L, Lott M, Lowe R, Luo Y, Mace G, Maslin M, Nilsson M, Oreszczyn T, Pye S, Quinn T, Svensdotter M, Venesky S, Warner K, Xu B, Yang J, Yin Y, Yu C, Zhang Q, Gong P, Montgomery H, Costello A. Health and climate change:policy responses to protect public health. The Lancet Commission. www.thelancet.com June 23, 2015, Available from: http://dx.doi.org/10.1016/S0140-6736(15)60854-6; Last visited 05/10/2015.

11. Food and Agriculture Organization - World Animal Health Organization – World Health Organization. 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, April 2010. Available from: http://www.who.int/influenza/resources/documents/tripartite_concept_note_hanoi_042011_en.pdf Last visited 05/10/2015.

12. Wildlife Conservation Society. Summary of

Conference One World-One Health: Building Interdisciplinary Bridges to Health in a Globalized World. New York, 29 September 2004. The Rockefeller University, New York. Available from: http://oneworldonehealth.org/sept2004/owoh_sept04.html (Accessed 8 October 2015).

13. Schwabe CW. Veterinary Medicine and Human Health. Williams & Wilkins: Baltimore, 1964; xvii, 1-516.

14. Schwabe CW. Veterinary Medicine and Human Health. 3rd edn. Williams & Wilkins: Baltimore, 1984; xix, 1-680.

15. Cardiff RD, Ward JM, Barthold SW. "One medicine – one pathology": are veterinary and human pathology prepared? Lab. Invest. 2008; 88, 18-26.

16. Battelli G, Mantovani A. The veterinary profession and one medicine: some considerations, with particular reference to Italy. Vet. Ital. 2011; 47 (4): 389-395.

17. Meisser A, Schelling E, Zinsstag J. One Health in Switzerland: A visionary concept at a crossroads? Swiss Med Wkly. 2011;141:w13201.

18. Seimenis AM. Zoonotic diseases in the Mediterranean region: a brief introduction. Vet. Ital. 2008; 44 (4): 573-576.

19. Lelli R, Monaco F, Cito P, Calistri P. Factors influencing the risks of emerging animal diseases in the Mediterranean Regions: a review. Giornale Italiano di Medicina Tropicale 2011; 16 (3-4): 83-91.

20. Linzi G. GNOSIS rivista italiana di intelligence. Editoriale 1/2015; Available from:http://gnosis.aisi.gov.it/Gnosis/Rivista42.nsf/servnavig/11 Last visited 08/10/2015.

21. Commissione europea. Le politiche dell'Unione europea. Sicurezza dei prodotti alimentari: Direzione Generale della Comunicazione. Dai campi alla tavola: alimenti sicuriu e sani per tutti. Novembre 2014 Available from: http://europa.eu/pol/pdf/flipbook/it/food_it.pdf; Last visited 12/10/2015.

22. Battelli G. Medicina unica – salute unica: per l'uomo, per gli animali e per l'ambiente. Giornale Italiano di Medicina Tropicale 2014; 19 (4): 17-23.

23. Italia: Regio Decreto 27 luglio 1934, n. 1265. Testo unico delle leggi sanitarie. GU n.186 del 9-8-1934-Suppl. Ordinario n. 186.

24. Caporale V. Sustainability of fight against infectious diseases of animals. Twinning projects in Africa, a bridge across countries to build a transboundary network. Journal of Commonwealth Veterinary Association - Proceedings of the 5th Pan Commonwealth Veterinary Conference - Special Issue July 2011; 27 (2).

25. Italia: Decreto Presidente della Repubblica (D.P.R.) 11 Febbraio 1961, n. 264. Disciplina dei servizi e degli organi che esercitano la propria attività nel campo dell'igiene e della sanità pubblica. G.U n. 100, 22 Aprile 1961.

26. Italia: Legge 11 marzo 1974, n. 101. Modifica della legge 23 giugno 1970, n. 503, sull'ordinamento degli Istituti zooprofilattici sperimentali. GU n.100, 17 Aprile 1974.

27. Caporale V. La funzione degli Istituti Zooprofilattici Sperimentali dal XIX al XXI secolo, una storia italiana di cultura, passioni, grandezza e varia umanità. p 65-98. Atti della Conferenza "La Medicina Veterinaria Unitaria (1861-2011)", 22 Giugno 2011, Ministero della Salute, Roma. Edito a cura della Fondazione Iniziative Zooprofilattiche e zootecniche, Brescia 2014 - ISBN 978-88-97562-08-5.

28. Caporale V, Lelli R, Scacchia M, Pini A. Namibia: un esempio di cooperazione internazionale per lo studio delle patologie emergenti. Vet. Ital. 2009, 45 (2): 243-248.

29. Muma JB, Mwacalimba KK, Munang'andu HM, Matope G, Jenkins A, Siamudaala V, Mweene AS, Marcotty T. The contribution of veterinary medicine to public health and poverty reduction in developing countries. Veterinaria Italiana 2014; 50 (2): 117-129.

Sanità pubblica veterinaria e cooperazione allo sviluppo

Il bosco e le foglie - riflessioni di un addetto ai lavori

F. MORIN

Già Funzionario della Commissione Europea, Bruxelles, Belgio

Riassunto - La Sanità pubblica veterinaria (SPV) fa parte delle attività messe in opera nell'ambito della cooperazione allo sviluppo. La SPV contribuisce allo sviluppo ma la maggioranza degli interventi non viene etichettata come SPV, bensì la troviamo in programmi/progetti, in ambito "commercio internazionale", "sicurezza alimentare", "agricoltura", "ambiente" e "ricerca biomedica". Una buona fonte di informazione sulla SPV nei Paesi in via di sviluppo è costituita dai *Performance of Veterinary Services* (PVS) *Gap analysis*" dell'Organizzazione mondiale di sanità animale (OIE). Risalta dall'analisi dei rapporti che tanto più un Paese sta "sviluppandosi", tanto più acquista importanza la SPV, non solo per posizionarsi sui mercati internazionali, ma anche per garantire ai suoi consumatori cibo sicuro. Il contributo più importante della SPV allo sviluppo è certamente passato per l'Accordo sulle Misure Sanitarie e Fitosanitarie, noto come "Accordo SPS". Le attività di SPV stanno assumendo sempre più importanza nell'aiuto allo sviluppo, soprattutto grazie al rilievo assunto dal commercio internazionale e dai diritti dei consumatori, sulla base dell'argomentazione che riconosce in quasi ogni misura di SPV una misura "SPS", ma la SPV potrebbe posizionarsi in modo più visibile negli altri campi come l'ambiente, la nutrizione, la ricerca biomedica.

Parole chiave: sanità pubblica veterinaria, cooperazione allo sviluppo, Accordo SPS

Veterinary Public Health and Development Cooperation: the wood and the leaves – some considerations by a development practitioner

Summary - Veterinary Public Health (VPH) is part of the activities put in place in the context of development cooperation. VPH contributes to development, but the majority of VPH interventions is not labeled as VPH but are rather programs/projects, in the "international trade", "food security", "agriculture", "environment" and "biomedical research" sectors. A good source of information on VPH in developing countries are the "Public Veterinary Services (PVS) Gap analysis" reports. The analysis of Office International des Epizooties (OIE) PVS Gap analysis shows that the more a country is developed, the more VPH acquires importance, not only in relation to it accessing international markets, but also to ensure safe food to its consumers. The most important way VPH is contributing to development is certainly via the implementation of the Agreement on Sanitary and Phytosanitary Measures, (SPS Agreement). VPH in development aid is growing, due to the importance taken by international trade and consumer rights, on the basis of the argument that acknowledges that almost every VPH measure might be an SPS measure, but VPH could better position itself more visible in other fields such as environment, nutrition, biomedical research.

Key words: veterinary public health, development cooperation, SPS Agreement

INTRODUZIONE

Invitata a condividere alcune riflessioni sulla base della mia esperienza di "Funzionario per il sostegno alla qualità - temi veterinari" alla Commissione europea (CE) presso la direzione che oggi si chiama Direzione Generale della Cooperazione Internazionale e dello Sviluppo (Directorate-General for International Cooperation and Development-DEVCO), sul tema "Sanità pubblica veterinaria (SPV) -cooperazione-politica-sviluppo", in varie combinazioni, presenterò prima alcune considerazione generali per posizionare la SPV nell'aiuto allo sviluppo, poi le mie riflessioni sul perché è così raro leggere di SPV in quanto tale nei documenti di cooperazione e di sviluppo, alcuni dati sulla SPV nelle priorità di alcuni paesi, sulla base dei rapporti "*Performances of Veterinary Services (PVS) Gap analysis*" dell'Office International des Epizooties (OIE) ed infine indicherò dove in pratica troviamo e troveremo la SPV.

La Direzione generale DEVCO, è divisa in direttorati, suddivisi in unità, che lavorano su base geografica, e direttorati che lavorano su tematiche specifiche, per esempio le problematiche del cambio climatico, dell'ambiente e delle risorse naturali. L'unità

Corrispondenza: Dr Fiorenza Morin,
E mail: mfiore14@libero.it

che si occupa di sviluppo rurale, sicurezza alimentare e nutrizione, è anche referente per le tematiche veterinarie. Il ruolo del funzionario per il sostegno alla qualità é di fornire, sul suo tema di competenza, un appoggio tecnico ai colleghi di tutto il direttorato, fornendo il suo parere tecnico (non vincolante) sulla qualità di un progetto, come per esempio un progetto di sostegno alla filiera bovina in un paese saheliano, oppure sul progetto "Laboratori di referenza africani per la gestione delle malattie e parassitosi delle api e altri insetti pronubi". La qualità dei progetti viene definita da criteri che costituiscono la base della "check-list" utilizzata. I criteri possono essere generali, come per esempio l'allineamento con la politica del Paese nel settore, o specifici a seconda dell'argomento. Per esempio in un progetto di sostegno ai laboratori si guarderà alle caratteristiche tecniche del laboratorio, alla sua sostenibilità o agli aspetti ambientali come lo smaltimento dei rifiuti. Un altro elemento molto importante di questo lavoro è quello di coordinamento con i colleghi delle altre Direzioni Generali della Commissione su temi specifici, per garantire la coerenza tra le diverse politiche comunitarie, per esempio la coordinazione intra commissione sul tema dell'influenza aviaria.

MATERIALI E METODI

Per scrivere queste riflessioni mi sono basata, da un lato e soprattutto, sulla mia esperienza di funzionario della Commissione Europea, e dall'altro lato sulla consultazione e analisi dei documenti dell'OIE, della Commissione e del Parlamento europeo, e sull'analisi dei siti web della "Organizzazione per l'Agricoltura e l'Alimentazione" FAO, Organizzazione Mondiale della Sanità (OMS), *Donor global platform for rural development, Scaling Up Nutrition (SUN), The global fund to fight AIDS, tuberculosis and malaria, Standard and Trade Development Facility* (STDF) e i siti dei vari progetti citati.

Sanità Pubblica Veterinaria - Cooperazione-Politica-Sviluppo

La Commissione Europea è attiva nell'ambito della cooperazione internazionale sin dal trattato di Roma, per un "incidente della storia" che ha avuto la sua base legislativa solo nel trattato di Maastricht.
Nel maggio 1956, verso la fine delle negoziazioni del trattato di Roma, la Francia, a sorpresa, esige l'associazione dei suoi territori d'oltremare alla futura Comunità economica europea (CEE); gli altri paesi, ad eccezione del Belgio, non erano favorevoli; alla fine si giunse a un compromesso per cui i quattro paesi che ancora possedevano territori d'oltremare, accettarono di abbandonare le relazioni economiche di quasi esclusività con i loro territori, aprendone i mercati all'insieme dei futuri membri della CEE e, in compenso, gli stati fondatori accettarono di partecipare al finanziamento della valorizzazione di questi territori.
Ma è il trattato di Maastricht – trattato dell'Unione europea (TUE) 1993, che segna una svolta per la cooperazione allo sviluppo, in quanto, per la prima volta, nel suo titolo XVII, conferisce a questa politica una base giuridica specifica.
A livello interno ricordo che la sanità animale e dei prodotti agricoli, in quanto possibile ostacolo al completamento del mercato unico interno, fa parte delle competenze comunitarie (competenze concorrenti), mentre la salute umana è competenza degli Stati membri. I trattati stabiliscono chiaramente che spetta agli Stati membri definire la loro politica sanitaria, organizzare e fornire i servizi sanitari e l'assistenza medica, compresa l'attribuzione delle risorse necessarie. L'Unione europea (UE) si limita in gran parte a integrare e sostenere le attività svolte a livello nazionale, laddove il coordinamento, la cooperazione e lo scambio di informazioni, conoscenze e migliori pratiche rappresentano la soluzione migliore e, se opportuno e nel rispetto con il principio di sussidiarietà, fa ricorso a strumenti legislativi per regolamentare taluni settori.
E' anche interessante ricordare che il Regolamento sanitario internazionale, (RSI) International Health Regulation - (IHR) del 2005 ha attinto molto dall'esperienza e dalla prassi dei servizi veterinari nel controllo delle malattie infettive.
Dall'associazione dei territori e paesi d'oltremare (trattato di Roma) con perseveranza e pragmatismo, a testimonio della "creatività politica" della commissione dell'epoca, (per riprendere le belle parole di Dieter Frisch [1]), si é arrivati alla situazione attuale dove l'UE è tra i più importanti donatori e la dimensione dell'aiuto allo sviluppo è chiaramente legata alla promozione di valori europei come la democrazia e i diritti umani. Nell'ambito dell'architettura europea attuale, le attività di cooperazione allo sviluppo della Commissione sono svolte dalla Direzione Generale DEVCO e dalle sezioni "cooperazione" delle Delegazione dell'UE nei Paesi in via di Sviluppo (PVS). La sede centrale (Bruxelles) ha funzioni di messa in opera dei programmi e progetti che non è possibile decentrare, per esempio i programmi "intra-ACP" (ACP: Africa, Caraibi, Pacifico), ossia quei programmi che coprono più paesi, per i quali c'è bisogno di una visione "dall'alto" e di contatti frequenti con tutti i paesi, per esempio il programma "Edu-link" che finanzia cooperazioni tra università e centri d'insegnamento di paesi europei e paesi ACP. Tra le iniziative finanziate da Edu-link citiamo ad esempio EAR-HEALTH - Institutional capacity building through an East African postgraduate teaching programme 'Public

Health' (Sviluppo di capacità delle istituzioni mediante la creazione di un programma di insegnamento postuniversitario in Sanità pubblica in Africa dell'Est). La sede centrale ha inoltre importanti funzioni di coordinamento e dialogo con le altre istituzioni europee, le organizzazioni internazionali e i rappresentanti della società civile.
Appena accettato di scrivere sull'argomento, mi sono chiesta, ma in che ordine? Serve una breve presentazione del contributo della SPV allo sviluppo, alle politiche di sviluppo, alle politiche di sviluppo della cooperazione, oppure ci chiediamo quale sia stato il contributo della cooperazione alla SPV?

Il contributo della SPV allo sviluppo
Il contributo della SPV allo sviluppo, è stato trattato egregiamente in articoli scientifici e di "*advocacy*" (difesa dei meriti), ne ricorderò solo due: il lavoro Mantovani-Marabelli et al. - La SPV spiegata ai Pubblici Amministratori' [2] e l'articolo apparso sulla rivista Veterinaria Italiana "*The contribution of veterinary medicine to public health and poverty reduction in developing countries*, di John B. Muma et al. [3], un articolo esaustivo, dove l'unica vera dimenticanza è la componente benessere animale. Ma questo contributo viene raramente valorizzato come tale. Per esempio i programmi di sostegno alla biodiversità in Africa, nelle zone dei grandi primati, comprendono spesso una componente di sanità e controllo delle malattie potenzialmente zoonotiche, ma questa non verrà mai indicata come SPV, e a volte i Servizi Veterinari (SV) pubblici sono stati coinvolti in modo insufficiente. Il rapporto dei veterinari con i medici, che può essere applicato, mutatis mutandis, al rapporto con il personale dei servizi di cooperazione, è stato descritto con un umorismo che la traduzione non rispecchia in un rapporto OMS/FAO/OIE del 2004 [4] "*An under estimated area is the preventive measures that may be taken to prevent or control emerging zoonoses. The debate between the disciplines human and veterinary medicine may be summarized by a discussion between such representatives about the same disease; the physician: this is very rare; I've hardly seen it in my career. The veterinarian: thanks to our initiatives and efforts this problem is under control"* - "Un settore sottostimato è quella delle misure preventive che possono essere prese per prevenire o controllare una zoonosi emergente. Il dibattito tra le discipline "medicina umana" e "medicina veterinaria" può essere riassunto da una discussione tra i rappresentanti di queste discipline a proposito della stessa malattia; il medico: "E' molto rara, in tutta la mia carriera, ne ho visto pochissimi casi, il veterinario: "Grazie alle nostre iniziative e sforzi questo problema è sotto controllo".
In sintesi, si può certamente affermare che la SPV è conosciuta, riconosciuta e anche praticata, ma la maggioranza degli interventi non viene etichettata come SPV e i SV, almeno nel passato, non hanno espresso una grossa domanda di finanziamenti dei servizi di SPV.

Il contributo della SPV alle Politiche di Sviluppo
Le politiche di sviluppo di chi? Nel corso di un serie di riunioni svoltesi a Parigi (2005), Accra (2008) e Busan (2011) sull'efficacia dell'aiuto allo sviluppo, i Paesi donatori e beneficiari si sono impegnati a rispettare un certo numero di principi, detti "principi della dichiarazione di Parigi". I primi due sono 1) l'appropriazione (*Ownership*): un maggior peso riconosciuto ai Paesi beneficiari nella definizione di strategie di sviluppo; 2) l'allineamento (*Alignment*) delle strategie di sviluppo sui documenti di programmazione economico e settoriale del Paese beneficiario.
Da alcuni anni, mettendo in pratica, questi buoni propositi, sono i Paesi beneficiari dell'aiuto internazionale che elaborano le loro politiche, politiche che i donatori devono solo accompagnare e sostenere e dunque anche la SPV va cercata nelle politiche e nei piani strategici dei Paesi beneficiari. Bisogna però ammettere che molto raramente troviamo referenze espresse alla SPV nei documenti nazionali. La stessa constatazione può essere fatta consultando i documenti dei principali donatori e le loro piattaforme per esempio sul sito della *global donor platform/livestock/pastoralism* [5], (piattaforma globale dei donatori/bestiame e allevamento/pastoralismo) - su cosa possono fare i donatori a sostegno dei pastoralisti, si legge al punto 3" i donatori possono aiutare lo sviluppo dell'allevamento e del pastoralismo sostenendo gli sforzi per affrontare le minacce alla salute animale ed umana in maniera olistica (*Donors help livestock development and pastoralism by supporting efforts to tackle challenges to human and animal health in a holistic way*), in mezzo alle problematiche fondiarie e la risoluzione dei conflitti.

Il contributo della Cooperazione internazionale alla SPV
Una tipica interrogazione europarlamentare, (che per fortuna nessuno ha ancora avuto l'idea di presentare!) potrebbe essere "Quale è il contributo della CE o dell'UE alla SPV nei PVS? Questo quesito, apparentemente facile da rispondere, è in realtà quasi impossibile perchè il sistema di classificazione delle attività della cooperazione, i codici "DAC, cioè i codici usati dal Comitato di aiuto allo sviluppo - *Development Assistance Committee* (DAC) dell'Organizzazione per la cooperazione e lo sviluppo economico (OCSE) per classificare i progetti o il settore di destinazione dei fondi, non presenta nessun codice che permetta di classificare facilmente un

progetto/programma come SPV. A questo problema si aggiunge la tendenza ad usare termini che sono sempre più dei grandi contenitori come "*Governance*, *global public good*", ecc, per cui solo una lettura completa ed approfondita dei documenti, di solito in forma di allegati, dunque ancora più difficili da recuperare, permette, a volte, di sapere cosa si nasconde dietro un titolo. La soluzione in questo caso sarebbe di andare a cercare all'interno dei programmi di aiuto tutto ciò che riguarda la salute, e vedere se ci sono fondi che vanno a settori che da vicino o lontano toccano la SPV, fare lo stesso per i fondi che vanno all'ambiente, i fondi che hanno un'etichetta agricoltura/ sottoetichetta allevamento, quelli dedicati alla ricerca, i fondi alla nutrizione, alla messa in opera degli accordi SPS (vedi sotto) e via dicendo. Una volta esaurita questa ricerca si potrà fare sia un semplice elenco, oppure dare delle cifre, che però saranno sempre cifre aggregate. In realtà, queste ricerche danno di solito dei risultati molto scarsi.

Nell'ambito della cooperazione internazionale la SPV è stata raramente inserita negli altri settori dove avrebbe pur potuto contribuire armoniosamente. Possiamo avere dei programmi di pura SPV, per esempio lotta alle zoonosi, alla rabbia, o controllo delle tripanosomiasi, ma quante attività di SPV troviamo appunto, nei programmi di cooperazioni del settore sanitario? Una rapida ricerca delle parole "*veterinary*" e " *animals*" su sito del Fondo globale per combattere HIV tubercolosi e malaria" (*The Global Fund to Fight AIDS, Tuberculosis and Malaria*) non ha prodotto risultati degni di essere citati. Una ricerca con le parole "*zoonosis*" e "*public health*" sui 600 e più progetti "*Livestock*" nella banca dati della Piattaforma dei donatori - settore *Livestock* porta alla luce otto e nove progetti rispettivamente. E del resto, quanta attenzione veniva data nei programmi di sviluppo dell'allevamento alle problematica dei residui e dell'antibiotico resistenza rispetto al massiccio "accesso degli allevatori agli *inputs*"? Se si scorrono i manuali per gli ausiliari veterinari ("*Community animal health worker*" *CAHW*) prodotti dai vari progetti, i problemi derivanti dall'inquinamento ambientale da antiparassitari, da farmaci e il problema degli antimicrobici vengono spesso solo accennati.

La tendenza attuale della cooperazione allo sviluppo e in particolare l'uso del "sostegno al bilancio' (*budget support*) come modalità di finanziamento rischia di essere una altra occasione persa. Un esempio ne è un programma di "sostegno al bilancio settoriale per la filiera latte" finanziato dalla CE in Colombia [6]. Benché il documento di presentazione citi la sicurezza sanitaria degli alimenti tra i motivi d'importanza strategica per il paese per motivare la scelta fatta, né negli indicatori scelti, né nelle attività presentate viene fatto alcun riferimento ad attività di SPV, mentre dall'altra parte, casi di zoonosi che possono essere legate al comparto latte in Colombia vengono segnalati e registrati dall'OIE.

PVS Gap analysis: le priorità espresse dai paesi in termini di SPV - Le stime dell'OIE sulla SPV

Una buona fonte di informazione sulla SPV nei PVS è costituita dal "PVS Gap *analysis*". L'OIE, oltre a produrre standards e linee guida nel campo della sanità animale, effettua anche, a richiesta dei Paesi interessati, delle valutazioni dei servizi veterinari, sulla base degli standard OIE, chiamati PVS - *Performance of veterinary services*. Dopo il PVS i Paesi interessati possono chiedere una missione "Gap *Analysis*", cioè una missione di una squadra di esperti che studia quali misure sarebbero necessarie per migliorare il livello del Paese, quantificando la spesa necessaria. I rapporti PVS Gap *analysis*, indicano quali sono le priorità dei servizi veterinari del Paese in termini di SPV e determinano quale sarebbe il *budget* necessario per permettere al Paese di migliorare il livello dei suoi servizi veterinari su criteri specifici, per esempio passare, per il criterio "sorveglianza epidemiologica", dal livello 2 "*I SV svolgono una sorveglianza attiva per certe malattie aventi un impatto economico e zoonotico ma la applicano solo ad una parte delle popolazioni sensibili oppure non lo aggiornano regolarmente*" al livello 3 "I SV svolgono una sorveglianza attiva per certe malattie importanti conformemente ai principi scientifici e alle norme OIE e la applicano a tutte le popolazioni sensibili ma non lo aggiornano regolarmente".

La tabella 1, elaborata a partire dai rapporti pubblici consultabili sul sito OIE (www.oie.int) riporta le priorità espresse da diversi Paesi in termini di SPV e la percentuale del budget totale dedicata alla SPV. Questi dati vanno letti tenendo presente che 1) nell'ambito dei GAP *analysis*, la SPV comprende: la sicurezza sanitaria degli alimenti, i farmaci e prodotto biologici veterinari e i residui. Le zoonosi sono trattate sia nella SPV che nella sanità animale; 2) i GAP *analysis* si basano sulle richieste degli Stati su quali competenze OIE vogliono migliorare e in che misura.

I PVS Gap *Analysis* ci mostrano come le priorità nella SPV cambino da Paese a Paese e siano quasi sempre legate allo sviluppo del commercio, e risalta il fatto che il farmaco veterinario è diventato un argomento importante. Questo è uno sviluppo molto interessante rispetto al passato, come già rilevato sopra; forse nel futuro avremo dei progetti di cooperazione, per rimediare ai danni prodotti da progetti di cooperazione precedenti!

Inoltre risalta dall'analisi dei rapporti che tanto più un Paese sta "sviluppandosi", tanto più acquista

Tabella 1 - *O.I.E. PVS Gap Analysis*

Paese	Priorità espresse dal Paese in termine di SPV	% del budget totale dedicata alla SPV
Sud Africa	Fornire lo stesso livello di sicurezza sanitaria degli alimenti ai consumatori nazionali e ai consumatori dei Paesi importatori. Garantire il controllo della distribuzione e uso del farmaco veterinario per garantirne un uso prudente ed efficace.	22%
Belize	Rafforzare la collaborazione tra i Servizi Veterinari ed il ministero della Salute nel campo della ispezione delle carni sia nella fase di macellazione che di lavorazione. Rafforzare il controllo del farmaco veterinario e il monitoraggio dei residui di farmaci negli alimenti. Prevenire e controllare le zoonosi, in particolare rabbia e brucellosi.	11%
Botswana	Garantire lo stesso livello di sicurezza sanitaria degli alimenti (incluso per i residui) per il mercato interno e per quello internazionale. Sviluppare un sistema completo di controllo dell'uso del farmaco veterinario e dei prodotti biologici veterinari per limitarne gli effetti collaterali.	12,6%
Repubblica Domenicana	Sviluppare una politica di nazionale de sicurezza alimentare per l'esportazione e il consumo nazionale. Implementare un programma nazionale sui residui chimici e biologici. Creare un programma di farmacovigilanza. Rinforzare la coordinazione interministeriale per i programmi di prevenzione, controllo e eradicazione delle zoonosi.	18%
Ghana	Adottare la legislazione per permettere ai servizi veterinari di svolgere tutti i compiti relativi all'ispezione delle carni a tutti i livelli amministrativi.	2%
Guinea Bissau	Sviluppo di programmi di controllo delle principali zoonosi (rabbia, idatidosi, cisticercosi, brucellosi). Rinforzare la sicurezza sanitaria degli alimenti. Questo approccio implica il miglioramento/rafforzamento della coordinazione intersettoriale tra la Salute umana e la Sanità animale e lo scambio di informazioni e dati sulle zoonosi.	1.5%
Haiti	Sviluppo della funzione di ispezione sanitaria, soprattutto ristabilendo il controllo delle macellazioni. Sviluppare la coordinazione sanità animale-sanità umana per le principali zoonosi. Instaurare un uso ragionato dei prodotti veterinari, che includa la gestione dei rifiuti delle attività veterinarie e dei residui con impatto ambientale.	6%
Israele	Garantire l'approvvigionamento di cibo fresco e di buona qualità ai residenti in Israele Promuovere l'uso efficiente e razionale dei pesticidi, dei farmaci veterinari e degli additivi nei mangimi.	25%
Nicaragua	Regolamentare ed implementare un registro dei farmaci veterinari. Implementare l'ispezione alla macellazione a tutti i livelli (per l'esportazione, per il mercato nazionale e quello locale. Sviluppare una politica nazionale di sicurezza sanitaria degli alimenti.	19%
Niger	Le due grandi priorità nell'ambito del Programma triennale di sviluppo dell'allevamento 2011-2013 sono la lotta contro le principali zoonosi come la rabbia e la tubercolosi da un lato e la sicurezza sanitaria degli alimenti di origine animale dall'altra.	16%
Nigeria	Miglioramento della gestione dei macelli e dell'ispezione al macello. Miglioramento della qualità, della distribuzione e dell'uso del farmaco veterinario.	20%
Tchad	Lottare contro le principali zoonosi presenti nel Paese. Garantire la sicurezza sanitaria dei prodotti di origine animale commercializzati (carne, latte).	8%
Togo	Lotta contro le zoonosi. Migliorare l'ispezione sanitaria alla macellazione. Rinforzare il controllo sanitario dei prodotti d'origine animale a livello della produzione, trasformazione e distribuzione. Garantire il controllo del farmaco veterinario.	14%
Vietnam	Migliorare l'igiene delle carni e l'ispezione nei più importanti macelli per raggiungere gli standard internazionali. Riorganizzare in modo progressivo i punti di macellazione e migliorarne l'igiene e l'ispezione sanitaria. Mantenere ed aumentare il piano di monitoraggio dei residui. Controllo della qualità dei farmaci prodotti biologici veterinari e, progressivamente, regolamentare la loro distribuzione e il loro uso.	8%

Fonte OIE website

importanza la SPV, non solo per posizionarsi sui mercati internazionali, ma anche per garantire ai suoi cittadini, anche sulla base delle richieste delle emergenti classi medie, un buon livello di sicurezza sanitaria degli alimenti.
L'esame delle attività SPV, condotta analizzando i siti web FAO e dell'OMS, cioè di organizzazioni internazionali che per mandato si occupano anche di SPV ma non hanno fondi propri e dipendono per la messa in opera di progetti di fondi altrui e dalla volontà dei governi e dei donatori di dedicare risorse economiche alla SPV, dà dei risultati diversi. Infatti le due organizzazioni che fanno parte del sistema Nazioni Unite, hanno soprattutto un ruolo di raccolta, elaborazione e diffusione dell'informazione e di "*advocacy*" per le loro rispettive competenze. Può essere utile ricordare che la buona collaborazione e la delimitazione delle competenze delle tre organizzazioni OIE-WHO-FAO é sancita nel documento "*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 April 2010*" [7].

SPV-SPS e altre vie per realizzare attività di SPV nella cooperazione internazionale

Nella realtà della cooperazione internazionale di oggi, il contributo più importante della SPV allo sviluppo è pero certamente passato per l'Accordo sulle misure sanitarie e fitosanitarie, noto come "Accordo SPS". L'Accordo SPS è un accordo che fa parte dell'Accordo sull'Organizzazione Mondiale del Commercio (OMC) e stabilisce le regole per permettere il libero commercio di animali e dei loro prodotti e di prodotti di origine vegetale limitando i rischi per la salute dei consumatori, degli animali e delle piante.
La sigla "SPS", sigla che, contrariamente a "SPV", ogni politico e funzionario conosce, ha la stessa capacità di poter includere di tutto e di più che la SPV, però ha la tinta del libero commercio caro al neoliberalismo, anziché quello della valorizzazione del servizio pubblico.
Uno degli articoli dell'accordo SPS, che è poi stato ripreso nella legislazione europea sulla sicurezza sanitaria dei prodotti alimentari, prevede l'obbligo dell'aiuto ai Paesi meno sviluppati che hanno difficoltà nel rispettare gli impegni presi firmando l'accordo.
Satellite all'accordo SPS è stato creato nel 2002 il STDF (http://www.standardsfacility.org/), un partenariato globale (con un fondo fiduciario e il suo segretariato) che da un lato finanzia, con sovvenzioni non rimborsabili piccoli progetti, studi di fattibilità di progetti più grandi, e dall'altro raccoglie e dissemina informazioni sulla messa in opera dell'accordo, sui progetti di cooperazione, organizza seminari sulle "buone pratiche (*best practices*), ecc.
Tra i progetti finanziati dall'STDF troviamo, ad esempio lo studio su come migliorare i servizi veterinari etiopi al fine di permettere all'Etiopia di esportare il suo bestiame; un progetto per valutare il sistema di gestione della sicurezza sanitaria degli alimenti in Sierra Leone al fine di sviluppare un programma di sviluppo delle capacità delle autorità competenti; la creazione di un scuola per la formazione degli Ispettori sanitari nei paesi del Centro America.
Praticamente, l'etichettature di attività come "SPS" ha permesso di utilizzare importanti fondi per attività/programmi/progetti ecc. di SPV a partire dai fondi destinati alle tematiche OMC e di far veramente entrare in modo strutturato, duraturo e forse anche sostenibile la SPV nella quotidianità dell'aiuto allo sviluppo. Alla fine l'importante è che l'attività sia fatta, non tanto chi la fa o sotto quale nome.
Infatti la sigla SPS designa l'aggettivo "sanitario e fitosanitario" e può essere usata sia per indicare le misure prese per poter esportare un prodotto, o per vietare l'importazione di un altro prodotto, ossia l'ambito del commercio internazionale, ma anche per indicare qualsiasi misura, norma, componente sanitario o fitosanitario, programma di eradicazione di zoonosi, monitoraggio e analisi di malattie di origine alimentare, cioè praticamente tutta la SPV ed è molto facile argomentare, per esempio, che un programma nazionale di controllo della brucellosi, con l'obiettivo di migliorare la sanità del bestiame e delle popolazione, prima o poi avrà sicuramente delle implicazioni per il commercio del Paese, e siccome ci sono obblighi internazionali di aiutare in PVS nel campo SPS, le possibilità di veder finanziati tali programmi aumentano in quanto si può negoziare sia sui fondi " Sanità," che "Agricoltura", che " Commercio", che " Accordi internazionali".
Per esempio i due grandi programmi della cooperazione europea nel campo della sicurezza sanitaria dei prodotti alimentari, il programma Iniziativa Pesticidi (PIP) e il programma EDES, anche se nati per aiutare i paesi beneficiari ad esportare, sono rigorosamente non discriminatori e sostengono i paesi nel proteggere la salute dei loro propri cittadini e consumatori quanto quella dei consumatori nei paesi importatori.
Il Programma Iniziativa Pesticidi (PIP) (http://pip.coleacp.org/) lavora su frutta e verdura. Anche se, soprattutto all'inizio, il campo d'intervento erano le produzioni per l'esportazione, nel PIP II, in corso, i mercati regionali e locali sono molto mirati, garantendo che anche i consumatori di frutta e verdura nei paesi beneficiari possano usufruire dei risultati positivi del PIP, come per esempio "obiettivo zero di residui di pesticidi".

Anche il programma EDES (http://edes.coleacp.org/) ("tu mangi" in latino, per una volta non è un acronimo dall'inglese!), che quando formulato, nel titolo conteneva "misure SPS" (si chiamava *Strengthening Food Safety Systems through SPS measures in ACP countries*- Rafforzamento dei sistemi di sicurezza sanitaria degli alimenti mediante misure SPS), ha per obiettivo finale di garantire la sicurezza sanitaria degli alimenti per tutti i consumatori, sia dei paesi beneficiari che dell'UE. L'obiettivo è di disporre di un sistema nazionale coerente per l'insieme dei prodotti, evitando così lo sviluppo di sistemi di sicurezza sanitaria a due velocità. Il programma lavora sia sui prodotti d'origine animale che i prodotti vegetali, per i consumatori locali, regionali, della UE, facilitando l'integrazione dei piccoli produttori nella catena di approvvigionamento. EDES lavora con una forte implicazione delle autorità competenti nazionali e gli operatori privati - anello essenziale della sicurezza sanitaria degli alimenti. Per esempio, in Kenya EDES lavora con i servizi veterinari kenioti coinvolgendo anche il Ministero della Salute per sviluppare un sistema di farmacovigilanza veterinaria [8]. Nella Repubblica Domenicana, il programma appoggia il Laboratorio centrale veterinario per migliorare la sorveglianza epidemiologica nella filiera avicola [9].

In misura molto più marginale troviamo anche dei progetti SPV sotto l'etichetta *food security*, sicurezza alimentare, in quanto è ormai accettato che "*food safety*" -sicurezza sanitaria degli alimenti- è parte della *food security*, e su questa base, la componente paesi terzi, inclusi i PVS, del programma di formazione in SPV della CE è stata finanziata dal programma " Sicurezza alimentare" di DEVCO.

Per quanto riguarda la nutrizione, la ricerca per parola chiave "SPV" sul sito di SUN [10], ha portato solo il Piano per la nutrizione del Mali 2005-2009, dove il "*Plan Strategique National pour l'alimentation et la Nutrition*"(PSNAN) prevede un obiettivo: controllare le antropozoonosi; e due strategie 5.1. Promozione delle azioni di sanità pubblica veterinaria (le attività del settore sanità animale) e 5.2. Rinforzare il controllo della qualità dei prodotti di origine animale e lottare contro la macellazione clandestina.

Conclusione: il bosco e le foglie

Ho fatto questa lunga descrizione per arrivare a quello che, secondo la mia esperienza, è uno dei problemi maggiori per la promozione della SPV: il suo essere materia olistica per eccellenza. La SPV infatti comprende: controllo delle malattie d'importanza economica; zoonosi; rischi occupazionali, sicurezza alimentare, controlli lungo tutta la filiera ("dal campo alla tavola"), zoonosi alimentari; ispezione delle carni, controllo della lavorazione, stoccaggio, distribuzione; residui e contaminanti ambientali; import/export, zoonosi di origine ambientale; zoonosi degli animali selvatici; vettori; raccolta ed eliminazione di carcasse, carni, rifiuti animali; inquinamento ambientale; controllo popolazioni animali in ambiente urbano e silvestre; nel campo della ricerca biomedica: la diagnostica e prodotti biologici; indagini ecologiche ed epidemiologiche; animali da laboratorio; nel settore emergenze: focolai di malattie esotiche; disastri naturali e non; e anche la *pet therapy*.

Sarà quindi possibile trovare le singole foglie, cioè singole iniziative, progetti, più o meno riusciti, più o meno sostenibili, ma il bosco, vale a dire la SPV come disciplina e insieme coerente di attività, non viene riconosciuto.

Nella pratica quotidiana, la SPV si risolve in una serie di epifanie in programmi/progetti, per lo più in ambito "commercio internazionale", "sicurezza alimentare", "agricoltura", molto meno nel campo dell'ambiente e della ricerca biomedica.

Per esempio, un progetto di aiuto a un Paese africano alla valorizzazione della sua flora e farmacopea che ha una componente che prevede la sperimentazione con protocolli "occidentali" su "animali da laboratorio" e dunque una parte del progetto riguarda la creazione di uno stabulario, con tutto ciò che è necessario per rendere questa componente del progetto duratura, sostenibile e rispettosa del benessere dell'animale da laboratorio, difficilmente si presenterà come un progetto con una componente di SPV.

In conclusione si può dire che le attività di SPV stanno assumendo sempre più importanza nell'aiuto allo sviluppo, soprattutto grazie al rilievo assunto dal commercio internazionale e dai diritti dei consumatori, sulla base dell'argomentazione che riconosce in quasi ogni misura di SPV una misura SPS, ma potrebbe posizionarsi in modo più visibile negli altri campi, come l'ambiente, la nutrizione, la ricerca biomedica. Ma non è tanto con i donatori quanto con le autorità nazionali (Ministero della Cooperazione, della Salute, delle Finanze, e simili) che i SV devono consolidare la propria immagine e la propria presenza.

Bibliografia

1. Frisch D. La politique de développement de l'Union Européenne. Rapports ECDPM n° 15 available from www.ecdpm.org/pmr15fr; last visited 14/08/2015.

2. Marabelli R, Mantovani A. La medicina veterinaria presentata ai pubblici amministratori. (Veterinary medicine presented to the public administrators). Capodarco di Fermo, Litográfica COM, 1997.

3. Muma JB, Mwacalimba KK, Munang'andu HM, Matope G, Jenkins A, Siamudaala V, Mweene AS, Marcotty T. The contribution of veterinary medicine to public health and poverty reduction in developing countries. Veterinaria Italiana 2014, 50 (2), 117-129. doi: 10.12834/VetIt.1405.32s

4. Report of the WHO/FAO/OIE joint consultation on emerging zoonotic diseases 3–5 May 2004 - Geneva, Switzerland http://whqlibdoc.who.int/hq/2004/WHO_CDS_CPE_ZFK_2004.9.pdf?ua=1

5. http://www.donorplatform.org/ last visited 15/08/2015

6. http://www.donorplatform.org/livestock-development/annual-meetings. 15 IADG meeting last visited 15/08/2015

7. http://www.who.int/influenza/resources/documents/tripartite_concept_note_hanoi_042011_en.pdf. Last visited 19/08/2015

8. http://edes.coleacp.org/edes/news/31970-kenya-developper-les-bases-d%E2%80%99un-systeme-national-de-pharmacovigilance-veterinaire last visited 12/08/2015

9. http://edes.coleacp.org/edes/news/32377-filiere-avicole-en-republique-dominicaine-renforcement-du-systeme-de-surveillance last visited 12/08/2015

10. http://scalingupnutrition.org last visited 12/08/2015

Experiences of international networks for collaborative education and research using the One Health approach

D. DE MENEGHI[1, 4,5], K. DE BALOGH[2, 4], M. VILHENA[3, 6]

[1]Università degli Studi di Torino, Dipartimento di Scienze Veterinarie, Grugliasco-Torino, Italy;
[2]Food and Agriculture Organization, VPH Unit, Rome, Italy;
[3]Universidade de Évora, Instituto de Ciências Agrárias e Ambientais Mediterrânicas, Evora, Portugal;
[4]Diplomate ECVPH-European College Veterinary Public Health;
[5]VSF-I Veterinari senza Frontiere, Padova, Italy;
[6]Asociacao ONE HEALTH INTERNATIONAL NETWORK (OHIN), Lisboa, Portugal

Summary - The Authors describe first-hand experiences carried out within the framework of selected International projects aimed at developing collaborative research and education using the One Health (OH) approach. Special emphasis is given to *SAPUVETNET*, a series of projects co-financed under the EU-ALFA program, and aimed to support an International network on Veterinary Public Health (VPH) formed by Veterinary Faculties from Latin-America (LA) and Europe (EU). *SAPUVETNET* has envisaged a series of objectives/activities aimed at promoting and enhancing VPH research/training and intersectoral collaboration across LA and EU using the OH approach, as well as participating in research and/or education projects/networks under the OH umbrella, namely EURNEGVEC-*European Network for Neglected Vectors & Vector-Borne Infections*, CYSTINET-*European* Network on Taeniosis/Cysticercosis, and *NEOH-Network for Evaluation of One Health*; the latter includes expertise in multiple disciplines (e.g. ecology, economics, human and animal health, epidemiology, social and environmental sciences, etc.) and has the primary purpose of enabling quantitative evaluation of OH initiatives by developing a standardized evaluation protocol. The Authors give also an account of the ongoing creation of OHIN-*OH International Network*, founded as a spin-off result of SAPUVETNET. Finally, some examples of cooperation development projects characterised by an OH approach are also briefly mentioned.

Key words: Inter-professional collaboration, *One Health* approach, collaborative education and research, international cooperation.

Riassunto - Gli Autori descrivono alcune esperienze svolte nell'ambito di alcuni progetti internazionali finalizzati a sviluppare modalità di ricerca e formazione collaborative utilizzando l'approccio *One Health* (OH). Particolare attenzione viene rivolta a *SAPUVETNET*, una serie di progetti cofinanziati dal programma UE-ALFA finalizzati a sostenere una rete internazionale per la Sanità Pubblica Veterinaria (SPV) formata da Facoltà di Veterinaria dell'America Latina (AL) ed Europa (EU). *SAPUVETNET* ha identificato una serie di obiettivi ed attività finalizzate a promuovere e sviluppare la ricerca e formazione in SPV e la collaborazione interdisciplinare tra AL ed EU utilizzando l'approccio *OH*, oltre alla partecipazione in svariati progetti/reti di ricerca e formazione sotto l'"Ombrello *OH*"; tra questi, EURNEGVEC (*European Network for Neglected Vectors & Vector-Borne Infections*), CYSTINET (*European Network on Taeniosis/cysticercosis*), e *NEOH* (*Network for Evaluation of One Health)*; quest'ultimo include esperti in varie discipline (es. ecologia, economia, sanità umana ed animale, epidemiologia, scienze sociali e ambientali) ed ha lo scopo primario di consentire valutazioni quantitative di iniziative OH tramite lo sviluppo di un protocollo di valutazione standardizzato. Inoltre gli Autori riferiscono della creazione, attualmente in corso, dell'Associazione OHIN-*OH International Network*, fondata come ricaduta di *SAPUVETNET*. Infine vengono menzionati alcuni esempi di progetti di cooperazione allo sviluppo caratterizzati da un approccio *OH*.

Parole chiave: collaborazione interprofessionale, approccio *One Health*, educazione e ricerca collaborativa, cooperazione internazionale.

INTRODUCTION

Historically, human and veterinary medicine have been called a *unicum* according to the holistic model devoted to the health and the wellbeing of humans and animals, and the respect for the environment. In 1984, Calvin W. Schwabe (veterinarian, epidemiologist and parasitologist) was the first to

Corresponding author: Dr Daniele De Meneghi,
Università degli Studi di Torino, L.go P. Braccini, 2 - 10095
Grugliasco-Torino (Italy). Tel. +39-011-6709189;
Fax +39-011-2369189; E mail: daniele.demeneghi@unito.it

introduce in the scientific literature the term "One Medicine" [1]. Since Swabe's writings, the concept of One Medicine has evolved towards a more broad concept, the "One Health" (OH), an aim to be achieved by integrating human and veterinary medicine and other branches of science (i.e. social and environmental sciences) associating also the eco-health concept [2]. As described by Gibbs [3], many and slightly different definitions of OH have been set by various initiatives and networks; and it can be ironically said that "there are more OH definitions than the initiatives, networks and projects that deal with OH itself". A list of the most relevant initiatives, networks, projects and useful links about OH can be found at http://www.onehealthglobal.net/.

The history of OH, its evolution and most relevant actions have been extensively reviewed by various authors; the comprehensive monography "One Health-One Medicine: linking human, animal and environmental health" by Kaplan *et al*. [4], the papers by Gibbs [3], and by Lerner & Berg [5] are worth to be quoted. The milestones in the global recognition of OH have been described by Gibbs [3].

OH may be defined as "the integrative effort of multiple disciplines, working locally, nationally, and globally, to attain optimal health for people, animals, and our environment"; this most widely used definition of OH is based on the Manhattan Principles, a list of 12 recommendations set in 2004 by health experts from around the World [6]. Similarly, the One Health Initiative (OHI), a movement to promote collaboration amongst scientific-health and environmentally related disciplines, defines OH as a worldwide strategy for expanding interdisciplinary collaborations and communications in all aspects of health care for humans, animals and the environment [7]. The OHI, in conjunction with OH Sweden (http://www.onehealth.se), have efficaciously synthesized and described the OH approach by drawing "the so called One Health umbrella" [7]. According to Gibbs [3] and Lerner & Berg [5], the OH Umbrella was first developed by OHI and OH Sweden, whereas it should be recalled that the first drawing of such an "umbrella" was actually done, almost two decades earlier by Parodi *et al*. [8]. This OH umbrella *ante litteram* was designed for describing the concept of Veterinary Public Health (VPH) according to the Italian VPH approach and tradition, the so called "Italian VPH school" led by the late Prof. Mantovani, as quoted by Battelli [2] and Venturi [9]. In fact VPH and OH are especially rooted within the Italian Public Health tradition and National health system/organisation: indeed, the Veterinary Services in Italy belong to the Ministry of Health administration, unlike the case in most other European and extra-European Countries, where Veterinary Services fall under the Ministry of Agriculture [2, 10].

A partaken OH approach is required to face and control, as effectively and efficiently as possible, the many health and environmental problems, which are emerging or prevailing worldwide (e.g. the emergence/re-emergence of zoonotic pathogens and the persistence of endemic or neglected zoonoses; food safety and food security; the impact of climate change on health; the reduction of biodiversity; bacterial resistance to antibiotics, etc.). To reach this purpose, a better cooperation between medical and veterinary services is of foremost importance. There is a need to change the culture and the training of professionals involved in human, animal and ecosystem health sectors in order to develop a holistic and trans-disciplinary approach. Moreover it is also essential to inform properly the public and the decision makers about the competences and the joint and complementary activities of the veterinarians and the medical doctors, in order to offer a true picture of the profession, not limited to the conventional model which the general public and stakeholders usually have of the "traditional" veterinary medicine, human medicine and environmental sciences [2, 10].

Following the outbreaks of highly pathogenic avian influenza H5N1 starting in December 2003 in poultry in South-east Asia, a number of human deaths were initially reported from Thailand and Vietnam. Thereafter the disease spread also to other parts of Asia, Europe and Africa causing human cases and deaths as well as important losses in commercial and backyard poultry production. In 2006 there was great concern for a widespread pandemic which led to the creation of avian influenza task forces and inter-ministerial committees in affected and at risk countries. Also at the international level, organizations such as the Food and Agriculture Organization of the United Nations (FAO), The World Organisation for Animal Health (OIE) and the World Health Organization (WHO) developed joint efforts to address H5N1. Global strategies were developed and assistance was provided to countries and regions by enhancing surveillance and diagnostic capacities, as well as emergency preparedness and response. These experiences also provided the basis for developing the OH approach by the three Organizations in conjunction with the World Bank, UNICEF and the UN System Influenza Coordination (UNSIC) which led to the launch of the document "*Contributing to One World, One Health-A Strategic Framework for Reducing Risks of Infectious Diseases at the Animal-Human-Ecosystems Interface*" [11]. This consensus

document reflected global measures needed to coordinate medical and veterinary health policies more effectively, taking into account new requirements to prevent and control zoonotic diseases; the document was presented and adopted by the Ministers of more than 100 Countries at a Conference in Sharm el-Sheikh, Egypt, in October 2008. In 2010, FAO, OIE and WHO presented the "*Tripartite Concept Note"* describing their collaboration to address health risks at the human-animal-environment interface. This Concept Note, signed by the Directors General of the three International Organizations, formalised the "*sharing of responsibilities and coordination of global activities to address health risks at the animal-human-ecosystems interfaces"* [12].

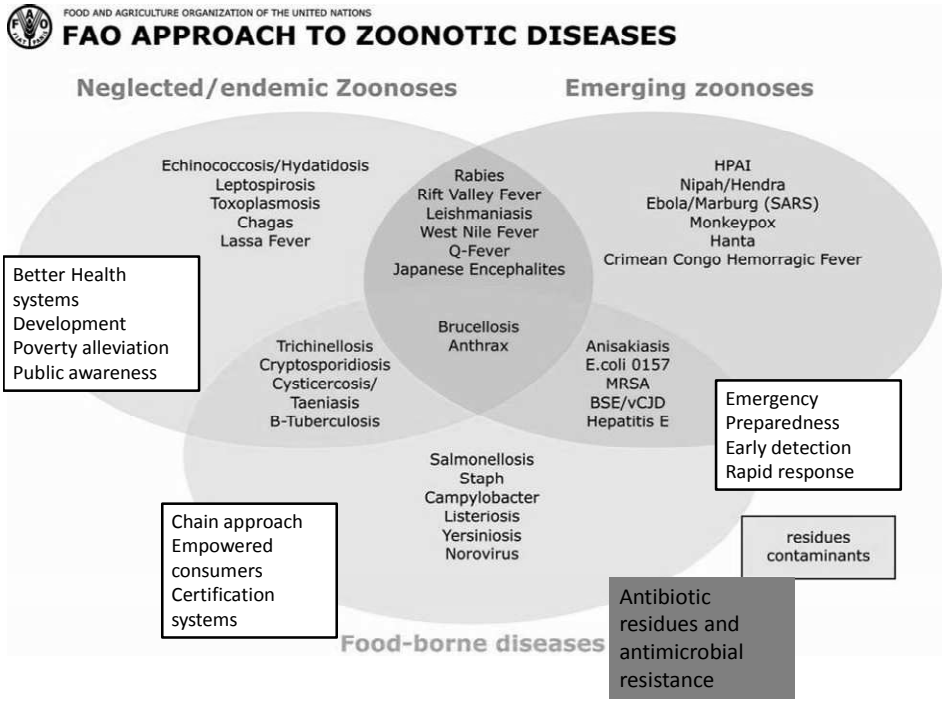
What is applicable for H5N1 can also be applied for other emerging diseases and zoonoses: OH can also be applied to address endemic/neglected zoonotic diseases, food-borne diseases as well as residues and antimicrobial resistance (Fig. 1). During the High-Level Technical Meeting to Address Health Risks at the Human-Animal-Ecosystems Interfaces, Mexico City, Mexico, 15-17 November 2011, the key elements for intersectoral collaboration, cooperation and communication were determined [13]; the Tripartite FAO/OIE/WHO chose zoonotic influenza, rabies and antimicrobial resistance as their priority topics for implementing OH. Since then, the use of the OH approach has further expanded to address food safety issues and environmental toxins affecting animals and humans, indicating that OH provides a system approach for tackling complex issues which affect animals, humans and ecosystems.

After this introductory section, the Authors describe some first-hand experiences and activities carried out within the framework of selected International academic collaboration and development cooperation projects aimed at collaborative research and education using the OH approach.

1. The SAPUVETNET projects: an example of collaborative education and research in Veterinary Public Health towards the Millennium Development Goals by using OH approach

In this section the Authors present the experience of a series of collaborative international projects – the SAPUVETNET projects- where the initial VPH approach has evolved towards a more holistic OH approach.

SAPUVETNET is the acronym of "*Red de Salud Publica Veterinaria/Network of Veterinary Public Health*" and is a series of projects co-financed under the EU ALFA program (https://ec.europa.eu/europe aid/regions/latin-america/alfa_en) that aimed at building and supporting an International network on VPH formed by several Veterinary Faculties from Latin-America (LA) and Europe (EU) (http://www.sapuvetnet.org). Since its start in 2002, until the official end in 2012, the SAPUVET network continuously grew and expanded its members, by including several International



Fonte: FAO website

Figure 1 - Diagramme of the FAO approach to zoonotic disease according the OH approach

collaborative Institutions/Organizations involved in global health promotion and agriculture development (i.e. OPS-PAHO, FAO, VSF-Intern., ECVPH, etc.). The objectives/activities of the SAPUVETNET projects aimed at promoting and enhancing VPH research/training and intersectoral collaboration across LA and EU using the OH approach.

Project partners use(d) a mail-list and distance learning platforms (e.g. Moodle, Colibri) to organize common teaching activities. Major results so far achieved are: harmonisation/development of a common curriculum for VPH teaching; creation of common modules/courses on selected VPH and OH topics; use of innovative teaching methods based on problem solving approach/case studies; publication of videos (DVDs) and self-learning program (CD-ROM) on meat inspection/hygiene (in 3 languages: English Spanish and Portuguese); development of an on-line VPH teaching Manual (also in 3 languages); development of an Atlas/Manual on Parasitology and Parasitic zoonoses (beta version, in Portuguese and Spanish, accessible online after registration); organization of e-conferences on upcoming VPH and OH issues; publication of a new International Journal "*Una Salud/One Health/Uma Saude*" (in 3 languages); exchanges of teachers and researchers (e.g. bilateral visits LA-EU-LA) and coordinating meetings; participation in and/or organization of VPH and OH seminars/congresses/ conferences at National and International level; publication of scientific and popular articles on VPH and OH issues related to project activities.

SAPUVETNET didactic tools have been tested/used by partner Faculties/Universities and other teaching institutions. Didactic material can be freely circulated and distributed, and can be used for distance learning, be modified/adapted to the local context of any country/geographical area, even outside the SAPUVET partner countries. Actually SAPUVETNET teaching material has been already satisfactorily utilised during: i.) field training in the framework of decentralised cooperation projects in West-Africa, projects co-financed by the Regione Piemonte-Office for International Cooperation (http://www.regione.piemonte.it/affari_internazionali/africaSubsahara.htm) and the University of Turin-CISAO (Interdepartmental Centre for Research and Cooperation for Africa) (http://www.cisao.unito.it) in Mali, Burkina Faso and Cabo Verde; ii.) training in integrated agriculture development cooperation projects implemented by VSF Italia (www.veterinarisenzafrontiere.it) and VSF International (http://vsf-international.org/) in Africa, Central and South America and Asia; iii.) academic training in Niger, within the framework of the International Master on Food Security and Environmental Sustainability (*projet* R.U.S.S.A.D.E., *Réseau des Universités Sahéliennes pour la Sécurité Alimentaire et le Développement Durable*; EU Edulink II, FED/2013/320-115; http://www.russade.eu/). The initiatives and the projects mentioned above are characterised by an OH approach and/or include OH activities.

Detailed information on the inception, evolution of the SAPUVET projects, the most important activities and outcomes and results of the three phases of the project have been revised and described by Ortega *et al*. [14, 15, 16]; De Rosa & de Balogh [17]; De Meneghi *et al*. [18] ; Vilhena *et al*. [19].

During the period of operation of SAPUVETNET, especially towards the end of the activities, the Authors and other collaborators involved in OH projects consolidated the results achieved so far and worked towards guaranteeing the continuation of the activities carried out under SAPUVET after its official termination. Some of this included the participation either by the SAPUVET members or their Institutions in various research and/or education projects under the OH umbrella. Amongst such projects and/or networks, the most relevant and interesting are described hereunder.

2. The *European Network for Neglected Vectors & Vector-Borne Infections* (*EurNegVec)*; it is an EU COST action (TD1303) which includes 33 participating countries with representatives from 55 Institutions, and represents a good example of OH approach and interdisciplinary collaboration in Public Health. Participants –researchers from different disciplines (veterinarians, medical doctors, biologists, entomologists, ecologists) are assigned as experts in Working Groups (WGs). The main objectives of EurNegVec TD1303 are to establish, across Europe, a powerful trans-boundary network of partner institutions involved in education and research on arthropod-transmitted infectious diseases of man and animals, and to address the growing importance of vector-borne diseases at a time of global change. WGs activities are all integrated under the OH concept and reflect the complexity and demands of current high-end research. Participants have compiled a list of neglected topics related to vectors and zoonotic vector-borne pathogens considered relevant for Europe which includes: ticks and tick-borne; dipterans and dipteran-borne; fleas and flea-borne pathogens. For more information and updates on EurNegVec activities and opportunities of collaboration, visit regularly the project website (http://www.eurnegvec.org/action.html).

3. The *European Network on Taeniosis/cysticercosis* (CYSTINET); it is an EU COST Action (TD1302), which includes 22

participating countries, 2 Near Neighbour Countries and 4 COST International Partner Countries. Participants are researchers from different disciplines (veterinarians, medical doctors, biologists)- and international experts on *Taenia solium* (pork tapeworm) and *T. saginata* (beef tapeworm) cysticercosis (CC)/taeniosis, which are zoonoses of public health importance, with significant economic impacts on the health and meat (pork and beef) sectors within and outside the EU. The main objective of CYSTINET is to build a strong, extensive, multi-disciplinary scientific network to induce sustainable collaborations with the aim to advance knowledge and understanding of these zoonotic disease complexes. Specific objectives include the development of innovative diagnostic and cost-efficient control tools, assessments of disease burden and economic impact, as well as the development of harmonized reporting and management procedures. The Action is aimed at both European economical/societal needs and scientific/technological advances, with positive spin-off effect for International and Near-Neighbour Countries. For updates and additional information on CYSTINET activities, visit the project website (http://www.cystinet.org/).

4. The *Network for Evaluation of One Health-NEOH*; it is a EU COST trans-disciplinary action (TD1404) established with the primary purpose of enabling quantitative evaluations of OH initiatives by developing a standardized evaluation protocol to be applied in a suite of case studies. The findings are expected to generate reliable evidence on the efficiency and cost-effectiveness of OH activities for experts, stakeholders and policy makers to implement effective and sustainable policies and optimal resource allocation. NEOH includes participants from 22 COST and several non-COST Countries, with expertise in multiple disciplines (e.g. ecology, economics, human and animal health, epidemiology, social and environmental sciences, etc.) working together in four different Working Groups (WGs) to develop a framework, index and protocol to be included in a OH handbook, and the application of such a framework to selected case studies using available primary and secondary datasets stemming from ongoing OH projects. Furthermore a meta-analysis of the available case-study is conducted to facilitate international comparison and elaborate policy recommendations as well as seeking a dialogue with national governments, NGOs, research organizations, and industry throughout the project to ensure that the evidence produced addresses decision-makers' needs. NEOH project is in its first year of operation and the activities to-date were focused on establishing the network, elaborating the OH handbook content and structure, training on evaluation, as well as dissemination and engagement activities. For more information and updates on NEOH activities and opportunities of collaboration, visit regularly the project website (neoh.onehealthglobal.net).

5. Association *One Health International Network (OHIN)*; after the last phase of the SAPUVET project, it was deemed necessary to create a body that would guarantee the sustainability of the project itself and future work. It was decided to found a private scientific association, registered in Portugal, but with an International vision and totally open. The aim of OHIN is to maintain, capitalize and make sustainable for the future the whole experience and the teaching material developed by the network SAPUVET during the past 10 years. During the first period after its foundation, OHIN has proceeded to the legalization and the transfer of some didactic material produced by the SAPUVETNET project, such as the Public Health Veterinary Manual and the journal "*Una Salud/One Health/Uma Saude*". At the same time OHIN is fostering the participation of other professionals from other areas of Public Health, who will contribute to the Association by producing training material relevant to their specific professional areas, but to be used, shared and integrated/linked to the already existing SAPUVET training material.
OHIN will continue to follow the tracks of SAPUVET, being an "open" association dedicated essentially to training and education, now extended to all professionals who want to work in public health within the paradigm One Health. OHIN is expected to become fully operational as soon as some bureaucratic constraints are solved. By then, an International call/invitation for collaboration with partners and Institutions involved in One Health projects will be launched.

CONCLUSIONS/FINAL REMARKS

Today' challenges affecting human and animal health and well-being, such as emerging and endemic zoonotic diseases, antimicrobial resistance, environmental and climate changes, are global both in distribution and effects. A OH approach has been advocated as an effective way forward in addressing these challenges since an inter-disciplinary effort recognizes their interdependence and complexity. As a result there is a growing number of OH initiatives worldwide, such as establishment of cross-sectoral coordination, communication and data sharing in some countries, integrated surveillance systems, etc. The vast majority of these OH

activities is fuelled by an expectation that joint actions are more efficient and cost-effective than addressing the same issues using a traditional single-disciplinary approach. However, attempts and procedures for scientific and standardized evaluation of OH are still lacking, which hinders science-based decision making and effective resource allocation. This is important to demonstrate that the application of a One Health approach while possibly requiring additional resources in its initial phases is cost-effective in the medium to long term. The vast number of initiatives and the growing number of OH courses at various levels, including MSc and PhDs, is indicative that adopting a OH approach to addressing health issues at the animal-human-ecosystems interface makes sense in an ever globalizing and complex world.

Acknowledgements

The Authors would like to acknowledge all participants and collaborators of the partner Universities, the collaborating Institutions, Organizations and Associations of the SAPUVETNET projects. All of them greatly contributed -in different moments and at different levels- to the overall success of the project(s) and to the development of the teaching material herein described. The SAPUVETNET projects (SAPUVET, contract n. AML/B7-311-97/0666/II-0056A; SAPUVETNET II, contract n. AML/B7-311/97/0666/II-0438-A; SAPUVETNET III, contract n.DCI-ALA/19.09.01/08/19189/169-157/ALFA III-75) have been co-financed by the European Union, ALFA programs, and are now officially ended. The present paper has been written as part of the dissemination activities under the frame of the following projects: *EurNegVec* COST action TD1303, Cystinet COST action TD1302, *NEOH* COST action TD1404, and *R.U.S.S.A.D.E. project* EU Edulink II (FED/2013/320-115). The views expressed in this document are solely the responsibility of the Authors and do not reflect the position of the European Commission.

References

1. Schwabe CW. Veterinary medicine and human health. 3rd edition. Baltimora: Williams & Wilkins; 1984

2. Battelli G. Medicina unica - Salute unica: per l'uomo, per gli animali e per l'ambiente. Giornale Italiano di Medicina Tropicale 2014; 19(4): 17-23

3. Gibbs EPJ. The evolution of One Health: a decade of progress and challenges for the future. Vet Rec 2014; 174: 85-91.

4. Kaplan B, Kahn LH, Monath TP (eds). One Health-One Medicine: linking human, animal and environmental health/Una sola salute-Una sola medicina per l'uomo, per l'animale e per l'ambiente. Vet Ital 2009; 45(1), 218 p

5. Lerner H, Berger C. The concept of health in One Health and some practical implications for research and education: what is One Health? Infection Ecology and Epidemiology 2015; 5: 25300

6. The Wildlife Conservation Society. Summary of the Conference "One World One Health: Building Interdisciplinary Bridges to Health in a Globalized World". New York, 29 September 2004, The Rockfeller University. Available at: http://www.oneworldonehealth.org/sept2004/owoh_sept04.html

7. The One Health Initiative. The One Health Umbrella. One Health Sweden in collaboration with the One Health Initiative Autonomous pro-bono team. Available at: http://onehealthinitiative.com/publications/One%20Health%20Umbrella%20v11.pdf

8. Parodi P, Calicchia MC, Capuano D, Del Papa S. L'educazione sanitaria in sanità pubblica veterinaria. Vet Ital 1993; monografia p.17-98.

9. Venturi L. Adriano Mantovani, il padre della "veterinary public health". Giornale Italiano di Medicina Tropicale 2014; 19(4): 51-55.

10. Marabelli R, Mantovani A. La medicina veterinaria presentata ai pubblici amministratori. Roma: edizioni SIVEMP; 1997.

11 FAO/OIE/WHO/UNSIC/UNICEF/WB. Contributing to One World, One Health - A Strategic Framework for Reducing Risks of Infectious Diseases at the Animal-Human-Ecosystems Interface, 14 October 2008, Consultation Document; ftp://ftp.fao.org/docrep/fao/011/aj137e/aj137e00.pdf

12. FAO/OIE/WHO. 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. April 2010. Available at: http://www.who.int/influenza/resources/documents/tripartite_concept_note_hanoi_042011_en.pdf

13. FAO/OIE/WHO/UN. High-Level Technical Meeting to Address Health Risks at the Human-Animal-Ecosystems Interfaces, Mexico City (Mexico), 15-17 November 2011. © FAO/OIE/WHO, 2012. Available at: http://www.fao.org/docrep/017/i3119e/i3119e.pdf

14. Ortega C, De Meneghi D, De Rosa M, Estol L, Leguia G, Fonseca A, Torres M, Caballero-Castillo M, de Balogh K. Importancia de la salud pública veterinaria en la actualidad; el proyecto SAPUVET. Rev Sci Tech OIE 2004; 23(3): 841-849.

15. Ortega C, Villamil LC, Cediel N, Rosenfeld C, De Meneghi D, De Rosa M, Estol L, Leguia G, Fonseca-Poveda A, Torres M, Caballero-Castillo M, De Balogh K. Las redes SAPUVET y SPVet: un modelo de integración en materia de Salud Pública

Veterinaria entre Europa e América Latina. Rev Panam Salud Publica 2005; 17: 60-65

16. Ortega C, Parilla G, de Balogh K, De Rosa M, Gimeno O, Estol L, Dobosh D, Leguia G, Falcon N, Fonseca-Poveda A, Torres M, Caballero-Castillo M, Quiros J, Clemente Vilhena M, Cediel N, Villamil LC, De Meneghi D. New approaches for education and training in Veterinary Public Health: the Sapuvet projects. J Vet Med Educ. 2007; 34(4): 492-496

17. De Rosa M, de Balogh K. Experiences and difficulties encountered during a course on Veterinary Public Health with students of different nationalities. J Vet Med Educ. 2005; 32(3): 373-376.

18. De Meneghi D, Bert E, Porporato P, Pattono D, Cediel N, Vilhena M, Padre L, Arroube S, Baltasar P, Custodio A, Villamil LC, Romero J, Mutis C, Sommerfelt I, Lopez C, van Knapen F, Keesen L, De Rosa M. Rosenfeld C. *et al*. The SAPUVETNET Projects: experiences of intersectoral collaboration and research/training in Veterinary Public Health across Latin America and Europe. Giornale Italiano di Medicina Tropicale 2011; 16(3-4): 93-101

19. Vilhena M. What kind of public health do we want? In: Abstract of Proceedings of 1st International Congress on Pathogens at the Human-Animal Interface (ICOPHAI). Addis Ababa, 15-17 September 2011, UN Conference Centre: Ethiopia; 2011 p.156. Available from: http://icophai2011.org/sites/icophai2011.org/files/sharedimages/2011Icophai/abstractBook.pdf

Strengthening integrated surveillance for arboviruses in the Mediterranean and Black Sea regions in the framework of the *One Health* approach

M. G. DENTE[1], F. RICCARDO[1,2], G. NACCA[1], A. RANGHIASCI[1], J. C. MANUGUERRA[3], C. ESCADAFAL[3], M. A. JIMENEZ-CLAVERO[4], E. PEREZ RAMIREZ[4], V. ROBERT[5], M. PICARD[5], F. CHERBLANC[3], L. GAAYEB[3], K. VICTOIR[3], S. DECLICH[1] ON BEHALF OF THE MEDILABSECURE NETWORK

[1]Istituto Superiore di Sanità (ISS), Rome, Italy
[2]European Programme for Intervention Epidemiology Training (EPIET), European Centre for Disease prevention and Control (ECDC), Stockholm, Sweden
[3]Institut Pasteur, Paris, France
[4]Centre for Research on Animal Health (INIA-CISA), Madrid, Spain
[5]Institut de Recherche pour le Développement (IRD), Montpellier, France

Summary - This article describes how the MediLabSecure European project contributes to the strengthening of One Health surveillance in the Mediterranean Basin and Black Sea Regions. We conducted a survey with 19 countries to assess and document the level of integration in surveillance of arboviruses between four disciplines: animal virology, human virology, medical entomology and human epidemiology across three different levels: policy and institutional, data collection and analysis, dissemination of results. Seventy-five contact points (CP) of the four disciplines from the 19 countries were invited to the survey. Responses were obtained from 63 CP (81%) of whom: 14 from the Black Sea, 26 from North Africa and the Middle East and 23 from the Balkans. Integration on all the explored levels was confirmed by all four disciplines independently in any of the countries included in the study. This suggests that implementation of fully integrated one health surveillance across the policy and institutional level to the data collection and dissemination level is yet to be fully developed in the Mediterranean and Black Sea regions with the four considered disciplines.

Key words: arbovirus, One Health, integrated surveillance, Mediterranean Basin, Black Sea

Riassunto - Questo articolo descrive come il progetto europeo MediLabSecure contribuisce al rafforzamento della sorveglianza integrata nel quadro strategico della "*One Health*" nelle regioni del Mediterraneo e del Mar Nero.
Abbiamo condotto uno studio con 19 paesi per valutare e documentare il livello di integrazione nella sorveglianza delle arbovirosi tra quattro discipline: virologia animale, virologia umana, entomologia medica e epidemiologia umana riscontrabile attraverso meccanismi di integrazione adottati in tre differenti livelli: politico e istituzionale, raccolta e analisi dei dati, divulgazione dei risultati. Settantacinque referenti delle quattro discipline sono stati invitati a partecipare allo studio. Hanno risposto 63 referenti (81%) di cui: 14 dal Mar Nero, 26 dal Nord Africa e dal Medio Oriente e 23 dai Balcani.
Nessuno dei Paesi coinvolti nello studio ha riportato l'esistenza di meccanismi di integrazione nei tre livelli considerati indipendentemente da tutte le quattro discipline. Questo suggerisce che l'attuazione della sorveglianza integrata per le arbovirosi non è stata ancora pienamente sviluppata nelle regioni del Mediterraneo e del Mar Nero con meccanismi integrativi che considerino le quattro discipline e i tre livelli considerati.

Parole chiave: arbovirosi, One Health, sorveglianza integrata, Mediterraneo, Mar Nero

INTRODUCTION

The emergence and reemergence of infectious diseases is linked to concurring determinants affecting the microbial agent, the human host and the human environment [1].
Among those determinants, human mobility and population growth, trade and climate change are recognized risk factors for the geographic expansion of diseases to new areas. In addition, globalization has been described as a determinant in redrawing pathogen distribution patterns in haphazard and unpredictable ways [2].
Emerging and reemerging infectious disease agents are for the most part (70%) vector-borne and/or zoonotic [3] and also include causative agents with

Corresponding author: Dr Flavia Riccardo,
Istituto Superiore di Sanità, Viale Regina Elena 299, 00161
Rome, Italy. Tel.: +39 06 49904322; Fax. +39 06 44232444;
E mail: flavia.riccardo@iss.it

bioterrorism potential [4]. These pathogens have been able to adapt to changing human and animal populations and to environments that have been altered by humans. They are also characterized by complex life cycles involving human and animal hosts and, in some cases, vectors. For this reason they require mutual animal and public health vigilance for rapid detection [4]. An example of the impact of inadequate surveillance and preparedness for zoonotic disease threats is the initially unrecognized emergence and establishment of West Nile virus in the US that led to 37,000 human illnesses and 1500 deaths [5].

Mosquitoes are the most important vectors of human diseases. The incidence of mosquito borne diseases like dengue, equine encephalitis, or West Nile Virus Disease has been increasing in recent years in tropical and temperate countries. Climate and environmental changes engender both short- and long-term impacts on vector-borne pathogen transmission. It is estimated that average global temperatures will rise by 1.0-3.58 °C by 2100, increasing the likelihood of many vector-borne diseases [6]. At the same time, deforestation causes drier conditions that will have an impact on the dynamics of infectious diseases, especially those associated with forest vectors and reservoirs, such as malaria, leishmaniasis, and arboviral infections. The fact that some pathogens can be transmitted by different competent vectors, such as Rift Valley Fever [7], further complicates this picture and explains rapid spread and establishment of diseases in new geographical areas.

Dengue virus and West Nile virus (WNV), two distantly related flaviviruses, are good examples of the rapid spread of arboviruses [8]. The widespread establishment of WNV in the US and in the Mediterranean basin also demonstrates the vulnerability of non-endemic countries to the introduction of arboviruses [6,9]. Furthermore, the presence of competent *Cx. pipiens* in southern Europe and North African countries represents a virtual risk for Rift Valley Fever virus epizootics in case of virus introduction in countries of the Mediterranean basin, even if the main vectors of the disease (*Aedes spp*) are not present [10].

The Mediterranean and Middle East Regions have long been "hot spots" of the emergence and re-emergence of zoonosis [11,12,13,14]. For this reason, in 1978, the World Health Organization started an interregional (Mediterranean and Middle East) Programme on Zoonoses and Foodborne Diseases prevention, surveillance and control based in Athens with the participation of 17 countries. The Programme aimed at promoting prevention, surveillance and control of zoonoses and related foodborne diseases; strengthening collaboration between animals and public health services; implementing training activities; promoting veterinary public health activities and public health education; and fostering collaboration among Member Countries [15].

This initiative fathered what, in 2004, would become known as the concept of "One Health", underscoring the interdependency of human and animal health and their link with the ecosystems in which they co-exist. In the intervening years, much progress has been made at the international level to identify ways of collaboration between animal and human health agencies to reach the joint goal of One Health. However, the translation of this international success into national programs has been slow [16].

The "One Health" conceptual approach has seen unprecedented revival in the last decade with fostered awareness, scientific debate, research programmes [17], integrated disease surveillance [18] and an open toolbox in the fields of disease surveillance, epidemiological studies and health care provision.

The Global Health Strategy agenda, recently launched by the USA and endorsed by over 40 countries, seeks to forge interdisciplinary global health collaboration. It focuses on all aspects of health care for humans, animals and the environment to better prevent, detect and control human diseases with an aim to strengthen country compliance with the International Health Regulations. This programme can also potentially generate collaborations, surveillance, interventions, research, and improved policies through a One Health approach [19].

Also the European Commission, with the publication of the 'Decision on serious cross-border threats to health' in 2013, has stressed the need of interoperability between public health and veterinary sectors for preparedness and response planning [20].

The development of a business case for One Health has also been proposed to describe the origin and expansion of this concept, with five potential areas where One Health could add value and reduce costs: (1) sharing health resources between the medical and veterinary sectors; (2) controlling zoonoses in animal reservoirs; (3) early detection and response to emerging diseases; (4) prevention of pandemics; and (5) generating insights and adding value to health research and development [21].

But despite all efforts of cooperation between human and animal health, isolated silo thinking persists, particularly in the public health sector that struggles to perceive advantages of using a One Health approach [22].

One Health Surveillance is the latest conceptual tool being proposed to prove the added value of the One

Health concept, as per the business case described above, and to ultimately reduce the risks of infectious diseases at the animal-human-ecosystem interfaces. One Health Surveillance consists of the systematic collection, validation, analysis, interpretation of data and dissemination of information collected on humans, animals and the environment to inform decisions for more effective, evidence- and system-based health interventions [23].

At this stage, sporadic national success stories exist in implementing One Health Surveillance that could serve as examples for further implementation [23,24] and integrated surveillance systems have worked in specific situations and contexts [25]. International initiatives have been launched and supported by the Food and Agriculture Organisation (FAO), the World Health Organisation (WHO) and the World Organisation for Animal Health (OIE) and methodologies for the aggregation of existing databases at the human-animal interface have been tested (for example the GLEWS database and the establishment of the "4-way linking" platforms) [26,27].

Notwithstanding, barriers impeding the development of One Health Surveillance still need to be addressed [5]. Legal issues, hurdles to data sharing, unclear responsibilities, structural barriers between Ministries of Health, Agriculture and the Environment/Natural Resources and a lack of communication were all raised as obstacles to progress at the second International Conference on Animal Health Surveillance (ICAHS) in Havana (May 7-9, 2014). Moreover, the difference in priorities between Ministries of Health and Agriculture was found to be even more apparent when joint control strategies are discussed.

Also, the identification of criteria and methods to describe and assess existing levels of integration of surveillance for specific exposures is recommended to facilitate the evaluation of the impact and the added value of One Health Surveillance in the contexts where this integrated approach is being implemented.

In 2009, the EpiSouth Network [28] created a Directory of Human Public Health and Veterinary Public Health Officials for Zoonoses [29] in order to facilitate the surveillance of zoonosis in the Mediterranean basin in the framework of One Health. The network also identified two main recommendations towards integrated preparedness. Firstly, the establishment of formally appointed national multidisciplinary forums on zoonoses and risk assessment composed by epidemiologists, veterinarians, entomologists, laboratory officials from human public health (HPH) and veterinary public health (VPH). Secondly, the creation of a national network for preparedness and response, in line with the International Health Regulations, including the HPH and VPH authorities and all recognized actors of the process [30].

Started on the basis of the Network of countries established by EpiSouth, the European project MediLabSecure (2014-2017) aims to create a framework for collaboration to improve surveillance and monitoring of emerging arbovirosis in the Mediterranean basin and Black Sea regions [31].

This article describes how the MediLabSecure project is contributing to the strengthening of One Health surveillance.

MATERIALS AND METHODS

Under the coordination of Institute Pasteur - IP (Paris, France), an integrative network of four main disciplines: animal virologists (coordinated by INIA-CISA Madrid, Spain), human virologists (coordinated by IP Paris, France), entomologists (coordinated by IRD Montpellier, France) and epidemiologists (coordinated by ISS Rome, Italy) in 19 non-EU countries of the Mediterranean and Black Sea areas has been established to enhance the preparedness and response to emerging arbovirosis and to improve the integration of surveillance (IS) across the involved network.

A number of arboviruses were identified as present threats or with a potential risk of emergence in the Mediterranean and Black Sea regions as reported in Table 1.

Table 1 - Arboviruses representing an actual threat or a potential risk in the Mediterranean and Black Sea regions.

Arboviruses
• Representing a present threat in the region
• West Nile virus
• Crimean-Congo hemorrhagic fever virus
• Representing a potential risk of emergence in the region
• Dengue virus
• Chikungunya virus
• Yellow fever virus
• Rift Valley fever virus

Following a consensus workshop of the project the priority has been narrowed down to mosquito-borne viruses.

The project implements activities aimed at identifying laboratory and human surveillance contact points in all involved countries; assessing and documenting laboratory capacities and level of integration of surveillance activities; identifying training needs; designing and conducting trainings and capacity building. These activities take place within each discipline and in collaboration between them.

The selection of participating laboratories was performed based on the responses of potential participants of each beneficiary country to a questionnaire assessing their activities and capacities. One laboratory per discipline (human virology, animal virology, medical entomology) and per country was consequently identified. The first meeting involving all the Heads of the selected laboratories was held in January 2015 at IP in Paris.
Contact points for human surveillance were selected among experts working in the Ministries of Health/ Institutes of Public Health either already part of the EpiSouth Network or selected *ad hoc* through the contact points of the identified laboratories.
In order to assess and document the level of integration between the animal virology, human virology and medical entomology entities with the central national surveillance system we identified criteria, reported in Table 2, proposed on the basis of existing operational protocol and procedures [32]. On the basis of the three critical levels reported in the Table 2, we designed a survey targeting all the contact points of the project that could explore: 1) the existence of a national policy addressing integrated surveillance; 2) the existence of coordination mechanisms among the institutions involved; 3) the existence of integrated data collection tools and 4) the existence of joint result dissemination mechanisms such as bulletins, reports, papers, media reports and/or websites. We then assessed the level of surveillance integration in the 19 countries of the project splitting them in three regions (Tab. 3).
We performed a frequency analysis for all

Table 2 - Proposed criteria to describe existing levels of integration between human/animal/entomological surveillance for a specific exposure

Level of integration	Sublevels of integration	Criteria
Policy and institutional level	Policy level	1. Existence of a National policy addressing integrated surveillance for this specific exposure 2. Existence of a policy addressing integrated surveillance for this specific exposure at subnational level
	Institutional level	3. Existence of agreements among the institutions involved in human/animal/entomological surveillance for the specific exposure, 4. Existence of a coordination mechanisms among the institutions involved, 5. Existence of identified focal points for each of human/animal/entomological surveillance for the specific exposure
Data collection and analysis level	Interoperability mechanisms at data collection level	6. Existence of integrated data collection tools 7. Existence of activation mechanisms of human surveillance based on signals from animal/entomological surveillance 8. Other interoperability mechanisms at data collection level
	Interoperability mechanisms at data analysis level	9. Presence of DB exchange/merging/other mechanisms to facilitate joint analysis among sectors. 10. Performance of joint/integrated data analysis among the different surveillance sectors 11. Other interoperability mechanisms at data analysis level
Dissemination level	-	12. Existence of joint result dissemination mechanisms (e.g. bulletins, reports, papers, media reports, websites …)

Table 3 - Countries and regions involved

Balkans	Black Sea	North Africa and Middle East
Albania	Armenia	Algeria
Bosnia and Herzegovina	Georgia	Egypt
Kosovo	Moldova	Jordan
Montenegro	Ukraine	Lebanon
Serbia		Libya
The Former Yugoslav Republic of Macedonia		Morocco
Turkey		Palestine

categorical variables, and the proportions of responses were calculated on the basis of the number or respondents for each question.

RESULTS

Fifty-six contact points (CP) from laboratories (animal virology, human virology and medical entomology) and 19 contact points (CP) from Public Health Institutes (PHI)/Ministries of Health (MoH) (human epidemiology) from the 19 countries were invited to participate in the survey between December 2014 and September 2015.

We obtained responses from 51 laboratories (51/56; 91%) and 12 PHI/MoH (12/19; 63%), of whom: 14 were from the Black Sea, 26 from North Africa and the Middle East and 23 from the Balkans.

Human virology laboratories (19/63; 30%) were the most represented, followed by animal virology laboratories (18/63; 29%), medical entomology laboratories (14/63; 22%), and human epidemiology experts (12/63; 19%).

Thirty-four responders (34/63; 54%), of 17 countries, reported the availability of a *National policy addressing integrated surveillance* in their countries. When considering the result by sub-regions we found national policies to be available for 57% (8/14) of the Black Sea respondents, 62% (16/26) of North Africa and Middle East respondents and 43% (10/23) of Balkan responders.

Positive replies were given by 50% (9/18) of all animal virology respondents, 42% (8/19) of human virology respondents, 50% (7/14) of medical entomology respondents and 83% (10/12) of human epidemiology respondents.

Thirty-one respondents (49%), of 16 countries, reported the *existence of coordination mechanisms* among the institutions involved, of whom 57% (8/14) of the Black Sea respondents, 54% (14/26) of North Africa and Middle East respondents and 39% (9/23) of Balkan respondents. Positive replies were given by 56% (10/18) of all animal virology respondents, 47% (9/19) of human virology respondents, 29% (4/14) of medical entomology respondents and 67% (8/12) of human epidemiology respondents.

Integration mechanisms in data collection were reported by 29% (18/63) of all respondents, of 11 countries. This response was positive among 29% (4/14) of all the Black Sea respondents, 27% (7/26) of North Africa and Middle East respondents and 30% (7/23) of Balkan respondents. Positive replies were given by 11% (2/18) of all animal virology respondents, 32% (6/19) of human virology respondents, 21% (3/14) of medical entomology respondents and 58% (7/12) of human epidemiology respondents.

Thirty-four respondents (34/63; 54%), of 16 out of 19 countries, reported the availability of *joint results dissemination mechanisms* in their countries. This response was positive among 43% (6/14) of all the Black Sea respondents, 69% (18/26) of North Africa and Middle East respondents and 43% (10/23) of Balkan respondents. Positive replies were given by 44% (8/18) of all animal virology respondents, 58% (11/19) of human virology respondents, 57% (8/14) of medical entomology respondents and 58% (7/12) of human epidemiology respondents.

In 8 countries (42%), three in the North Africa and Middle East and Balkans and two in the Black Sea, all four contact points (animal virology; human virology; medical entomology; human epidemiology) answered the survey.

The positive replies given by the respondents of each discipline (animal virology; human virology; medical entomology; human epidemiology) in each region regarding the availability of national policy addressing integrated surveillance; existence of coordination mechanisms; integration mechanisms in data collection and joint results dissemination mechanisms, are reported in Figure 1.

A positive response to all the levels of integration explored in the survey was provided in one country by all four disciplines. In two countries, two disciplines replied positively to all the questions while in four countries one discipline indicated the existence of integration for all the levels explored.

DISCUSSION

To our knowledge this is the first study in the Mediterranean and Black Sea regions aimed at assessing the level of integration in the surveillance of arboviruses across four disciplines: animal virology, human virology, medical entomology and human epidemiology.

We found that integration on all the explored levels was confirmed by all four disciplines independently in only one country included in the study and by two disciplines in two countries. This suggests that implementation of fully integrated one health surveillance across the policy and institutional level to the data collection and dissemination level is yet to be fully developed in the Mediterranean and Black Sea regions.

Notwithstanding, some integration mechanisms have reportedly been set up in a number of countries, more frequently directed to the joint dissemination of results. Conversely, fewer countries have reported the existence of mechanisms/procedures for integrated data collection.

This might indicate that each laboratory collects surveillance data separately and that results are

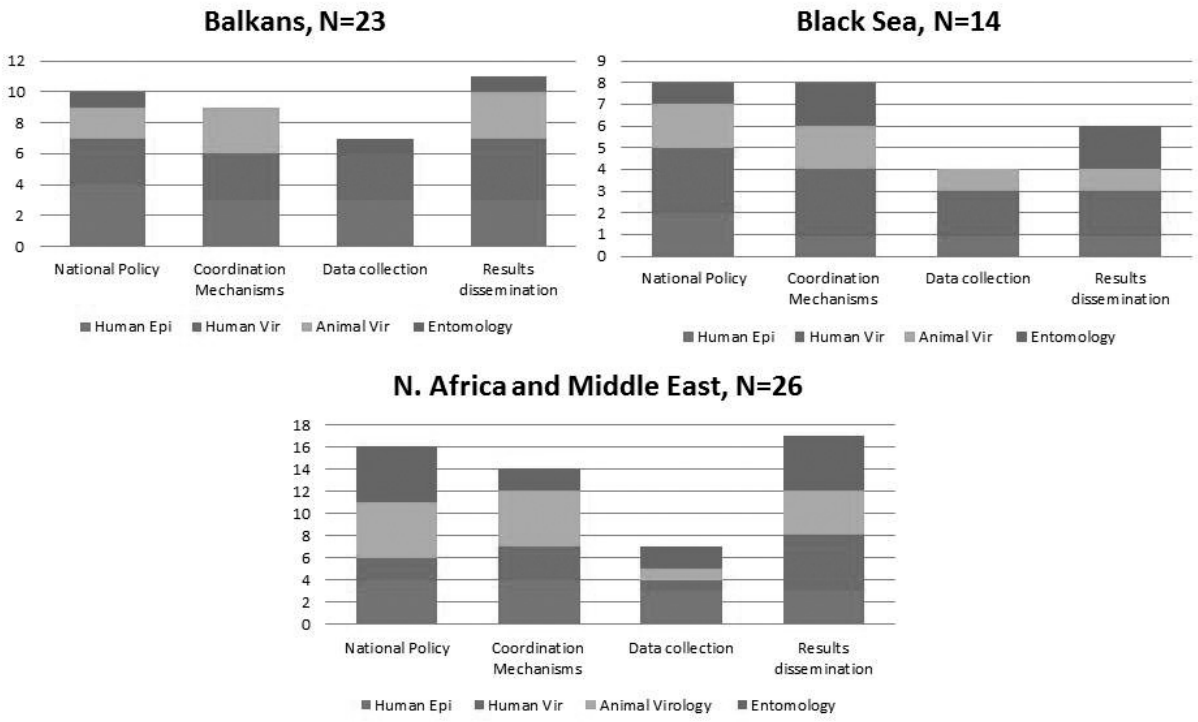


Figure 1 – Existence of policy and mechanisms for integrated surveillance

collated in a second step for coordinated dissemination.

The fact that all the contact points of the four disciplines answered the survey in eight countries might be indicative of a more defined role of each discipline and possibly increased motivation to report surveillance in an integrated way .

However, it has to be noted that the disciplines of the countries involved have not always replied consistently. Where one discipline reported integration in surveillance at one or more levels, in the same country this integration was commonly described differently by the other disciplines.

The questionnaire addressed purposely only some of the proposed criteria for levels of integration with the aim of acquiring a preliminary description of the situation in the 19 countries involved in the MediLabSecure Project without overloading participants with questions and thus enhancing the response rate. Detailed assessment of existing links and procedures will be carried out in selected countries which have disclosed a certain level of integration in this survey.

CONCLUSIONS

One Health surveillance should lead to faster disease detection, more efficient disease control and tangible financial savings when formally compared against separated surveillance streams [23,33].

While there seems to be a broad consensus about the value of One Health in the published studies, there is an evident lack of metrics and associated methods to estimate One Health benefits in a systematic way [34].

The first step to estimate the One Health benefits could be the assessment of the level of integration between relevant sectors/disciplines in the surveillance of specific emerging and re-emerging infectious diseases as described above in the study conducted in the framework of MediLabSecure Project.

Additional studies should describe procedures and mechanisms adopted by those countries with a certain level of integration, and good practices collected and shared to increase awareness.

Finally, the outcomes of integrated surveillance (in terms of disease detection, more efficient disease control and tangible financial savings) for the countries adopting it should be assessed and compared to the outcomes of countries with scarce or absent integrated surveillance mechanisms and procedures.

This should provide data and information to feed in an evidence based “business case” on One Health surveillance which can legitimately guide the development of national and international One Health policy.

ACKNOWLEDGEMENTS

We are very grateful to all the MediLabSecure contact points of all four discipline (animal virology; human virology; medical entomology; human epidemiology) who replied to the survey. Moreover we thank Antonella Lattanzi for her support in the references of this article.
The MediLabSecure Project is supported by the European Commission (DEVCO: IFS/21010/23/_194).

REFERENCES

1. IOM (Institute of Medicine). Emerging Viral Diseases: The One Health Connection. Washington, DC: The National Academies Press; 2015. Available from: http://www.ncbi.nlm.nih.gov/books/NBK280057/; last visited 21/12/2015.

2. Torres-Vélez F, Brown C. Emerging infections in animals - potential new zoonoses? Clin Lab Med 2004; 24(3): 825-8.

3. One health Initiative. Available from: http://www.onehealthinitiative.com/index.php; last visited 21/12/2015.

4. Kahn LH. Confronting zoonoses, linking human and veterinary medicine. Emerg Infect Dis 2006; 12(4):556-61.

5. Uchtmann N, Herrmann JA, Hahn EC 3rd, Beasley VR. Barriers to, efforts in, and optimization of integrated One Health surveillance: a review and synthesis. EcoHealth 2015; 12(2):368-84.

6. Faburay B. The case for a 'one health' approach to combating vector-borne diseases. Infect Ecol Epidemiol 2015; 5:28132.

7. Pfeffer M, Dobler G. Emergence of zoonotic arboviruses by animal trade and migration. Parasit Vectors 2010; 3(1):35.

8. Morens DM, Fauci AS. Emerging infectious diseases: threats to human health and global stability. PLoS Pathog 2013; 9(7): e1003467.

9. Bueno-Marí R, Almeida APG, Navarro JC. Editorial: Emerging zoonoses: eco-epidemiology, involved mechanisms, and public health implications. Front Public Health 2015; 3:157.

10. Moutailler S, Krida G, Schaffner F, Vazeille M, Failloux AB. Potential vectors of Rift Valley fever virus in the Mediterranean Region. Vector Borne Zoonotic Dis 2008; 8(6):749-53.

11. World Health Organization (WHO), Eastern Mediterranean Regional Office (EMRO). Wkly Epidemiol Monit 2011 21 Aug; 4(34). Available from: http://applications.emro.who.int/dsaf/epi/2011/Epi_Monitor_2011_4_34.pdf; last visited 21/12/2015.

12. Fenga C, Pugliese M. Endemic zoonosis in Mediterranean area. G Ital Med Lav Ergon 2013; 35(4):347-9.

13. Vittecoq M, Thomas F, Jourdain E, Moutou F, Renaud F, Gauthier-Clerc M. Risks of emerging infectious diseases: evolving threats in a changing area, the Mediterranean basin. Transbound Emerg Dis 2014; 61:17–27.

14. Seimenis A, Morelli D, Mantovani A. Zoonoses in the Mediterranean region. Ann Ist Super Sanita 2006; 42(4): 437-45.

15. Mediterranean Zooneses Control Programme (MZCP) of the World Health Organization. Available from: http://www.who.int/zoonoses/institutions/mzcp/en/; last visited 21/12/2015.

16. Operationalizing "One Health": a policy perspective. Meeting overvierw, May 4-6, 2010 Stone mountain, Georgia. Available from: http://www.oie.int/fileadmin/Home/eng/Media_Center/docs/pdf/meeting-overview.pdf last visited 21/12/2015.

17. One Health Commission. Available from: https://www.onehealthcommission.org/; last visited 21/12/2015.

18. ProMED mail. Available from: http://www.promedmail.org/; last visited 21/12/2015.

19. GlobalHealth.gov- Global Programs & Initiatives. Available from: http://www.globalhealth.gov/global-programs-and-initiatives/one-health/index.html; last visited 21/12/2015.

20. Decision No 1082/2013/EU of the European Parliament and of the Council of 22 October 2013 on serious cross-border threats to health and repealing Decision No 2119/98/EC.

21. Grace D. The business case for One Health. Onderstepoort J Vet Res 2014; 81(2):E 1-6.

22. Zinsstag J, Schelling E, Waltner-Toews D, Tanner M. From "one medicine" to "one health" and systemic approaches to health and well-being. Prev Vet Med 2011; 101(3-4): 148-56.

23. Stärk KDC, Arroyo Kuribreña M, Dauphin G, Vokaty S, Ward MP, Wieland B, Lindberg A.One Health surveillance - More than a buzz word? Prev Vet Med 2015; 120 (1):124-30.

24. Napoli C, Bella A, Declich S, Grazzini G, Lombardini L, Nanni Costa A, Nicoletti L, Pompa MG, Pupella S, Russo F, Rizzo C. Integrated human surveillance systems of West Nile virus infections in Italy: the 2012 experience. Int J Environ Res Public Health 2013; 10(12): 7180-92.

25. Goutard FL, Binot A, Duboz R. Rasamoelina-

Andriamanivo H, Pedrono M, Holl D, Peyre MI, Cappelle J, Chevalier V, Figuié M, Molia S, Roger FL. Surveillance: how to reach the poor? Surveillance in low-income countries, lessons from experiences in Cambodia and Madagascar. Prev Vet Med 2015; 120(1):12–26.

26. GLEWS. The Joint FAO–OIE–WHO Global Early Warning System for health threats and emerging risks at the human–animal–ecosystems interface. Available at: http://www.glews.net/ last visited 21/12/2015

27. FAO, OIE, WHO Four-way linking project for assessing health risks at the Human-Animal Interface. Project Description, August 2013. Available from: http://www.oie.int/fileadmin/Home/eng/Media_Center/docs/pdf/13_08_web_summary_4-way_linking_v7_fin_for_clearance_3_.pdf; last visited 21/12/2015.

28. Dente MG, Fabiani M, Gnesotto R, Putoto G, Montagna C, Simon-Soria F, Martin de Pando C, Barboza P, Ait-Belghiti F, Kojouharova M, Vladimirova N, Vorou R, Mellou K, Thinus G, Declich S, for the EpiSouth Network . EpiSouth: a network for communicable disease control in the Mediterranean region and the Balkans. Euro Surveill 2009; 14(5): pii: 19113.

29. Episouth WP8 Directory of Human Public Health and Veterinary Public Health Officials for Zoonose. Available from: http://www.episouth.org/search_zoonosis.php; last visited 21/12/2015.

30. Declich S, Simon Soria F, Martin de Pando C, *et al*. EpiSouth Strategic Documents. EpiSouth Report 10/2010. Available from: http://www.episouth.org/outputs/wp4/1_EpiSouth%20Strategic%20Documents_Rev%20Luglio%202010.pdf; last visited 21/12/2015.

31. Medilabsecure project. Available from: http://medilabsecure.com/; last visited 21/12/2015.

32. World Health Organization. Monitoring & evaluation Indicators for Integrated vector management. WHO/HTM/NTD/VEM/2012.4. ISBN 978 92 4 150402 7. Available from: http://apps.who.int/iris/bitstream/10665/76504/1/9789241504027_eng.pdf; last visited 21/12/2015.

33. Food and Agriculture Organization of the United Nations. World Livestock 2013 - Changing Disease Landscapes. Food and Agriculture Organization, Roma, 2013. Available from: http://www.fao.org/news/story/en/item/210621/icode/; last visited 21/12/15.

34. Häsler B, Cornelsen L, Bennani H, Rushton J. A review of the metrics for One Health benefits. Rev Sci Tech 2014; 33(2)453-64.

Nip'em in the bud: why collaboration of veterinarians and physicians is crucial to tackle cystic echinococcosis globally

F. TAMAROZZI[1,*], S. MAGNINO[2,*], A. CASULLI[3], G. MASALA[4], M. W. LIGHTOWLERS[5], E. LARRIEU[6], E. BRUNETTI[1]

[1]Department of Clinical, Surgical, Diagnostic and Paediatric Sciences, University of Pavia, WHO Collaborating Centre for Clinical Management of Cystic Echinococcosis, Pavia, Italy
[2]Istituto Zooprofilattico Sperimentale della Lombardia e dell'Emilia Romagna "Bruno Ubertini", Sezione Diagnostica di Pavia, Pavia, Italy
[3]Department of Infectious, Parasitic and Immunomediated Diseases, Istituto Superiore di Sanità, Rome, Italy
[4]Istituto Zooprofilattico Sperimentale della Sardegna, National Reference Centre for Cystic Echinococcosis (CeNRE), Sassari, Italy
[5]The University of Melbourne, Faculty of Veterinary and Agricultural Sciences, Veterinary Clinical Centre, Werribee, Victoria, Australia
[6]The University of Rio Negro, School of Veterinary, Choele Choel, Provincia de Río Negro, Argentina

Summary - Cystic echinococcosis (CE) is a worldwide-distributed parasitic zoonosis caused by infection with the dog tapeworm *Echinococcus granulosus sensu lato*. The World Health Organization (WHO) has included CE in the list of 17 Neglected Tropical Diseases towards which concerted actions should be prioritized locally and on a global scale. There are historical examples of successful control, elimination and eradication of CE from defined regions, and new tools have become available for its diagnosis and control, such as coproantigen detection in dogs, immunization of sheep with the EG95 vaccine, portable ultrasound for early diagnosis and surveillance in humans, geospatial analysis tools and mathematical modelling. Three international agencies (WHO, OIE and FAO) recommend to promote the intersectoral collaboration of medical and veterinary services with a "One Health" approach, also by implementing integrated control packages for more than one disease at the same time, sharing the same intervention or population. This work aims at illustrating intervention frameworks and highlighting the importance of intersectoral collaboration to achieve a successful control of CE.

Key words: hydatidosis, control, One Health, neglected diseases, zoonosis

Riassunto - L'echinococcosi cistica (EC) è una zoonosi parassitaria a diffusione mondiale, causata dall'infezione con la tenia del cane *Echinococcus granulosus sensu lato*. L'Organizzazione Mondiale della Sanità (OMS) la include tra le 17 malattie tropicali neglette verso le quali si dovrebbero indirizzare misure di controllo prioritarie a livello globale. Vi sono esempi storici di successo nell'eliminazione e eradicazione dell'EC in regioni delimitate e sono oggi disponibili nuovi strumenti per la sua diagnosi e controllo, come il rilevamento dell'antigene parassitario nelle feci dei cani, l'immunizzazione delle pecore con il vaccino EG95, l'ecografia con apparecchi portatili per la diagnosi precoce e sorveglianza nei pazienti umani, gli strumenti per analisi geospaziali e la modellistica matematica. L'approccio raccomandato dalle tre agenzie internazionali attive nel settore della salute umana e animale (OMS, FAO e OIE) è la collaborazione intersettoriale dei servizi medici e veterinari secondo il modello "One Health", anche con l'attuazione simultanea di pacchetti di controllo integrati per più malattie che condividano lo stesso intervento o popolazione bersaglio. In questo lavoro vengono illustrati i contesti e sottolineata l'importanza della collaborazione intersettoriale per un controllo efficace dell'EC.

Parole Chiave: idatidosi, controllo, One Health, malattie neglette, zoonosi

Cystic echinococcosis – a globally distributed zoonosis

Cystic echinococcosis (CE; syn.: hydatidosis) is a worldwide-distributed parasitic zoonosis caused by infection with the cestode *Echinococcus granulosus sensu lato*. It has a predator-prey life cycle involving carnivore definitive hosts (mostly domestic dogs) and herbivore/omnivore intermediate hosts (mostly sheep and other livestock), while humans are accidental dead-end intermediate hosts. CE

Corresponding author: Prof. Enrico Brunetti,
University of Pavia, Via Taramelli, 5 - 27100 Pavia, Italy.
Phone +39 0382 50 21 59; Fax +39 0382 50 22 96;
E mail: enrico.brunetti@unipv.it

** Equal contributions*

prevalence is therefore highest in livestock raising regions such as western China, Central Asia, Siberia, southern South America, eastern part of the Mediterranean region, southern and eastern Europe, the Middle East and northern and eastern Africa. In hyperendemic regions, the incidence of human CE can exceed 50/100,000 person-years and prevalences as high as 5-10% may occur. Present estimates indicate that its global burden may range from 1 to 3.6 million Disability Adjusted Life Years (DALYs), with annual costs associated with CE of over 3 billion US$ for human treatment and livestock production losses, but these figures are likely to be underestimates of the full costs [1, 2]. CE was recognized as a public health problem as early as 1950 by the World Health Assembly (resolution WHA3.23) and is included in the list of 17 Neglected Tropical Diseases (NTD) identified by the World Health Organization (WHO), yet more than 50 years have elapsed before CE was included in another WHA resolution (WHA66.12) in 2013 [3]. CE is also listed among the 7 priority Neglected Zoonotic Diseases (NZD, a subset of NTD) towards which WHO advocates the direction of concerted efforts towards control [4]. NZD mostly affect poor and marginalized populations in low-resource settings that rely on their animals for their living, often in remote rural areas, therefore attracting scarce attention by authorities and making the prospect of the affected population to sustain control measures unrealistic. Adding to this, common tools used to estimate disease burden such as DALYs may not be appropriate in the context of NTD, and in particular NZD, where quantification of local, rather than global, impact of the disease including full societal and economic assessment is pivotal. Finally, effective control of NZD relies mostly on intervention in animals, while humans experience the main benefits. This makes very difficult the individuation and agreement on the relative share of costs and coordination between human and veterinary health services. All these conditions perfectly apply to CE.

Integrated intersectoral control programmes for NZD, and in particular CE, have been generally lagging behind the roadmap schedule formulated by the WHO in 2012 for the elimination of target NTD [5]. Potentially pandemic emerging zoonoses such as H5N1 avian influenza or SARS mobilize consistent funding and prompt intensive intersectoral collaboration of medical and veterinary services as envisaged by the One Health approach, as a consequence of the general sense of threat associated with their emergence. On the contrary, endemic zoonoses such as CE for the most part are not perceived as posing a global threat and are generally neglected. Patients affected by CE cannot transmit the disease to other humans and cannot be a source of epidemic transmission. Nevertheless, the costs to those affected are often life-long or life threatening and medical costs in endemic countries are substantial. One important reason why CE can be considered an NTD that is particularly neglected is the lack of tools available to estimate the real burden of infection and the acknowledged massive underreporting of human CE [4, 6, 7]. NZD such as CE are difficult to diagnose and their endemicity difficult to assess due to their often patchy distribution linked to very specific transmission conditions and interaction between humans and their animals. Nonetheless, CE can be prevented, controlled (i.e. its prevalence can be limited by implementation of a programme) and eliminated at the country/region level (i.e. its prevalence may be reduced to the point that continued absence of transmission is achieved) [8, 9]. With regard to that, the WHO Informal Working Group on Echinococcosis (WHO-IWGE) recently proposed a practical definition of "elimination of CE as a public health problem" in a specified region, defined by the occurrence of no cases in humans <15 years of age, prevalence <0.1% in sheep (or other key intermediate hosts) <3 years, and prevalence <0.01% in dogs [10].

There are historical examples of successful control, elimination and eradication of CE from defined regions, achieved through implementation of focused interventions. Moreover, new tools for CE diagnosis and control, such as coproantigen detection in dogs, immunization of sheep with the EG95 vaccine, geospatial analysis tools to help individuate high risk areas, and mathematical modelling are now available for inclusion in the control programmes [10, 11]. This work aims at illustrating intervention frameworks and highlighting the importance of intersectoral collaboration to achieve a successful control of CE.

Perspectives from the International Organizations

Several international agencies, namely the WHO, the Pan American Health Organization (PAHO), the Food and Agriculture Organization of the United Nations (FAO), and the World Organisation for Animal Health (OIE) have a long history of advice and support to countries worldwide for the control of zoonoses. An interagency collaboration has recently been strengthened and formalized in a Tripartite Concept Note coauthored by FAO, OIE and WHO, where it is recognized that multi-sectoral and multi-institutional collaboration, involving in particular the medical and veterinary services, is key for addressing health risks arising at the human-animal-environment interface [12]. The agencies

consistently prompt the international community to engage in control activities of zoonotic diseases, including endemic NZD, and advocate a multi-disease approach as it may substantially increase the efficacy and cost effectiveness of control programmes.

There is now consensus in the international community that the existing knowledge and currently available tools may allow control of most NZD [6]. Some years ago, WHO and OIE jointly published a comprehensive manual on public health aspects of human and animal echinococcosis [8], where detailed recommendations for CE control are given. More recently, a joint meeting held by WHO, FAO, and OIE on surveillance, prevention and control of echinococcosis outlined current control programmes and indicated possible approaches for an integrated control of CE [10]. In another recent meeting held in Geneva [13], the international agencies have recapitulated their activities and detailed their intended contribution for collaborative actions on NZD, including CE, as follows:

- WHO formally recommends the application of veterinary public health (VPH) measures, i.e. the application of veterinary sciences to ensure the health and well-being of humans, as one of the five public health strategies for the prevention and control of NTD [2]. WHO also advocates the application by national governments of cross-sectoral approaches that combine leadership with community-level engagement for greater impact of initiatives aiming at the control of NZD [6]. Specifically on CE, WHO is assisting countries to develop and implement pilot projects leading to the validation of effective CE control strategies by 2020, prompting a close collaboration between veterinary and medical services.
- PAHO works towards strengthening capacity at local level for the management of zoonosis control and has identified CE as a priority in its efforts to address neglected diseases in disadvantaged populations of the Americas. In 2004, the *Southern Cone Sub-regional Project on Cystic Echinococcosis Control and Surveillance* was established in four countries of South America (Argentina, Brazil, Chile, and Uruguay). The project has been extended in 2013 to a fifth country (Peru) with the objective of defining strategies and action plans for eliminating CE in the Southern Cone, Andean region and other sub-regions of South America.
- FAO has established a global network of VPH professionals to spread information on the diagnosis, prevention and control of major zoonotic diseases, organizes expert consultations and promotes capacity building for surveillance and control of zoonoses, including CE. In addition, FAO has provided support to the implementation of CE control programmes in endemic countries (e.g. Lithuania) through specific Technical Cooperation Projects.
- OIE aims at strengthening the public health capacities of veterinary services and exploiting laboratory networks in member countries and sub-regions to address veterinary public health issues, including NZDs prevention and control. In order to do so, OIE promotes twinning programmes for laboratories and institutions (north–south and south–south collaboration) by linking an OIE reference laboratory or collaborating centre with laboratories that wish to upgrade their capacity and capability. In addition, OIE has recently revised the *Echinococcus granulosus* chapter of the OIE Terrestrial Code [14], thus providing guidance on the requirements for international trade of animals and animal products.

Lessons learned from past control programmes

Because human CE does not pose a risk of infection to other humans, all control programmes intended to interrupt CE transmission other than education activities in at-risk human populations have to target the animal hosts with well-known practical interventions (Fig. 1) [10, 11]. The population of dogs should be managed by compulsory registration of owned dogs and reduction of the unwanted dog population, possibly by strategies alternative to culling. Dogs should receive regular treatment with an effective cestocidal drug (praziquantel, PZQ) for long enough and with enough population coverage. These measures will interrupt transmission of the parasite from the definitive to the intermediate host. There are some operational problems with PZQ treatment in dogs, such as poor acceptability due to its unpleasant taste and smell, and difficulties for the rural workers in charge of the programme to adequately estimate the weight of each dog, calculate the correct dose and force the dogs to completely ingest it, which normally results in sub-dosage. The frequency and method of treatment should be sustainable for the health authorities, bearing in mind that fewer treatment interventions can lead to a significant decrease in the occurrence of CE cases even when eradication is not the objective of the control programme [15]. The frequency of treatment can be adjusted to local epidemiological needs, based on the identification of populations at risks, regions or villages with persistent levels of transmission, and speed of reinfection of dogs.

Enforcement of controlled slaughter in legal abattoirs, including provision of adequate infrastructures to hygienically dispose of infected

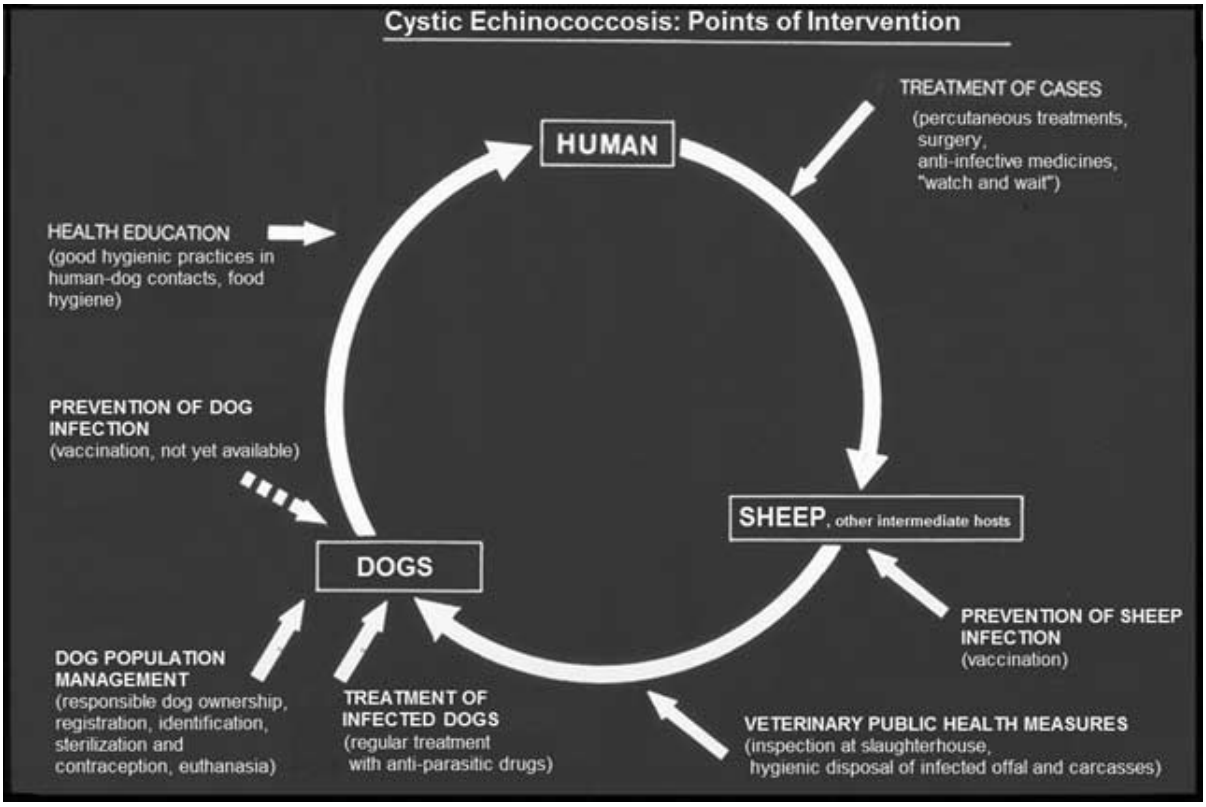


Figure 1 – Cystic echinococcosis: points of intervention for prevention and treatment

offal and to prevent dogs from accessing them will interrupt transmission from the intermediate to the definitive host. Sheep vaccination will also operate at this point of the parasite transmission cycle. Vaccination of livestock requires fewer interventions per year than dog treatment (2 initial interventions and yearly vaccinations versus 4-8 PZQ treatments, see also below) but has to be administered to a higher number of animals, requires an adequate infrastructure and should be carried out in a short period of time to minimize costs.

Pre-implementation steps include human and animal baseline prevalence data gathering, definition of control end-points and operating procedures to monitor them, mathematical modelling of interventions in terms of effectiveness and budget and time required, and pre-assessment of societal perceptions and dynamics that may impact control activities. The implementation of control activities requires government commitment in terms of leadership (coordination between involved Agencies/Ministries/Departments), provision of relevant legislation (e.g. passing of a law/regulation that requires compulsory registration of dogs, define slaughter practices, institute the notification of human and animal cases) and provision of adequate funding over time. In this regard, reliance on strategies such as animal owners taxation to sustain a programme that is perceived as having little benefit may not be effective in the long term, while incentives to animal owners should be considered instead.

Six options and four phases of CE control programmes have been advocated [8, 11, 16] (Tab.1). The main control measures include horizontal (not necessarily CE-specific) activities, such as health education, sanitation, amelioration of abattoir activities including hygienic disposal of infected offal and accurate meat inspection, and vertical interventions such as pharmacological treatment and population control in dogs, and quarantine measures for infected premises. Other measures may include vaccination of sheep with the highly effective EG95 vaccine and culling of older sheep. Different combinations of interventions have been modelled for effectiveness [17, 18] and have been or are currently being implemented in national or regional control programmes [10, 11]. As of today, CE is considered eradicated in 4 islands (Iceland, New Zealand, Tasmania, and Falkland Islands), as summarized by different authors [9, 11, 16]. To be successful, control measures should be tailored on the target area, as same or similar activities may be effective in one setting but not in another. For example, health education activities were eventually successful *per se* in the unique

Table 1 - Schematic overview of control options and implementation phases of CE control programmes (compiled after [11, 16]).

Control options		
Type	**Main measures and examples of success**	**Notes**
Option 1	No control due to absence of CE-related health problem or conditions preventing the implementation of a control programme	
Option 2	Horizontal slow attack approach involving health education, reliance on owners to treat dogs and amelioration of abattoirs and meat inspection (Iceland)	Unsuccessful in New Zealand and Falkland Islands
Option 3	Vertical slow attack approach with annual dog purge with Arecoline, education of owners and quarantine of positive dogs (Tasmania)	Arecoline purge now replaced by Praziquantel
Option 4	Vertical "fast-track" approach involving culling and sterilization of stray dogs and Arecoline-positive owned dogs (Cyprus)	Unacceptable in most contexts
Option 5	Vertical "fast-track" approach involving regular treatment of owned dogs with Praziquantel (New Zealand, Falkland Islands)	Possible to include Praziquantel baits for stray dogs
Option 6	Vertical "fast-track" approach involving Option 5 with the adjunct of sheep vaccination	Modelled and pilot trials in China and Argentina
Phases of a control programme		
Planning phase	Gathering of baseline prevalence data; identification of stakeholders including funders; undertaking of cost-benefit analysis; identification of appropriate control options; establishment of logistics and quality surveillance system; active reservoir identification by genotyping	Estimated duration: 1-2 years
Attack phase	Implementation of the control measures (see Options above)	Most costly phase; duration depends on the control Option (average 10-15 years)
Consolidation phase	Inspection at abattoirs with trace-back ability, treatment of dogs with Praziquantel, quarantine measures for affected areas	Long term or even permanent phase
Maintenance of elimination	Meat inspection, implementation of measures to avoid re-introduction with infected animals	Recovery of transmission is possible if surveillance is interrupted as shown by the example of Cyprus

conditions of Iceland while did not achieve significant reduction of CE prevalence in New Zealand or Falkland Islands.

After reviewing the implementation and achievements of past control programmes, the main factors that connotate successful versus unsuccessful control programmes can be identified as being associated with:

1) *Identification of the control measures and implementers most accepted by the target population*. A recent paper [19] highlighted the importance of a pre-assessment of societal perceptions and dynamics with reference to multiple neglected zoonoses, including CE, in Morocco. In particular, as fast-track vertical approaches mainly target the dog populations, a thorough assessment of acceptance, feasibility, sustainability, ethical aspects and impact of the different possible control measures applicable to the canine population is pivotal [20]. In addition, health education tools should be part of any control campaign even though evidence of their effectiveness as the sole intervention is limited to the unique example of Iceland. Education may improve community involvement and support, as rural communities may not have a correct knowledge of CE, its transmission cycle and impact on human and animal health [21].

2) *Presence of government-based leadership to provide adequate legislation and infrastructures, coordinate intersectoral activities and guarantee long-term funding for the implementation of measures*. The implementation of non-government led programmes, among other reasons, did not allow a significant reduction in CE prevalence in New Zealand and Turkana region of Kenya. Also, putting dog owners in charge of purchase of anthelmintics and of dog treatment, is less effective than implementing a systematic external intervention, as exemplified by the experiences of New Zealand, Uruguay, and Sardinia, Italy. The precocious interruption of control activities has been identified as one of the main factors that caused the resurgence of CE transmission in Cyprus, Chile and Wales (UK), and yielded overall limited success of South American control programmes [22].

Strategies and tools for CE control - a One Health approach

One Health has been defined as "*the collaborative effort of multiple disciplines - working locally, nationally, and globally - to attain optimal health for people, animals and the environment*" [23].

Among the major obstacles to the implementation of One Health interventions are institutional and financial barriers, ranging from competition between institutions and professional figures to lack of bureaucratic framework to coordinate intersectoral activities and lack/unclear allocation of funding among the structures involved [4, 7]. Several examples of effective One Health interventions in response to emerging zoonotic threats such as H5N1 avian influenza demonstrate the feasibility of such approach, but the long-term maintenance of the infrastructures built during public health crises, that would be required to address endemic NZD, is difficult [7]. Furthermore, although control of NZD, including CE, has been demonstrated to be highly cost–effective [24], this action can still be unaffordable or perceived as not worthy by affected communities. One option to overcome these issues would be to implement integrated control packages for more than one disease at the same time, sharing the same intervention or population targets as appropriate for a particular geographical area (e.g. targeting rabies, echinococcosis and leishmaniasis in dogs) [25]. Trials on integrated control programmes for other NTD such as soil transmitted helminthiasis, filariasis, schistosomiasis and trachoma have shown both feasibility and effectiveness [26].

To put things into practice towards CE elimination in a region or country or part of it, a methodical approach is required. Before initiating a CE control programme, its objectives should be clearly stated and agreed with the actors that will be in charge of implementing the activities. Based on the baseline situation of human and animal CE, a reduction of the CE prevalence might be considered as a first objective, to be subsequently expanded to aim at CE elimination. The passing of a law/act that officially institutes the programme and specifies its funding needs to be provided. The allocation of resources and responsibilities in the control programme should be done in accordance with the principle that more costs should be borne by the sector deriving most benefit from the intervention, irrespective of the burden of control required within that sector.

In the general and CE-specific context, pivotal strategic issues and tools include [4, 6, 9, 10, 11, 16]:

1) *Baseline assessment of the prevalence of infection in both animals and humans and estimation of the comprehensive cost of the infection, taking into account both human and non-human, monetary and non-monetary costs*. Some recently-introduced tools supporting this preparation phase of CE control programmes, and also applicable to the assessment of control outcomes, are population-based ultrasound screening of humans and dog coproantigen ELISA tests. As to the estimation of costs, special attention should be given to the ones related to misdiagnosis, in terms of resources wasted in misallocating cases to the wrong diagnosis. Animal costs should include a full societal assessment of the value of livestock and dogs in different communities. The assessment of the feasibility of interventions will also benefit from social and anthropological analyses of the population dynamics in the area where the programme is being implemented.

2) *Evaluation of the distribution and burden of other infections* that would benefit from an integrated approach because they share the similar intervention targets or population in that particular geographical area. Such integrated approach may be more cost-effective and would possibly increase compliance. For example, aspects of rabies control that involve control of stray dogs would have clear benefits for both rabies and CE.

3) *Calculation of the cost-benefit of different interventions/combination of them for each sector*. Data for such evaluations may be gathered through strategic case studies on a relatively small scale, although for CE these may require consistent funding and long-term commitment. Cost-benefit analysis is vital to implement a "separate costs" approach where costs are allocated between sectors in proportion to the monetary benefit the sector is expected to gain from the control activity. This exercise will avoid the veterinary sector having to bear most costs for interventions that would mostly benefit human health. Important tools are mathematical models, which can provide a theoretical basis against which to plan and assess control programmes [17, 18]. In the context of CE control, the use of the highly effective EG95 vaccine for sheep immunization should be included among the possible control options. A pilot control program using the EG95 vaccine has been underway in the Rio Negro province of Argentina where it has been found that use of the vaccine substantially reduced CE transmission by sheep, even though the programme was implemented in challenging rural circumstances [27]. Further studies to optimize vaccine administration regimes and promote integration with other control measures, such as dog anthelmintic treatment, are required.

4) *Government leadership and commitment*. Historically, the implementation of CE control measures has been demonstrated to be more effective if driven by government rather than non-government agencies. Government agencies can implement strategies to guarantee adequate long-term funding and provide the required legislation and infrastructures. Incentives to animal owners, who often perceive little direct benefit from

interventions, should also be considered. Funding for treatment of human cases detected during surveillance campaigns, e.g. via ultrasound imaging, should also be taken into account.

5) *Assessment of the effect of control programmes*. Continuous ultrasound-based surveys in a population living in the control programme target area is currently the only way to assess the effect of control interventions in humans and has the added value of allowing detection of early cysts. This approach is made possible by the use of the WHO-IWGE standardized ultrasound classification of echinococcal cysts [28], which distinguishes active, transitional and inactive stages. This classification has not only clinical, but also epidemiological implications. Small CE1 cysts point to current transmission in areas of residence of individuals harbouring this stage, and a high rate of CE1 and CE3a cysts in a given population points to the need for control programmes [29]. In addition, repeated screening programmes employing general practitioners (GP) trained in focused ultrasound assessment of CE [30, 31] provide a means of overcoming the dearth of imaging specialists in remote areas where CE can be prevalent. Early detection of cysts also saves a sizeable amount of medical resources because small, early CE1 and CE3a cysts respond favourably to albendazole alone, which can be administered directly by said GPs without sending positive cases to distant tertiary care hospitals with the attending expenses and loss of salary [31]. Conversely, lack of such repeated screening programmes allows the cysts progress toward other stages (e.g. CE2 and CE3b) that are not responsive to percutaneous or medical treatment and frequently become complicated and require surgery [32]. Last but not least, continuous ultrasound screenings allow the detection of inactive, uncomplicated cysts that only need conservative management ("watch and wait"), with further avoidance of unnecessary treatment [33]. Data from the surveys can be fed into national registries for CE, a newly introduced tool that shows promise in addressing the current problems plaguing collection of reliable clinical and epidemiological data concerning human CE [34].

The impact of a CE control programme in animals can be measured by the reduction of *E. granulosus* coproantigen prevalence in dogs, and of CE lesions prevalence in sheep at meat inspection. Adequate frequencies of treatment of dogs – at least 4 times, preferably 5-6 times per year - and the use of sentinel lambs to detect circulation of *E. granulosus* need to be provided in order to maximize the chances of success. The impact of the programme is challenged in case clandestine slaughtering of livestock is widely performed and adequate coproantigen testing coverage of unwanted dogs is not ensured [11].

CONCLUSIONS

New tools for CE diagnosis and control, such as coproantigen detection in dogs, immunization of sheep with the EG95 vaccine, portable ultrasound for early diagnosis and surveillance in humans, geospatial analysis tools and mathematical modelling are now available for inclusion in the control programmes. The rationale for integrated approaches to CE is based on both policy and technical considerations. For example, elimination of human CE requires a long-term, multi-sectoral plan that builds on strong political mobilization, infrastructures and significant front-loading (establishment of vaccine banks; drugs and logistics for mass treatments; and educational campaigns), and behaviour change interventions. Even in the most favourable environments, it may take up to 20 years to reach the goal of the programme. These programmes can be difficult to support within government or donor funding cycles and often, once the number of cases begins to decrease, systems for surveillance and control become difficult to sustain.

The concept of 'One Medicine' includes the beneficial flow of knowledge and techniques from human medicine to veterinary medicine, and vice versa [35]. The experience of the response to zoonotic pandemics proves that intersectoral collaboration of medical and veterinary services as envisaged by this approach is feasible, but the long-term maintenance of the infrastructures required to address endemic NZD such as CE is difficult. One option to overcome at least in part these issues would be to implement integrated control packages for more than one disease at the same time, sharing the same intervention or population targets, following the example of what has been applied for the control of other NTD.

REFERENCES

1. Craig PS, Budke CM, Schantz PM, Li T, Qiu J, Yang Y, Zeyhle E, Rogan MT, Ito A. Human echinococcosis: a neglected disease? Trop Med Health 2007; 35: 283–92.

2. World Health Organization. First WHO report on Neglected Tropical Diseases: working to overcome the global impact of neglected tropical diseases. World Health Organization, Geneva, 2010.

3. World Health Assembly. WHA66.12 Resolution: Neglected Tropical Diseases: Prevention, Control, Elimination and Eradication. World Health Organization, Geneva, 2013. Available from: www.who.int/neglected_diseases/mediacentre/WHA

_66.12_Eng.pdf?ua=1; last visited 30/09/2015.

4. World Health Organization. The control of neglected zoonotic diseases: a route to poverty alleviation. Report of a joint WHO/DFID-AHP meeting, 20 and 21 September 2005, WHO Headquarters, Geneva, with the participation of FAO and OIE. World Health Organization, Geneva. 2005.

5. World Health Organization. Accelerating work to overcome the global impact of neglected tropical diseases: a roadmap for implementation. World Health Organization, Geneva, 2012.

6. World Health Organization. The Control of Neglected Zoonotic Diseases: from Advocacy to Action. Report of the fourth international meeting. 19–20 November 2014, WHO Headquarters, Geneva. World Health Organization, Geneva, 2015a.

7. Okello AL, Bardosh K, Smith J, Welburn SC. One Health: past successes and future challenges in three African contexts. PLoS Negl Trop Dis 2014; 8 (5): e2884.

8. World Health Organization, World Organisation for Animal Health. WHO/OIE Manual on Echinococcosis in Humans and Animals: a Public Health Problem of Global Concern. Eckert J, Gemmell MA, Meslin FX, Pawloski ZS (Eds). Paris, France: World Organisation for Animal Health; 2001.

9. Lightowlers MW. Cysticercosis and echinococcosis. In: Mackenzie JS, Jeggo M, Daszak P, Richt JA (Eds). One Health: The Human-Animal-Environment Interfaces in Emerging Infectious Diseases. Current Topics in Microbiology and Immunology 2013; Vol. 365, p. 315-35.

10. World Health Organization. Report of the WHO Informal Working Group on cystic and alveolar echinococcosis surveillance, prevention and control, with the participation of the Food and Agriculture Organization of the United Nations and the World Organisation for Animal Health, 22–23 June 2011, WHO Headquarters, Geneva. World Health Organization, Geneva, 2011a.

11. Lembo T, Craig PS, Miles MA, Hampson KR, Meslin, FX. Zoonoses prevention, control, and elimination in dogs. In: Macpherson CNL, Meslin FX, Wandeler AI (Eds). Dogs, Zoonoses and Public Health. Wallingford, Oxfordshire; Boston, MA: CABI; 2013. p. 205-58.

12. FAO/OIE/WHO. 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. 2010. Available from: www.who.int/foodsafety/zoonoses/final_concept_note_Hanoi.pdf?ua=1; last visited 30/09/2015.

13. World Health Organization. Interagency Meeting on Planning the Prevention and Control of Neglected Zoonotic Diseases (NZDs), 5–6 July 2011, WHO Headquarters, Geneva. World Health Organization, Geneva, 2011c.

14. World Organisation for Animal Health (OIE). OIE Terrestrial Animal Health Code. Chapter 8.5. Infection with Echinococcus granulosus. Available at: www.oie.int/fileadmin/Home/eng/Health_standards/tahc/2010/chapitre_echinococcus_granulosus.pdf; last visited 30/09/2015.

15. Cabrera PA, Lloyd S, Haran G, Pineyro L, Parietti S, Gemmell MA, Correa O, Morana A, Valledor S. Control of Echinococcus granulosus in Uruguay: evaluation of different treatment intervals for dogs. Vet Parasitol 2002; 103: 333-40.

16. Craig PS, Larrieu E. Control of cystic echinococcosis/hydatidosis: 1863-2002. Adv Parasitol 2006; 61: 443-508.

17. Torgerson PR. The use of mathematical models to simulate control options for echinococcosis. Acta Trop 2003; 85: 211-21.

18. Huang L, Huang Y, Wang Q, Xiao N, Yi D, Yu W, Qiu D. An agent-based model for control strategies of Echinococcus granulosus. Vet Parasitol 2011; 179: 84-91.

19. Ducrotoy MJ, Yahyaoui Azami H, El Berbri I, Bouslikhane M, Fassi Fihri O, Boué F, Petavy AF, Dakkak A, Welburn S, Bardosh KL. Integrated health messaging for multiple neglected zoonoses: Approaches, challenges and opportunities in Morocco. Acta Trop 2015; 152: 17-25.

20. Kachani M, Heath D. Dog population management for the control of human echinococcosis. Acta Trop 2014; 139: 99-108.

21. Marcotty T, Thys E, Conrad P, Godfroid J, Craig P, Zinsstag J, Meheus F, Boukary AR, Badé MA, Sahibi H, Filali H, Hendrickx S, Pissang C, Van Herp M, van der Roost D, Thys S, Hendrickx D, Claes M, Demeulenaere T, van Mierlo J, Dehoux JP, Boelaert M. Intersectoral collaboration between the medical and veterinary professions in low-resource societies: The role of research and training institutions. Comp Immunol Microbiol Infect Dis 2013; 36: 233-9.

22. Larrieu E, Zanini F. Critical analysis of the strategies to control cystic echinococcosis and the use of praziquantel in South America: 1980 – 2009. Rev Panam Salud Pública 2012; 31: 81-7.

23. American Veterinary Medical Association. One Health: A New Professional Imperative. 2008. Available from: www.avma.org /KB/Resources/Reports/Documents/onehealth_final.pdf; last visited 30/09/2015.

24. Jiménez S, Pérez A, Gil H, Schantz P, Ramalle E, Juste R. Progress in control of cystic echinococcosis in La Rioja, Spain: decline in infection prevalences in human and animal hosts and economic costs and benefits. Acta Trop 2002; 83: 213-21.

25. Welburn SC, Beange I, Ducrotoy MJ, Okello AL. The neglected zoonoses-the case for integrated control and advocacy. Clin Microbiol Infect 2015; 21: 433-443.

26. Linehan M, Hanson C, Weaver A, Baker M, Kabore A, Zoerhoff KL, Sankara D, Torres S, Ottesen EA. Integrated implementation of programs targeting neglected tropical diseases through preventive chemotherapy: proving the feasibility at national scale. Am J Trop Med Hyg 2011; 84: 5-14.

27. Larrieu E, Mujica G, Gauci CG, Vizcaychipi K, Seleiman M, Herrero E, Labanchi JL, Araya D, Sepúlveda L, Grizmado C, Calabro A, Talmon G, Poggio TV, Crowley P, Cespedes G, Santillán G, Cachau MG, Lamberti R, Donadeu M, Lightowlers MW. Pilot field trial of the EG95 vaccine against ovine cystic echinococcosis in Rio Negro, Argentina: second study of impact. PLoS Negl Trop Dis 2015; 9(10): e0004134.

28. World Health Organization - Informal Working Group on Echinococcosis. International classification of ultrasound images in cystic echinococcosis for application in clinical and field epidemiological settings. Acta Trop 2003; 85: 253-61.

29. Karim MF, Brunetti E, Rahman S, Budke CM, Ahsan AS, Al-Mahtab M, Zaki KM, Alam MJ, Akbar SM, Jalil MA. Abdominal cystic echinococcosis in Bangladesh: a hospital-based study. J Infect Dev Ctries 2015; 9: 70-5.

30. Bélard S, Tamarozzi F, Bustinduy AL, Wallrauch C, Grobusch MP, Kuhn W, Brunetti E, Joekes E, Heller T. Point-of-Care Ultrasound Assessment of Tropical Infectious Diseases - A Review of Applications and Perspectives. Am J Trop Med Hyg 2015; Published online Sep 28. pii: 15-0421.

31. Del Carpio M, Mercapide CH, Salvitti JC, Uchiumi L, Sustercic J, Panomarenko H, Moguilensky J, Herrero E, Talmon G, Volpe M, Araya D, Mujica G, Calabro A, Mancini S, Chiosso C, Labanchi JL, Saad R, Goblirsch S, Brunetti E, Larrieu E. Early diagnosis, treatment and follow-up of cystic echinococcosis in remote rural areas in Patagonia: impact of ultrasound training of non-specialists. PLoS Negl Trop Dis 2012; 6 (1): e1444.

32. Rinaldi F, De Silvestri A, Tamarozzi F, Cattaneo F, Lissandrin R, Brunetti E. Medical treatment versus "Watch and Wait" in the clinical management of CE3b echinococcal cysts of the liver. BMC Infect Dis 2014; 14: 492

33. Piccoli L, Tamarozzi F, Cattaneo F, Mariconti M, Filice C, Bruno A, Brunetti E. Long-term sonographic and serological follow-up of inactive echinococcal cysts of the liver: hints for a "watch-and-wait" approach. PLoS Negl Trop Dis 2014; 8 (8): e3057.

34. Tamarozzi F, Rossi P, Galati F, Mariconti M, Nicoletti GJ, Rinaldi F, Casulli A, Pozio E, Brunetti E. The Italian registry of cystic echinococcosis (RIEC): the first prospective registry with a European future. Euro Surveill 2015; 20 (18):pii=21115.

35. McAllister MM. Successful vaccines for naturally occurring protozoal diseases of animals should guide human vaccine research. A review of protozoal vaccines and their designs. Parasitology 2014; 141: 624-40.

Veterinary Public Health: a long-lasting collaboration between Angola and Italy

P. PARODI[1], M. BARBOSA[2], S. DANIEL[2], N. FERRI[1], A. MANCUSO[1], L. POSSENTI[1], M. SANTOS[2], M. SCACCHIA[1], L. VENTURI[3]

[1]Istituto Zooprofilattico Sperimentale dell'Abruzzo e del Molise, Teramo, Italia
[2]Departamento Provincial da Huila, Instituto dos Serviços de Veterinária de Angola, Lubango, Angola
[3]Già docente a contratto, Università di Bologna, Bologna, Italia

Summary - In this paper the evolution in Veterinary Public Health collaboration between Angola and Italy, started more than thirty years ago is delineated. Some of the most important projects are described, along with their results and the contextual Angolan and international policies on development.

Key words: Veterinary public health, Angola

Riassunto - La collaborazione in sanità pubblica veterinaria fra Italia e Angola, iniziata oltre trent'anni fa, ha subito un'evoluzione, che viene sinteticamente descritta in questo articolo. Sono presentati alcuni dei principali progetti di sanità pubblica, i loro risultati e le contestuali politiche dell'Angola e internazionali sullo sviluppo.

Parole chiave: Sanità pubblica veterinaria, Angola

INTRODUCTION

Angola, a former Portuguese colony, became independent in 1975. Afterward, a 30-years civil war devastated the country, terminating in 2002. According to the preliminary data of the national census 2014, the country has a population of about 24 million people, 38% of which is dedicated to agro-pastoral activities. This sector accounts for about 8% to the gross domestic product (GDP) [1, 2].

Angola has a total area of 124 million hectares, more than 40% devoted to pasture, mainly in the south, where most of the cattle is reared. Traditional agriculture depending on the first rain and the regularity of the followings, most of the land is used as natural pasture, while cereals production is very limited. Even coming late, rains will ensure enough pasture to maintain livestock, and milk production in quantity sufficient both for humans and calves.

Equilibrium is the key word here: an equilibrium mainly based on livestock and milk production. Bovine, ovine and caprine are generally reared together, being complementary parts of the same family income sources.

The area is mainly inhabited by semi-nomadic tribes pertaining to the Herero group. They live on livestock: milk, associated with millet porridge, represents the basis for human nutrition, and is generally consumed fresh or transformed in yoghurt. Meat is mostly eaten in special occasions: funeral, marriage, and other feasts. Livestock breeding is considered the true symbol of richness, and the only possible source of survival and revenue.

Before independence, Angola's economy was relatively diversified, counting on a wide range of agricultural production and exports, and self-sufficient in food. According to International Organizations, rural poverty and malnutrition are decreasing but still widespread, affecting respectively about 58% and 27% of the population [2, 3].

Angola adopted the Millennium Development Goals, and the priorities of malnutrition and poverty reduction indicated in the agenda of the New Partnership for Africa Development (NEPAD) and Southern African Development Community (SADC). The National Strategy for Food and Nutrition Security approved in 2009, was implemented through an intersectoral approach aimed at increasing and diversifying agricultural production, restore internal market, improve food access, reduce malnutrition, ensure food security,

Corresponding author: Dr Patrizia Parodi, Lubango.
Cell. +244 936204740; E mail: patparodi05@libero.it

food safety and protect public health, implement rapid alert system at national and local level [4].
Urbanization is increasing, diminishing agriculture productivity and access to food. The rebuilding of destroyed rural infrastructures and ensuring food security are therefore Government priorities. In these policies the Government is supported by FAO and other organizations, including Italian cooperation [2, 4].
The Ministry of Agriculture and Rural Development (MINADER) is directly responsible for all agricultural, livestock and forestry rural development.
The Institute of Veterinary Services, born in 1923 by the High Commissioner Norton de Matos, at present is a body under MINADER, in charge of veterinary public health (VPH), animal health and livestock improvement, and food safety. Since its start, it counts with a network of veterinary offices and laboratories all over the country [5, 6].
At international level, Angola, a member of SADC, is fostering integration into the multilateral trading system. In the last years the Government has introduced (and still is introducing) new legislation and policies in many sectors, including agriculture and livestock [2].

A long-lasting collaboration

The Italian Cooperation considers that the aid for the development of Angola played a fundamental role in the bilateral relationship between the two countries since 1975, when Angola promulgated its independence declaration.
This aid covered many sectors, deemed as priorities for the rehabilitation and development of the country, using a number of tools, such as bilateral and multilateral projects, direct and indirect management, but always in line with the Angolan strategy of poverty reduction.
In accordance with OCSE-DAC policy, an exit strategy is now ongoing, but some Italian non governmental organizations (NGOs) are still implementing some projects in several fields, among which food security and public health.

Pioneering

Since the institution of the Veterinary Services, VPH was recognized as a priority, being livestock the major living condition for people. Nevertheless, many diseases, such as anthrax, blackleg, piroplasmosis, and external parasites, affected livestock. According to the World Organisation for Animal Health (OIE), animal health status in Angola was poor, with some zoonosis, such as rabies and anthrax reported as enzootic [6].
In the early '80s, a period characterized by a diminished intensity in civil war, Angola's policies in agriculture were aimed at restoring the production of the former colonial period, through the support to state farms, replacing the Portuguese properties.
At that time, may cooperation activities were implemented in several sectors, including livestock melioration and VPH. Among them an agricultural programme directly managed by the Italian Ministry of Foreign Affairs, at whose side was realized, by Snamprogetti-ENI, a satellite project (Missão Tecneco) devoted to improve animal health and food hygiene.
While the first-one was aimed at converting some agricultural land through the construction of water mains, land tillage, culture improvement, and construction of housing for workers, the latter supplemented these activities with the provision of an itinerant veterinary care to the livestock of the Herero population. Moreover, Missão Tecneco, focused on improving many types of livestock production, including chicken, swine, bovine and contributed to ensuring food safety through meat inspection in the slaughterhouse of Namibe, disease surveillance and intersectoral collaboration [7].
In 1990 and 1991, through a collaboration with the National Institute of Veterinary Research (IIVA), who had moved from Huambo to Lubango for security reasons, an inventory of the fauna of ticks in cattle was made all around the province of Huila [8]. The results represent updating findings of the only existing previous work [9]. The long period between the two surveys: 18 years, from 1973 to 1991, is of great interest because every drug control activities had come to an end due to the war, and the fauna of ticks did not suffer from any subsequent selection.
After the re-exacerbation of civil war, most of these projects stopped: nevertheless, in 1998, the NGO *Nuova Frontiera* organized in Lubango the 1st National Workshop on the Impact of Veterinary Medicine on Public Health, with the participation of more than 30 public officers, physicians and veterinarians [10].

Peace and reconstruction

After 30 years of civil war, peace was resettled in Angola at the beginning of the new century, and a period of reconstruction started.
At the same time, a process of privatization was ongoing, in order to facilitate the supply of goods (food, drugs, etc.) all over the country.
State farms were replaced by private farms, but most of livestock was, and still is, owned by Herero people, using a very traditional, semi nomadic way.
Public-private investments were limited and unable to restore infrastructures, badly damaged by the war.
The heavy losses in people and the lack of appropriate technical assistance hampered the

agricultural development.
At that time, Sub-Saharan Africa was a priority for the Italian Cooperation. In Angola, many initiatives were funded, among which a new project in VPH, considered one of the key priorities due to the sanitary situation, the heavy losses in infrastructures, equipments and qualified professionals, and the lack of epidemiological studies and disease control.
From 2001 to 2005 the NGO *Alisei* implemented a VPH project, funded by the Italian Cooperation, in the South West of Angola, in Namibe and Huila Provinces.
Aim of the project was the improvement of meat production, and food safety more in general (Fig. 1). Data on some zoonoses were collected, using the slaughterhouse as an epidemiological unit, with the aim of investigating their prevalence and control

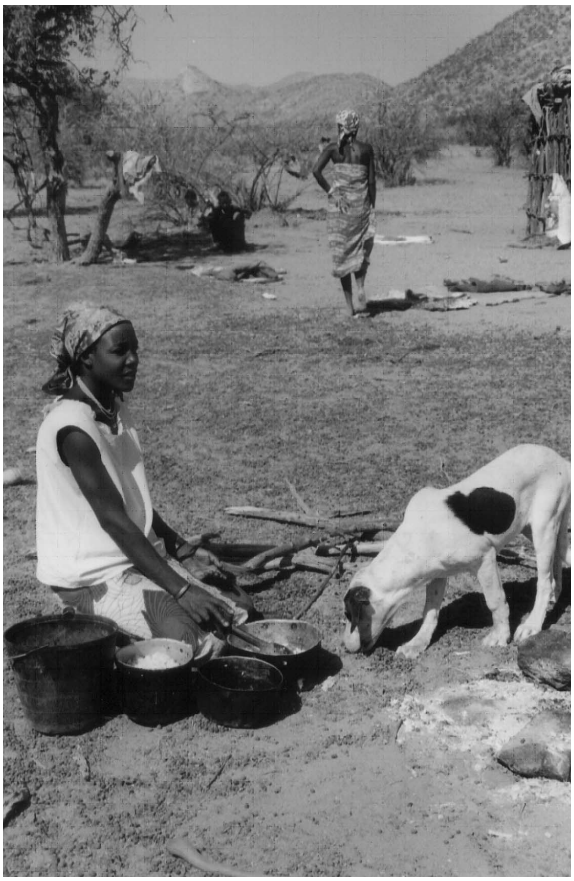


Figure 1 - Food preparation in a rural area of Angola

strategies. Training and health education were also developed, and a number of information materials prepared, including a mobile exhibition entitled "A correct nutrition to stay in good health" made with students' work [11-14].
At that time, Angola was pioneering intersectoral collaboration.
In addition, the project supported the implementation of international policies, such as the use of an interdisciplinary approach as a basis to include health in all policies, where public health (both human and veterinary), education, local administrations, private stakeholders, participate in the whole process, from planning to final evaluation. Epidemiological studies were the roots for suggesting more effective public health policies, and best practices. In particular, to prevent the spread of diseases through the consumption of contaminated meats, all cases of zoonoses detected during meat inspection as well as pathologies diagnosed during health checks of slaughterhouse staff, butchers and street vendors were communicated to Public Health and Veterinary Services. In case a Municipality show a high prevalence for some zoonoses, an open workshop was organized to disseminate information and increase citizens awareness.
The project was committed to the Paris Principles on Aid Effectiveness [15], nevertheless sustainability was partially fulfilled due to budget restrictions and logistic constrains.

Development and international harmonization
The Guidelines on Italian Cooperation for the period 2014-2016 focus the attention on the new Development Agenda of the United Nations, and reaffirm the Italian commitment for poverty reduction. Food security and nutrition, and an integrated rural development, are some of the most qualified themes of cooperation activities. Two of the objectives of the Italian cooperation refer specifically to the improvement of food security and agricultural development, and to the support to global health, particularly in rural areas.
In agriculture, activities should be focused on eco-sustainability, on support to small producers and their associations, and on better services. In addition, particular attention should be put on nutrition and food security, central theme of EXPO 2015 "Feeding the Planet, Energy for Life". Although Sub-Saharan Africa remains a priority for the Italian cooperation, Angola is not included into the beneficiary countries [16].
In this context, the Integrated Project of Public Health (PISP), born as a partnership between some Angolan Provincial Governments, the Institute of Veterinary Services, the Abruzzo Region, the Istituto Zooprofilattico Sperimentale "G. Caporale" dell'Abruzzo e del Molise (IZS AM) and the Association Marco Di Martino, is mostly funded by the same Angola.
It started on July 2014 and will last for three years. At present it is under implementation in Huila province, the one with the highest livestock concentration, but it is expected to cover all the South of Angola.

Considering trade globalization, and its impact on public health, the project strategy is aimed at fostering regional collaboration, basing its activities on international standards.
Angola, in fact, is a net oil exporter, while is importing most of other goods, including food. The recent oil crisis stressed the need to diversify exports and to enhance food security. In line with the Angolan Development Plan 2013-2017 [17], the PISP is expected to facilitate better market access, export increase and diversification.
More in detail, objective of the project is the improvement of public health through the reduction of zoonoses and food-borne diseases transmission.
In order to achieve the objective, three main lines of activities are encompassed:
- animal identification and registration;
- improving meat hygiene and slaughter facilities;
- training and laboratory update.

For permitting the learning from experience, a pilot project on animal identification and registration, is included.
After completing the assessment of slaughter facilities, the project will support the construction of improved rural slaughterhouses in each Municipality.
Key staff of the new and well equipped veterinary laboratory – the Veterinary Investigation Institute - are receiving training on tests and methodologies internationally recognized, to fully implement the laboratory capacity, and permit certification accepted at international level [18].

RESULTS

Animal identification and recording is considered a pre-condition for animal and public health, disease control and food safety and quality, and should be regarded both as public and private good [19].
In this context, the on-going collaboration in VPH is focused on the implementation of an animal identification and recording system, adapted to socio-economic conditions and local environment, together with food safety activities and laboratory update.
Animal identification is now piloting in a single province, covering about 30,000 heads, through breeders census, sensitization meetings, production of information materials, tagging, software development. The allocation of an unique identification number for premises has been completed, as well as the assessment of Veterinary Services, IT, infrastructures and procedures, and tagging is expected to start at short.
Animal identification is intended to extend on national basis, after learning form experience and adjusting, and after the approval of an harmonized national regulation.
Training of laboratory technician on new tests in bacteriology, serology, food microbiology, culture media production, anatomo-pathology, and parasitology is ongoing in Italy at the IZS, using the "training on the job" methodology, in order to permit a better control of food and animal diseases.
The current activities are based on the results of previous VPH projects, showing that some zoonoses and foodborne diseases are present in Angola and may potentially affect human health. Among theses, brucellosis, cysticercosis, echinococcosis/ hydatidosis (E/H), tuberculosis.
Data notified to OIE illustrate that the animal health situation in the country is improving, with bovine brucellosis last reported in 2013 and E/H in 2012.
Further efforts are nevertheless needed, especially in zoonoses reporting and control measures.
Rabies outbreaks, in fact, peaked in 2009 with 248 human cases, but still are very high with 91 cases in 2014. Further data are summarized in Table 1.
These data are in accordance with the findings of the Italian VPH projects.
In particular, the first study, conducted in 1980 on 227 bovine and 107 swine slaughtered in Namibe, showed a significant prevalence of tuberculosis (18,5%) and E/H (13,2%) in bovines, while E/H (29,9%), cysticercosis (15,8%), and tuberculosis (8,4%) were predominant in swines. Stray dogs

Table 1 - Angola. Animal health status for some zoonoses in 1982, 2005 and 2014

Disease	1982	2005	2014
Anthrax	124 outbreaks	clinical	clinical
Bovine brucellosis	sporadic	clinical	not reported (last occurrence 12/2013)
Bovine cysticercosis	--	clinical	--
Bovine tuberculosis	sporadic	clinical	confirmed infection
E/H	--	clinical	not reported (last occurrence 12/2012)
Porcine cysticercosis	--	clinical	confirmed infection
Rabies	enzootic	clinical	clinical

Source: OIE data, modified

were considered a threat for VPH and their control was recommended [7].
From March 2002 to June 2003, meat inspection conducted on 1156 bovine, 463 swine and 164 sheep and goats showed lower prevalence in zoonoses, being E/H 7,2% in bovine, 0,2% in swine and 1,2% in sheep and goats; tuberculosis 2,2% in bovine and cysticercosis 2,1% in bovine and 4,3 in swine [12].
In the same period, two serological survey for bovine brucellosis were performed using Rose Bengal Rapid Agglutination Test. The first, at Namibe slaughterhouse, collected 335 sample, 25 of which (7,4%) tested positive. The infection was found to be spread all over Namibe Province.
The second, conducted in the farms of the Municipality of Bibala, tested 1175 bovines, with 93 positive sample (7,9%). The importance of the disease is enhanced by the lack of surveys at national level, which does not permit to establish the predominant *Brucella* species, nor the animals mainly involved in the transmission to humans [11, 14].

DISCUSSION

Development indicators show that Angola is rapidly improving: life expectancy at birth gained about 11 years from 1980 to 2013, but remains below most neighboring countries; general government expenditure on health increased, but is still much lower than the value for the African region; the prevalence of undernourishment sharply diminished passing from 63% in 1991 to 18% in 2013, but malnutrition is high among children [20].
Though classified as middle income country, with a gross national income *per-capita* of 6,770 US$, rural poverty is still very high (58,3% of rural population). The gap between rich and poor is increasing, and urbanization contributes to create new groups of marginalization.
Urbanization impacts negatively on agricultural production, worsening food security. At the same time uncontrolled urbanization is a major cause of pollution, affecting both the environment and pubic health. Access to improved water source and sanitation facilities is guaranteed only to about half of the population, but in rural areas these values are almost halved. In rural areas, it is of concern the decreasing trend in access to improved water source, passed from 41,8% in 1990 to 34,3% in 2012. Environmental sanitation need to be strengthened, as it is a major factor for interrupting the biological cycle of several zoonoses.
Being rural about one-third of the population, the improvement of their living conditions, based mainly on livestock rearing, should be regarded as a priority, benefiting both the environment, human and animal health, and trade diversification. In this context, the fact that Angola is financing a project in VPH, using international technical assistance, can be seen as an indicator of the country commitment towards rural development.
The importance of intersectoral collaboration, including public health and veterinary services, education, municipal and traditional authorities, should be supported through joint actions, mutual exchange of information, joint training, etc.
The need to contain Government expenditure caused staff reduction in veterinary services, affecting both veterinarians and para-veterinarians, but particularly community animal health workers, those primarily involved on the ground.
Food hygiene is still very low and data on foodborne diseases are lacking, an effective surveillance system does not exist, nor control measures for their control. Animal identification and registration, allowing traceability, should be guarded as a key step for enhancing public health and consumer protection.
The practices followed to rear cattle, along with poor hygiene and extremely strict cohabitation between human and animals, represent relevant risk factors for rural people.
The use of slaughterhouse as an epidemiological unit should be strengthen, and data on meat inspection used to support the adoption of public health policies.
Health education and information activities, fostering participation, contribute to ensure sustainability and long-term results, such as changes in behaviors. The basic principles of food security, food hygiene and nutrition should be included in teaching programs, and appropriate curricula developed.

CONCLUSIONS

More than thirty years of collaboration in VPH, created a climate of mutual accountability between the Veterinary Services of the two countries, root for aid effectiveness, one of the key condition for development, as stated in the Paris Declaration [15].
A multi-year commitment is recognized as a positive factor for predictability, institutional capacity and result-driven development strategies.
A bilateral agreement in veterinary issues is under negotiation and will act as a framework for all initiatives in this area. It should be noted that Veterinary Services are under the Ministry of Health in Italy, with a strong vocation for public health and consumer protection.
The increasing trade globalization, together with the rapidly evolving social and environmental context, called for a more active international approach, in

which the IZS network plays a key role, fully recognized by the most important international Organizations (WHO, FAO, OIE), and in rapid growth.
These Organizations assigned 24 international Collaborating Centers and Reference Laboratories to Italy, one third of which at the IZS AM.
The OIE's Reference Laboratories and Collaborating Centers global network is essential to the definition of international standards, norms and guidelines for the protection of public health, the prevention and control of animal diseases as well as for the safe trade of live animals and their products.

ACKNOWLEDGMENT

In memoriam of Professor Adriano Mantovani who strongly supported Veterinary Public Health all over the world, intended as a mean to contribute to human rights, peace and well-being.

REFERENCES

1. República de Angola, Ministério da Agricultura. Estudo do impacto do VIH na agricultura e segurança alimentar. República de Angola, Luanda, 7 pp.

2. World Trade Organization. Trade Policy Review. Report by the Secretariat. Angola. World Trade Organization, Geneva, 2006, WT/TPR/S/158/Rev.13 April 2006, 91 pp.

3. FAO. State of Food Insecurity in the Word. Food security indicators. Available from: www.fao.org7publications/sofi/food-security-indicators/en/; last visited 11/06/2015

4. República de Angola. Estratégia Nacional de Segurança Alimentar e Nutricional. Luanda, Março de 2009, 87 pp

5. Angola: Decreto Executivo 127-06 de 22 de Setembro. Regulamento Interno do Instituto dos Serviços de Veterinaria

6. Mendes AM. História dos Serviços Veterinários de Angola - Os primeiros anos. Revista Portuguesa de Ciéncias Veterinárias 2003; 98(545): 11-18

7. Venturi L. Alcuni dati sul patrimonio zootecnico e sulle malattie trasmissibili del bestiame nella provincia di Moçamedes (Angola). Rivista di Agricultura Subtropicale e Tropicale 1983; 4:521-535

8. Gomes FA, Pombal AM Jr, Venturi L. Observations on cattle ticks in Huila Province (Angola). Veterinary Parasitology 1994; 51, 333-336.

9. Serrano MHF. Luta contra as carraças. Instituto de Investigaçao Veterinaria de Angola, Segunda Ediçao, 1973.

10. Venturi L, Lolli A, Dinis J, Kiassekoka M. O Impacto da Medicina Veterinaria na Saude Pública em Angola. Relatorio do Primeiro Seminario Nacional, Lubango-Huila, 15-16 Setembro 1998

11. Parodi P, Raimundo Gonga D, Felgueiras FT, Felix GF, Venturi L, and Mantovani A. Bovine brucellosis in South West Angola: results of a survey. Italian Journal of Tropical Medicine 2004; 9 (3-4): 89-93

12. Parodi P, Felgueiras FT, Felix GF, Contundo ML, Venturi L, and Mantovani A. The use of slaughterhouse as an epidemiological unit. An experience in the South of Angola. Italian Journal of Tropical Medicine 2006; 11 (1-2): 35-40

13. Parodi P, Felgueiras FT, Felix GF, Venturi L, Mantovani A. Alcune note su di un progetto di sanità pubblica veterinaria realizzato in Angola, Provincia di Namibe. SNOP 2005; 64:21-23

14. Calicchia MC, Mantovani A, Parodi P, Venturi L. Considerations on epidemiology and control strategies for some zoonoses in South West Angola. Abstract Book of the 2nd Med-Vet-Net Annual General Meeting. Malta, 3-6 May 2006. p 39

15. OECD. Paris Declaration on Aid Effectiveness (2005) and Accra Agenda for Action (2008). Available from: www.oecd.org/dac/effectiveness/parisdeclarationandaccraagendaforaction.htm; last visited 11/06/15.

16. MAE DGCS. La cooperazione italiana allo sviluppo nel triennio 2014-2016. Linee guida e indirizzi di programmazione. Aggiornamento: marzo 2014. Available from: http://www.cooperazioneallo sviluppo.esteri.it/pdgcs/Documentazione/PubblicazioniTrattati/2014-04-01_LLGG%202014-2016%20-%20Comitato%20Direzionale%2027%20marzo%202014.pdf; last visited 12/06/2015

17. República de Angola, Ministério do Planeamento e do Desenvolvimento Territorial. Plano nacional de Desenvolvimento 2013-2017. Dezembro 2012. Available from: www.minfin.gv.ao/fsys/PND.pdf; last visited 12/06/15

18. Samo D, Nazario ASG, Barbosa M, Di Francesco C, Ferri N, Possenti L, Scacchia M and Parodi P. Angola: Pilot Project on Integrated Animal Recording System. Preliminary Data. FAO/ICAR Symposium on Animal Identification and Recording (AIR) and Livestock Development in Sub-Saharan Africa, Pretoria, 14-15 April 2015. Available from www.icar.org/Documents/Pretoria_2015/Pictures/05%20Posters/DSC_0576JPG; last visited 11/06/2015

19. Pretoria Declaration On Animal Identification and Recording Systems for Traceability and Livestock Development in Sub-Saharan Africa. Pretoria, 16 April 2015. Available from: www.fao.org/africa/news/detail-news/en/c/284638/; last visited 11/06/15

20. World Bank. World Data Bank. Available from: www.databank.worldbank.org; last visited: 12/06/2015.

Il declino delle popolazioni di avvoltoi in Eurasia e Africa: un'emergenza ambientale, sanitaria e sociale

M. DELOGU[1], L. VENTURI[2]

[1]Dipartimento di Scienze Mediche Veterinarie, Università di Bologna, Italia
[2]Già docente a contratto, Università di Bologna, Bologna, Italia

Riassunto - Il declino delle popolazioni di avvoltoi, a seguito della introduzione del Diclofenac in terapia veterinaria, costituisce un tema di grande rilievo sanitario, ambientale e sociale in Eurasia e Africa.
L'effetto nefrotossico della molecola, sui grandi volatili necrofagi, ha già prodotto dei decrementi numerici che, in molti casi, mettono a rischio di estinzione le specie. Gli Stati asiatici interessati hanno messo al bando il farmaco in sanità animale ma il Diclofenac è ancora ampiamente usato illegalmente. Il decremento numerico degli avvoltoi ha fatto emergere importanti rischi sanitari: alcuni agenti di malattia, presenti nelle carcasse animali, non vengono più neutralizzati e anche disagi sociali: alcune etnie (Parsi) vengono private di fondamentali condizioni legate alle celebrazioni funebri (Sepoltura celeste). L'emergenza sta venendo, purtroppo lentamente, all'attenzione della Comunità Internazionale a cui occorre fare ricorso per azioni di cooperazione indispensabili a invertire la tendenza e a evitare l'estinzione degli avvoltoi.

Parole chiave: Avvoltoi, diclofenac, nefrotossicità, diminuzione, popolazione.

The decline of vultures populations in Eurasia and Africa: an environmental, health and social emergency
Summary - The decline in the populations of vultures, following the introduction of Diclofenac in veterinary therapy, is an important topic regarding public health, environment and social life in Eurasia and Africa. The nephrotoxic effect on these birds has already produced a steap decrease decrement that, in many cases, is bringing scavengers endangered. Some Asian Nations have banned the drug for animal health but Diclofenac is still widely used illegally. The decrease of vultures has highlighted relevant health risks: some pathogens, in animal carcasses, are no more neutralized and also social problems: some ethnic groups (Parsis) are deprived of the basic conditions related to the funerary celebrations (Celestial burial). The emergency is coming, with sad delay, to the attention of the International Community that should be invoked for cooperation measures necessary to reverse the trend and prevent the extinction of vultures.

Key words: Vultures, diclofenac, nephrotoxicity, decrease, population.

INTRODUZIONE

La popolazione ornitica mondiale vede identificate, al momento, oltre 10.000 specie e 22.000 sottospecie. La dinamica di popolazione, regolatrice delle consistenze e dei movimenti di ognuna di esse, è direttamente correlata alla sostenibilità ambientale delle diverse specie ed è guidata e condizionata dalla capacità portante dell'ambiente ovvero da quell'enorme intreccio di interrelazioni che, di fatto, unisce la vita nel pianeta e che attraverso la biodiversità massimizza questa in tutte le sue forme. Il dinamismo numerico - che vede estinzioni, sostituzioni od espansioni di specie - è quindi in strettissima connessione con l'ambiente naturale e con le modificazioni strutturali o gestionali dello stesso quando operate dall'uomo. All'interno delle catene trofiche troviamo specie evolutivamente plastiche e altamente prolifiche (con strategie riproduttive veloci di tipo R, in cui viene preferita la "quantità" impegnando le energie per mantenere un tasso riproduttivo elevato con molti nati che si sviluppano velocemente) quali Corvidi, Storni, Piccioni, alcuni gabbiani. Tra queste le cosiddette specie "*commensali o sinantrope*" – uccelli che riescono a sedersi alla mensa della specie umana e che si alimentano agevolati da quanto l'uomo produce per se stesso o per le specie domestiche che alleva, utilizzando le produzioni agro-alimentari umane quale supporto trofico, cibandosi degli avanzi e degli scarti delle catene alimentari e produttive umane. Contrapposte a queste troviamo specie fragili e poco adattabili ai cambiamenti (con strategie riproduttive lente di tipo K, in cui viene privilegiata la "qualità", caratterizzate da un basso tasso riproduttivo con un solo nato alimentato per lunghi periodi) evolutesi per occupare i vertici delle piramidi ali-

Corrispondenza: Dr Mauro Delogu e Dr Luciano Venturi;
E mail: mauro.delogu@unibo.it;
E mail: luciano.venturi@hotmail.com

mentari.
Esponenti tipici di quest'ultima tipologia di specie sono i grandi avvoltoi che, estremamente specializzati, svolgono una rilevante funzione necrofaga in quasi tutte le regioni del pianeta. Per entrambi i gruppi sono quasi sempre le economie delle società umane ad indurre le modificazioni ambientali, che a loro volta finiscono con il condizionare in maniera determinante le dinamiche demografiche delle popolazioni animali. E' evidente come in un'era appena iniziata quale l'*Antropocene*, dove l'uomo condiziona di fatto l'esistenza di tutte le altre forme viventi del pianeta, la gestione degli ecosistemi operata in quantità sempre maggiore dalla nostra specie richiede una saggezza biologica applicata con adeguato tempismo e prospettiva.
Un paradigmatico esempio di tale fenomeno – sia nelle sue cause determinanti che negli effetti che ne derivano per la vita di milioni di persone risiedenti nei territori interessati - è rappresentato dal declino della popolazione di avvoltoi verificatosi, in alcuni stati continentali dell'Asia meridionale ed orientale. Tale condizione trova oggi un equivalente ecologico anche nel sud del continente africano con interessamento degli avvoltoi che biologicamente si alimentano sulle carcasse dei grandi erbivori.
Gli avvoltoi in senso lato costituiscono nel vecchio e nuovo mondo un gruppo di necrofagi aviari che seppur filogeneticamente lontani tra loro nelle origini (geneticamente correlati ai ciconiformi, gli avvoltoi del nuovo mondo), basano il loro regime alimentare sull'ingestione di materiali organici in maggiore o minore stato di decomposizione derivanti principalmente da carcasse animali ed in alcuni casi umane. Essi svolgono un ruolo di fondamentale importanza nel processo di mantenimento e controllo sanitario di alcuni patogeni in ambiente contribuendo, attraverso una attiva azione di demolizione, allo smaltimento rapido delle carcasse di animali domestici e selvatici morti per le più varie cause e presenti sul territorio.
Attualmente il fenomeno del declino numerico di questi volatili ha assunto dimensioni drammatiche (Fig.1) e le specie maggiormente coinvolte in circa un decennio sono passate da popolazioni relativamente stabili al raggiungimento del rischio di estinzione. L'areale costituito da India, Pakistan, Afghanistan, Bangladesh, Nepal e dalla parte meridionale della Cina costituisce il naturale habitat [1,2,3] di alcune specie di avvoltoio tra le quali le più rappresentate numericamente sono: l'Avvoltoio dal becco sottile (*Gyps tenuirostris*), l'Avvoltoio indiano (*Gyps indicus*), il Grifone del Bengala (*Gyps bengalensis*), il Capovaccaio (*Neophron percnopterus*), il Grifone euroasiatico (*Gyps fulvus),* l'Avvoltoio reale indiano *(Sarcogyps calvus),* l'Avvoltoio monaco (*Aegypius monachus*), l'Avvoltoio dell'Himalaya (*Gyps himalayensis*) e l'Avvoltoio degli agnelli *(Gypaetus barbatus)*. In Africa le specie interessate sono principalmente l'Avvoltoio del Capo (*Gyps coprotheres*) il Grifone di Ruppel (*Gyps rueppellii*), l'Avvoltoio dal dorso bianco (*Gyps africanus*), ed in parte il Grifone euroasiatico (*Gyps fulvus*), l'Avvoltoio orecchiuto (*Torgos tracheliotus*) e l'Avvoltoio dalla testa bianca (*Trigonoceps occipitalis*).

Figura 1 - Episodi di mortalità massiva per avvelenamento da *Diclofenac* in avvoltoi Asiatici

Da sempre l'uomo ha condiviso miti e leggende costruiti attorno a questi volatili e ne ha riconosciuto il ruolo di difesa ambientale. Ruyard Kipling, nel 1894, così descrive il loro intervento nel processo di rimozione delle carcasse dall'ambiente [4,5]:
[..] *Chil, l'avvoltoio che volteggiava sorvegliando la giungla in attesa che qualche animale morisse.*
[..] *quando gli avvoltoi planarono uno dopo l'altro sul letto del fiume alla fine della grande battaglia.*
E ancora più tardi, narrando di avvenimenti del 1947, relativi alla partizione e indipendenza del Pakistan dall'India, Khushwant Singh descrive l'intervento di questi volatili [6].
[..] *Ben presto il cielo si riempì di avvoltoi e nibbi, che si abbatterono in picchiata sulle carcasse. Beccavano sino a che i corpi non si rigiravano* [..]
Anche in Africa la letteratura ha ritenuto di non far passare sotto silenzio la loro presenza. Il grande poeta e romanziere nigeriano Chinua Achebe, in una poesia intitolata "Avvoltoi", descrive la loro presenza come una scena di vita quotidiana.
[..] *Ieri spolpavano gli occhi di un cadavere gonfio in un fosso inzuppato*
e ne mangiavano il contenuto delle budella.
Dopo l'abbuffata, si scelgono il posatoio,
tenendo i resti svuotati
alla comoda portata dei freddi occhi telescopici. [..]
Il rapido smaltimento delle carcasse operato dai mammiferi e dagli uccelli necrofagi, poi successivamente dagli insetti, limita rapidamente la diffusione di alcuni agenti di malattia, sia trasferendoli negli apparati digerenti di ospiti non recettivi sia attraverso la loro inattivazione nel corso del processo digestivo.
L'azione di rimozione delle carcasse operata da sistemi naturali diviene in gran parte un efficace limite di diffusione per molti patogeni limitando un reale rischio sanitario per uomini e animali sia domestici sia selvatici. In Eurasia, la sinergia con grandi mammiferi necrofagi (Orso bruno, Cinghiale, Lupo) o con analoghe specie minori (Volpe, Tasso, Cane procione, Sciacallo dorato) rende possibile lo smaltimento di una carcassa di grosso ungulato (es. Daino) già nell'arco di poco più di 48 ore.
Nelle società umane, il loro ruolo passa attraverso il coinvolgimento di alcune lontane divinità dell'antico Egitto, Nekhbet (spesso raffigurata come un avvoltoio di colore bianco) all'attualità più stringente dove alcuni equilibri sociali all'interno della comunità dei Parsi (uno sviluppo locale del mazdeismo o zoroastrismo iranico d'origine persiana, da cui il nome Parsismo, che in persiano indica il popolo omonimo) e da cui hanno avuto origine nuclei etnici stanziatisi in India e concentrati, principalmente, nella regione di Mumbay. I loro principi religiosi non consentono che le spoglie delle persone defunte siano inumate o incenerite; viene ammessa un'unica pratica [7] che prevede l'esposizione delle salme sulle "torri del silenzio" (*dhakmas*) affinché gli avvoltoi possano dilaniare e spolpare i corpi in quella che viene definita "sepoltura celeste" evitando, così, di contaminare il fuoco, la terra e l'acqua tramite alcune altre usanze diffuse nella cultura indiana come la cremazione, l'inumazione o l'abbandono dei corpi nei fiumi.
Da parte della Comunità Parsi viene, in tal modo, *"evitata l'impurità e ristabilita la purità"*.

Analisi del problema
Tutte le specie di avvoltoi presenti nell'area hanno registrato, negli ultimi 30 anni, una drastica riduzione numerica della popolazione stabile originale che, in particolare, per *Gyps tenuirostris, Gyps bengalensis* e *Gyps indicus* è stimata in circa il 95% prefigurando, con ciò, un reale rischio di estinzione, ancora maggiore per *Sarcogyps calvus* dove la popolazione è collassata da decine di migliaia di individui a meno di un centinaio a vita libera
La popolazione di tali volatili, stimata presente secondo le valutazioni delle più attendibili Istituzioni e Centri di ricerca che si sono occupati del problema [8,9,10] è passata da circa 50.000.000 di individui, agli inizi degli anni Novanta, a non oltre 60.000 volatili, nel 2011.
I tentativi di interpretazione del fenomeno avevano fatto sì che, inizialmente, fossero state avanzate due ipotesi.
La prima, ed inizialmente, più accreditata: un meccanismo di bio-accumulazione dei pesticidi impiegati in agricoltura, cosa avente non irrealistiche analogie con precedenti situazioni registrate in altri Continenti a danno della popolazione di uccelli, come il caso del Falco pellegrino (*Falco peregrinus*) intossicato da DDT [11]. Questa tesi trovava, tra l'altro, un terreno fertile di accettazione nella popolazione e nelle Autorità nazionali dopo la catastrofe chimica provocata da Union Carbide a Bophal, in India, nel 1984.
La seconda: il diffondersi di malattie trasmissibili tra la popolazione di avvoltoi; quest'ultima interpretazione risultava pure rafforzata da suggestive teorie anti-occidentali che non escludevano azioni mirate di lotta batteriologica e bioterrorismo tramite l'utilizzo di agenti ad alta patogenicità e spiccato tropismo selettivo per le specie interessate.
Nessuna delle due interpretazioni, però, è stata comprovata dalle imponenti ricerche messe in campo dai Governi degli stati coinvolti e dalla Comunità scientifica internazionale; fu solo nel 2003 che in Pakistan - scoperta successivamente confermata anche in India e Nepal - venne individuata [12,13,14] la causa di questo veloce e imponente declino demografico: il *Diclofenac*, una molecola farmaceutica ad effetto anti-infiammatorio non ste-

roidea (FANS), molto usata anche in medicina umana, aveva trovato ampia diffusione in veterinaria nel trattamento di affezioni di bovini, cammelli ed ovicaprini. I suoi residui, presenti nelle carni degli animali curati, in contesti ove le carcasse permangono in natura disponibili per l'azione necrofaga degli avvoltoi, si collocano lungo la catena alimentare di questi volatili esplicando su di loro una specifica attività nefrotossica con riduzione dell'escrezione degli acidi urici e aumento della deposizione di cristalli di acidi urici nei tessuti, in particolare nei reni e nel fegato. A seguito dell'assunzione del principio attivo questi volatili che giungono a morte in poche settimane o addirittura in pochi giorni.

Gli effetti di questo declino demografico hanno coinvolto alcuni aspetti della vita delle persone che vanno ben oltre la salvaguardia della biodiversità per fini zoofili o meramente protezionistici. In maniera assai efficace ed affatto paradossale Vibhu Prakash - Direttore del Centro di riproduzione e salvaguardia per gli avvoltoi sito a Pinjore, nel Nord-Ovest dell'India – sintetizza [15] quali possono essere le conseguenze del processo di depopolamento di avvoltoi in atto. *"Senza tigri ed elefanti l'equilibrio ecologico può ancora reggere, il loro ruolo è venuto meno ormai vicariato dagli uomini. Ma nessuno può sostituire gli avvoltoi. Sono spazzini molto efficienti. Niente sarà mai in grado di riempire quella nicchia"*.

Da sempre, infatti, l'avvoltoio svolge una funzione di alto valore all'interno del processo di lotta alle malattie contagiose che affliggono le popolazioni svantaggiate, che vivono in precarie condizioni igieniche e che, per carenze sia culturali che di risorse e servizi, non provvedono a distruggere le carogne degli animali morti tramite seppellimento o incenerimento. Di fondamentale importanza è, inoltre, l'azione che svolgono alimentandosi nelle discariche di rifiuti che sono sempre più enormi e sempre più critiche nella loro gestione a causa dei meccanismi di esodo delle popolazioni umane dalle campagne e di concentrazione in agglomerati urbani.

E' sorprendente la straordinaria la rapidità, pochi minuti, con cui gli avvoltoi demoliscono le carcasse ingurgitando ogni parte organica molle. L'azione necrofaga inizia con i grandi avvoltoi dal becco massiccio (es *Aegypius monachus*, *Torgos tracheliotus, Sarcogyps calvus)* che lacerano la spessa cute con i loro becchi potenti, per poi cedere il passo ai gruppi specializzati nell'ingestione di masse muscolari e visceri (*Gyps tenuirostris, Gyps bengalensis* e *Gyps indicus, Gyps rueppellii*, (*Gyps africanus*), (*Gyps fulvus*), che a loro volta lasciano i resti di muscoli adesi alla carcassa al becco sottile del *Neophron pernocpterus* e poi le ossa all'ossivoro *Gypaetus barbatus*. L'azione a cascata delle diverse specie attive è sinergizzata da diversi mammiferi ed uccelli necrofagi e permette l'eliminazione rapida della carcassa e della possibile fonte di infezione limitando il fatto che alcuni agenti di malattia riescano a permanere nell'ambiente in attesa di nuovi ospiti da infettare; è il caso, ad esempio, di *Bacillus antracis*, agente causale del *Carbonchio ematico* che, dopo essersi replicato nelle carcasse passa alla forma "sporigena", che evoluta in spora può disperdersi sul terreno e sopravvivere decine di anni in fase latente: il carbonchio costituisce in natura una delle principali cause di mortalità naturale tra gli elefanti nei due continenti (in entrambe le specie, *Loxodonta* ed *Elephas*, è presente l'abitudine di interagire con le ossa dei conspecifici raccolte in natura) e le loro carcasse da 3/5 tonnellate se permangono in natura costituiscono un ottimo substrato per bacilli e clostridi.

La ripugnanza che questi volatili suscitano nelle persone è, di conseguenza, più un atteggiamento occidentale e antropocentrico tipico dei "paesi economicamente avanzati", in quanto nelle aree ove sono presenti viene loro riconosciuto un fondamentale ruolo ed una specifica funzione di "manutentori igienico-sanitari" dell'ambiente.

Su di un altro piano di osservazione, di non trascurabile rilievo, il declino degli avvoltoi produce i propri effetti incidendo pesantemente sulla vita della Comunità indiana Parsi di religione zoroastriana, stimata in un effettivo di persone oscillante tra i 60.000 ed i 140.000 individui, ma che possiede un notevole peso sociale ed economico. Appartengono alla comunità l'industriale indiano Ratan Tata mentre la diaspora Parsi nel mondo annovera alcune figure di spicco [16] come il Direttore d'orchestra Zubin Mehta, lo scrittore Rohinton Mistry e Freddie Mercury, defunto leader del gruppo musicale rock dei "Queen".

In un rituale, tanto antico da essere descritto [17] da Erodoto nel V sec. A.C., il fondatore di questa religione, Zoroastro, dopo la morte venne esposto, su di una "torre del silenzio", all'aria, al sole e, soprattutto, agli avvoltoi. Questa pratica, che costituisce uno dei fondamenti religiosi della Comunità [6,18], è oggi compromessa dalla scarsità, più spesso una totale assenza, di avvoltoi [19]. I Parsi hanno tentato di ricorrere all'uso di lenti e specchi di grandi dimensioni per concentrare, sulle salme, i raggi solari e così supplire all'azione combinata degli agenti atmosferici naturali e degli avvoltoi; il metodo ha prodotto scarsi ed insoddisfacenti effetti, oltre al venir meno del principale risultato della totale scomparsa di parti non ossee dei cadaveri.

Alcuni altri volatili, come i Nibbi bruni (*Milvus migrans*), hanno parzialmente occupato il vuoto lasciato dagli avvoltoi nella nicchia ecologica non riuscendo a impedire il verificarsi di inconvenienti quali sgradevoli emanazioni odorose stagnanti per la

persistente e prolungata putrefazione delle salme e la disseminazione, sul terreno e nelle aree private circostanti, di piccole parti anatomiche dei cadaveri come dita delle mani e dei piedi, lasciate cadere dai questi ultimi volatili che scontano un'inadeguatezza funzionale nello svolgimento del ruolo vicariante assunto.
Anche sui versanti himalayani i Corvi neri (*Gorak*, in lingua nepalese) hanno potuto incrementare fortemente la loro presenza senza, in ogni caso, riuscire a sostituire gli avvoltoi nella loro funzione di smaltitori di carcasse animali.
Va segnalato inoltre come in larghe parti del territorio delle Nazioni interessate dal fenomeno, già afflitte dalle tipiche malattie indotte dal sottosviluppo e da strutturali carenze igieniche, alcune zoonosi (Tubercolosi, Carbonchio, Brucellosi etc.) rappresentano un importante rischio per la salute pubblica e infine che altre che colpiscono solamente gli animali [20], seppure non-diagnosticate ufficialmente, (Afta epizootica, Peste bovina e Pleuropolmonite contagiosa dei bovini) minacciano pesantemente il patrimonio zootecnico con ripercussioni per la Sicurezza Alimentare [21] della popolazione umana.
L'interruzione, a causa del declino numerico della popolazione di avvoltoi, di un ciclo biologico di tale efficienza ed appropriatezza per l'eliminazione delle cause di diffusione di malattia, ha destato l'allarme nelle Autorità nazionali che hanno cercato di porre rimedio e di invertire la tendenza in atto.
Le azioni ed i provvedimenti correttivi adottati dagli Stati hanno seguito due principali linee direttrici: la sottrazione [22] dall'ambiente del *Diclofenac* e l'istituzione di centri di riproduzione, allevamento e salvaguardia per gli avvoltoi con l'intento di creare dei punti di alimentazione (c.d. carnai) per i volatili da liberare nell'ambiente.
Con il primo provvedimento sono state adottate norme per impedire l'utilizzo [23, 24] in terapia veterinaria del principio attivo responsabile del fenomeno: nel maggio 2006 una direttiva generale dell'Organismo Governativo Indiano "*Drug Controller*" è stata trasmessa agli uffici e funzionari competenti richiedendo il ritiro delle licenze di fabbricazione per le formulazioni terapeutiche veterinarie contenenti *Diclofenac*.
Questa normativa è stata ulteriormente rafforzata nel 2008 ed analoghi provvedimenti legislativi sono stati adottati anche dal Pakistan e dal Nepal.
L'azione non ha, purtroppo, ottenuto gli effetti perseguiti dalla messa al bando del farmaco dalla pratica terapeutica negli animali domestici allevati a causa del basso prezzo della molecola in confronto ad altre con un analogo effetto. Il costo molto vantaggioso ne ha reso diseconomica la sostituzione ed immediatamente, anche alimentato da importazioni illegali, si è creato un mercato parallelo che ha lasciato invariata, nei fatti, la condizione di presenza di residui del prodotto farmaceutico nelle carni delle carcasse di animali venuti a morte dopo terapia con *Diclofenac*.
Con la seconda azione sono stati istituiti alcuni Centri di riproduzione, allevamento e salvaguardia per gli avvoltoi [25, 26] ove l'obiettivo è quello di garantire un'alimentazione esente da residui del farmaco in modo da facilitare la ripresa demografica attraverso la riproduzione naturale dei volatili. Nei fatti la fisiologica scarsa prolificità della specie – non oltre un uovo/anno per coppia di avvoltoi, che iniziano a riprodursi dopo il quinto anno di vita – e gli insufficienti finanziamenti a fronte degli alti costi di gestione per l'acquisto di spoglie animali indispensabili per nutrire i soggetti ospitati, hanno fatto sì che l'esperienza, pur riuscita sul piano tecnico, non abbia potuto superare la fase sperimentale, sia rimasta assai limitata per il numero di avvoltoi prodotti e quindi sia risultata inadeguata a incidere sulla realtà del territorio.

Considerazioni conclusive

Il problema del declino numerico degli avvoltoi in Asia meridionale, India e Africa del sud, impatta - per tutta una serie di motivazioni sinteticamente descritte – sull'ambiente, la salute, l'alimentazione, i costumi, le credenze e la religione delle popolazioni di un'area assai ampia, ben oltre quello che potrebbe apparire un ambito riservato ad alcuni specialisti dei vari aspetti coinvolti. Anche in Europa la presenza di residui di *Diclofenac* rappresenta un fattore di rischio di avvelenamento nei contesti in cui si pratica la pastorizia estensiva, così come cascami e carcasse derivati dall'allevamento intensivo possono finire come alimento per le specie allevate in cattività nei progetti di conservazione (Captive breeding) e reintroduzione (Restoking). La violazione delle norme per la tracciabilità e il corretto smaltimento delle carogne di animali deceduti, pur se curati farmacologicamente, nonché alcune abitudini sociali fanno si che anche una sola carcassa trattata possa trasformarsi in una trappola mortale per intere colonie, impattando aree vaste molte centinaia di Km quadrati.
Sulla base di queste considerazioni il fenomeno e le sue conseguenze assumono, quindi, un valore politico ed un carattere di emergenza per la Comunità internazionale rendendo urgente e non procrastinabile il suo coinvolgimento nel sostenere e cooperare con le Autorità nazionali direttamente interessate per agire su due fondamentali direttrici volte a cercare di invertire il non-inverosimile e già avviato processo di estinzione degli avvoltoi: *a)* interrompere il ciclo tossico che affligge i volatili necrofagi tramite la riduzione dell'uso, in veterinaria, della molecola responsabile; *b)* promuovere la creazione di centri di

salvaguardia, riproduzione e addestramento avvoltoi.

Se infatti ormai chiaro, "non-multifattoriale" e ampiamente supportato da evidenze scientifiche è il processo che sta alla causa del declino numerico di queste popolazioni ornitiche, altrettanto innegabile è l'esigenza di un approccio integrato al problema in cui anche le Comunità locali vengano coinvolte per contribuire a ripristinare lo stato preesistente - una stabile e sostenibile popolazione di avvoltoi - che ha rilevanti influenze sulle condizioni di vita della gente.

Su questa via un importante obiettivo è stato recentemente raggiunto durante l'undicesima "Conferenza delle Parti della Convenzione per le Specie Migratrici" (COP11, meglio conosciuta come "Convenzione di Bonn", operante sotto l'egida delle Nazioni Unite), tenutasi a Quito in Ecuador dal 4 al 9 Novembre 2014. Nel corso dei lavori alcune tematiche emergenti, tra cui quella riguardante il rapporto esistente tra *Diclofenac* e uccelli necrofagi sensibili al suo effetto tossico, hanno ricevuto particolare attenzione. La Risoluzione finale [27], infatti, rivolge l'invito alla "Organizzazione per la cooperazione e lo sviluppo economico" (OCSE) affinché venga valutato il rischio che i medicinali veterinari possono rappresentare per gli uccelli migratori e i risultati siano utilizzati per fornire indicazioni agli Stati orientandone le politiche negli specifici campi.

RIFERIMENTI BIBLIOGRAFICI

1. Oates EW. The Fauna of British India, Including Ceylon and Burma: Birds; 1895. Available at: http://www.biodiversitylibrary.org/item/67407#page/5/mode/1up

2. Prakash V., Green RE, Pain DJ, Ranade SP, Saravanan S, Prakash N, Venkitachalam R, Cuthbert R., Rahmani AR and Cunningham AA. Recent changes in populations of residents Gyps vultures. Journal of the Bombay Natural History Society, 104 (2), May-Aug 2007 129-135.

3. Venturi L, Shaukat Ali Yousufzai. Il declino della popolazione di avvoltoi in Asia. Africana, XIX,151-158; 2013

4. Kipling R. Il libro della Giungla 1894. A cura di Carlo Pagetti, Gruppo Editoriale L'Espresso, Roma; 2004.

5. Kipling R. Il secondo libro della Giungla 1895. A cura di Carlo Pagetti, Gruppo Editoriale L'Espresso, Roma; 2004.

6. Khushwant Singh. Quel treno per il Pakistan, 1988 Traduzione di Maria Teresa Marenco. Marsilio Editori, Venezia; 1996.

7. Subramanian M. A crisis for the faithful. The Wall Street Journal, April 30, 2010. http://online.wsj.com/article/SB10001424052702304017404575165732562175068.html

8. Watson RT, Gilbert M, Lindsay Oaks J & Munir Virani. The collapse of vulture populations in South Asia. Biodiversity 2004; 5(3): 3-7.

9. Shahid Iqbal, Uzma Khan, Campbell Murn. Vulture Population and Status Survey, Pakistan (Draft only). 2011 WWF.ARCH.

10. Prakash V**.** Status of vultures in Keoladeo National Park, Bharatpur, Rajasthan with special reference to population crash in *Gyps* species. Journal of Bombay Natural History Society 1999; 96:365-378.

11. Cade TJ, Enderson JH, Thelander CG & White M. Peregrine Falcon populations: their management and recovery. The Peregrine Fund, Boise, ID; 1988

12. Lindsay Oaks J, Gilbert M, Virani MZ, Watson RT, Meteyer CU, Rideout BA, Shivaprasad HL, Shakeel Ahmed, Muhammad Jamshed Iqbal Chaundhry, Muhammad Arshad, Shahid Mahmood, Ahmad Ali & Aleem Ahmed Khan. Diclofenac residues as the cause of vulture population decline in Pakistan. *Nature* (12 February 2004); 427, 630-633

13. Roach J. Has mysterious killer of India's vultures been found? National Geographic News. Thursday, October 28, 2010. http://news.nationalgeographic.com/news/2004/01/0128_040128_indiavultures_2.html

14. Green R S., Newton I, Shultz S, Cunningham AA, Gilbert M, Pain DJ, Prakash V. Diclofenac poisoning as a cause of vulture population declines across the Indian subcontinent. Journal of Applied Ecology 2004; 41, 793-800.

15. Subramanian M. India's Vanishing Vultures. The Virginia Quarterly Review. Spring 2011.

16**.** Ramesh R. Parsi tradition dying out for lack of vultures. The Guardian, Thursday 6 October, 2005. http://www.guardian.co.uk/world/2005/oct/06/religion.uk

17. Erodoto. Storie. Traduzione di A. Izzo D'Accinni. RCS Libri, 1984-2009, Milano.

18. Gnoli G. Zoroastrismo. Enciclopedia delle Scienze Sociali (1998). http://www.treccani.it/enciclopedia/zoroastrismo_%28Enciclopedia-delle-Scienze-Sociali%29/

19. Uzra Khan. Waiting for vultures. The Yale Globalist. December 1, 2010.

20. World Animal Health Information Database (Wahid) Interface. http://web.oie.int/wahis/public.php?

page=country&WAHIDPHPSESSID=0795944a09c4809fa03268580adc9405

21. World Health Organisation. Food Security. http://www.who.int/trade/glossary/story028/en/

22. Birdlife International. Manifesto on diclofenac and vulture conservation. January 2004.

23. Kein B. Drug ban may save India's vultures from extinction. Wired Science. May 17, 2011.

24. Cuthbert R, Taggart MA, Prakash V, Saini M, Swarup D, Upreti S, Mateo R, Soumya Sunder Chakraborty, Parag Eori & Green RE. Effectiveness of action in India to reduce exposure of Gyps vultures to the toxic veterinary drug Diclofenac. http://www.plosone.org/article/info:doi/10.1371/journal.pone.0019069

25. Gilbert M, Watson RT, Ahmed S, Asim M, Johnson JA. Vulture restaurants and their role in reducing diclofenac exposure in Asian vultures. Bird Conservation International 2007; 17: 63-77.

26. Ministry Of Environment & Forests – Government Of India. Action plan for vulture conservation in India. April 2006.

27. Conference of the Parties to the Convention on the Conservation of Migratory Species of Wild Animals UNEP/CMS/COP11/CRP31 Amendments proposed in session, Draft Resolution Preventing Poisoning Of Migratory Birds. 8 November 2014. http://www.cms.int/sites/default/files/document/cop11_crp31_dr_preventing_poisoning_migratory_birds.pdf

One Health/One Prevention/One Resilience and zoonoses applied to the Mediterranean: features analyses for successful intervention based on toxicological risk assessment

C. FRAZZOLI[1], A. MANTOVANI[2], A. MANTOVANI[3] (†)

[1]External Relations Office, Istituto Superiore di Sanità, Rome, Italy
[2]Food and Veterinary Toxicology Unit, Department of Food Safety and Veterinary Public Health, Istituto Superiore di Sanità, Rome, Italy
[3]WHO/FAO Collaborating Centre, Department of Food Safety and Veterinary Public Health, Istituto Superiore di Sanità, Rome, Italy

Summary - The Mediterranean and Middle East Region (MME) has been defined as the cradle of zoonoses for some relevant features as biodiversity, large human and animal populations, close coexistence between humans and animals, variety of environments and climates, human and animal movements and migrations. Other papers focused their attention on the "classical" zoonoses, caused by biological agents (viruses, bacteria, helminths, etc.). Here, we discuss how modern MME features, including EU food safety approaches, criteria, and rules, make it urgent a thorough consideration of the novel zoonoses (caused by non-biological agents, such as chemical contaminants). In MME the One Health concept, already present in the ancient times, can be currently known and translated in One Health practice in areas with a strong public health culture. Multidisciplinary (vertical and horizontal skills) and multidimensional challenges posed by classical and novel zoonoses (space and time dimensions of spread and public health impact) requires higher degree of One Health governance and formal mandate to guarantee proactive and reactive public health systems, including "One Resilience" in contaminated sites; the chronic chemical contamination of Sacco river valley (Italy) is discussed as example of OH/One Resilience.

Key words: contaminants, residues, food safety, food security, global health, one resilience

Riassunto - La Regione del Mediterraneo e del Medio Oriente (MME) è stata definita come la culla delle zoonosi per alcune caratteristiche importanti come la biodiversità, le vaste popolazioni umane e animali, la stretta convivenza tra esseri umani e animali, la varietà di ambienti e climi, i movimenti umani e animali, e le migrazioni. Altri lavori hanno centrato l'attenzione sulle zoonosi "classiche", causate da agenti biologici (virus, batteri, elminti, etc.). Qui viene discusso come le moderne caratteristiche del MME, inclusi gli approcci, i criteri e le regole europee per la sicurezza alimentare, rendano urgente un esame approfondito delle "nuove" zoonosi (causate da agenti non biologici, come i contaminanti chimici). Nel MME il concetto di One Health, già presente nei tempi antichi, può essere attualmente conosciuto e praticato in aree con una forte cultura di sanità pubblica. La multidisciplinarietà (competenze verticali e orizzontali) e le sfide multidimensionali poste dalle zoonosi classiche e dalle nuove (impatto spazio-temporale di salute pubblica) richiedono un maggior livello di *governance* in One Health e formale mandato per garantire sistemi di sanità pubblica proattivi ed efficaci, comprendenti la *One Resilience* nei siti contaminati; la contaminazione cronica della Valle del fiume Sacco è discussa come esempio.

Parole chiave: contaminanti, residui, sicurezza alimentare, salute globale, one resilience

1. Zoonoses and veterinary public health history of definitions

The fact that animals can transmit infections to humans was recognised from antiquity: the introduction of the term zoonoses is attributed to Wirchow (1885) and found a unanimous success in the beginning of the bacteriological era, when it was necessary to have names for discovered phenomena and agents. In 1959, WHO gave the following definition of zoonoses: "*Those diseases and infections (the agents of which) are naturally transmitted between (other) vertebrate animals and man*". It was unanimously agreed that zoonoses were caused by biological agents capable to be transmitted.

On the second half of the XXth Century there was the

Corresponding author: Dr Chiara Frazzoli,
External Relations Office, Istituto Superiore di Sanità, Via Giano della Bella 34, 00162 Rome, Italy. Tel: +39(0)649904133;
E mail: chiara.frazzoli@iss.it

development of Veterinary Public Health (VPH) defined by WHO in 1974 and in 1999 as "*a component of public health activities devoted to the application of professional veterinary skills, knowledge and resources to the protection and improvement of human health*".
Initially, it was felt that the duties of Public Health (PH), and in particular of VPH, were (mostly) limited to the problems derived from biological agents causing zoonoses, but the demands increased to include the following emerged duties:

- Biological food contamination
- Chemical food contaminaton
- Economic losses
- Emergencies (epidemic and non epidemic)
- Environmental contamination
- Improper human nutrition
- Infections of immunocompromised people
- Nuclear food contamination
- Occupational diseases
- Pharmaco-resistance
- Zoonoses

The sum of these problems involved such consideration as:

a. the term "zoonosis", as generally accepted, was insufficient to define all these problems; PH has to face not only problems caused by biological agents, but also problems caused by chemical and physical agents.

Consequently, in 2000 Adriano Mantovani proposed the following definition of zoonoses: "*Any detriment to the health and/or quality of human life deriving from relationship with (other) vertebrate or edible or toxic invertebrate animals*". This definition was abbreviated by Blancou (2000) as "*detriment to health and quality of human life derived from the relationship with (other) animals*".

2. Features of the Mediterranean and Middle East Region (MME) and the novel zoonoses

The Mediterranean and Middle East Region (MME) has been defined as the cradle of zoonoses for some relevant features as biodiversity, large presence of humans and animals, close coexistence between humans and animals, variety of environments and climates, human and animal movements and migrations. In the MME we may distinguish two main patterns, influencing both the classic and the novel zoonoses; these patterns may be either be distinct, co-existing or overlapping:

- THE CLASSICAL (TRADITIONAL) PATTERN, which has been discussed in other papers as the main background justifying the relevance of classical zoonoses in the MME [1]. The methods applied in the farm adopting this pattern did not traditionally imply the use or contact with drugs or other chemicals. This use has been introduced in recent years both for farming and food production. Contacts with contaminated materials are also possible in places where classical farming is practiced in close contact with industrial sites, dumping places and other possible source of contaminants (e.g. dioxins).
- THE MODERN CHANGING PATTERN, which has been discussed in other papers [2] with regards to classic zoonoses, especially those with a urban cycle. The modern changing patterns are closely linked to the geopolitical and geoeconomical feature of MME: a fraction of MME is part of the European Union, where the rules on food safety are the most stringent in the world. Even if adopted in EU areas only, the EU rules inevitably affect the whole MME in terms of requirements for international trade in animals and products. On the other side, severe measures against unsafe products can lead to commercial dumping [3] in countries unprotected by national laws. In particular, some factors are deeply affected by regulatory restrictions and their effective application, starting from good zootechnic practice by livestock producers:

a. large use of drugs and other chemicals for farming, animal therapy and feed and food processing; concentration of these products on the food of animal origin as well as occupational exposure of farmers and their families;
b. progressive urbanisation, intended both as concentration of people in cities and towns and as the adoption of urban habits by rural people; food distribution concentrated on large firms;
c. changes of food habits and preferences; use of food produced in other parts of the country or of the world;
d. feed possibly produced with uncontrolled materials, often imported, selected on economic basis with poor consideration of the PH factors;
e. use of commercial food, sometimes derived from small scale production;
f. food control that is not practiced in all the MME; there are areas in which (veterinary) PH services are not available or poorly practiced;
g. increased industrial production means increased output of potentially toxic waste, which can be improperly, or illegally, disposed in agro-farming areas;
h. the increased adoption of intensive farming techniques to provide food to large urban populations leads to an increasing environmental impact of animal excreta;
i increasing education and awareness of consumers and media as well as the development of enterprises involved in food and chemical production put increasing and often conflicting

pressures on (veterinary) PH services.
Dietary exposure to toxicants has been associated to the degree of socioeconomic development, e.g. the rapid economic growth and implementation of information and communication technologies (ICT) [4-6]. The outset and extent of the risk is strongly associated with characteristics of the productive chain (feed, living environment of farm animals, social and cultural features). Both the classical and the modern pattern of farming and food production may imply the use of substances which may have an harmful effect on the consumer and have been classified as "novel zoonoses" (Tab. 1).

Table 1 - The more relevant agents causing novel zoonoses.

Agents causing novel zoonoses
Veterinary drug residues (e.g. benzimidazoles, antibiotics, pyrethroids)
Feed additives (e.g. coccidiostats, trace nutrients)
Illicit farm animals treatments (e.g. β-agonists, glucocorticoids)
Pesticides and biocides in feeds and farm environment (e.g. organophosphates, dicarboximides)
Persistent organic pollutants (e.g. dioxins, PCBs, DDT and related pesticides)
Chemicals in industrial and/or consumer products (e.g. brominated flame retardants, phthalates)
Chemical elements and relevant forms/species (methilmercury, Cadmium, Arsenic)
Plant-derived compounds (e.g. soy phyto-oestrogens, tetrahydrocannabinol from hemp-derived feed materials)
Mycotoxins (e.g. Aflatoxins M1, the hydroxylated metabolite of aflatoxin B1)

For instance, socioeconomic development has been associated to cow milk consumption as possible risk factor for endocrine-related cancers such as breast cancer [7]: this may be due to the high hormone content in milk produced by animals forced to produce milk during the entire reproductive cycle, intrinsic factors (e.g. excess of vitamin D in milk from intensive productions), and/or chronic effects of low doses of bacterial toxins unaffected by antibiotic and thermic treatments.
Therefore, both classical (infections) and novel (toxicant-related) zoonoses may be connected both with traditional and modern pattern, and are prone to be managed within the same control framework [8].

3. The novel zoonoses: risk assessment and one health interventions

One Health (OH) is intended as the contribution of all disciplines dealing with human and animal health, foods and the environment to protect and improve human and animal health, based on the sharing of living resources and the reciprocal interconnections. It is applied to all fields of prevention where food chains and living environment are involved, and is useful to protect the general public, agrofarming production, domestic, synanthropic and wild animal populations. The modern concept of zoonoses includes the chemical contamination of the life environment and production cycle of livestock: these can lead to the transfer of active concentrations of pollutants to food of animal origin, with long-term risks to human health, as well as to a decreased availability of wholesome foods [8-9]. Toxicological new zoonoses, therefore, are a critical example for the development of the OH/One Prevention approach, as they involve interactions between environmental quality, animal health and human health [5]. The critical nature of these interactions was recognized in the European strategy on food safety "from farm to fork", which points out a key role to the environment in which living food producing animals dwell [9]. Considering foods as products of living organisms is very important for risk assessment: the different ability of these organisms to metabolize or accumulate specific pollutants is crucial, in fact, for human exposure. It is therefore clear the importance of nutrition of farm animals for the protection of the wholesomeness of human nutrition as well as hub of factors involved in OH/One Prevention, in particular where - as in livestock activities that utilize pastures- animals are exposed in a repeated, prolonged and direct way to the open environment [10]. The frame of One Resilience in several areas affected by environmental contamination is characterised by effects on health that are not immediate; the slow and continuous accumulation and transfer (environment-food-producing organisms- humans) of substances that increase the risk of chronic diseases such as cancer, or the predisposition to develop these diseases, especially when exposure occurs during the developing age. A staple example are endocrine disruptors (ED, http://www.iss.it/inte), i.e. substances that cause adverse health effects by altering the hormonal balance. In particular, ED are considered as tumor promoters for tissues with strong endocrine

regulation such as testicular and breast tissues, as well as risk factors for male and female infertility and increasing the risk of obesity and neurobehavioural disorders upon developmental exposures (11). Noticeably, the carry-over from animal feed to human food, a typical OH topic, is a main exposure pathway for several ED (e.g., dioxins, polychlorinated biphenyls) (12). The issue of risk assessment of the food chain of animal origin in contaminated sites can be better understood when based on a case study, e.g. the contamination by beta-esachlorocycloexane (β-HCH) of cattle farms of the Sacco river valley (Italy). The case was revealed by the data of the official control of contaminants in foods of animal origin, which showed levels of β-HCH 20 times higher than the legal limit (0.003 mg/kg) in the milk of dairy farms in the area. Subsequent investigations indicated that the animals had been exposed to β-HCH through fodder cultivated near the Sacco river or irrigated with its water [13].

3.1. The toxicological characterization of β*-HCH and the consequent potential risk to human health*

β-HCH was both a component of HCH, a chlorinated insecticide made of a mixture of isomers and banned in Europe since 1978, and a synthesis intermediate and impurity of Lindane (β-HCH), a common agricultural insecticide and fumigant used in Europe until 2000, when it was banned. Currently β-HCH is considered only as a contaminant of feed and food products, and as such it has been assessed by the European Food Safety Authority in 2005 [14].

The β-HCH has a very low insecticidal activity; consequently, the data available on Lindane, as active substance, are more abundant and better organized than the β-HCH. On the other side, the toxicological properties of Lindane are not directly extrapolated to β-HCH; indeed, the two substances appear different under various and important aspects. In summary, Lindane appears to have a greater potential for organ toxicity, with effects on both the nervous system and reproductive development (the latter mediated by the interaction with the estrogen receptor b) [15]; by contrast, β-HCH has a greater capacity for persistence and bioaccumulation.

Limited experimental toxicology data on β-HCH show a picture similar to that of the most persistent chlorinated insecticides, such as DDT [14]: hepatotoxic effect with enzyme induction, and also tumor promotion at high doses, and estrogenic activity *in vitro* with agonistic activity towards the estrogen receptor alpha (absent for Lindane) [15]. While waiting for adequate *in vivo* data, β-HCH is considered as a potential endocrine disruptor; EFSA also noted the *in vitro* interaction with c-erbb2, a receptor for growth factors, also involved in breast cancer. In any case, the information highlight issues of concern to be explored, but currently too sketchy to define a tolerable level of intake [14]. β-HCH, like many other organochlorines, is a persistent pollutant able to bioaccumulate. High oral bioavailability, slow metabolism and lipophilicity mean that long-term exposure leads to the formation of a body burden, mainly in adipose tissue and liver. In cattle the half-life is 4-22 weeks and carry over in milk is important, corresponding to 30-37% of the ingested dose. Milk is therefore a viable matrix for monitoring exposure and bioaccumulation in ruminants as well as a critical food item to assess human dietary exposure. By contrast, the scant available data suggest that the bioaccumulation of β-HCH is rather tolerated by livestock; however, toxicological studies are missing that would allow to characterize biomarkers of effective dose (e.g., hormonal, metabolic) as early signs of risk in animal populations [14, 16].

Human exposure occurs mostly via food. The content of β-HCH in food is associated with the lipid content and with the area of origin, the latter being related to extent and duration of use of HCH and/or Lindane.

Interestingly, exposure to β-HCH, similar to other lipophilic contaminants, fall into two major scenarios for the benefit-to-risk assessment in food safety [17]: i) feed for aquaculture rich in fats and derived from aquatic organisms [18], whose contamination can lead to bioaccumulation in farmed fish up to jeopardizing its nutritional benefit; ii) exposure of the infant through breastfeeding reflecting the maternal body burden and representing the first step for bioaccumulation in the new generation; the mother-child transfer of toxicants is one critical issue of the conceptual framework of sustainable food safety [19].

The data collected in the EFSA evaluation show a gradual and generalized decline, in the course of time, of the presence of β-HCH in food and feed [14]. However, local environmental situations still exist, generally due to the on-land disposal of industrial waste such as the Sacco river valley. In such situations, the potential endocrine disrupting and important excretion in milk of β-HCH indicate the need for attention to possible long-term effects on human health, especially on prenatal and childhood development. Also, the overall dietary exposure should be evaluated considering factors such as the concentration process from milk to dairy products or the possible transfer from contaminated farmland to specific foods of vegetable origin with high lipid content, such as olive oil, a major product of most MME agricultural areas.

3.2. The experience of the Sacco river valley as a model of successful One Health intervention

The contamination of the food chain with chemicals released into the environment is a risk in different socio-environmental scenarios. For instance, it can occur in all areas of high density of industrial activity, intensive agriculture, or installations for waste disposal. Even greater risks occur where waste disposal is done illegally and where there are hydro-geological problems.

Examples of recent environmental problems in Italy, that also had echoes in the media, have been the detection of β-HCH) in cow and sheep milk (Sacco river valley), of dioxins in cow milk (Val di Susa), buffalo mozzarella (Campania) and shellfish (Taranto), of radioactive substances in meat of wild boar, of mercury in fish, and of arsenic in drinking water.

The experience made in the Sacco river valley, in the Lazio region (provinces of Rome and Frosinone, central Italy), is an example of integration of different disciplines to highlight the pattern of contamination spread and to relate it to the features of a specific environmental scenario. In European countries like Italy, the approach adopted to address the issue of contaminated sites, at scientific and regulatory level, is based on risk assessment (hazard identification, dose-response evaluation, exposure assessment, risk characterization). Exposure assessment includes all potential sources of pollution, transport routes and environmental fate of pollutants, identifying the main routes of exposure (ingestion, inhalation, dermal) for the specific population living in the territory. The agricultural vocation of the Sacco river valley has been joined in the last forty years by a remarkable industrial development. The pollution of livestock production in the Sacco river valley was officially recorded in May 2005 following the sampling of bovine bulk milk from a farm in the town of Gavignano for the analysis of organochlorine pesticides [13]. The sample was found to contain β-HCH at concentration level of 62 ppb, i.e. 20 times higher than the maximum allowed. Following the detection of non-compliant samples, a surveillance programme on bulk milk of the local farms was carried out by the veterinary services and a crisis unit was established. The crisis unit was composed of representatives of the Lazio Region (Area Veterinary Health and Protection of Animals), Istituto Zooprofilattico Sperimentale of Lazio and Tuscany regions (Osservatorio Epidemiologico and Department of Chemistry), Department of Prevention of concerned ASL (Frosinone and Rome G) and ARPA, and involved the integration of vertical and horizontal skills including chemists, geologists, biologists, veterinarians and epidemiologists to highlight the pattern of contamination spread and to relate it to the features of a specific environmental scenario. A sampling plan including various animal matrices (cattle and sheep milk, eggs, meat, fodder) was designed and extended to cover a wide area along the flow direction of the Sacco river, up to 30 km away from the contamination source. In response to the economic and social crisis determined by the threat of closure of hundreds of farms in the area, numerous measures of veterinary police were immediately taken to ensure the safety of consumers and, at the same time, the continuation of production and marketing activities. The main measures were: the seizure of the farms whose milk was non compliant (34 out of 244 in the first survey), the destruction of the contaminated bulk milk, the slaughtering ban, and the seizure of contaminated fodder.

The primary source of contamination was identified in the industrial waste area of Colleferro, where processing by-products of Lindane were illegally buried; land and fodder were contaminated through contact with the river water and sediments. The Sacco river was then recognized as the secondary contamination source, because despite being solely responsible for the transport and not of the generation of pollution, it determined the spread into the farming grounds closer to the shores. The large number of milk samples analysed on the investigated area allowed to observe how such a matrix esteemed with good accuracy the spatial diffusion of the contamination in the environment. The investigation result was also possible through an accurate georeferencing of farms. The emergency management incurred high costs: 15 million euros, of which 8 for compensation for cattle and sheep farmers and 7 for the implementation of safety measures and restrictions. The monitoring plan has been renewed annually to ensure the monitoring and wholesomeness of foods of animal origin. The interdiction of pastures is currently established in the band at 100 meters from the shore; however, a detailed analysis over time revealed that the areas at risk may extend beyond this limit along some stretches of the river, while along other stretches there may be no or little β-HCH contamination near the shores [13]. A thorough study on the extent of contamination is also desirable for the purpose of remediation and requalification of the areas.

In conclusion, the integration of environment and health information, as sought by the major international agencies, is essential to set up a surveillance of environmental pollution, including exposure of the infant through breastfeeding, reflecting the maternal body burden and possible long-term effects on human health, especially on

prenatal and childhood development. Equally important are the application of GIS tools, spatial analysis, and accurate and updated livestock registry. The integration of different vertical and horizontal skills is essential to achieve the goal of OH between humans, animals and environment, as put forward by national and international authorities.

3.3. Lessons learned

Contaminated sites are areas generally characterized by chemical contamination of different environmental matrices (soil, groundwater, sediment, air); such contamination can be very different in relation to the type and timing of activities, the environmental scenarios, the biota present in the area and, last but not least, the characteristics of the chemical(s). Therefore, in such areas an integrated approach is needed (in line with the principle of OH) in order to be able to assess the risks to human health and the environment and then identify and apply the appropriate measures of risk management (mitigation / remediation). In the last decade interest has increased on possible applications of biomonitoring of farmed animals to prevent the health risks to humans [16]. In fact, the regular and systematic collection of data on biomarkers in exposed animals can be a sentinel for early detection of the risk of hazardous intake by humans. Farm animals have a double meaning in the study of risk since, in addition to highlight the hazard, are themselves potential accumulators, given their role in the food chain. Animal biomonitoring means a system that allows the periodical measurement of some indicators (chemical, biochemical, molecular) in animal tissues and biological fluids to indirectly quantify changes over time of certain contaminants in the environment [16].

The experience of the Sacco river valley showed how spatial probability of contamination can be estimated at the early stage of an emergency, before starting sampling operations. It can be done based on probability maps and definition of high-risk areas following geo-statistical estimators and geographical/environmental predictors (e.g. distance from the river, distance from the pollution site, elevation above the river level, intrinsic vulnerability of hydro-geological formations) [13]. In Italy, the National Residues Plan and the National Plan for Animal Feeding ensure food safety through the programming of sampling surveys of food matrices aimed at detecting all the undesired substances, including some environmental chemical contaminants. In 2011 the Italian Ministry of Health has started a specific plan for the nationwide monitoring of contaminants in environmental remediation sites. However, the samples provided are often scant compared to the territorial needs and selected without considering risk-based criteria, with the result that monitoring data are unbalanced and not completely fit to the needs of risk analysis. Limited attention is given to some pollutant groups (brominated flame retardants, perfluorinated compounds) pointed out by EFSA because they are widespread in the environment as well as able to disrupt endocrine homeostasis and concentrate along the feed-food chain.

The EU Scientific Committee on Health and Environmental Risks (SCHER) has pointed out in some instances the soil pollution problems posed by specific chemicals present in fertilizers (17, 18). Nevertheless, the current EU legislation does not provide concentration limits for contaminants in soils intended for agricultural use. A fit-for-purpose monitoring should be built integrating the available knowledge about the target pollutant(s), the area, and the animal population(s). In a given area, the spatial distribution of the contamination and the concentration of pollutants generally is not homogeneous; the spread of chemicals in the environment and the interaction with receptor animal populations follows preferential pathways. Consequently, livestock activities in the area are not all exposed to the same risk. Account for this variability is critical to implement effective and sustainable monitoring plans, as well as to plan the land management and protection actions, including the restriction of use of certain areas. The conceptual model that is generally used in all studies of environmental risk is: “source-spread patterns-receptors”. The study of environmental contamination spread pattern, distance between source and receptor, and environmental characteristics facilitating contamination spread is fundamental. In polluted areas, the livestock farms and foods of animal origin act as primary receptors because of the strong interaction of livestock with the environment (use of pastures, fodder cultivation, irrigation and watering with local waters). The selection of animal matrices to be sampled should consider therefore animal species, but also the breeding and feeding practices, that influence significantly the exposure. Generally, animals reared extensively are more exposed to local environmental issues, while those under intensive rearing can be subject to contamination arising from technological failures of feed chains, often from feed ingredients produced far away from the farms. The transmission paths are those followed by the contaminant according to its physicochemical and ecological characteristics (e.g., volatility, persistence, solubility), from the source to the animal receptor. For this reason it is important to consider some natural geographic and hydrological features of the

area: distance of the primary and secondary pollutant source, transport direction through the river system, water or winds, presence and relative position of hydrogeological and topographical barriers, type of use of the soil. Since pollution related issues generally affect the whole ecosystem and are primarily associated with space, both the spatial analysis and the multi-disciplinary approach are needed starting from the preliminary study phases.

4. The linkages among classical and new zoonoses

Classical/infectious and novel/toxic zoonoses present such linkages in:

- Their terminology. The epidemiologic triangle, with the Agent, the Host and the Environment at the three vertices foresees specific concepts and terms, such as incubation and reservoir for infectious zoonoses and residues and bioaccumulation for toxicant-related zoonoses [8]. In the center of the triangle is time, that represents, e.g., the incubation period for effective diagnosis and treatment. Toxicant-related zoonoses are not readily discernable, and may reveal their health effects in the long-time; they are often also communicable, due to carry over from food producing animals to human, and to the mother-child transmission [8].
- Their implication in health sustainability and sustainable food safety. In the field of (veterinary) PH and food safety, the application of the sustainability concept means protecting the population, including the next generation, from long-term risks: following previous discussion [20], we define Sustainable Food Safety (SFS) as the complex of actions intended to minimize adverse health impact on future generation associated to today's safety of foods and nutritional quality of diet. Infectious and (toxicant-related) new foodborne zoonoses imply a complex scenario of the population to be protected: infectious zoonoses spreads over a space-dimension whereas the toxicant-related foodborne ones over the time-dimension: endocrine disrupting chemicals (EDCs) provide a new view on the developmental origins of adult health and disease. A telling example of a food safety issue implicating sustainability is the parental dietary exposure to substances (e.g. methylmercury or bioaccumulating EDC, such as dioxins) in feeds for food producing animals); feed-to-food driven dietary intake during such vulnerable lifecycle as intrauterine life and breastfeeding, may increase the long- progeny's burden of endocrine, metabolic and reproductive diseases.
- Their synergy towards increased susceptibility to disease. A conceptual distinction between vulnerability and susceptibility marks the difference between being intact but fragile - vulnerable (e.g., lifecycle phases as critical developmental windows) - and being weak (e.g. under-nourished), diseased and predisposed to compound additional harm – i.e. susceptible. In this context, toxicological risk factors should be assessed in the holistic approach to infectious diseases aetiology and prevention and the vice versa. For instance, beyond the infectious agent itself, other factors are required to support the onset of an infectious disease, and/or to facilitate its progression or the effectiveness of immune responses. Several EDCs, such as dioxin-like compounds, have a recognized ability to alter immune response, leading to an impaired response to viral agents, such as influenza viruses. Environmentally-relevant exposure levels of widespread contaminants are suspected to jeopardize the effectiveness of antiviral defences. For instance, inorganic arsenic, which is a toxic trace element identified also as an ED, affects the immune response to infection from the swine flu virus H1N1 in the mouse [21]. An interaction between toxicants and infections is also highlighted by some epidemiological data. For instance prospective epidemiological studies show a more than multiplicative interaction between infection with hepatitis B viruses and dietary exposure to aflatoxins, e.g. aflatoxin B1, in terms of hepatocellular carcinoma risk. Aflatoxin B1 has long been linked to immune suppression and growth faltering previously observed in veterinary studies [22]. Overall, the extent to which factors such as toxicant-immune suppression contribute to the overall burden of infectious disease is difficult to quantify, but is undoubtedly significant.
- Their role in the balance among food security and safety. The increasing demand for foods of animal origin requires both sustainability in animal production systems and a broader context of global food security in the changing environment in which feed is produced and used (e.g. changes in climate). New technologies to make use of available potential feed sources are being developed along with new feed production systems and feed sources like aquatic plants and marine resources. However, the enthusiasm for such new sources should be balanced by an integrated risk analysis, pointing out the main biological and chemical hazards for food-producing animals as well as for consumers of foods of animal origin [23].

5. How awareness can translate into effective action for food security and food safety

5.1. General population and dietary behaviour

With reference to the points described in section 4, exposure to some pollutants may indeed pose risks not yet fully characterized but potentially crucial in altering the developmental programming of the next generation. Dietary exposure to widespread pollutants (dioxins and dioxin-like PCBs, Arsenic, Cadmium, Organophosphate insecticides) may represent a trigger, i.e. a key risk factor in the increased proneness to the onset of metabolic syndrome [24]. Such contaminants may alter programming of body composition or development by acting, e.g., on the glucorticoid and/or thyroid axis and/or by modulating epigenetic regulation of gene expression. In most situations the levels of individual contaminants are too low to affect a healthy individual; however one has to consider the possibility of additive modes of action as well as, most important, the unique vulnerability of the unborn child. Such exposure takes place mostly through foods containing high percentage of lipids (some kinds of fish, fatty meat, and dairy products). The general shift in dietary habits from a traditional Mediterranean diet to industrial food could explain, in part, the nutritional and metabolic disorders reported in the population of this region [25].

Southern Mediterranean countries are undergoing health and nutrition transition. Indeed, while malnutrition and micronutrients deficiencies are not eradicated, there is an increased prevalence of diseases such as obesity, hypertension, diabetes, hypercholesterolaemia and cardiovascular disorders [26]. More than 60% of all deaths in the southern Mediterranean region are attributed to classic non-communicable diseases, with major impact due to cardiovascular diseases significantly associated with obesity. However, these diseases are not recognised as a high PH priority in several southern Mediterranean countries, as they are still confronted with the heavy burden of infectious diseases and poor maternal and child health, may be aggravated by difficult political situations [26].

The risk of developing metabolic disorders in adult life is influenced by environmental factors that operate during pre- and early postnatal development (Developmental Origins hypothesis). In fact, even though much of the rise in obesity pandemic is attributed to lifestyle factors as hyper-caloric/nutritionally poor diet and sedentary life, other additional risk factors have been proposed as possible "trigger". The developmental programming is a process during which a stimulus in utero or in the early life stages may establish a permanent response leading to enhanced risk of developing adulthood disease. The Thrifty Phenotype hypothesis explains the role of insufficient in utero nutrition as strong programming stimulus in later development of Type 2 diabetes. The "Predictive Adaptive Response" hypothesis proposes that the degree of mismatch between the pre- and postnatal environments is a key determinant in abnormal programming and subsequent disease outcome. It has been suggested that neuroendocrine development during fetal life may be based on predictions about postnatal environmental conditions: following this hypothesis, interaction between the prenatal under-nutrition and postnatal high-fat nutrition amplifies the propensity towards diet-induced obesity [27]. The potential relationship between environmental metabolic disrupting chemicals and the obesity and metabolic disease epidemics, has been reviewed and the authors proposed to broaden the definition of obesogens to include metabolic disruptors, to encompass environmental chemicals that play a role in altered susceptibility to obesity, diabetes and related metabolic disorders including metabolic syndrome [28]. Overall, the issue of predisposition to metabolic syndrome links diet quality, food safety, living environment and lifestyles with emphasis on the prenatal and early postnatal lifestages.

The perception and understanding of novel zoonoses should correct health exposure behaviours, whereas more targeted and up-to date controls and preventive actions could effectively contribute to PH plans against pandemic obesity. Preventive actions to reduce the chance of contamination and control/risk management interventions on specific food production chains would thus contribute to implement the SFS framework, ensuring protection also to the next generation. Concurrent options to minimize exposure through foods include selecting lower-fat meats, fishes, poultry, and dairy products [19].

5.2. Food production chains and innovation

Dietary intake is the major route of exposure to residues and contaminants in live animals and their products (Tab. 1). Possible protective actions could be at different levels, as:

- Sovereignty of raw materials and short food chains [20], including protection from dumping and investment in agro-zootechnic productions, including those that intensive husbandry may consider as "marginal", e.g., sheep and goat rearing. For instance, with current saturation of fishery, farmed fish and aquaculture are respectively recognised as possible "sustainable food" and "sustainable production" of animal origin [29]. "Sustainable food" means, e.g., the possible use of local ingredients for fish feeds not

competitive with human food, whereas "sustainable production" means, e.g., current significant availability of environmental renewable resources for fish farming, whose use must be preserved by addressed environmental, waste and biodiversity management. Thus, food sovereignty is critical to the socio-economical status of the population but also to food and nutrition security and safety (fish is a staple food rich in proteins, fatty acids, vitamins and minerals).

- Risk Assessment: poor animal nutrition and feed safety/environmental quality have been overlooked as a cause of human malnutrition. Currently, innovation is particularly addressed to the optimization of the risk-to-benefit ratio in feeds, especially targeting developmental programming and next generation's health [29]. For instance, innovation aims at fish feeds both based on ingredients less vulnerable to contamination by such pollutants as, e.g., methylmercury, PCBs, PFOS and PBDEs, and richer in essential nutrients (e.g., Ω_3, iodine). On the other side, the EFSA has pointed out the potential risks arising from feed supplementation with excessive amounts of certain nutrients that have a recognized toxicity (e.g. iodine, cobalt, vitamin A). Further to surveillance/control plans pointing at quantifying the agent level in foods, risk assessment, that is strongly associated with the productive chain, characterizes the effects of (intended for use) chemicals by dose-response studies, exposure/ carry over scenarios (where the physiology and metabolism of the living animal are critical) and worst cases. For a translational approach "from the bench to the real-life" [30], research should: i) develop and characterize human and animal biomarkers (BMs), that are pivotal in the world of exposure assessment [16]. BMs are chemicals, metabolites, characteristics, or changes related to undesirable exposure to substances (chemical and microbial pollutants), health and welfare status of each animal (e.g., mastitis, metabolic dysregulations and stress) and milking hygiene (protein, fat, lactose, urea, somatic cell count, traces of blood) to provide both a comprehensive metabolomic-based picture of the herd management (animal feeding, rearing conditions) and quality and safety of milk and dairy products. ii) develop and in situ validate technologies for the environmental monitoring and surveillance of chemicals, in particular EDs, and environmental remediation. iii) assess and update the impact of global climate change on agricultural and livestock production (food security) and feed and food safety.
- Risk Management: food traceability and early warning from farm to fork. A rapid response to an accidental or intentional contamination or other triggering event through improved tracing of foods and food ingredients at each stage along the food chain – from farm to retailer or restaurant – aims at reducing food-borne diseases; tracing products occurs in a system, not in a firm alone and may be costly to implement. However, no product tracing system can be effective without product tracing in place at the firm level. Risk management is a field where innovation and technology are needed to manage on the field controllable health risks from the exposure in critical agent/animal (or animal product) pairs. At micro level, risk management will help improving the use of agricultural inputs (fertilisers, pesticides, veterinary drugs, etc.) and good agricultural practices (e.g., early harvesting, proper drying, sanitation, proper storage and insect management), good hygiene practices during production and distribution, with direct benefits on animal health and performance, and economics of their management and trade [31]. Effective product tracing would yield social benefits beyond the direct benefits and cost reductions to the firms, where improved efficiency and speed of response time following a food safety triggering event would greatly contribute to the protection of the PH and maintain consumer confidence. As short term benefit at macro level, the activities will support the gradual integration and competitiveness of the agro-food sector, strengthening the pivotal role of agriculture towards rural development and food security and food safety, increasing market access for the Mediterranean producers, both within the area and with the rest of the world.

CONCLUSIONS

The MME has been defined as the cradle of (classic) zoonoses because of its features, which have permitted during centuries to develop and maintain these infections in the regions, whereas biodiversity, large presence of farm animals and their close coexistence with humans, variety of environments and climates, human and animals movements and migrations, variety of farming practices and foods (practically the history of the region connected with animals) have explained the "MME and zoonoses binomium".

The possibility that some diseases could be transmitted from animals to humans is in the roots of Mediterranean medical (and also popular) culture. This concept was linked to the times in which it developed, i.e. those of traditional societies largely based on farming, where the use and breeding of

animals was not restricted to food production but was involved in most human activities: war, work, transportation, hunting and provision of materials for bedding, burning, etc. This reality has developed together with the history of the MME, and influenced the concept of comprehensiveness/ entirety (unity of medicine, meant as health practice) already present in the early times well before the recent definition as "One Health.

The bacteriological era identified the connection between specific zoonoses, biological agents causing them, animal vectors, and susceptible humans: indeed, the first definitions of zoonoses were based on this trinomium. The modern changing patterns see the EU rules on food chemical/toxicological safety affecting the whole MME in terms of requirements for international trade in animals and products under a global health view, these stringent standards may e.g. lead to dumping of unsafe products toward countries with weaker safety management systems.

An essential feature of classical zoonoses was their horizontal (short-term health outcome) transmission from animal to animal, and from animal to human based on the capacity of the agent to reproduce: classical zoonoses are characterized by the "space dimension" of their spread and PH impact. These concepts were dominant until the modern times, when three main developments have influenced them:

1. animal husbandry has become intensive (traditional animal husbandry is predominant only in some regions of the MME);
2. production and trade of foods of animal origin have been industrialised; the trade of these products is performed on large distances and must respect certain rules; in parallel a substantial illicit trade of animals and products may be observed, at least in some areas. Conversely, a limited space is left to traditional production and trade;
3. the intensive animal industry makes large use of chemical substances, which through the product (meat, milk, eggs, honey) may reach the consumer; this possibility may be present, often uncontrolled, in classical farms reached by modernity;
4. the majority of problems caused by animals through their products is caused by chemicals, this is the norm in the modern type of production, and is becoming more and more frequent in the classical type of production;
5. the increasing attention to One Prevention in the context of One Health (from risk analyses to the network of prevention initiatives based on standards and harmonised field controls in the MME);
6. an essential feature of novel/toxicant zoonoses is their vertical (transgenerational) transmission from animal to animal, and from animal to human with postponed (adult life) health outcome based on the capacity of the agent to accumulate, persist, and carry over (sustainable food safety). Novel zoonoses are characterized by the "time dimension" of their spread and PH impact.

Multidisciplinary (vertical and horizontal skills) and multidimensional (space and time dimensions) OH prevention concepts, schemes and tools do exist in the MME and comply its features, but need higher degree of structured governance and formal mandate to guarantee proactive and reactive PH systems. MME' OH schemes based on MME'S features and capacity must be also integrated in the scenario of global health, based on updated ethics (e.g. low dose exposures, extra EU trade), regulations and social dynamics.

Public preparedness in One Resilience scenarios posed by novel zoonoses (e.g. chemically contaminated sites) requires formal guidelines and institutions. Emergencies due to severe environmental contamination occurred in the MME (e.g. the Sacco river valley) demonstrated how both features and multidisciplinary competences do already exist in the MME and ask for follow up, summing up, organization, harmonization and spread in the MME, e.g. through a MME high school of One Health and One Resilience.

ACKNOWLEDGEMENTS

The paper stems from the activities of the project Integrated system of biosensors and sensors ("BEST") for the monitoring of wholesomeness and quality, as well as for traceability in the cow milk chain (ALERT) (http://www.alert2015.it) funded by the Italian Ministry for Economic Development under the Call Industria 2015 "New technologies for Made in Italy". The "Nutrition & Food Safety and Wholesomeness. Prevention, education and research Network" (NOODLES, http://www.noodlesonlus.org) is acknowledged for bridging research on One Health with socioeconomically developing countries.

REFERENCES

1. Mantovani A, Prosperi S, Seimenis A, Tabbaa D. The Mediterranean and zoonoses: a relationship. In: Veggetti A, Zoccarato I, Lasagna E (Eds.). Proceedings of the 35th International Congress for the History of Veterinary Medicine. Grugliasco (TO), 8-11 September 2004. Brescia: Fondazione Iniziative Zooprofilattiche e Zootecniche; 2005. p. 59-56.

2. Seimenis A, Morelli D, Mantovani A. Zoonoses in the Mediterranean region. Annali dell'Istituto Superiore di Sanità 2006; 42:437-445.

3. Pouokam GB, Ajaezi GC, Mantovani A, Orisakwe OE, Frazzoli C. Use of Bisphenol A-containing baby bottles in Cameroon and Nigeria and possible risk management and mitigation measures: community as milestone for prevention. Science of the Total Environment 2014; 481:296–302.

4. Luzardo OP, Boada LD, Carranza C, Ruiz-Suárez N, Henríquez-Hernández LA, Valerón PF, Zumbado M, Camacho M, Arellano JL. Socioeconomic development as a determinant of the levels of organochlorine pesticides and PCBs in the inhabitants of Western and Central African countries. Science of the Total Environment 2014; 12:97-105.

5. Frazzoli C, Asongalem EA, Orisakwe OE (Eds.). Cameroon-Nigeria-Italy scientific cooperation: veterinary public health and sustainable food safety to promote "One Health/One Prevention". Roma: Istituto Superiore di Sanità; Rapporti ISTISAN 12/49; 2012.

6. Frazzoli C, Orisakwe OE, Dragone R, Mantovani A. Diagnostic health risk assessment of e-waste on the general population in developing countries' scenarios. Environmental Impact Assessment Review 2010; 30:388–399.

7. zur Hausen H, de Villiers EM. Dairy cattle serum and milk factors contributing to the risk of colon and breast cancers. International Journal of Cancer 2015;137:959-967.

8. Frazzoli C, Mantovani A. Toxicants Exposures as Novel Zoonoses: Reflections on Sustainable Development, Food Safety and Veterinary Public Health. Zoonoses and Public Health 2010; 7-8:e136-e142.

9. Mantovani A, Frazzoli C. Le nuove zoonosi da sostanze tossiche: dall'ambiente agli animali, agli alimenti, all'uomo. In: Gli animali, l'uomo e l'ambiente. Ruolo sociale della sanità pubblica veterinaria (a cura di G. Battelli, R. Baldelli, F. Ostanello, S. Prosperi), Bononia University Press (Bologna), 2013, pp. 327-339.

10. Mantovani A, Frazzoli C. Risk assessment of toxic contaminants in animal feed. CAB Reviews: Perspectives in Agriculture, Veterinary Science, Nutrition and Natural Resources 2010; 5:1-14.

11. WHO/UNEP. State of the science of endocrine disrupting chemicals, 2013. pp.296. ISBN: 978 92 4 150503 1.

12. FAO/WHO. Executive summary of the report on Joint FAO/WHO expert meeting on hazards associated with animal feed (12-15 Maggio 2015, FAO, Roma).

13. Battisti S, Caminiti A., Ciotoli G, Panetta V, Rombolà P, Sala M, Ubaldi A, Scaramozzino P. A spatial, statistical approach to map the risk of milk contamination by β-hexachlorocyclohexane in dairy farms. Geospatial Health 2013; 8:77-86.

14. European Food Safety Authority. Opinion of the scientific. Panel on Contaminants in the food chain on a request from the Commission related to gamma-HCH and other hexachlorocyclohexanes as undesirable substances in animal feed. The EFSA Journal 2005; 250:1–39.

15. Maranghi F, Rescia M, Macri C, Di Consiglio E, De Angelis G, Testai E, Farini D, De Felici M, Lorenzetti S, Mantovani A. Lindane may modulate the female reproductive development through the interaction with ER-beta: an in vivo-in vitro approach. Chemico-Biological Interactions 2007; 169:1-14.

16. Frazzoli C, Bocca B, Mantovani A. The one health perspective in trace elements biomonitoring. Journal of Toxicology and Environmental Health, Part B: Critical Reviews 2015; in press.

17. SCHER (Scientific Committee on Health and Environmental Risks), Potential risks to human health and the environment from the use of calcium cyanamide as fertiliser, 6 November 2015.

18. SCHER (Scientific Committee on Health and Environmental Risks), SCHER Opinion on new conclusions regarding future trends of cadmium accumulation in EU arable soils, 27 November 2015.

19. Mantovani A, Baldi F, Frazzoli C, Lorenzetti S, Maranghi F. Modelli per la valutazione rischio-beneficio in sicurezza alimentare. Rapporti ISTISAN 12/50; 2012.

20. Frazzoli C, Petrini C, Mantovani A. Sustainable development and next generation's health: a long-term perspective about the consequences of today's activities for food safety. Annali dell'Istituto Superiore di Sanità 2009; 45:65-75.

21. Kozul CD, Ely KH, Enelow RI, Hamilton JW. Low dose arsenic compromises the immune response to influenza A infection in vivo. Environmental Health Perspectives 2009; 117:1441-1447.

22. Shephard GS. Impact of mycotoxins on human health in developing countries. Food Additives and Contaminants Part A 2008; 25:146-151.

23. Joint FAO/WHO food standards programme Codex Alimentarius commission Thirty eighth session, CIGC Geneva, Switzerland 6-11 July 2015. Executive summary of the report on Joint FAO/WHO expert meeting on hazards associated with animal feed conducted from 12 to 15 May 2015, Rome, Italy.

24. Wild CP, Montesano R. A model of interaction: Aflatoxins and hepatitis viruses in liver cancer

aetiology and prevention. Cancer Letters 2009; 286: 22-28.

25. Belahsen R, Rguibi M. Population health and Mediterranean diet in southern Mediterranean countries. Public Health Nutrition 2006; 9:1130-1135.

26. Papandreou C, Abu Mourad T, Jildeh C, Abdeen Z, Philalithis A, Tzanakis N. Obesity in Mediterranean region (1997–2007): a systematic review, obesity reviews. Obesity reviews 2008; 9: 389-399.

27. Ikenasio-Thorpe BA, Breier BH, Vickers MH, Fraser M. Prenatal influences on susceptibility to diet-induced obesity are mediated by altered neuroendocrine gene expression. Journal of Endocrinology 2007; 193: 31-37.

28. Heindel JJ, vom Saal FS, Blumberg B, Bovolin P, Calamandrei G, Ceresini G, Cohn BA, Fabbri E, Gioiosa L, Kassotis C, Legler J, La Merrill M, Rizzir L, Machtinger R, Mantovani A, Mendez MA, Montanini L, Molteni L, Nagel SC, Parmigiani S, Panzica G, Paterlini S, Pomatto V, Ruzzin J, Sartor G, Schug TT, Street ME, Suvorov A, Volpi R, Zoeller RT, Palanza P. Parma consensus statement on metabolic disruptors. Environmental Health 2015; 14: 54.

29. Mantovani A, Ferrari D, Frazzoli C. Sustainability, security and safety in the feed-to-fish chain: focus on toxic contamination. International Journal of Nutrition and Food Sciences 2015; 4: 6-24.

30. Frazzoli C, Mantovani A, Dragone R. Local role of food producers' communities for a Global One-Health framework: the experience of traslational research in an Italian dairy chain. Journal of Agricultural Chemistry and Environment 2014; 3:14-19.

31. Frazzoli C. Trade not aid: challenges for market drivers of safe foods in Africa. In: Frazzoli C, Asongalem EA, Orisakwe OE (Eds.). Cameroon-Nigeria-Italy scientific cooperation: veterinary public health and sustainable food safety to promote "one health/one prevention". Rapporti ISTISAN 12/49; 2012.

Rabies, a fatal zoonosis still neglected: laboratory diagnosis, prevention and control tools.

R. AIELLO[1], A. ANGOT[1], K. DE BALOGH[2], P. DE BENEDICTIS[1]

[1]FAO and National Reference Centre for Rabies, OIE Collaborating Centre for Diseases at the Animal-Human Interface, Istituto Zooprofilattico Sperimentale delle Venezie, Legnaro (PD), Italia
[2]Food and Agriculture Organization of the United Nations (FAO-UN), Rome, Italy

Summary - With more than 95% of cases occurring in Asia and Africa, and only few cases in developed countries acquired abroad, rabies is currently at the very bottom of the priority list of national authorities and donors. Especially in Africa, the circle of neglect is self-triggered by poor data on disease incidence due to lack of surveillance, and no interest to stakeholders. Many achievements have been reached towards dog-mediated human rabies elimination in low-resourced countries. Pilot projects have proved the feasibility of sustainable dog mass-vaccination campaigns and valid alternatives to the existent diagnostic gold standard test have been developed. However, an accurate disease burden is still impeded in Africa by surveillance gaps and constraints in laboratory maintenance. International organizations have joined their efforts in advocating disease control and have developed a stepwise approach, to measure the progress towards rabies elimination at a country level.
Although Latin America is close to rabies elimination and South East Asia has officially committed itself to reach this objective, in Africa this is far from being achieved despite it being feasible, cost-effective and overall socially equitable.

Key words: Dog-mediated human rabies, vaccination, diagnosis, prevention, elimination

Riassunto - Con oltre il 95% dei casi in Asia e Africa, la rabbia è in fondo alla lista delle priorità nazional e internazionali. In Africa, il circolo vizioso è auto-alimentato dalla scarsità di dati sull'incidenza della malattia, a sua volta dovuta a scarsa sorveglianza, e assenza d'interesse degli *stakeholder*. Numerosi traguardi sono stati raggiunti per l'eliminazione della rabbia canina in Paesi in via di sviluppo. Il successo di alcuni progetti pilota ha dimostrato la possibile applicazione sostenibile della vaccinazione di massa nei cani e validi protocolli sono stati sviluppati in alternativa al test diagnostico standard. Ciononostante, le lacune della sorveglianza e le limitazioni dei laboratori diagnostici ancora impediscono una quantificazione accurata della malattia in Africa. Le organizzazioni internazionali alleate raccomandano il controllo della malattia ed hanno sviluppato un approccio progressivo, per misurare i progressi nazionali verso l'eliminazione della rabbia.
Nonostante l'America Latina abbia quasi raggiunto e il Sud Est Asiatico si sia ufficialmente impegnato per l'eliminazione della rabbia umana trasmessa dal cane, in Africa quest'obiettivo è ancora lontano. Eppure il suo raggiungimento è fattibile, economicamente vantaggioso, e soprattutto socialmente equo.

Parole chiave: rabbia canina, vaccinazione, diagnosi, prevenzione, eliminazione

Rabies is a viral fatal encephalomyelitis, which affects mammals, including humans, most often associated to a dog-mediated infection transmitted through a bite. As most patients belong to lower socio-economic groups, the disease is often linked to poverty and to resource-poor countries. Although fully preventable, rabies still kills an estimated 60,000 people worldwide each year [1]. Dog-to-human transmission accounts for 99% of human rabies cases and can be eliminated at source by massive dog vaccination campaigns. Eliminating rabies from dog populations significantly reduces human exposure to the disease and is the single most cost-effective intervention to control and eliminate canine rabies [2]. Despite Latin America and South East Asia have successfully committed themselves to eliminate dog-transmitted human rabies in the upcoming years [3], such a goal is far from being achieved in Africa for a number of reasons, mostly due to the lack of political commitment and rabies considered a low priority. According to a recent global burden estimation, the Sub-Saharan region accounts for the highest estimated per-person death rate [1]. Hampson *et al*. [1] has indicated the burden of rabies in the entire African continent as mainly ascribable to preventable costs, such as those linked to productivity losses due to premature death (≅60%), livestock losses (≅22%), and direct and

Corresponding author: Dr Paola De Benedictis,
Istituto Zooprofilattico Sperimentale delle Venezie, Viale dell'Università 10, 35020 Legnaro (PD), Italia.
Tel. +39-049-8084371; Fax +39-049-8084360;
E mail: pdebenedictis@izsvenezie.it

indirect costs for Post-Exposure Prophylaxis (PEP) (≅17%). On the contrary, a limited budget appears to be allocated for prevention, as dog vaccination, dog population management and surveillance, together account for a ≅1% of the entire expenditures in the continent, with negligible cost for surveillance [1]. Thus, in summary, very little is done in Africa to reduce the disease burden and to eventually eliminate the incidence of human deaths; furthermore, limited rabies surveillance plans resulted in poor reliable data.

Lessons learnt from dog vaccination experiences. Researches show that approximately 70% of the canine population should be vaccinated to effectively break the rabies transmission cycle [4]. However, as highlighted in a recent burden study [1], dog vaccination still represents a small pocket in the African setting and data from the continent show that very few control efforts have reached the minimum required level of coverage [5]. Several misperceptions need to be systematically dispelled to advocate for dog vaccination, i.e., the high proportion of stray and inaccessible dogs, the unwillingness of owners to bring dogs for vaccination and the insufficient knowledge of dog population size and ecology, being the mostly perceived as operational constraints [5]. As a matter of fact, several independent studies have estimated a percentage lower than 11% of inaccessible dogs in several Sub-Saharan realities, and pilot studies in urban and rural Africa have achieved >60% vaccination coverage when owners were not charged for dog vaccination [5]. From an epidemiological point of view, evidences that some wildlife species may be infected and may transmit the canid virus variant in geographically confined loci, have raised a growing concern about the role of wildlife in the maintenance of rabies in Sub-Saharan Africa [6,7]. However, although the general concern that vaccination coverage for dogs only might be insufficient in wildlife-abundant communities, especially in high-turnover growing dog populations, modelling studies and field evidences both indicate that an annual dog vaccination campaign at the recommended target of 70% would eventually control rabies in wildlife-abundant areas in Tanzania [8,9]. Moreover, there is an increasing evidence that a more pragmatic approach may be applied in case of limited resources, a solution that is often more attractive to governments which have to cope with many competing priorities. Mass vaccination in areas with a high incidence of rabies, referred to as corridors or source areas, would dam the spread of disease and ultimately break the transmission cycle [9,10].

Practical examples of successful dog vaccinations campaigns have also worked for improving sustainability of their projects on dog-transmitted human rabies elimination. Thus, one of the major aims of the WHO/Bill & Melinda Gates Foundation (BMGF) pilot project to eliminate human and dog rabies in three endemic sites is to guarantee sustainability not only by continuing the successful strategies at the project sites but also by inspiring and sustaining projects in the neighbouring areas [9]. A successful strategy adopted in Kwa-Zulu-Natal (KZN - South Africa) foresees to safeguard the sustainability of the project by preventing the importation of rabies cases from bordering regions. Field experts from Kwa-Zulu-Natal are also playing the role of champions as those implementing vaccination at the border (Mozambique, Lesotho, Swaziland and the remaining South African provinces). They have also capitalised their field knowledge by offering standard operating procedures (http://www.rabiesblueprint.com/) and actively training local champions at a continental level (such as in Republic of Congo, Kenya and Senegal) [9]. KZN bordering areas have already benefited of dog vaccine extra doses to ensure sufficient coverage and speed-up dog mass vaccination campaigns, thanks to the successful exploitation of the rabies vaccine bank. As vaccine procurement is often difficult for countries that have to manage disease control, the OIE strategy of a veterinary vaccine bank has been recently implemented also for dog rabies. Such a centralised strategy would finally offer a series of benefits to national and regional authorities in the fight against rabies, such as ensuring the quality of the administered vaccines, reducing costs by directly negotiating with manufacturers and accelerating in turns the final country supply (http://www.rr-asia.oie.int/activities/sub-regional-programme/hped/vaccine-bank-fmd-rabies/vaccine-bank-for-rabies/).

Current and future strategies for rabies prevention in humans. Despite it being a preventable disease, human deaths due to rabies are still a burden in endemic countries. Effective immunization is available and schedules have been developed for pre-exposure prophylaxis (PrEP) and PEP. Human vaccines are based on tissue culture or embryonated egg-based vaccines (CCEEVs); however, in some countries nerve tissue-based vaccines are still applied, although their use has been highly discouraged [2].

The World Health Organization (WHO) recommends PrEP to all those who are at continuous, frequent or increased risk of exposure to the virus. However, rabies PrEP schemes currently target travelers to endemic countries or people with

an occupational risk for viral exposure, especially in the developed world. The at risk groups in endemic areas rarely receive PrEP. Children represent one of the mostly affected categories, given that up to 60% of dog bites and human rabies cases occur in patients less than 15 years [2]. There has been a recent proposal to investigate the feasibility of introducing the administration of an adjuvanted rabies vaccine in combination with a currently used MMR (Measles–Mumps–Rubella) live-attenuated vaccine as part of a WHO-EPI (Expandend Immunisation Programme) childhood vaccination strategy [11]. Children would receive the first shot at 9-12 months, with a second dose administered at ≅2–9 years of age, which is the time point in which toddlers and youngsters are most likely to be exposed to RABV. Thus, a child preventatively immunized would have a greater chance to survive a rabies exposure also in case of PEP booster administered at a later stage, and would not require RIG administration, which is often not available in an endemic area.

Another risk category, which is far from being protected includes laboratory workers. This is especially the case of Sub-Saharan African countries where PrEP is not always administered to those who handle rabies suspect cases, with discontinuation of required periodical booster injections and irregular controls of post-vaccination immunity (http://www.fao-ectad-bamako.org/fr/-Rabies-Sub-Network-?lang=en).

As for PEP, current protocols [2] include the first-aid treatment of the wound, the administration of a rabies vaccine approved protocol, in specific high-risk cases together with rabies immunoglobulin (RIG) administration into and around the wound site. More than 15 million people a year are treated after an episode of rabies exposure, mostly following a biting from a suspected or confirmed rabid animal. Unfortunately, PEP is not always available in endemic countries and it is often charged to the bite victim [2]. The intramuscular administration of one dose of a safe and potent CCEEV is estimated in ≅11.90 USD [12]. If the standard intra muscular administration is applied, this cost must be multiplied by 4 or 5 times, according to the protocol adopted, thus making the PEP price clearly inaccessible to the majority of people in low-resource countries such as West and Central Africa, where the average monthly salary is 76.42 USD only, Gabon excluded [13]. In order to reduce the cost of vaccination, the WHO strongly advocates the intradermal (i.d.) administration of CCEEVs, as an equally safe alternative route to the intra muscular (i.m.) one [2, 14]. The alternative i.d. protocols require one or two vaccine vials (rather than four or five) to complete a full course of PEP, eventually reducing up to 60-80% the direct cost of a full PEP in high throughput clinics, where opened vials are timely used within a few hours [2]. However, this cost-effective alternative is still inconsistently applied in Sub-Saharan Africa [9, 15]. The limited production and the high costs of RIGs make them scarcely available on the market, especially in developing countries. Moreover, vaccine and RIG do not confer protection against infection with all the non-RABV lyssavirus species, and this may represent a matter of concern in Africa, where we find their highest variability [16]. Although current evidences indicate that rabies-related infections do occur very rarely in humans [17], the incidence of non-RABV lyssaviruses in domestic animals seems to be higher than expected. In example, a third of all previous cat rabies cases in Kwa-Zulu-Natal (South Africa) results from Mokola virus infection and cats may be also infected by Lagos Bat virus [9]. Thus, the need to replace HRIG with at least equally potent rabies monoclonal antibody-based products is strongly encouraged by the WHO [2] and to this end, mouse as well as human monoclonal antibodies have recently been developed, with two products in advanced clinical trials 18]. However, both these two products have been shown to fail in neutralizing some of the circulating rabies viruses [19], thus preventing them to replace existent RIG.

Challenges to laboratory diagnosis in low-resource countries. Better local diagnostic capabilities and effective surveillance systems are essential not only to demonstrate the burden of the disease in endemic areas, but also to assess the positive outcome of control efforts and to identify residual foci or imported cases as the rabies-free status is gradually achieved [5, 20]. Nevertheless, despite the existence of a reliable and simple diagnostic method, rabies in endemic areas is still highly under-diagnosed and consequently under-reported [1] (http://www.fao-ectad-bamako.org/fr/-Rabies-Sub-Network-?lang=en)
(http://www.oie.int/wahis_2/public/wahid.php/Wahidhome/Home).

The fluorescent antibody test (FAT) on samples from the central nervous system (CNS) of suspected animals is the "gold-standard" and the most widely applied rabies diagnostic technique. Although it is a simple, rapid and cheap method, highly sensitive and specific on fresh specimens [21], FAT is currently under-exploited in low-resource areas. The causes for such a scarce success are due, although not exclusively, to the technique itself (i.e., maintenance of the UV microscope; the cost for

supplying fluorescently labelled antibodies in remote areas; the difficulty to deliver the laboratory materials; the risk of misinterpretation of the test by non-experienced staff). In endemic low-resourced countries, CNS samples for diagnostic purposes (confirmation) are rarely collected from the suspect animal or from patients dying in medical facilities [17, 22]. Especially in humans, an incorrect clinical diagnosis (i.e. neurological signs are often misdiagnosed as cerebral malaria in endemic areas) [23], as well as cultural and social taboos related to the care of the deceased body [17], systematically prevents brain sampling. The cases diagnosed through clinical investigation or, even more rarely, through laboratory testing, are often not reported to national and international authorities due to the absence of clear reporting requirements and human rabies still not being a notifiable disease in some countries.

At a national and international level, improvements and validation of simplified and affordable rabies diagnostic tests, suitable for extensive field applications when reference techniques are not applicable, are internationally strongly encouraged [24]. Thus, in the last decades, antigen detection tests alternative to FAT have been devised to meet the specific demands of laboratories in under-resourced endemic areas and to develop extensively applicable diagnostic tools. All the proposed alternatives were developed with the final aim of reducing the gap in surveillance by implementing decentralised surveillance opportunities. Different ELISA tests able to virtually identify any lyssavirus infection have been developed and validated under field conditions [21, 25-26] (Tab. 1). ELISA is a cheap and high-throughput method, which allows the analysis of several samples within the same session; this could potentially improve the diagnostic capability and encourage submission of field cases. Furthermore, it does not require personal interpretation, which means that errors due to misinterpretations of poorly experienced personnel are reduced to a minimum. Besides, any veterinary diagnostic laboratory in Africa is more than familiar with such a technique, as it has been widely applied within the context of the Global Rinderpest Eradication Programme (GREP). Similarly, a direct rapid immunohistochemical test (dRIT) has also been developed, which presents a diagnostic sensitivity and specificity equal to that of the FAT test but requires a smaller initial capital investment than FAT [27]. Similarly to FAT, this test is based on the specific antibody-based recognition of the viral antigen and on the microscopic observation of the biotinylated-antibody-antigen complexes; however, comparable to FAT, the interpretation of the slides may be misinterpreted by a poorly-experienced reader.

Although immuno-chromatographic tests (RDIT) have the maximum potential for implementing decentralised surveillance and may be applied in field conditions without the support of a diagnostic laboratory, their performances in the field still needs to be further demonstrated [26, 28] (Tab. 1). Thus, extensive validation in multiple laboratories is required before RDIT, as well remaining alternatives, may be applied on a larger scale [21].

A planning tool to eliminate dog-mediated human rabies. Over the past years, many efforts have been made towards an internationally coordinated control and elimination of dog-transmitted rabies. International organizations such as FAO, OIE and WHO together with the Global Alliance for Rabies Control (GARC) have joined forces to enhance global capacities and strengthen national public health systems and veterinary services.

However, the implementation of rabies prevention and control programs is entrusted to national authorities that have to cope with a multiplicity of other human and animal disease priorities. With an attempt to offer a tool to stakeholders to develop and implement dog-rabies control in their countries, the Stepwise Approach towards Rabies Elimination (SARE) is intended to provide guidance to countries to develop rabies prevention and control programs and to measure the progress towards achieving rabies control and eventually elimination of dog transmitted human rabies. SARE is not intended to replace existing regional or national rabies control strategies: it may serve as self-assessment and practical guide in developing a national rabies program and to successfully implement the long-term elimination strategy. The SARE is divided into 6 stages: countries can progress from stage 0 (at which no information on rabies is available) to stage 5 (continuous monitoring for freedom from dog-transmitted human rabies). Across the stage key themes such as a) legislation, b) data collection and analysis, including laboratory data, c) information, education and communication, d) prevention and control measures, e) dog population knowledge and management and f) cross cutting issues are considered.

Within this context, UN-FAO has been promoting national seminars/stakeholder consultations with the aim of bringing together the key players to start the fight against rabies and of introducing national stakeholders to the use of SARE. The consultations, which have been held in four capitals in Central Africa since 2012, allow participants to exchange

and share information, practices and control of the disease and serve as a platform to identify and develop short- and medium–term goals for prevention and control strategies (http://www.fao-ectad-bamako.org/fr/-Rabies-Sub-Network-?lang=en).

The positive impact of such initiatives is exemplified by the case of the Republic of Congo. Before 2013, the country had never diagnosed nor notified any rabies case (classified as in SARE stage 0). Although rabies was officially inexistent in the country, there were unofficial evidence of human cases of fatal encephalitis likely attributable to rabies. Thanks to the networking developed during the FAO meeting and to the hands-on training in the Laboratoire de Diagnostic Vétérinaire de Brazzaville (June 2013), a first laboratory confirmation of a dog rabies case was reported some months later (November 2013) [29], immediately moving the country from stage 0 to 1 (assessment of the local rabies epidemiological plan and elaboration of a short term rabies action plan) (Fig. 1). The Republic of Congo, as well as several other countries in Sub-Saharan Africa, still has a long way to go before achieving the freedom from dog-mediated human rabies. However, this first step is a precious milestone that will undoubtedly help setting up national and regional rabies control plans and contribute to the target of a dog transmitted human rabies free Africa hopefully achieved by 2030.

Table 1 - Reproducibility of three diagnostic techniques for animal rabies. Three National Reference Laboratories, one located in Europe and the remaining two in Central Africa, here referred to as NRL1, NRL2 and NRL3, participated to the interlaboratory trial. The panel consisted of 18 blindly coded samples, nine positive [rabies positive brains obtained from mice infected with Challenge Virus Strain (CVS) -11 (ATCC n. VR 959)], and nine negative (unchallenged mice). All animal experiments were approved by the local Ethics Committee and were conducted in accordance with the national legislation on the use of animals for scientific purposes.

Sample	Diagnostic technique								
	FAT[1)]			DAS-ELISA[2)]			RIDT[3)]		
	NRL1	NRL2	NRL3	NRL1	NRL2	NRL3	NRL1	NRL2	NRL3
A1	-	-	-	-	-	-	-	-	-
A2	+	+	+	+	+	+	-	-	-
A3	-	-	-	-	-	-	-	-	-
A4	+	+	+	+	+	+	-	-	-
A5	-	-	-	-	-	-	-	-	-
A6	-	-	-	-	-	-	-	-	-
A7	+	+	+	+	+	+	-	-	Doubtful
A8	+	+	+	+	+	+	-	-	-
A9	+	+	+	+	+	+	-	-	-
A10	-	-	-	-	-	-	-	-	-
A11	-	-	-	-	-	-	-	n.e.	-
A12	+	+	+	+	+	+	-	n.e.	-
A13	+	+	+	+	+	+	-	n.e.	-
A14	-	-	-	-	-	-	-	n.e.	-
A15	-	-	-	-	-	-	-	n.e.	-
A16	-	-	-	-	Doubtful	-	-	n.e.	-
A17	+	+	+	+	+	+	-	n.e.	-
A18	+	+	+	+	+	+	-	n.e.	-
Pos. control	+	+	+	+	+	+	-	-	-
Neg. control	-	-	-	-	-	-	-	-	-

1) FAT: Fluorescent Antibody Test, gold standard test, performed in compliance to international standard guidelines [21].
2) DAS-ELISA: Double Antibody Sandwich- Enzyme-Linked Immunosorbent Assay [26].
3) RIDT: Rapid Immunodiagnostic Test (Antigen Rapid Rabies Ag Test Kit, RG18-01. Bionote®, South Korea).
n.e. = not executed

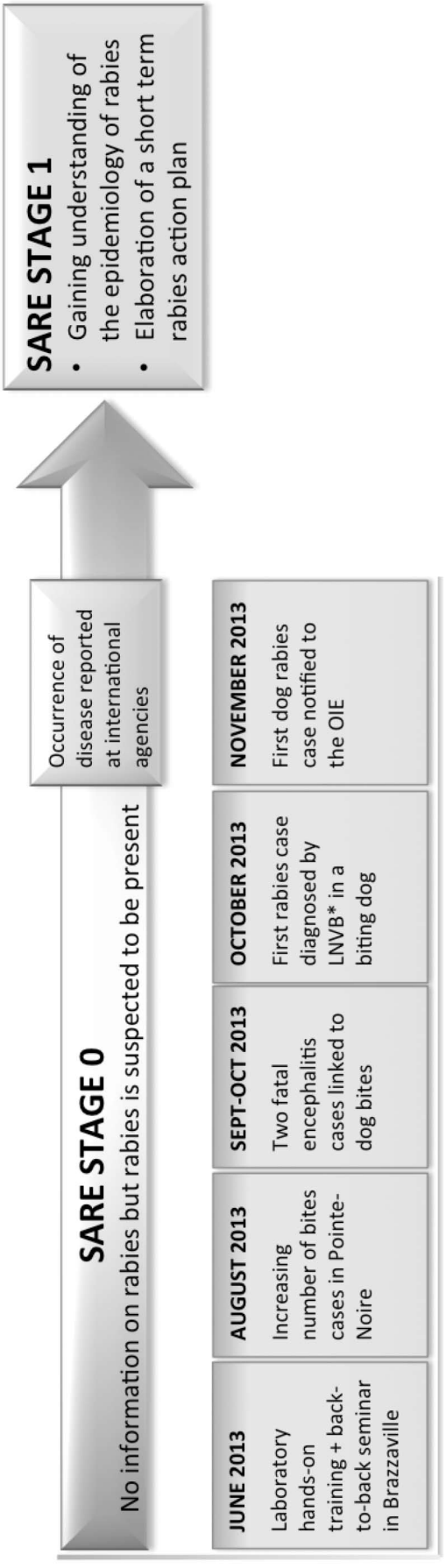


Figure 1 - A successful application of Stepwise Approach for Rabies Elimination (SARE): the Republic of Congo. Thanks to the networking facilitated by the FAO stakeholder consultation and the concomitant hand-on training at the laboratory level (June 2013), a first laboratory confirmation of a rabid dog was officially reported (November 2013). This activity immediately upgraded the country from SARE stage 0 to 1.

REFERENCES

1. Hampson K, Coudeville L, Lembo T, Sambo M, Kieffer A, Attlan M, Barrat J, Blanton JD, Briggs DJ, Cleaveland S, Costa P, Freuling CM, Hiby E, Knopf L, Leanes F, Meslin FX, Metlin A, Miranda ME, Müller T, Nel LH, Recuenco S, Rupprecht CE, Schumacher C, Taylor L, Antonio M, Vigilato N, Zinsstag J, Dushoff J; Global Alliance for Rabies Control Partners for Rabies Prevention. Estimating the global burden of endemic canine rabies. PLoS Negl Trop Dis 2015 Apr 16;9(4):e0003709.

2. World Health Organization. WHO Expert Consultation on Rabies. Second report. World Health Organ Tech Rep Ser 2013;(982)(982):1-139, back cover.

3. Vigilato MA, Clavijo A, Knobl T, Silva HM, Cosivi O, Schneider MC, Leanes LF, Belotto AJ, Espinal MA. Progress towards eliminating canine rabies: policies and perspectives from Latin America and the Caribbean. Philos Trans R Soc Lond B Biol Sci 2013 Jun 24;368(1623):20120143.

4. Coleman PG, Dye C. Immunization coverage required to prevent outbreaks of dog rabies. Vaccine 1996 Feb;14(3):185-186.

5. Lembo T, Hampson K, Kaare MT, Ernest E, Knobel D, Kazwala RR, Haydon DT, Cleaveland S. The feasibility of canine rabies elimination in Africa: dispelling doubts with data. PLoS Negl Trop Dis 2010 Feb 23;4(2):e626.

6. Sabeta CT, Mansfield KL, McElhinney LM, Fooks AR, Nel LH. Molecular epidemiology of rabies in bat-eared foxes (Otocyon megalotis) in South Africa. Virus Res 2007 Oct;129(1):1-10.

7. Zulu GC, Sabeta CT, Nel LH. Molecular epidemiology of rabies: focus on domestic dogs (*Canis familiaris*) and black-backed jackals (*Canis mesomelas*) from northern South Africa. Virus Res 2009 Mar;140(1-2):71-78.

8. Fitzpatrick MC, Hampson K, Cleaveland S, Meyers LA, Townsend JP, Galvani AP. Potential for rabies control through dog vaccination in wildlife-abundant communities of Tanzania. PLoS Negl Trop Dis 2012;6(8):e1796.

9. Report of the sixth meeting of the International Coordinating Group of the World Health Organization and the Bill & Melinda Gates Foundation project on eliminating human and dog rabies. 2015.

10. Haydon DT, Randall DA, Matthews L, Knobel DL, Tallents LA, Gravenor MB, *et al*. Low-coverage vaccination strategies for the conservation of endangered species. Nature 2006 Oct 12;443(7112):692-695.

11. Fooks AR, Koraka P, de Swart RL, Rupprecht CE, Osterhaus AD. Development of a multivalent paediatric human vaccine for rabies virus in combination with Measles-Mumps-Rubella (MMR). Vaccine 2014 Apr 11;32(18):2020-2021.

12. Knobel DL, Cleaveland S, Coleman PG, Fèvre EM, Meltzer MI, Miranda ME, Shaw A, Zinsstag J, Meslin FX. Re-evaluating the burden of rabies in Africa and Asia. Bull World Health Organ 2005 May;83(5):360-368.

13 WDR2013 Occupational Wages around the World, World Bank Group. 2012; Available from: http://data.worldbank.org/data-catalog/occupational-wages. Last visited 28/08/2015.

14. Hampson K, Cleaveland S, Briggs D. Evaluation of cost-effective strategies for rabies post-exposure vaccination in low-income countries. PLoS Negl Trop Dis 2011 Mar 8;5(3):e982.

15. Dodet B, Tejiokem MC, Aguemon AR, Bourhy H. Human rabies deaths in Africa: breaking the cycle of indifference. Int Health 2015 Jan;7(1):4-6.

16. Fooks AR, Marston D. 2014: EC 46, Montreal, Canada, July 2014, Email ratification 2015 (MSL #29). Virus Taxonomy: VIIIth Report of the International Committee on Taxonomy of Viruses; 2014.

17. Weyer J, Szmyd-Potapczuk AV, Blumberg LH, Leman PA, Markotter W, Swanepoel R, Paweska JT, Nel LH. Epidemiology of human rabies in South Africa, 1983-2007. Virus Res 2011 Jan;155(1):283-290.

18. Goudsmit J, Marissen WE, Weldon WC, Niezgoda M, Hanlon CA, Rice AB, Kruif Jd, Dietzschold B, Bakker AB, Rupprecht CE. Comparison of an anti-rabies human monoclonal antibody combination with human polyclonal anti-rabies immune globulin. J Infect Dis 2006 Mar 15;193(6):796-801.

19. Kuzmina NA, Kuzmin IV, Ellison JA, Rupprecht CE. Conservation of binding epitopes for Monoclonal Antibodies on the rabies virus glycoprotein. Journal of Antivirals and Antiretrovirals 2013;5(2):37-43.

20. Townsend SE, Lembo T, Cleaveland S, Meslin FX, Miranda ME, Putra AA, Haydon DT, Hampson K. Surveillance guidelines for disease elimination: a case study of canine rabies. Comp Immunol Microbiol Infect Dis 2013 May;36(3):249-261.

21. World Organization for Animal Health. 2.1.13 Rabies. OIE Terrestrial Manual. 2013th ed.; 2013. p. 1-28.

22. Nel LH. Discrepancies in data reporting for rabies, Africa. Emerg Infect Dis 2013 Apr;19(4):529-533.

23. Mallewa M, Fooks AR, Banda D, Chikungwa P, Mankhambo L, Molyneux E, Molyneux ME, Solomon T. Rabies encephalitis in malaria-endemic area, Malawi, Africa. Emerg Infect Dis 2007 Jan;13(1):136-139.

24. Partners for Rabies Prevention. Minutes of the PRP 7th Annual Meeting. Global Rabies Elimination - Making the Case. 2014.

25. Xu G, Weber P, Hu Q, Xue H, Audry L, Li C, Wu J, Bourhy H. A simple sandwich ELISA (WELYSSA) for the detection of lyssavirus nucleocapsid in rabies suspected specimens using mouse monoclonal antibodies. Biologicals 2007;35(4):297-302.

26. Rota Nodari E, Zecchin B, Mancin M, Corti D, Minola A, Cattoli G, De Benedictis P. Development of an ELISA assay for the diagnosis of rabies in animals. In: Rabies in The Americas (RITA) Meeting Abstracts. Toronto, Canada, 27-31 October 2013.

27. Lembo T, Niezgoda M, Velasco-Villa A, Cleaveland S, Ernest E, Rupprecht CE. Evaluation of a direct, rapid immunohistochemical test for rabies diagnosis. Emerg Infect Dis 2006 Feb;12(2):310-313.

28. Markotter W, York D, Sabeta CT, Shumba W, Zulu G, Le Roux K, Nel LH. Evaluation of a rapid immunodiagnostic test kit for detection of African lyssaviruses from brain material. Onderstepoort J Vet Res 2009 Jun;76(2):257-262.

29. Angot A, Bebay C, Kaboré Y, De Balogh K, Dauphin G, De Benedictis P. Rabies Veterinary Laboratory Capabilities In West and Central Africa. Proceedings of the International Meeting on Emerging Diseases and Surveillance 2014:88-89.

Epidemiologia e controllo della febbre della Valle del Rift

S. PROSPERI, G. TOTH

Dipartimento di Scienze Mediche Veterinarie, *Alma Mater Studiorum* - Università di Bologna, Italia

Riassunto - La Febbre della Valle del Rift è una importante malattia transfrontaliera endemica in molti Paesi africani, attualmente a rischio di diffusione in tutti i Paesi del Bacino del Mediterraneo. Gli Autori analizzano le condizione di allevamento dei ruminanti in Africa, la situazione epidemiologica e le difficoltà oggettive per l'applicazione delle norme generali di profilassi. Essi riconoscono il ruolo strategico della profilassi diretta, dell'educazione sanitaria e della formazione di personale tecnico ma giungono alla conclusione che il vaccino rappresenta il metodo più efficace per combattere la malattia in Africa.

Parole chiave: Febbre della Valle del Rift, rischio, bacino del Mediterraneo, zoonosi, malattie transfrontaliere.

Epidemiology and control of Rift Valley Fever
Summary - The Rift Valley Fever is an important transboundary disease endemic in many African countries; currently it is at risk of spread in all countries of the Mediterranean Basin. The authors analyze the breeding condition of ruminants in Africa, the epidemiological situation and the objective difficulties for the application of the general rules of prophylaxis. They recognize the strategic role of the direct prophylaxis, the health education and the training of technical personnel but conclude that the vaccine is the most effective way to fight the disease in Africa.

Key words: Rift Valley Fever, risk, Mediterranean basin, zoonosis, transboundary diseases.

1. INTRODUZIONE

La Febbre della Valle del Rift (FVR) è una malattia acuta causata da un virus appartenente al genere Phlebovirus, che colpisce ruminanti domestici e selvatici, nonchè l'uomo e quindi rappresenta una grave zoonosi. Le Organizzazioni Internazionali che si occupano di Sanità Animale -WHO (World Health Organization), FAO (Food and Agriculture Organization) e OIE (Office Internationale des Epizooties)- considerano la FVR la malattia transfrontaliera per eccellenza con gravi ripercussioni sulla salute umana e sulle produzioni animali. Attualmente essa è esotica per l'Italia ma secondo l'EFSA (European Food Safety Authority) è a medio rischio d'introduzione nel nostro Paese; tale affermazione viene supportata anche dalla diffusione in Africa Occidentale: in ottobre 2012 si è verificata una grave epidemia in Mauritania, a dimostrazione della rapidità con cui la malattia si è diffusa a macchia d'olio dal suo Paese d'origine, il Kenya, all'Africa Occidentale. La capacità del virus di sopravvivere nel ciclo biologico di alcune specie di zanzare (*Aedes sp*.) e l'alta resistenza in organi e tessuti può avere un impatto notevole sul commercio degli animali e dei prodotti di origine animale, ma anche sulla salute dell'uomo. Le specie più colpite sono anche le più importanti dal punto di vista zootecnico, sia per l'Africa sia per l'Europa, appartengono ai ruminanti domestici, con alta letalità negli agnelli e nei capretti neonati a causa dell'epatite acuta; la FVR presenta una certa gravità anche nelle femmine gravide, dove provoca un alto tasso di aborti a qualsiasi stadio di gestazione. Al contrario, gli animali adulti non gravidi, seppur recettivi, sono più resistenti e spesso manifestano la malattia in forma subacuta o inapparente, diventando in tal modo potenziali portatori eliminatori [1].

2. Epidemiologia

2.1 Modalità di trasmissione

La FVR prevede una modalità di trasmissione sia indiretta, tramite la puntura di artropodi vettori (zanzare ematofaghe), che diretta, mediante i prodotti di origine animale, i secreti e gli escreti; sono competenti come vettori oltre 40 specie di zanzare. I vettori biologici predominanti sono raggruppati in quelli di mantenimento (*Aedes* spp.), e in quelli di amplificazione, (*Culex, Anopheles, Mansonia e Ochlerotatus* spp.); le zanzare responsabili della trasmissione prediligono raccolte d'acqua stagnante ed aree paludose [2]. Durante i periodi interepidemici, il virus sopravvive anche in assenza di reservoir vertebrati e a climi sfavorevoli grazie alla trasmissione transovarica in alcune specie di zanzare (*Aedes vexans* e *Aedes*

Corresponding author: Prof. Santino Prosperi,
Università di Bologna, Via Tolara di Sopra 50, 40064 Ozzano Emilia. Tel. 051 20769090; E mail: santino.prosperi@unibo.it

mcintoshi) [3]. Di converso la maggior parte delle infezioni umane si verifica tramite contatto diretto con animali malati e i loro prodotti: ingerendo alcuni alimenti di origine animale, come latte e carne cruda, e maneggiando prodotti dell'aborto, fluidi di animali viremici come sangue, saliva e secrezioni nasali [4]. In particolare, il virus può resistere per mesi in secrezioni essiccate e fino a 20 giorni in organi quali milza, fegato e cervello, rendendo pericolosa la loro manipolazione. Il rischio di trasmissione con gli alimenti in Europa non viene considerato alto, a differenza dell'Africa, in quanto i controlli e i trattamenti degli alimenti di origine animale riducono notevolmente il rischio di diffusione [5].

2.2 Ciclo epidemiologico

La Febbre della Valle del Rift è contraddistinta da un ciclo epidemiologico complesso, regolato da molteplici fattori ambientali, climatici e animali. Nel ciclo endemico, il virus si mantiene all'interno delle uova delle zanzare (*Aedes vexans* e *Aedes mcintoshi*), in modo da essere identificato solo durante intense attività di sorveglianza, difficili da realizzare nelle condizioni africane. Le piogge copiose e persistenti consentono la schiusa delle uova e la liberazione degli adulti infetti. In assenza di elevata piovosità, i vettori possono riprodursi sfruttando le pianure alluvionali e i sistemi d'irrigazione, come dimostrato dalle epidemie in Mauritania, Egitto e Sudan (Fig. 1) [6]. Attualmente il miglioramento dei sistemi d'irrigazione sta aumentando l'ampiezza e il numero delle aree adatte allo sviluppo degli artropodi vettori responsabili della trasmissione della RVF, come attestano le epidemie verificatesi in prossimità di invasi artificiali: la diga Diama, il lago Nasser e la diga Manantali [5].

2.3. Diffusione della malattia

L'epidemiologia della FVR richiede continui aggiornamenti, a causa della costante evoluzione dell'infezione e del complicato modello seguito dalle ondate epidemiche. La malattia è ampiamente distribuita nel continente africano e nella Penisola Arabica [7] e nel tempo si è diffusa a macchia d'olio, superando barriere geografiche degne di nota. Nel 1977 e 1997 ha attraversato il deserto del Sahara raggiungendo l'Egitto, grazie alla costruzione della diga di Aswan e lungo l'asta del fiume Nilo, congiuntamente alla movimentazione animale [8]. Nel 1993-94 la malattia si è diffusa in Africa Occidentale interessando il Senegal e la Mauritania. Nel 2000 ha oltrepassato il Mar Rosso per giungere nella Penisola Arabica e nel 2007 ha interessato il Madagascar.

L'Europa Mediterranea in termini di presenza di artropodi vettori, di animali recettivi, di clima e di

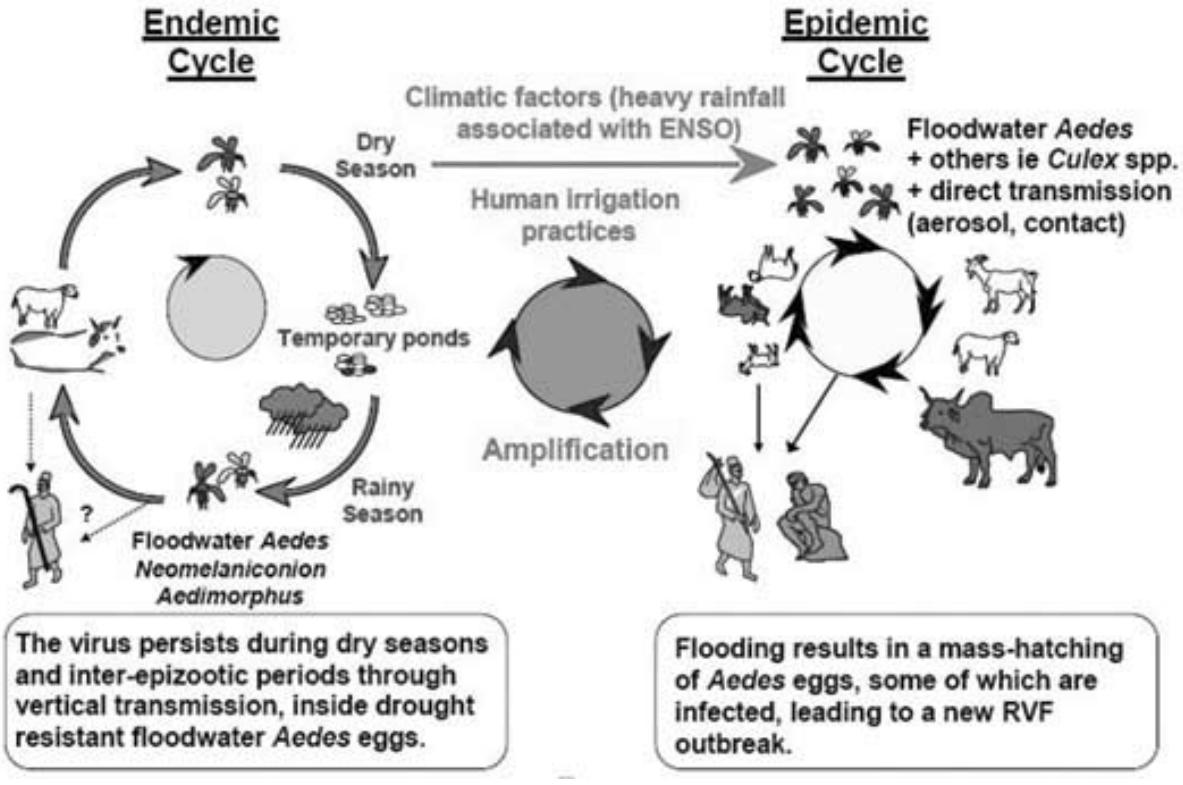


Figura 1 - Ciclo epidemiologico della Febbre della Valle del Rift: ciclo endemico ed epidemico [5].

ambiente presenta tutte le condizioni favorevoli per la diffusione della FVR. Il fattore di rischio principale per l'introduzione del virus nei Paesi indenni è rappresentato dalla movimentazione animale ma anche dal trasporto di zanzare infette mediante il vento [9].

2.4. Situazione in Africa

Da sempre le epidemie di FVR colpiscono in modo inclemente il continente africano e l'andamento del ciclo epidemiologico varia a seconda della zona interessata. In Africa Meridionale ed Orientale, l'ecosistema favorevole al mantenimento della malattia è rappresentato rispettivamente dai *pan, vlei e dambo*: depressioni poco profonde ed estesi bacini erbosi che sono in grado di trattenere l'acqua per mesi. L'Africa Occidentale e Settentrionale, invece, sono caratterizzate da territori aridi, apparentemente sfavorevoli alla sopravvivenza dei vettori biologici e quindi del virus. Tuttavia, il delta e l'asta del Nilo, le rive dei grandi fiumi, le oasi e la creazione di nuovi grandi invasi artificiali, con l'irrigazione di nuove aree agricole rappresentano un fattore di rischio ambientale molto importante, in quanto aumenta, oltre alle zanzare, anche la concentrazione degli animali recettivi [4; 10]. In Africa, il fattore di rischio principale per la diffusione del virus su larga scala non è rappresentato tanto dallo spostamento dei vettori biologici e meccanici tramite il vento, ma dalla movimentazione degli animali recettivi per motivi commerciali e per la ricerca di nuovi pascoli, ma anche a causa del loro commercio illegale [9]. Ogni anno, tra dicembre e marzo, alcuni milioni di pecore e capre raggiungono la penisola Arabica dalla Somalia Settentrionale attraverso i porti di Berbera e Bosaso per motivi commerciali [11]. L'analisi genetica dei ceppi virali isolati in Arabia Saudita ha confermato l'ipotesi secondo cui il virus, arrivato in passato tramite tali commerci durante le ricorrenze religiose, fosse rimasto quiescente in attesa di condizioni favorevoli che alla fine si verificarono nel 2000, anno della grande epidemia in Yemen ed Arabia Saudita, perché erano stati resi irrigui vasti territori [12].

Attualmente l'Europa importa carne fresca di ovino, bovino, e suino da Sud Africa, Namibia, Botswana [5]; in aggiunta, alcuni Paesi (Qatar e Arabia Saudita) possono giocare un ruolo di mediatori tra Paesi infetti e Paesi indenni, favorendo quello che commercialmente viene definita una triangolazione. Nelle movimentazioni illegali gli animali e i prodotti di origine animale non vengono sottoposti ad un controllo diagnostico specifico prima della partenza e, pertanto, se gli animali erano portatori di virus, la probabilità che arrivino nel Paese indenne è alta. I flussi commerciali più importanti in Africa sono due: il primo si verifica tra Sudan ed Egitto, lungo la Valle del Nilo, il secondo collega il Corno d'Africa a Yemen e Arabia Saudita, con una movimentazione annuale di circa 6 milioni di ruminanti (Central Department of Statistics and Information/Kingdom of Saudi Arabia-CDSI, 2013); senza tralasciare la movimentazione che esiste, sempre per motivi commerciali, anche se di dimensioni inferiori, tra Est ed Ovest in Nord Africa; infatti il numero di capi importati negli Stati africani indenni che si affacciano sul Mediterraneo dall'Africa Occidentale, nel 2013 si aggirava attorno ai 200.000 capi [9], con la quasi assenza di adeguati controlli alle frontiere. Un ruolo molto importante viene giocato dalle festività religiose, durante le quali aumenta il commercio degli animali in quanto viene praticato il sacrificio rituale islamico (Halal) [13]; inoltre, nella festa di Eid-al-Adha, molti animali sono esportati dalla Somalia verso la Penisola Arabica durante il periodo di massima attività dei vettori, con il rischio di esportare la RVF negli stati indenni della penisola Arabica [14]. In altre aree geografiche può dipendere anche dalla dieta di alcune popolazioni che include il consumo di latte e sangue crudo (Masai in Africa Orientale).

Tuttavia per quanto riguarda la movimentazione animale, questa non avviene soltanto per commerci durante le festività religiose ma anche per motivi climatici: durante la siccità i pastori si spostano per diversi chilometri alla ricerca di acqua e di pascoli, rimanendo sempre lontani dai centri abitati dove generalmente sono dislocati i presidi sanitari pubblici e in tal modo saltano i sistemi di sorveglianza [13]. Nei Paesi Africani più poveri, i sistemi di quarantena non sono stati ancora armonizzati e nelle movimentazioni gli animali e i prodotti non vengono sottoposti a nessun tipo di test diagnostico specifico prima dell'esportazione. Inoltre, i problemi economici dei Paesi africani che si aggravano ogni anno che passa di più, incentivano i commerci illegali; essi spesso riescono a superare i controlli ai posti d'ispezione frontalieri grazie anche all'esibizione di documenti contraffatti. In aggiunta, negli Stati economicamente più poveri, la popolazione dipende strettamente dall'allevamento e dall'agricoltura, quindi diventa difficile intervenire con norme draconiane. Quindi la mancanza di strategie di controllo delle malattie e di buone pratiche d'allevamento condizionano la prevalenza delle malattie endemiche [13]. Un altro fattore importante che ostacola la sorveglianza delle malattie diffusive in Africa è rappresentato dalla carenza di strumenti e mezzi adeguati per poter raccogliere e trasmettere sia dati raccolti riguardanti la sanità pubblica che i campioni provenienti dagli allevamenti sospetti [15].

3. Diagnosi

Attualmente le capacità diagnostica dei laboratori

africani è limitata a poche strutture, ma è in via di miglioramento grazie al supporto delle Organizzazioni. Nelle regioni più povere dell'Africa esiste una scarsa capacità di risposta alle epidemie e spesso la malattia viene rilevata quando ormai i sintomi cominciano a comparire anche nell'uomo [16]. Non tutti i laboratori sono dotati di personale qualificato, che abbia avuto esperienza con la RVF; i nuovi sistemi di sorveglianza spesso non raggiungono le aree più povere e spesso i dati ricevuti sono incompleti o errati. In aggiunta, in molti Paesi africani manca una definizione di "caso" e questo non facilita l'attivazione di procedure di emergenza specifiche in tempi adeguati [17].

Le tecniche di laboratorio per mettere in evidenza il virus della FVR possono essere quelle tradizionali come l'immunofluorescenza diretta, la doppia diffusione in gel di agar, l'ELISA ma la tecnica diagnostica più valida è rappresentata dalla RT-PCR, che riesce ad evidenziare l'antigene fino a 10 giorni dopo la comparsa dei sintomi clinici; essa può essere impiegata partendo da molteplici campioni (sangue e tessuti), anche in condizioni in cui la catena del freddo è difficile da mantenere, come avviene nei Paesi africani. Nonostante alcune limitazioni in termini di costi e di formazione del personale di laboratorio, è inconfutabile la sua rapidità e accuratezza nella diagnosi di recenti focolai di RVF; la sensibilità e la specificità sono molto elevate. Per un'accurata diagnosi di conferma, però, è necessario integrare in parallelo i risultati della RT-PCR con quelli dei test sierologici (ELISA diretta) che identificano gli anticorpi specifici. Per esempio, la presenza di viremia e di IgM conferma l'infezione recente. In linea generale, la principale caratteristica che deve possedere un test diagnostico impiegato per la valutazione del rischio di FVR è un'alta sensibilità in condizioni di campo. Tale risultato è ottenuto quando i test sierologici e virologici vengono combinati con osservazioni cliniche ed epidemiologiche eseguite da personale qualificato e formato [5].

4. Controllo nei Paesi Africani

La FVR è una malattia diffusiva e quindi è sottoposta a notifica obbligatoria in tutti i Paesi aderenti all'OIE: questo atto implica l'attivazione di un sistema veterinario nazionale che dovrebbe far scattare un efficace sistema di sorveglianza e di controllo. L'OIE ha stabilito una serie di requisiti che il Paese esportatore deve avere al momento della compravendita di animali vivi o prodotti di origine animale destinati all'esportazione; in questi casi il ruolo del servizio veterinario è di fondamentale importanza e l'educazione sanitaria delle categorie professionali a rischio e adibite ai controlli diventa strategico.

Nei PVS il deficit nella diagnosi della FVR è stata in parte colmata dal supporto delle Organizzazioni Internazionali, quali FAO, OIE e CDC (Centers for Diseases Control and Prevention), con la creazione di laboratori specializzati, con l'implementazione di corsi di formazione professionale e con l'invio di strumentazioni adeguate ai laboratori nazionali. Il Terrestrial Manual dell'OIE fornisce le linee-guida delle diverse tecniche diagnostiche richieste dall'International Animal Health Code prima di ogni movimentazione animale [9].

Un piano di sorveglianza e controllo per la FVR dev'essere ben strutturato e sebbene sia difficile implementarlo in modo che si adegui perfettamente alle differenti circostanze, esistono degli elementi costitutivi fondamentali da prendere in considerazione che fanno da base per un adeguato piano d'emergenza. Infatti alla base della prevenzione c'è l'analisi del rischio, utile per decidere le misure da prendere sia per un Paese indenne sia per un Paese infetto, in quanto la valutazione del rischio non è una condizione statica ma in continua evoluzione in funzione del clima, dell'insorgenza di nuove malattie e dei flussi commerciali. Quindi l'analisi del rischio deve essere aggiornata e condotta da epidemiologi esperti; la fonte dei dati epidemiologici più aggiornati ed attendibili è costituito dal sistema informativo dell'OIE, attraverso i precisi e dettagliati resoconti settimanali e annuali, tenendo sempre presente che essi dipendono dall'attendibilità delle segnalazioni del Paese. Ad essa si aggiunge la FAO, con il Bollettino annuale sulle malattie transfrontaliere animali e il programma in rete di Monitoraggio delle Malattie Animali (ProMED) [18]. Secondo la maggior parte degli Autori, un prerequisito per sviluppare un buon sistema di sorveglianza è quello di classificare le aree a rischio, in base ai fattori predisponenti la malattia e la sua diffusione; esse dipendono da diversi fattori: dalla presenza e dall'abbondanza degli artropodi vettori, dall'intensità delle piogge, dalla temperatura media, dalla vegetazione presente e dalla distribuzione delle specie animali recettive. Recenti mappe di rischio sono state costruite quindi contestualmente nella zona del Maghreb, che ha evidenziato come tale area soddisfi tutti i requisiti per l'endemizzazione della FVR, oltrechè per l'esplosione epidemica [19].

La maggiore fonte di sostentamento per la popolazione umana di molti Paesi Africani, in particolare quelli più poveri, è l'allevamento e il commercio di animali vivi e prodotti di origine animale, pertanto il blocco della movimentazione degli animali rischia di mettere in crisi il sistema economico e potrebbe incentivare il commercio illegale, rendendo in tal modo ancora più difficoltoso il controllo delle malattie diffusive. In aggiunta bisogna tenere presente che nei PVS, durante gli ultimi 15-20 anni, sono quasi scomparsi i copiosi aiuti che venivano profusi quando esistevano i due blocchi.

Secondo l'OIE, qualora l'importazione o il transito di ruminanti avesse origine da Paesi infetti con focolai di malattia in atto, il commercio dovrebbe comunque essere regolarizzato senza essere bloccato del tutto. Infatti, il blocco delle movimentazioni potrebbe risultare deleterio per l'economia africana, in quanto l'allevamento di tipo estensivo-nomade costringe l'allevatore a spostarsi in continuazione alla ricerca di cibo ed acqua per la sua mandria. Pertanto, le indicazioni dell'OIE anche in questi casi consentono la movimentazione animale, e in particolare in presenza di un certificato che dichiari l'assenza di segni clinici in animali vaccinati con il ceppo Smithburn, almeno 21 giorni prima della partenza. In alternativa, è possibile tenere gli animali in una stazione di quarantena per almeno 30 giorni durante i quali gli animali non devono manifestare sintomi di FVR e devono essere protetti contro la zanzare; situazione quest'ultima più facile da teorizzare che da realizzare. I prodotti di origine animale, invece, devono provenire da animali macellati in strutture approvate e sottoposte ad ispezione antemortem e post-mortem, con risultati negativi per la FVR. Nel caso in cui vengano importati embrioni di ruminanti, essi devono provenire da animali vaccinati 21 giorni prima del prelievo e che non evidenzino segni di malattia 28 giorni prima e 28 giorni dopo il prelievo degli embrioni. Il latte e i prodotti caseari possono essere importati da Paesi indenni solo previa pastorizzazione od altri processi termici elencati nel Codex Alimentarius, che consentano una sicura inattivazione del virus.

Risulta evidente come il ruolo del servizio veterinario, non sempre ben organizzato nei Paesi africani, sia di fondamentale importanza, quindi è necessario che i veterinari e i medici addetti alla Sanità Pubblica siano in grado di gestire le diverse situazioni epidemiologiche e che siano informati e formati. In molti Paesi colpiti dalla FVR, è esiguo il personale impegnato nella tutela della salute pubblica ed animale, con un'esperienza diretta con la malattia. Pertanto, è fondamentale istituire un programma di formazione aggiornato e completo per tutti coloro che per ragioni professionali entrano in contatto diretto con gli animali e quindi, potenzialmente, anche con il virus. I progetti di formazione prevedono la partecipazione a convegni internazionali e la partecipazione a gruppi di lavoro sulle malattie emergenti; essi devono coinvolgere i veterinari ufficiali, il personale di laboratorio, i veterinari doganali, i veterinari liberi professionisti ma anche i lavoratori del settore agricolo. Lo scambio di informazioni e di conoscenze tecniche tra laboratori di referenza e laboratori locali deve rientrare nella norma; inoltre, risultano utili i manuali e le linee-guida sulla malattia pubblicati da FAO e OIE, pratici e di facile accesso. I programmi di educazione sanitaria devono incidere sia in ambito medico che veterinario, attraverso il miglioramento dei rapporti e della cooperazione tra veterinari, medici, allevatori ed autorità locali, con l'istituzione di gruppi di lavoro ad hoc. Pertanto può risultare strategico che in un programma di sorveglianza efficiente ci sia il coinvolgimento delle comunità locali, in quanto esse possiedono le conoscenze tradizionali delle malattie [16]. A causa delle numerose instabilità politiche, in diversi Paesi Africani si verificano molte divergenze nell'ambito di processi decisionali riguardanti la medesima situazione epidemiologica; per superare tale ostacolo, sarebbe opportuno valutare gli interessi comuni, in modo da ottenere soluzioni condivisibili da tutti. Questo può incentivare il miglioramento dei processi di comunicazione, discussione, negoziazione e condivisione delle conoscenze, in modo da formare solide basi per costruire dei piani di sorveglianza delle malattie diffusive. Tale approccio viene definito partecipatorio, in quanto il processo decisionale include servizi veterinari, autorità governative e comunità locali nel quadro della sanità pubblica e della sanità pubblica veterinaria [15].

I sistemi informativi d'emergenza devono essere supportati da efficienti capacità diagnostiche, dal consolidamento delle risorse e delle strutture epidemiologiche nazionali. Si raccomanda la costituzione di un gruppo diagnostico specialistico all'interno di ogni Stato, da mobilitare in caso di sospetto di FVR, costituito da veterinari, epidemiologi ed entomologi. Tale gruppo di lavoro deve collaborare nelle indagini iniziali di tipo epidemiologico ed entomologico, dev'essere in grado di prendere decisioni competenti al fine di controllare la diffusione della malattia e di coordinare le azioni dei veterinari locali.

I programmi di educazione sanitaria e di comunicazione sono indispensabili per rendere l'opinione pubblica edotta e farla diventare un supporto alla sorveglianza e nel controllo delle malattie infettive; i cittadini possono fornire un approccio dal basso nell'implementazione di un piano di controllo, completando la tradizionale strategia dall'alto adottata dalle Autorità Sanitarie. Al fine di salvaguardare il benessere e la salute della popolazione umana e animale, è necessario creare un clima di fiducia e sicurezza tra i vari attori che intervengono in occasione della comparsa di un focolaio di FVR. Infatti a seguito dell'identificazione delle zone a rischio, i servizi veterinari pubblici e i medici devono informare le persone a rischio (sanitari, agricoltori, commercianti) sugli aspetti salienti della FVR (epidemiologia, specie recettive, modalità di diffusione), avvalendosi di tutti i mezzi di comunicazione disponibili quali incontri, manifesti, radio, televisione, giornali [15].

Le attività di sorveglianza clinica e sierologica sono indirizzate ad acquisire informazioni sui modelli di trasmissione virale nei periodi interepidemici e nelle

aree a rischio in modo da promuovere un sistema di risposta a qualsiasi aumento dell'attività virale o del livello della popolazione di vettori [20]. Sono necessari campionamenti sierologici regolari sul campo, in particolare implementando gruppi di animali sentinella; in tal modo si potrebbe svelare il ciclo criptico della FVR nei periodi interepidemici [15].
Il controllo sugli artropodi vettori ha come obiettivo principale di limitare la diffusione virale e interrompere il ciclo epidemiologico della FVR; i metodi utilizzati includono trattamenti individuali, sulle strutture ed ambientali. Gli insetticidi, costosi e difficili da impiegare, servono a trattare sia aree estese che limitate, ma possono causare gravi conseguenze ecologiche e ambientali [20]. Le sostanze larvicide sono impiegate qualora i siti di riproduzione degli artropodi vettori siano ben identificati e coprano aree limitate, condizione questa che in Africa si verifica raramente. In conclusione l'applicazione di tutte queste misure potrebbe rappresentare una buona linea per il controllo della diffusione della malattia in un Paese infetto dell'emisfero nord, mentre non sempre il servizio veterinario e le condizioni socio-economiche e politiche le rendono attuabili in Africa.

5. Vaccinazione

Assunto che è praticamente impossibile eradicare la FVR nei Paesi nei quali è endemica, un ruolo strategico viene svolto dalla vaccinazione degli animali recettivi. Il vaccino Smithburn è ampiamente utilizzato nei Paesi Africani in cui la malattia è endemica; i Paesi indenni, invece, dovrebbero utilizzare vaccini inattivati. Quando le condizioni epidemiologiche ed ambientali suggeriscono l'arrivo di un'epidemia di FVR, i servizi veterinari nazionali dovrebbero agire prima che l'attività virale diventi apparente e tenere di scorta un certo numero di dosi di vaccino spento.
In questi ultimi anni stanno trovando spazio numerosi vaccini di nuova generazione, prodotti grazie all'ingegneria genetica. I candidati principali sono due.

a. Il primo, MVP12, è un ceppo mutato termosensibile del virus della FVR in tutti e 3 i segmenti, derivante dal ceppo virulento egiziano ZH548. Tuttavia, ulteriori studi condotti sulle pecore hanno dimostrato che il vaccino inoculato dopo 28 giorni di gravidanza, ossia nel primo trimestre, è in grado di causare aborto (4%) e gravi malformazioni fetali (14%) perciò il vaccino è in fase di studio [21].
b. Il secondo candidato alle future profilassi indirette è il vaccino attenuato designato come Clone-13, una piccola variante del precedente, ed altamente immunogeno, con bassa probabilità di retromutazioni. Al giorno d'oggi è registrato ed utilizzato in Sud Africa e recentemente è stato testato anche in Kenya, mostrandosi sicuro e privo di effetti collaterali [22].

La messa a punto di vaccini efficaci e sicuri è fondamentale durante un'epidemia, per proteggere sia l'uomo che gli animali coinvolti. Considerando una circolazione virale a lungo termine nelle popolazioni di zanzare, una vaccinazione dovrebbe essere altrettanto efficace. Il miglioramento dei vaccini già in commercio e la nascita di nuove generazioni vaccinali potrebbero aumentare l'efficacia della risposta contro il virus della FVR, anche in caso di introduzione in Paesi indenni.
Per quanto riguarda l'uomo è disponibile sul mercato internazionale un vaccino di vecchia generazione costituito da un ceppo virale coltivato su cellule diploidi umane e inattivato con la formalina; attualmente sono in atto alcune ricerche per la messa a punto di vaccini ricombinanti ma non ancora disponibili.
In accordo con FAO e OIE, 10 stati che si affacciano sul bacino del Mediterraneo (Mauritania, Marocco, Algeria, Tunisia, Libia, Egitto per la sponda sud e Portogallo, Spagna, Francia e Italia per la sponda nord) hanno costituito il Reseau Mediterraneén de Santé Animale (REMESA), un ambiente di cooperazione capace d'inquadrare ed animare lo sviluppo di progetti e programmi futuri inerenti la sanità animale in entrambe le sponde del Mediterraneo. In particolare REMESA ha obiettivi specifici sulle malattie transfrontaliere che riguardano:

a) il coordinamento, l'armonizzazione e la cooperazione dei Paesi che ne fanno parte;
b) il miglioramento e la standardizzazione della diagnosi;
c) il potenziamento della sorveglianza epidemiologica;
d) il miglioramento e la standardizzazione dei metodi di prevenzione e controllo basati sulla valutazione del rischio.

CONCLUSIONI

La Febbre della Valle del Rift è una zoonosi transfrontaliera di importanza mondiale, non solo per il potenziale epidemico per l'uomo ma anche per i danni che provoca agli animali, al commercio degli animali e dei prodotti di origine animale. Lo stato di allerta è aumentato a seguito dell'ultima epidemia in Mauritania nell'ottobre 2012; infatti, per far fronte al rischio di introduzione in Europa della FVR e delle altre malattie emergenti nel 2010 è stato istituito l'ambiente comune di lavoro denominato REMESA (Reseau Mediterranéen de Santé Animale). In questo modo, in futuro la malattia verrà prontamente rilevata e notificata alle Autorità competenti, che potranno mettere in moto le adeguate misure di con-

trollo e garantire una più sicura movimentazione degli animali, e la collaborazione tra Paesi del Sud Europa e del Nord Africa. Quindi è opportuno che nei territori africani vengano istituite adeguate misure di controllo della malattia, rinforzando e migliorando le attività di sorveglianza e la capacità diagnostica dei laboratori, implementando programmi di quarantena e piani d'emergenza adeguati senza arrecare danni al commercio di animali e prodotti di origine animale.

BIBLIOGRAFIA

1. Davies FG, Martin V. Recognising Rift Valley fever. FAO Animal Health Manual. EMPRES; 2003

2. McIntosh BM, Jupp PG. Epidemiological aspects of Rift Valley fever in South Africa with reference to vectors, in: Swartz TA, Klinberg MA, Goldblum N, Papier CM (Eds), Contributions to epidemiology and biostatics: Rift Valley fever, S. Krager AG, Basel; 19.81 p. 92-99.

3. Linthicum KJ, Davies FG, Kairo A, Bailey CL. Rift Valley fever virus (Family Bunyaviridae, genus Phlebovirus). Isolations from diptera collected during an inter-epizootic period in Kenya. Journal of Hygiene 1985; 95:197-209

4. Swanepoel R, Coetzer JAW. Rift Valley Fever. In: Coetzer J, Tustin R, editors. Infectious Disease of livestock, (2 ed.) Oxford (UK). Oxford University Press; 2004. p.1037-1070.

5. EFSA (The European Food Safety Authority). Opinion of the Scientific Panel on Animal Health and Welfare (AHAW) on a request from the Commission related to "The risk of a Rift Valley fever incursion and its persistente within the Community". EFSA journal 2005; 238:1-128.

6. Linthicum KJ, Anyamba A, Tucker CJ, Kelley PW, Myers MF, Peters CJ. Climate and satellite indicators to forecast Rift Valley fever epidemics in Kenya. Science, 1999; 285: 397-400.

7. Clements ACA, Pfeiffer DU, Martin V, Otte MJ. A Rift Valley fever atlas for Africa. Preventive Veterinary Medicine 2007; 82:72-82.

8. Bird BH, Ksiazek TG, Nichol ST, MacLachlan J. Rift Valley virus. Veterinary Medicine Today: Zoonosis Update 2009; 234(7):883-893.

9. EFSA (The European Food Safety Authority). Technical meeting of the EFSA Scientific Network on EFSA Scientific Network for risk assessment in Animal Health and Welfare-Risk of introduction of Rift Valley fever into the Southern Mediterranean area through undocumented movement of infected animals, 2013, EN-416.

10. Turell MJ, Linthicum KJ, Patrican LA, Davies FG, Kairo A e Bailey CL. Vector Competence of selected African mosquito (Diptera: Culicidae) species for Rift Valley fever virus. Journal of Medical Entomology 2008; 45 (1), 102-108.

11. Gad AM, Feinsod FM, Allam IH, Eisa M, Hassan AN, Soliman BA, el Said S, Saah AJ. A possible route for the introduction of Rift Valley fever virus into Egypt during 1977. Journal of Tropical Medicine and Hygiene 1986; 89:233-236.

12. Shoemaker T, Boulianne C, Vincent MJ, Pezzanite L, Al-Qahtani MM, Al-Mazrou Y, Khan AS, Rollin PE, Swanepoel R, Ksiazek TG, Nichol S. Genetic analysis of viruses associated with emergence of Rift Valley fever in Saudi Arabia and Yemen, 2000-2001. Emerging Infectious Disease 2002; 8, 1415-1420.

13. Muga GO, Onyango-Ouma W, Sang R, Affognon H. Review articole: Sociocultural and Economic Dimensions of Rift Valley Fever. American Journal of Tropical Medicine and Hygiene 2015; 92(4):730-738.

14. Abdo-Salem S, Tran A, Grosbois V, Gerbier G, Al-Qudasi M, Saeed K, Etter E, Thrty E, Roger F, Chevalier V. Can environmental and socio-economic factors explain the recent emergency of RIft Valley in Yemen? 2000-2001. Vector Borne Zoonotic Diseases 2011; 11:773-779.

15. Goutard FL, Binot A, Duboz R, Rasamoelina-Andriamanivo H, Pedrono M, Holl D, Peyre MI, Cappelle J, Chevalier V, Figuié, Molia S, Roger FL. How to reach the poor? Surveillance in low-income countries, lessons from experiences in Cambodia and Madagascar. Preventive Veterinary Medicine 2015; 120:12-26.

16. Jost CC, Mariner JC, Roeder PL, Sawitri E, Macgregor-Skinner GJ. Participatory epidemiology in desease surveillance and research. Revue scientifique et technique (International Office of Epizootics) 2007; 26:537-549.

17. Cito F, Narcisi V, Danzetta ML, Iannetti S, Sabatino DD, Bruno R, Carvelli A, Atzeni M, Sauro F, Calistri P. Analysis of Surveillance Systems in Place in European Mediterranean Countries for West Nile Virus (WNV) and Rift Valley Fever (RVF). Transboundary and Emerging Diseases 2012; 60(Suppl. 2): 40-44.

18. Thiongane Y, Martin V. Systeme sous-regional d'alèrte et de controle de la Fièvre de la Vallée du Rift (FVR) en Afrique de l'Ouest. Bulletin d'information 8. ISRA-FAO: Dakar; 2004

19. Arsevska E, Hellal J, Mejri S, Hammami S, Marianneau P, Calavas D, Hènaux V. Identifying areas suitable for the occurrence of Rift Valley Fever

in North Africa: implications for surveillance. Transboudary and Emerging Diseases, Feb 2015.

20. Geering WA, Davies FG. Preparation of Rift Valley fever contingency plans (15). FAO; 2002

21. Hunter P, Erasmus BJ, Viorster JH. Teratogenicity of a mutagenised Rift Valleyfever virus (MVP 12) in sheep. Onderstepoort Journal of Veterinary Research 2002; 69: 95-98.

22. Njenga MK, Njagi L, Thumbi SM, Kahariri S, Githnji J, Omondi E, Baden A, Murithi M, Paweska J, Ithondeka PM, Ngeiywa KJ, Dungu B, Donadeu M, Munyua PM. Randomized controlled field trial to assess the immunogenicity and safety of Rift Valley Fever Clone 13 vaccine in livestock. PLOS Neglected Tropical Diseases 2015; 9(3):e00003550.

Encefalopatie spongiformi animali: un approccio multidisciplinare per una sorveglianza efficace.

C. CASALONE, C. MAURELLA, M. MAZZA, B. IULINI, D. MELONI, D. MARCHIS, R. DESIATO, G. RU, P. L. ACUTIS, M. CARAMELLI, E. BOZZETTA

Istituto Zooprofilattico Sperimentale del Piemonte, Liguria e Valle d'Aosta, Torino, Italia

Riassunto - L'encefalopatia spongiforme bovina (BSE) è tra le encefalopatie spongiformi trasmissibili (EST) la più conosciuta al mondo e anche l'unica certamente zoonotica. L'epidemia di BSE esplosa nel Regno Unito nel 1986, ma soprattutto l'evidenza nel 1996 dell'origine della variante della Malattia di Creutzfeldt – Jakob (vCJD) umana dalla BSE, ha provocato enorme preoccupazione e ha provocato una notevole crisi dei consumi di carne bovina nell'ambito dell'Unione Europea. Per questi motivi l'Unione Europea (UE) ha adottato una serie di misure per la tutela della salute pubblica. In questo contesto, proprio a Torino, è stato istituito il Centro di Referenza Nazionale per le encefalopatie spongiformi animali (CEA) che ha offerto la propria esperienza, maturata in ambito nazionale ed internazionale, in materia di coordinamento e gestione di tutti gli aspetti legati alle EST. Le collaborazioni nazionali ed internazionali e tutte le attività svolte nel corso del tempo, dalla sua nascita ad oggi, hanno avuto una ricaduta pratica nella lotta alle EST. Infatti, l'adozione di misure di riduzione del rischio applicate, come il divieto di utilizzo delle farine animali, l'esclusione dalle catene alimentari dei materiali specifici a rischio e il trattamento termico a pressione degli scarti animali si sono rivelate particolarmente efficaci nel combattere l'epidemia insieme alla sorveglianza sistematica applicata e hanno consentito nel tempo di ritoccare il sistema di controllo e di poter classificare il nostro Paese in una categoria favorevole, ovvero a rischio trascurabile per BSE.

Parole chiave: BSE, sorveglianza, normativa, rischio.

Anima spongiform encephalopathy: a multidisciplinary approach to achieve effective surveillance

Summary - Bovine spongiform encephalopathy (BSE) is a transmissible spongiform encephalopathy (TSEs), the best known in the world and the only zoonotic. The first outbreak occurred in the UK in 1986, but only in 1996 BSE was associated to a emerging new variant of the Creutzfeldt - Jakob disease (vCJD), which caused huge concern and led to a worldwide crisis in meat consumption. For these reasons the European Union (EU) enforced protection measures for public health, issuing specific regulations for BSE prevention, control and eradication. In this context, in Turin, the National Reference Centre for Animal Spongiform Encephalopathy (CEA) was established. The national and international collaborations, and all activities implemented over time, has allowed an effective control of TSEs. The adoption of measures of risk mitigation, like the meat and bone meal ban, the removal from the food chains of specific risk materials and the appropriate treatment of animal waste, combined with an effective systematic surveillance allowed to classify our country in the OIE negligible risk category for BSE.

Key words: BSE, surveillance, legislation, risk

L'encefalopatia spongiforme bovina (BSE) è tra le encefalopatie spongiformi trasmissibili (EST) la più conosciuta al mondo e anche l'unica certamente zoonotica.

Caratterizzata da un lungo periodo d'incubazione, da un decorso clinico progressivo con sintomatologia neurologica e dall'assenza di reazioni infiammatorie o immunitarie, la BSE pone un grave rischio alla salute umana e animale.

L'epidemia di BSE esplosa nel Regno Unito nel 1986, ma soprattutto l'evidenza nel 1996 dell'origine della variante della Malattia di Creutzfeldt – Jakob (vCJD) umana dalla BSE, ha provocato una notevole crisi dei consumi di carne bovina nell'ambito dell'Unione Europea. Per questi motivi l'Unione Europea (UE) ha adottato una serie di misure per la tutela della salute pubblica, emanando norme specifiche per la sua prevenzione, controllo ed eradicazione.

Per monitorare la presenza di BSE in modo più efficace sono stati applicati due diversi sistemi di sorveglianza: passiva e attiva. Per sorveglianza "passiva" si intende principalmente la notifica, da parte di tutti gli operatori del settore, di un capo bovino sospetto di malattia (presenza di sintomi neurologici) (Fig. 1). Tutti i casi clinicamente sospetti di BSE devono

Corrispondenza: Dr Cristina Casalone,
S.S. Laboratorio Neuropatologia, Istituto Zooprofilattico Sperimentale del Piemonte, Liguria e Valle d'Aosta, Via Bologna 148 – 10154 Torino. Tel. 011-2686341; Fax 011- 2686360.
E mail: cristina.casalone@izsto.it

essere sottoposti per conferma ad esame istologico, immunoistochimico e immunobiochimico sul tronco encefalico; in caso di esito negativo il manuale dell'Office International des Epizooties (OIE) prevede che l'intero encefalo di questi animali venga sottoposto ad ulteriori indagini neuropatologiche al fine della formulazione di una diagnosi differenziale.

Figura 1 - Bovino con sintomatologia neurologica, caso sospetto.

Il primo tentativo di sorveglianza attiva, in linea con le indicazioni dell'OIE, è stato effettuato da parte della Comunità Europea con l'emanazione della Decisione 98/272/CE [1] seguita poi dal Regolamento N. 999/2001/CE del Parlamento Europeo e del Consiglio del 22 maggio 2001 [2] e si basa sull'esecuzione di specifici test diagnostici di screening definiti "rapidi" perché in grado di fornire un esito diagnostico nell'arco di 24-48 ore.
L'applicazione della sorveglianza attiva oltre a definire l'assetto epidemiologico della BSE nei Paesi europei ha inoltre permesso l'identificazione, accanto alla forma classica di due nuove forme di BSE definite atipiche. La forma L-BSE (Low BSE) è stata segnalata per la prima volta in Italia [3] nell'ambito di uno studio approfondito sulle caratteristiche neuropatologiche e molecolari dei casi italiani di BSE, ed è stata denominata BASE (Bovine Amyloidotic Spongiform Encephalopathy) (Fig. 2). Successivamente casi simili sono stati identificati anche in altri paesi europei quali: Francia [4], Germania [5], Polonia [6] e Gran Bretagna [7], insieme ad un'altra forma atipica, la forma H-BSE (High BSE).
I casi di BSE atipica sono stati rilevati dalla sorveglianza attiva soprattutto in animali sopra gli 8 anni di età con un numero costante di casi notificati ogni anno.
La complessità di approccio alla problematica BSE ha implicato la messa in atto di misure di sorveglianza trasversali per strutturare, pianificare, attuare e verificare interventi in sanità pubblica. L'entrata in vigore della sorveglianza attiva ha permesso di valutare l'entità dell'epidemia e la successiva definizione delle misure di protezione della salute umana quali il divieto di utilizzo delle proteine animali trasformate nell'alimentazione animale, la distruzione dei materiali specifici a rischio (MSR) e il trattamento termico a pressione degli scarti animali. Tali misure si sono rivelate, in ambito Europeo, eccezionalmente efficaci nel contrastare l'epidemia.

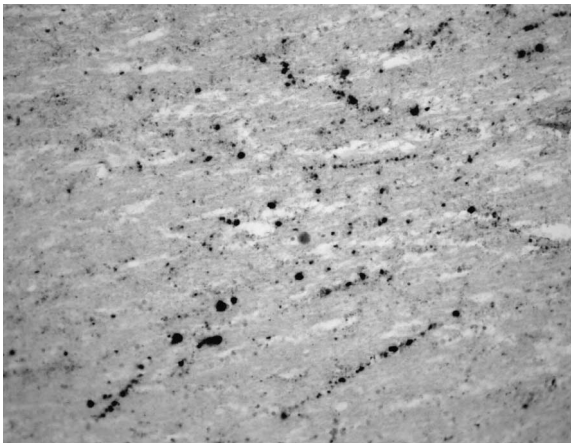


Figura 2 - Depositi di PrPsc (placche) messe in evidenza mediante immunoistochimica su campione di talamo (BASE).

L'emanazione della Decisione 98/272/CE impose per la prima volta a tutti gli Stati Membri l'obbligo di esaminare da un lato un numero minimo di bovini adulti manifestanti segni clinici neurologici compatibili con la malattia e dall'altro gli animali ad alto rischio (animali provenienti da Paesi in cui erano stati registrati casi di EST, animali che avevano assunto alimenti potenzialmente contaminati o animali nati da animali infetti).
Il Regolamento N. 999/2001/CE reca al suo interno le disposizioni per la prevenzione, il controllo e l'eradicazione di alcune EST animali.
Tale regolamento si applica alla produzione e all'immissione sul mercato di animali vivi e prodotti di origine animale. E' stato continuamente aggiornato e rivisto tenendo anche conto dei numerosi pareri scientifici dell'European Food Safety Authority (EFSA) pervenuti alla Commissione Europea su vari aspetti delle EST (al momento ne è disponibile una versione consolidata aggiornata al 27.05.2015).
Sempre in base al Regolamento N. 999/2001/CE, e a quanto stabilito dal Manuale OIE, ogni Stato Membro o Paese Terzo o una loro regione può acquisire un determinato status sanitario in base ad una categorizzazione del rischio.
La classificazione dei Paesi in funzione del rischio di BSE intende definire norme in grado di regolare gli scambi commerciali per ciascuna categoria di rischio, facendo in modo di garantire da un lato la protezione degli animali e della salute pubblica nei

paesi importatori e dall'altro garantire le misure di prevenzione proporzionate al rischio.
La categorizzazione prevede un'analisi del rischio basata su tutti i fattori potenziali di insorgenza della BSE. Essa prevede la classificazione di ciascun Paese in tre categorie: rischio trascurabile, rischio controllato e rischio indeterminato in base ad alcuni criteri: presenza o assenza dell'agente della BSE nel Paese, e suo livello di prevalenza; produzione di farine di carne e ossa, importazione di animali, mangimi e ingredienti di mangimi potenzialmente contaminati, utilizzo di carcasse, scarti e sottoprodotti della macellazione di ruminanti; applicazione di programmi di sorveglianza attiva e passiva calibrati sulla categoria di rischio del Paese o della regione e sulla loro evoluzione nel tempo. L'Unione Europea è l'area in cui la sorveglianza nei confronti delle EST risulta esaustiva e sistematica dal 2001. Al di fuori dell'Unione Europea, la sorveglianza per i paesi che la applicano non risulta sistematica, ma su base campionaria. La presenza o l'assenza di tale malattia sulla base del rischio geografico non può essere determinata in Paesi che non possiedono un adeguato sistema di sorveglianza come per esempio i Paesi africani, alcuni dei quali (Nigeria, Kenya, Botswana, Namibia, Swaziland) sono stati valutati dalla Commissione di esperti scientifici (Scientific Steering Committee). Le conclusioni attestano che è improbabile, ma non è da escludere, che gli allevamenti bovini presenti sul territorio siano infetti in forma clinica o pre-clinica da parte dell'agente BSE.
L'Italia ha ottenuto recentemente dall'OIE la revisione dello stato sanitario relativo alla BSE con una risoluzione adottata dall'Assemblea Generale di Parigi del 28 maggio 2013 [8].
Il nostro Paese ha quindi acquisito la categoria di rischio trascurabile con modifica della Decisione 2009/719/CE [9] e l'approvazione della Decisione 2013/76/CE [10] e con l'emanazione di una Nota Ministeriale [11] con cui il sistema di sorveglianza è stato modificato. A partire dal 1 luglio 2013, infatti, l'obbligatorietà di testare per BSE tutti i capi bovini regolarmente macellati è stata ufficialmente sospesa.
Il passaggio dal livello di rischio 'controllato' a quello 'trascurabile' (Negligible BSE risk) è stato ottenuto grazie alle misure di contenimento del rischio e in base all'evoluzione nel tempo della malattia documentata dal suo sistema di sorveglianza, dimostrando che l'Italia possiede un solido sistema di sorveglianza che fornisce forti evidenze sull'efficacia della prevenzione, controllo ed eradicazione di questa malattia e che ha capacità di fronteggiare un potenziale nuovo ingresso della malattia.
Insieme a Giappone, Israele, Olanda, Slovenia e USA, l'Italia è andata ad aggiungersi ai Paesi aderenti all'OIE, che avevano raggiunto la qualifica sanitaria di rischio 'trascurabile'. Questo significa, oltre ad una rassicurazione per il consumatore, la possibilità per l'Italia di collocarsi in una condizione di forza nei confronti dei Paesi con i quali commercia e dimostra l'efficacia delle misure di controllo ed eradicazione intraprese.
In questo contesto il Centro di Referenza Nazionale per le encefalopatie spongiformi animali (CEA) (Fig. 3) ha offerto la propria esperienza, maturata in ambito nazionale ed internazionale, in materia di coordinamento e gestione di tutti gli aspetti legati alle EST, al fine di definire modalità comuni a tutti gli attori, centrali e periferici, per la valutazione del rischio, la diagnostica e lo studio delle forme classiche e atipiche di BSE.
Il CEA è stato infatti insignito con decreto del Ministro della Sanità del 3 agosto 1991 del compito di occuparsi delle EST quale Centro di Referenza Nazionale, per lo studio e le ricerche sulle encefalopatie animali e neuropatologie comparate.
Nel 2001 con l'emanazione del Regolamento N. 999/2001/CE del Parlamento Europeo e del Consiglio del 22 maggio 2001 (allegato X, capitolo A, art. 3), il CEA è stato designato anche come Laboratorio di Riferimento Nazionale. Il CEA svolge compiti istituzionali e ha come interlocutori l'Unione Europea, il Ministero della Salute, le Regioni e i Servizi Veterinari operanti sul territorio. Esso offre consulenza tecnico-scientifica, svolge la raccolta, l'elaborazione e il trasferimento di dati di sorveglianza epidemiologica, sviluppa modelli di valutazione del rischio, produce pareri scientifici e partecipa alla stesura di atti normativi per il controllo e la prevenzione delle EST, offre formazione e aggiornamento agli operatori.
Inoltre, conduce ricerche nell'ambito della patogenesi, trasmissibilità, genetica ed epidemiologia delle EST.
L'attività diagnostica di routine si basa essenzialmente sulla sorveglianza attiva mediante l'impiego di test rapidi e sulla conferma diagnostica. Nell'ambito della sorveglianza e del coordinamento dell'attività diagnostica nazionale, si procede alla produzione e distribuzione di reagenti, all'allestimento di circuiti interlaboratorio, alla consulenza in caso di problematiche tecnico-diagnostiche, all'attività di audit presso i laboratori test rapidi degli II.ZZ.SS ai sensi del Regolamento N. 999/2001/CE.
L'attività epidemiologica è basata essenzialmente sulle attività di raccolta, verifica ed elaborazione dei dati di sorveglianza, attiva e passiva e ha come obiettivo quello di valutare i trend spaziali e temporali della BSE a livello nazionale.
Inoltre il CEA ha fornito fattivo supporto al Ministero per la compilazione dei questionari richiesti dai vari Ministeri di Stati Extra Europei per favorire la commercializzazione di animali bovini vivi e dei loro prodotti.

Sulla base dell'esperienza tecnico-diagnostica acquisita dal personale del CEA nel corso dell'applicazione della sorveglianza attiva in Europa, sono state implementate le metodologie di diagnosi rapida più adatte al contesto territoriale al fine della rispettiva applicazione su larga scala quali strumento di screening; le tecniche diagnostiche di conferma ufficiale dei casi sospetti di EST, quali esame western blot, immunoistochimico e istologico; le indagini neuropatologiche condotte sull'intero encefalo dei casi risultati negativi ai test diagnostici per EST al fine di giungere ad una diagnosi differenziale; le metodiche di caratterizzazione molecolare della proteina prionica patologica, marker diagnostico di EST, al fine di discriminare tra la forma classica e le forme atipiche di BSE.

Per quanto riguarda i metodi per il riconoscimento delle proteine animali trasformate (PAT), secondo quanto normato nell'UE, le tecniche utilizzate sono il metodo in microscopia ottica per il riconoscimento dei costituenti di origine animale e il metodo in RT-PCR per la determinazione del DNA di ruminante nei mangimi. Sono stati dimostrati declino e omogeneità territoriale della contaminazione dei mangimi con farine animali: ciò è stato ottenuto utilizzando i risultati temporali e spaziali dell'attività di sorveglianza sulla contaminazione.

Altra importante attività che il CEA svolge abitualmente è la collaborazione nazionale e internazionale, docenza, partecipazione a Comitati scientifici e gruppi di lavoro internazionali (EFSA), Nella seconda metà del 2004, il CEA ha partecipato allo svolgimento delle attività di progetto nel Twining Project – SK/02/IB/AG/O1 denominato "Control EST– Food Safety" a Bratislava (Slovacchia).

Il progetto mirava ad implementare la cooperazione tra Paesi, sviluppando una strategia condivisa per la creazione di strumenti metodologici comuni, e per rendere più efficaci le azioni di sanità pubblica nella lotta contro le EST.

Il trasferimento di competenze, dato dal periodo di training, insieme alla condivisione di esperienze, di allestimento e gestione di flussi di dati e campioni biologici sono stati fondamentali per la creazione di un nuovo e più adeguato modello di sorveglianza in un Paese dell'Est Europa.

In particolare, il periodo di training si è sviluppato in due diversi momenti: il primo aveva l'obiettivo di comprendere a fondo il funzionamento dei flussi campioni e i sistemi informativi slovacchi, nonché le procedure diagnostiche di identificazione dei ceppi, raccogliere informazioni preliminari volte alla creazione di un sistema di sorveglianza nel controllo delle EST.

Quindi, sulla base dell'esperienza pregressa del CEA, è stato fornito un supporto per valutare e migliorare il sistema di sorveglianza a partire dall'anagrafe zootecnica e dalle modalità di gestione dei campioni. Inoltre, è stata fornita una consulenza per apportare modifiche al sistema informativo e alle

Figura 3 - Il gruppo di lavoro del Centro di Referenza Nazionale per le encefalopatie spongiformi animali (CEA).

procedure diagnostiche, fornendo un supporto di tipo epidemiologico e diagnostico con l'organizzazione di un corso di formazione.
Un'esperienza analoga ha caratterizzato il Twinning project LT/2004/AG/07 "Strengthening of Official Control of Animal Health and Food Safety through Implementation of Veterinary Information Management System", svolto nel medesimo anno (2004) attraverso un contratto stipulato tra la Repubblica Lituana e la Regione Piemonte. L'obiettivo generale era quello di valutare ed implementare il sistema di sorveglianza dei diversi piani applicati alle malattie infettive e diffusive degli animali, tra cui le EST, per garantire il controllo della salute degli animali e della sicurezza alimentare in linea con la normativa UE.
Il progetto ha permesso di realizzare un efficace sistema di informazione e gestione dei dati sanitari per garantire la piena rintracciabilità in tutto il sistema ufficiale di sanità animale e controllo della sicurezza alimentare. Inoltre, ha permesso di rafforzare le capacità amministrative e tecniche della sanità pubblica, attraverso una migliore gestione del benessere degli animali e dei controlli sanitari, delle modalità di campionamento, nell'identificazione del flusso campioni verso i laboratori e all'interno degli stessi, del sistema di notifica dei risultati positivi dei test, della verifica dei controlli svolti e dei dati inviati a livello centrale.
Più recentemente, le attività a livello internazionale hanno riguardato la formazione di veterinari e altri operatori sanitari di amministrazioni coinvolte nei controlli ufficiali in materia di sanità animale e sicurezza degli alimenti, con la diffusione di conoscenze e competenze nell'ambito dei corsi organizzati all'interno del progetto della Commissione Europea-DG-SANCO denominato "Better Training for Safer Food". Il personale del CEA ha fornito docenza in qualità di esperto in molte occasioni: nel 2008 a Oldenburg (Germania), nel 2014 a Utrecht e Lisbona sul controllo ed eradicazione delle EST, fornendo una panoramica generale che spazia dall'eziologia, alla clinica, alla patologia e diagnostica di queste malattie fino alle misure di prevenzione e di eradicazione, alla epidemiologia e la sorveglianza.
Nell'ambito del progetto EU "Capacity building of the veterinary service for implementation of EU Acquis - EuropeAid/124586/C/SER/MK" è stata erogata formazione al personale governativo responsabile per i controlli in sicurezza alimentare. I corsi si sono tenuti a Skopje (Macedonia) nel settembre 2012.
Altri eventi di docenza internazionale ha visto il personale del CEA coinvolto a Sarajevo (Bosnia, 2009), Amman, (Giordania, 2009), Zagabria (Croazia, 2012), nell'ambito del programma denominato TAIEX (Technical Assistance and Information Exchange instrument of the European Commission). TAIEX è un programma di cooperazione interregionale della Commissione Europea che ha l'obiettivo di fornire supporto alle pubbliche amministrazioni riguardo l'applicazione e l'implementazione della normativa, in questo caso in materia di EST. In questo programma il CEA ha fornito alcuni esperti per offrire consulenza su questioni connesse all'applicazione della normativa e all'implementazione del sistema di sorveglianza nel controllo delle EST.
E' inoltre stata pianificata un'attività formativa destinata a delegati provenienti da paesi candidati o potenziali candidati per l'ingresso in Unione Europea. I paesi coinvolti saranno: Serbia, Bosnia Erzegovina, Former Yugoslav Republic of Macedonia, Montenegro, Turchia, Albania e Kosovo.
Il personale CEA ha partecipato e partecipa a Comitati scientifici e gruppi di lavoro nell'ambito del BSE/ESTEFSA Network e del SsynCAHD Standardising Syndromic Classification in Animal Health Data, OIE (Office International des Epizooties). Attraverso il suo personale partecipa anche come membro del Gruppo di Esperti sui Casi Atipici della BSE dell'OIE e ai Working group del Panel EFSA Biological Hazards per il triennio 2012/2015 e per il triennio successivo.
In ambito internazionale il CEA collabora con diversi laboratori, europei ed extra europei come laboratorio esperto per esaminare e caratterizzare i ceppi tipici e atipici di BSE.
Di grande importanza è la partecipazione del CEA al Network of Excellence NeuroPrion iniziato nel 2003 con l'obiettivo di strutturare e integrare gli sforzi dei principali gruppi di ricerca europei sui prioni, per realizzare delle sinergie durature e quindi difendere uomini e animali dalle patologie prioniche. Il Network of Excellence Neuroprion si è concluso alla fine del 2009, ma le attività del Network proseguono nel tempo attraverso l'associazione denominata Neuroprion Association – International association for reasearch on prions and related diseases alla quale il nostro Istituto ha aderito nel 2010.
All'interno del 6° Programma Quadro il CEA è partner di un progetto denominato GoatBSE, i cui principali obiettivi sono studiare la patogenesi della BSE nelle capre, e il conseguente rischio di esposizione per l'uomo, e generare dati sulla resistenza genetica alle EST nei caprini. Il sito del progetto GoatBSE consente di consultare i risultati ottenuti oltre a informazioni generali sulle EST nei caprini e ad aggiornamenti della bibliografia scientifica.
Tutte le attività fin qui riportate nel corso del tempo, dalla sua nascita ad oggi, hanno contribuito da un lato a fare del CEA un centro di eccellenza ed un esempio autorevole di organizzazione, formazione e

competenze in ambito di sanità pubblica e sicurezza degli alimenti, dall'altro di dimostrare come tutto il lavoro svolto in ambito epidemiologico, diagnostico e di innovazione tecnologica abbia portato ad una ricaduta pratica nella lotta alle EST.
Le misure di riduzione del rischio applicate, come il divieto di utilizzo delle farine animali, l'esclusione dalle catene alimentari dei materiali specifici a rischio e il trattamento termico a pressione degli scarti animali si sono rivelate particolarmente efficaci nel combattere l'epidemia insieme alla sorveglianza sistematica applicata e hanno consentito nel tempo di ritoccare il sistema di controllo e di poter classificare il nostro Paese in una categoria favorevole, ovvero a rischio trascurabile per BSE.

BIBLIOGRAFIA

1. Decisione N. 98/272/CE della Commissione del 23 aprile 1998 relativa alla sorveglianza epidemiologica delle encefalopatie spongiformi trasmissibili e recante modifica della decisione 94/474/CE.

2. Regolamento N. 999/2001/CE del Parlamento Europeo e del Consiglio del 22 maggio 2001 recante disposizioni per la prevenzione, il controllo e l'eradicazione di alcune encefalopatie spongiformi trasmissibili.

3. Casalone C, Zanusso G, Acutis P, Ferrari S, Capucci L, Tagliavini F, Monaco S and Caramelli M. Identification of a second bovine amyloidotic spongiform encephalopathy: molecular similarities with sporadic Creutzfeldt-Jakob disease. Proc Natl Acad Sci U S A 2004; 101: 3065-3070.

4. Biacabe AG, Laplanche JL, Ryder S and Baron T. Distinct molecular phenotypes in bovine prion diseases. Embo Reports 2004; 5: 110-114.

5. Buschmann A, Gretzschel A, Biacabe AG, Schiebel K, Corona C, Hoffmann C, Eiden M, Baron T, Casalone C and Groschup MH. Atypical BSE in Germany- proof of transmissibility and biochemical characterization. Veterinary Microbiology 2006; 117: 103-116.

6. Polak MP, Zmudzinski JF, Jacobs JG and Langeveld JP. Atypical status of bovine spongiform encephalopathy in Poland: a molecular typing study. Arch Virol 2008; 153: 69-79.

7. Stack MJ, Chaplin MJ, Davis LA, Everitt S, Simmons MM, Windl O, Hope J and Burke P. Four BSE cases with an L-BSE molecular profile in cattle from Great Britain. Veterinary Record 2013; 172: 70.

8. Resolution N. 20 Recognition of the Bovine Spongiform Encephalopathy Risk Status of Member Countries.

9. Decisione N. 2009/719/CE della Commissione del 28 settembre 2009 che autorizza determinati Stati membri a rivedere il proprio programma anche di controllo della BSE.

10. Decisione N. 2013/76/CE di esecuzione della commissione del 4 febbraio 2013 recante modifica della decisione 2009/719/CE che autorizza determinati Stati Membri a rivedere il proprio programma di controllo della BSE.

11. Nota del Ministero della Salute DGSAF 0011885-P-12/06/2013 Applicazione Dec. 2013/76/CE - Sospensione dei test sui bovini regolarmente macellati.

Educate the future: strengthening food safety through a project of international training

P. D'AMICO[1], X. JIANJUN[2], A. LETO[3], F. DI IACOVO[1,4], R. ROSATI[4], WEI-YI HUANG[5], G. SHENG[6], A. GUIDI[1]

[1]Sino Italian Center for Food Safety, Department of Veterinary Sciences, University of Pisa, Pisa, Italy
[2]Uni-Italia Association, Beijing, People's Republic of China
[3]Tuscany Region, Regional Government. General Directorate for Rights of Citizenship and Social Cohesion, Florence, Italy
[4]Experimental Zooprophylactic Institute of Lazio and Tuscany, Roma, Italy
[4]College of Animal Science and Technology, Guangxi University, Nanning, People's Republic of China
[6]Food and Drug Administration of Guangxi, Nanning, People's Republic of China

Summary - In recent years, People's Republic of China (PRC) has been involved in numerous food scandals, which have highlighted the serious difficulties of the Country to adapt to the international food safety standards. However, PRC has shown the willingness for improvement by adopting new management and control systems and promoting policies of training and information exchange with leading edge Countries. Among these stands out Italy, whose food control system has aroused particular interest in the PRC. For this reason and according to the European food safety principles regarding the training support to be provided to Third Countries, in 2009, on a proposal of the Department of Veterinary Science of the University of Pisa, the Sino Italian Center for Food Safety (CSISA) was established, with the aim to promote the exchange of knowledge on food production and controls. Over the years, the CSISA has signed agreements with Chinese Universities and Institutions in charge of food safety in their Country and carried out various training and research activities, involving academic and institutional executives and officials.

Key words: food safety, public health, international cooperation, training, People's Republic of China

Riassunto - Negli ultimi anni la Repubblica Popolare Cinese (RPC) è stata al centro di numerosi scandali alimentari che hanno evidenziato le gravi difficoltà del Paese ad adeguarsi agli standard internazionali di sicurezza alimentare. La RPC ha comunque dimostrato la volontà di migliorarsi attraverso l'adozione di nuovi sistemi di gestione e la promozione di politiche di scambio formativo e informativo con i Paesi ritenuti all'avanguardia. Tra questi spicca anche l'Italia, i cui sistemi di controllo hanno suscitato un particolare interesse da parte della RPC. Per tale motivo, anche sulla base di quanto previsto dalla normativa comunitaria in merito alla necessità di fornire sostegno formativo ai Paesi Terzi, nel 2009, su proposta del Dipartimento di Scienze Veterinarie dell'Università di Pisa, è nato il Centro Sino Italiano per la Sicurezza Alimentare (CSISA), con l'obiettivo di favorire lo scambio di conoscenze sulla produzioni alimentari ed i relativi controlli. Nel corso degli anni il CSISA ha siglato accordi con Università ed Istituzioni cinesi preposte alla sicurezza alimentare nel proprio Paese e ha dato vita ad una serie di attività bilaterali di formazione e ricerca, coinvolgendo dirigenti e funzionari del mondo accademico e istituzionale.

Parole chiave: sicurezza alimentare, sanità pubblica, cooperazione internazionale, formazione, Repubblica Popolare Cinese

1. INTRODUCTION

Ensuring food safety is a growing challenge worldwide, which cannot leave aside other issues related to food security and global quality, in a view of a holistic concept of nutrition. The food safety problem is more prevalent in the least industrialized world, such as Asia, where the policies and strategies enforced by governments seems to be inadequate to guarantee high quality productions and effective control systems [1]. In particular, Asian national programs use to address superficially the nature and extent of internal food safety problems and most of the policy actions have still focused on food quantity, rather than quality [1]. For this reasons, the Food and Agricultural Organization (FAO) and the World Health Organization (WHO) have been involved in several initiatives related to capacity building and technical assistance, in order to sustain Asian developing and in-transition

Corresponding author: Prof. Alessandra Guidi,
Department of Veterinary Sciences, University of Pisa, Viale delle Piagge 2 - 56124 Pisa. E mail: alessandra.guidi@unipi.it

countries. According to the international guidance "Guidelines for strengthening national food control systems" [2], provided by FAO and WHO in 2003, the five key elements of a national food control system are represented by food law and regulation, food control management, inspection service, laboratory services and Information, Education, Communication and Training (IECT). Following this principles, FAO and WHO, the pillars of the preeminent food standard setting body *Codex Alimentarius Commission* (CAC), support Asian local governments in improving their national legislation and in implementing measures to enable veterinary and public health Authorities to carry out key functions, including controls at the level of animal production, inspection and certification of animal products, as well as supervision on compliance with international obligations. Moreover, FAO and WHO also support the specific training needs of Asian inspectors and laboratory analysts, whose role is essential to pursue food safety [2].

Alongside CAC activities, over the years, other parallel initiatives have been undertaken to elevate the quality of Asian productions and the efficiency of the control systems [3]. In 2007, the Food Safety Cooperation Forum (FSCF) of the Asia-Pacific Economic Cooperation (APEC) was established. It was co-chaired by the People's Republic of China (PRC) and Australia, with the aim of encouraging the use of international standards and accelerating progress towards harmonization among the APEC members [4].

However, it is necessary to point out that there are substantial differences in the food safety status of the Asian Countries [5]. In fact, some of them, mainly concentrated in the South East, still suffer of both shortage and overall poor quality of food, while others, such as the PRC, which have put food safety on the political agenda in the last years and employed considerable financial and human resource in this sector, can be considered more advanced [6,7]. The improvement of food safety standards has become a prerogative for the PRC, especially following the big scandal occurred in 2008, when almost 40,000 infants were hospitalized following the deliberate contamination of milk powder with melamine. In addition to this, many other health emergencies, such as the avian flu, clenbuterol into fodder for pigs, and dioxin have seriously damaged the reputation of the PRC, resulting in several safety alerts and bans on food importation worldwide [8]. The spread of food crisis has highlighted how the rapid industrialization and the resulting modernization of production systems have paradoxically elevated the domestic risk of public health in the PRC, inasmuch the development of production process has not evolved together with the full adoption of good food production and processing practices. Currently, the PRC's food safety problems are mainly due to the improper use of veterinary drugs, hormones, additives and other illegal substances in food production and processing and in certain contexts, such as rural areas, inadequate handling during food storage and consumption [1]. Moreover, the intense industrialization has had a considerable impact on the environment by determining a worrying presence of contaminants and polluting at all levels of the supply chain. Among the main causes that have most contributed to the food safety problems in the PRC, undoubtedly there are the lack of coordination amongst regulators and the inconsistencies in the development, interpretation, and enforcement of food safety standards, which have weakened regulatory oversight and created systemic vulnerabilities [8]. For this reason, the PRC's leaders have undertaken measures to increase cohesion in government supervision, unify food safety standards and toughen penalties for non-compliance [8], also driven by two special events of global interest, such as the Olympic Games in 2008 and the World Expo 2010 in Shanghai. The enforcement of the "Food Safety Law" in 2009 and the reorganization of the inspection bodies have represented, for the PRC, the first concrete attempt to create a more modern control system [8], which has been further strengthened by the issue of a new law on food safety in 2015.

In addition to the political and legislative efforts, the Chinese Government, following the principles of FAO and WHO, has tried to improve food safety even through the training and technical assistance of the personnel in charge of official controls [9]. Recently, PRC has established several collaborations with government, academic and research Institutions worldwide, also involving Italy, which is considered one of the most advanced Country in this area [10, 11].

1.1 The CSISA project

One example of these partnerships is the Sino-Italian Center for Food Safety (CSISA), founded in 2009 on the initiative of the University of Pisa, supported by the Tuscany Region and in collaboration with the Autonomous Province of Guangxi.

Before the foundation of the CSISA, the University of Pisa and the PRC began their collaboration in the field of food safety and veterinary public health at the academic level, promoting the international PhD *"Issues and sanitary inspection of animal products in trade between the European Union and the Republic of China"*, which was activated by the will

of the Department of Veterinary Sciences as part of the internationalization projects of the Italian Ministry of University and Research and attended by several Chinese and Italian Institutions. The PhD was joined for the Italian side by the Italian Ministry of Health, Tuscany Region, the Experimental Zooprophylactic Institute of Lazio and Tuscany and the Universities of Parma and Turin and for the Chinese counterpart by the College of Animal Science and Technology of Guangxi, the Qinghai Animal Husbandry and Veterinary Medicine College and the Graduate School of the Chinese Academy of Agricultural Sciences in Beijing. The PhD course was structured on the basis of a three-year program of study during which the admitted students, thanks to grants and mobility contributions, have spent part of their formative period (almost 18 months) at Chinese, Italian or EU Institutions. The main objectives of the PhD program were the interdisciplinary education of students and the creation of educators and professionals able to operate in the field of hygiene and control of livestock and food production. Following the activation of the PhD, the Department of Veterinary Sciences of the University of Pisa and the Autonomous Province of Guangxi organized some bilateral meetings, which created the fundamentals for further collaboration between the two parties. During the meeting *"Food safety problems in a globalized world: Cooperation among Countries and Institutions"*, organized in Nanning (Guangxi) in 2007, the Chinese counterpart manifested a clear interest in the Italian and Tuscan food safety systems, formulating the hypothesis to create a joint Center for food safety. Two years later the CSISA was founded and the parties appointed a Joint Committee, composed of official representatives for the Region of Tuscany and the Autonomous Region of Guangxi, starting from the elaboration of a quadrennial Action Plan. The partnership has been attended by Chinese and Italian leading academic Institutions and government Agencies. On the Italian side: the General Direction of Rights of Citizenship and Social Cohesion, Sector of Prevention and Safety in Living and Working Environments, Food and Veterinary of Tuscany Region, the Department of Veterinary Sciences of the University of Pisa and the Experimental Zooprophylactic Institute of Lazio and Tuscany. With regard to the Chinese counterpart, Official Authorities involved in food control, namely the Food and Drugs Administration and the Entry and Exit Inspection and Quarantine Bureau of Guangxi together with the academic representation of Guangxi University, have joined the project.

The CSISA has the primary objective to share mutual knowledge on production and control of food and veterinary public health, in order to create professional figures able to lay the groundwork for the improvement of food safety standards and the development of quality management systems. Moreover, collaboration projects have also aimed to improve the training of Chinese Food Business Operators (CFBO) in the Tuscany Region (Chinese community of Prato).

Over the years, the repeated contacts, the many activities and the renewal of the agreement have consolidated the cooperation more and more. Currently, the CSISA, in addition to running its ordinary activities, is working on an even bigger goal as the foundation of a permanent Sino-Italian School, held by Italian, Chinese and international teachers, to educate a new generation of inspectors and control personnel and further raise the quality standards adopted.

Finally, a new agreement has been signed between the Zhejiang University of Finance and Economics and the University of Pisa, for the establishment of a Sino-Italian Research Center on Food Safety Regulation. The Zhejiang University of Finance and Economics ranks high among Chinese universities and boasts excellence expertise in the systematic and theoretical research on regulations on the production and supervision of food. Through this collaboration, the CSISA has the opportunity to carry on and complete its activities with a partner that actively operates in the legislative framework and the organization of food safety systems, especially in relation to the new Chinese Food Safety Law of 2015. This new partnership will allow a further development of the CSISA's educative strategies, including the planning of an international master in Management of Food Safety.

2. Materials and methods: activities carried on

Training and research were identified as the two main areas of mutual interest. The counterparts, in addition to continuing their joint academic and research collaboration, begun to closely work in training of government personnel operating in the Chinese food safety sector.

In order to give greater visibility to the CSISA and to promote its activities, the counterparts have adopted modern multimedia and interactive tools to create a common area of sharing. In this regard, a website (www.csisa.unipi.it) has been built, available in three languages (Italian, English and Chinese), which, in addition to providing useful information about the CSISA organization, partners and projects, has a section entirely dedicated to training, with documentation on the past experiences (programs of the courses, teaching materials, photo galley). Currently, the CSISA is working on the development of more innovative multimedia

systems for advanced training through the use of digital devices and multi-touch publications.

2.1 High level training course.

The CSISA has developed various formats of training, including high-level education courses, workshops, conventions with the aim to train the staff, which operates at different level in the two main local food control Agencies of Guangxi: the Food and Drug Administration Department (FDA) and the Administration of Quality Supervision, Inspection and Quarantine Department (AQSIQ). In particular, the CSISA has organized and structured periodic courses, of variable duration (from 1 to even 3 weeks), paying particular attention to the needs and specific requests of the Chinese counterpart. Thanks to a large group of academic and institutional highly qualified trainers, coming from the Official Laboratories at Experimental Zooprophylactic Institute of Lazio and Tuscany, the Local Health Authorities and the University of Pisa, the CSISA can offer different educational paths in the field of food hygiene and control, food safety management systems, official controls, food laboratory management and food testing. In particular, issues are addressed regarding contaminants, microbiology and Genetically Modified Organisms, veterinary drugs, quantitative risk assessment and Hazard Analysis and Critical Control Points (HACCP) and proficiency testing. The courses are carried out including classroom lessons, field experiences and laboratory activities. Particular attention was paid on practical activities, which allow participants to be involved in the daily activities of Italian Official Laboratories and Control Authorities. Thanks to the feedbacks, which emerged from discussions with participants of the courses, the structure and the organization of the training offer is continuously revised, in order to overcome the cultural differences between the two Countries, improving the didactical approach on the basis of the attendant's needs, and set up specific targets.

All the CSISA's training activities are supported by a native Chinese speaker, which plays a pivotal role in supporting participants during their stay in Italy.

2.1.1 Training and education of Chinese Food Business Operators (CFBOs) in the Region of Tuscany.

The CSISA also organizes activities at local level dealing with the professional education of the CFBOs operating in catering enterprises (restaurants and supermarkets), settled in the area between Florence and Prato, where there is one of the biggest Chinese community of Europe. With the *"Project for the improvement of health quality of food distribution companies in the Chinese Community of Prato"* different activities were carried out, such as meetings and seminars, held by local Official Veterinarians, academic staff and Chinese technicians and teachers. During the project, the CFBOs were provided with practical and useful tools to operate in compliance with the Italian and EU laws and were also shown about the changes in food safety policies occurred in PRC.

2.2 Research and academic activities.

The CSISA aims to develop joint research projects with Universities, Research Center and Institutions on topics of mutual interest by promoting the exchange of students and researchers between Tuscany and PRC, involving managers and technicians from Official Laboratories of analysis and production managers of enterprises. In particular, the Section of biotechnology applied to Food Inspection of the Department of Veterinary Sciences of Pisa has performed, together with the Chinese counterparts, studies and research concerning the management of food safety and control systems, food traceability, the detection of banned substances and residues as well as the unveiling of food frauds. In particular, the FishLab of the aforesaid Department, dealing with DNA technologies, has focused its activities on the identification of fish species. Moreover, the partnerships with Chinese researchers allowed to perform research on food sold in local markets in China and in ethnic supermarkets of the Chinese community of Florence and Prato.

3. Results obtained

The main result obtained by the cooperation is undoubtedly the mutual benefit of the parties involved. The cooperation have supported Chinese experts to develop skills and modern management systems and improve the risk assessment, the monitoring of foodborne diseases and the surveillance on food hygiene and safety. In particular, these experts could now contribute to the redevelopment and/or revising of control systems and reshaping of health care costs and management in their respective countries. For example, the Guangxi Organization in charge of food controls has developed a stronger connection with the Department of Human Health, on the model of the Italian system.

At the same time, Chinese experiences have been of great value to the Italian counterparts, especially regarding the Chinese food production systems and the safety issues affecting food products imported in EU. The Tuscany Region's Institutions have had the opportunity to broaden their experience in the Chinese supervision system of food safety and

nutrition, revising control model within the Chinese community. The CSISA's activities, carried on within the provinces of Florence and Prato, have allowed achieving an important goal as the penetration of the local strongly closed Chinese community and the removal of cultural barriers. Moreover, thanks to the Chinese technicians and teachers involved in the CSISA's exchange projects, the mistakes resulting from translation of technical language, made by unspecialized translators, have been overcome and this have stimulated, for the very first time, the debate between CFBOs and the Local Institutions. The dialogue between this two world have allowed the Italian part to better understand the lacks in knowledge and the main food hygiene problems affecting the CFBOs's activities and provide them with "problem-solving" answers and support. Thanks to this experience, a similar project is being set up for collaboration with the Chinese community of Rome, in the multicultural district of Esquilino.

As regards the research field, the joint projects have led to the publication of several articles and reviews in international scientific journals [12-16]. During their drafting and development, it was possible to explore and learn more about the Chinese food chain, traceability and fraud detection of Chinese food products. Studies and debate with the Chinese researchers have allowed to bring to light certain aspects of the Chinese food chain and food safety management and control systems, which still suffer from some deficiencies. In particular, it was possible to reveal the growing issue of mislabeling, which affects both products sold in local markets in China and in ethnic supermarkets in Florence and Prato. This issue is particularly serious in the fishing industry, a sector that has undergone a deep change in the PRC in the past decade [17-18] and that can determine important repercussions on the EU markets, considering the large quantities of seafood annually imported by the Member States.

Disputes emerging from research projects represent for the CSISA an excellent base to plan and structure its training initiatives, in order to better address the Chinese participants on the persisting problems of their Country and offer them support on the basis of the Italian and European proven experience.

Moreover, thanks to this, the Italian counterpart has fine-tuned new training methodologies and tools in order to make them as targeted as possible to the Chinese counterpart.

Considering that food safety is a topic of considerable and growing interest in PRC, the partnership between Guangxi and Tuscany Region has drawn the attention of several Asian media, especially Chinese, interested in understanding how the parties plan, structure and organize their joint activities [19]. Both the Italian and the Chinese partners have given interviews in newspapers, magazines and radios with the aim to divulge the importance of international cooperation in the field of food safety, explaining how it has contributed to improving the national management and control systems in their respective Country. Media interest, besides disclosing the Center's activities, has also greatly increased the interest of the CSISA's partners themselves and other Chinese Provinces and Asian Countries, which, once become aware of the collaboration model established, have expressed their desire to meet the CSISA's representatives, in order to establish cooperation at different levels.

DISCUSSION

Currently, the PRC is in a state of transition regarding the food safety issues, which are gradually shifting from those considered "traditional" and associated with general lacks towards those associated to the intensification and industrialization of food production, the expansion of the food processing and catering sectors and more complex supply chains [20]. This has had a considerable impact on the Chinese food management and control system as well as on the personnel responsible for inspection [20]. Worldwide, the official personnel in charge of food control has become a multiprofessional figure, with a wide range of tasks to accomplish and requiring high qualification and robust multidisciplinary education to ensure effective performances [21]. The qualifications that control Authorities should have are also specified in the EU Regulation (EC) No 882/2004 [22], according to which official controls should be carried out with appropriate techniques and by a staff properly educated and trained. In addition to "traditional" skills related to animal product inspection techniques and knowledge on the main principles of processing foodstuffs, methods of microbiological control and international veterinary legislation, the operators in the food safety control system need to possess a more complex and updated range of know how [23, 24]. This is particular true in those Countries, as the PRC, where the development of the food industry had an impressive acceleration in few years and was not accompanied by the same growth rate of food safety policies [25, 26]. In this context, it is pivotal to provide Official Authorities with modern education and training, taking into consideration the rapid developments in food industries as well as the hygiene and technology of new products [23]. Moreover, considering that the laboratory detection instruments and tasks represent a valuable support to inspective

controls is also important to train food control Authorities in the field of sampling techniques and give them a clear idea of the possibilities associated to the fast developing field of the molecular biology, analytical chemistry and immunodiagnostic, which nowadays represent fundamental tools to make more efficient the control strategies [27]. In this regard, the CSISA aims to provide advanced skills that could be relevant to participants in their daily work and the choice of the Tuscan Health System as a reference model for food safety and public health has allowed parties to achieve many of the goals set in their agreement. Currently, the main objective is the creation of a permanent and diversified training and educational offer, which the CSISA intends to pursue both through the foundation of a structured training school in Nanning (China) and Pisa and the activation of an international master on Management of Food Safety. The establishment of the training school is part of the partnership with the Guangxi Province and it will allow parties to have a point of reference for a permanent exchange of information relating to food safety and for the training of those who work at multiple levels in this sector. The international master on Management of Food Safety, which falls within the cooperation with the Zhejiang University of Finance and Economics, will involve Italian and Chinese trainers and is intended for teachers, Public Officials and managers, with the aim of giving a different vision of the objectives for food safety in PRC and creating stable relationships in research. The cooperation with the Zhejiang University of Finance and Economics will enable the CSISA to extensively work on the Chinese food safety regulatory framework, relying on a very active partner on this topic and in direct contact with provincial bodies responsible for legislative systems.

Finally, the CSISA's activities, besides deepening mutual understanding among partners in all those aspects purely related to food safety and its management, contributes to the enhancement of the commercial contacts between partners, favoring the exchanges between the PRC and Italy.

CONCLUSION

Since the establishment of the CSISA, the objectives of training and research achieved by the counterparties have been many and the intent is to continue to cooperate, expanding the areas of activity. Since the food safety falls within the primary objectives of the governmental agreements between Italy and the PRC, there are further premises to strengthen and stabilize the partnership. This is also fundamental for the definition of high-level training course not only for the Chinese counterpart, but also for the Italian one. The mutual knowledge, besides being important in the context of food productions, could improve the trade relations between Italy and PRC.

BIBLIOGRAPHY

1. Prabhakar SVRK, Daisuke S, Nalin S. Food safety in the Asia-Pacific region: Current status, policy perspectives, and a way forward. IGES White Paper, Sustainable consumption and production in the Asia-Pacific region; 2010. p. 215-238.

2. Food and Agriculture Organization of the United Nations. Assuring food safety and quality: guidelines for strengthening national food control systems. FAO, Rome, 2003 Food and Nutrition Paper No. 76. Available from: http://www.fao.org/docrep/006/y8705e/y8705e00.htm; last visited 21/07/2015.

3. Yang Y. Study of the Role of NGO in Strengthening the Food Safety and Construction of the Relevant Law. Open J Pol Sci 2014; 4: 137-142.

4. Food Standards Australia New Zealand. The Global Food Safety Capacity Building Partnership. Indicative Roadmap 2012. Available from: https://www.foodstandards.gov.au/science/international/apec/Pages/default.aspx; last visited 21/07/2015.

5. Hall DC, Nguyen-Viet H, Willyanto I, Tung DX, Chotinun S. Improving food safety in Asia through increased capacity in ecohealth. J Public Health 2013; 5: 336-40.

6. Akhtar S, Mahfuzur RS, Ashfaque H. Microbiological food safety: a dilemma of developing societies. Crit Rev Microbiol 2014; 40: 348-59.

7. Sarter S, Ho PH, To KA. Current context of food safety in Vietnam: a glance at food of animal origin. Qual Assur Saf Crop 2014; 7:57-62.

8. Jia C, Jukes D. The national food safety control system of China–a systematic review. Food Control 2013; 32: 236-45.

9. World Health Orgnization. The Work of WHO in the Western Pacific Region. Food safety: strategies and action. World Health Organization, 2014. Available from: http://www.wpro.who.int/regional_director/regional_directors_report/2014/media/2014_02_dse_03_fos.pdf; last visited 21/07/2015.

10. Wu L, Dian Z. Food Safety in China: A Comprehensive Review. Boca Raton: CRC Press; 2014.

11. Cordini G. Domestic protection of food safety and quality rights. Torino: Giappichelli Editore; 2013.

12. D'Amico P, Armani A, Castigliego L, Sheng G, Gianfaldoni D, Guidi A. Seafood traceability issues in Chinese food business activities in the light of the European provisions. Food Control 2014, 35: 7-13.

13. Armani A, Guardone L, La Castellana R, Gianfaldoni D, Guidi A, Castigliego, L. DNA barcoding reveals commercial and health issues in ethnic seafood sold on the Italian market. Food Control 2015, 55, 206-214.

14. Armani A, Tinacci L, Xiong X, Castigliego L, Gianfaldoni D, Guidi A. Fish species identification in canned pet food by BLAST and Forensically Informative Nucleotide Sequencing (FINS) analysis of short fragments of the mitochondrial 16s ribosomal RNA gene (16S rRNA). Food Control 2015; 50: 821-30.

15. Castigliego L, Li XN, Armani, A, Razzano M, Mazzi M, Rosati R, Gianfaldoni D, Guidi A. Somatotropic gene response to recombinant growth hormone treatment in buffalo leucocyte. Biol Chem 2011; 392:1145-54.

16. Castigliego L, Li XN, Armani A, Grifoni G, Boselli C, Rosati R, Gianfaldoni D, Guidi A. Hormone variations in serum and milk of buffaloes (Bubalus bubalis) as potential indicators of treatment with recombinant bovine somatotropin. J Dairy Res 2011; 78:412-20.

17. Cao L, Naylor R, Henriksson P, Leadbitter D, Metian M, Troell M, Zhang, W. China's aquaculture and the world's wild fisheries. Science 2015; 347: 133-35.

18. Charlebois S, Sterling B, Haratifar S, Naing SK. Comparison of Global Food Traceability Regulations and Requirements. Compr Rev Food Sci F 2014; 13: 1104-23.

19. Liu Pai. Guangxi e Toscana: i traguardi di Cina e Italia nella sicurezza alimentare. Cinitalia 2013, 1: 35-8.

20. FORHEAD Working Group on Food Safety. Food Safety in China: A Mapping of Problems, Governance and Research. Forum on Health, Environment and Development (FORHEAD), February, 2014. Available from: http://webarchive.ssrc.org/cehi/PDFs/Food-Safety-in-China-Web.pdf; last visited 21/07/2015.

21. Cácer SB. The roles of veterinarians in meeting the challenges of health and welfare of livestock and global food security. Vet Res Forum 2012; 3: 155-57.

22. Regulation (EC) No. 882/2004 of the European Parliament and of the Council of 29 April 2004 on official controls performed to ensure the verification of compliance with feed and food law, animal health and animal welfare rules. Official Journal of European Union, L165.

23. Balieva GN. Organizational, legislative and professional aspects of training veterinarians in food quality and safety in some member states." J Hyg Eng Des 2012; 1: 166-70.

24. Ianieri A, Borrello S, Conter M, Guizzardi S. The challenge of education for the veterinary inspector. Vet Res Commun 2008; 32: S57–S60.

25. Yasuda, JK. Why Food Safety Fails in China: The Politics of Scale. The China Quarterly 2015; 1-25.

26. Jia C, Jukes D. The national food safety control system of China–a systematic review. Food Control 2013; 32: 236-245.

27. De Beer JO, Van Poucke C. Ensuring the quality of results from food control laboratories: laboratory accreditation, method validation and measurement uncertainty. Woodhead Publishing Series in Food Science, Technology and Nutrition 2011, 203: 194-222.

Sustainable food safety and toxicant zoonoses: new prevention challenges in Global Health Governance

C. FRAZZOLI[1], A. MANTOVANI[2], R. ESPOSITO[1]

[1]External Relations Office, Istituto Superiore di Sanità, Rome Italy
[2]Food and Veterinary Toxicology Unit, Department of Veterinary Public Health and Food Safety, Istituto Superiore di Sanità, Rome, Italy

Summary - The concept of Sustainable Food Safety promotes the today's safety of foods and nutritional quality of diet within the sustainable development paradigm, i.e. without compromising the ability of the future generation to meet its own right to health. The paper discusses aspects of sustainable development introduced by novel (toxicant) zoonoses, such as (mother-to-child) transgenerational diet and challenges of healthy adulthood at birth. Health prevention/promotion in socio-ecological systems is considered as (glocal) methodological approach of research and analysis combining local aspects and priorities with complex health systems dynamics in a global health (GH) setting. Relevant and new global health governance (GHG) mechanisms implying trans-disciplinary, multi-dimension, multi-sector and multi-actors approaches are considered, also including transboundary harmonization and involvement of health and non-health sectors. The paper suggests the implementation of One Health (OH) strategies based on the contribution of all disciplines dealing with human and animal health, foods and the environment to share living resources and meet health challenges for present and future generations. In fact, governance and concepts as GHG, GH and OH are strongly related because embedded within the present globalization process.

Key words: one health, global health, determinant of health, socio-ecological systems, glocal, endocrine disrupters

Riassunto - Il concetto di Sicurezza Alimentare Sostenibile promuove la sicurezza degli alimenti e della qualità nutrizionale della dieta di oggi nell'ambito del modello di sviluppo sostenibile, ovvero senza compromettere la capacità della generazione futura di soddisfare il proprio diritto alla salute. In particolare, il lavoro discute nuovi aspetti di sviluppo sostenibile introdotti dalle nuove zoonosi associate ad esposizioni a sostanze tossiche, come la dieta transgenerazionale (madre-figlio) e le prospettive alla nascita di una vita adulta in buona salute. La salute in "sistemi socio-ecologici" è considerata come approccio metodologico di ricerca e analisi che combina gli aspetti e le priorità locali con le complesse dinamiche dei sistemi sanitari in un contesto di salute globale (glocal). Vengono considerati i nuovi meccanismi di *governance* della salute globale, che implicano approcci transdisciplinari, multidimensionali, multi-settoriali ed il coinvolgimento di differenti attori, inclusa l'armonizzazione fra ambiti diversi e i determinanti non direttamente associati alla salute. Il lavoro suggerisce l'attuazione di strategie di "salute unica" basate sul contributo di tutte le discipline che si occupano di salute umana e animale, alimenti e ambiente, per condividere le risorse e soddisfare le possibilità di salute per la generazione presente e futura. Infatti, i concetti discussi sono fortemente correlati perché incorporati all'interno dell'attuale processo di globalizzazione.

Parole chiave: salute unica, salute globale, determinanti di salute, sistemi socio-ecologici, glocal, interferenti endocrini

1. INTRODUCTION

Sustainable development (SD) is a process for making decisions today that meet human development goals while maintaining the ability of natural systems to provide the resources for the needs of the future. The term first appeared in 1987 as the "*Development that meets the needs of the present without compromising the ability of future generations to meet their own needs*" [1]. Sustainable development has been described in terms of three pillars: "economic, environmental and social" and then expanded by some authors to include as fourth pillar "culture, institutions or governance [2].

As discussed in Frazzoli *et al*. [3] the "sustainability" conceptual framework implies insight into long-term consequences but, in its current implementation, does not explicitly cover health issues. Nevertheless, scientific evidence demonstrates how sustainability implies also the public health standpoint: the "long-term capital" is associated to the prevention of risk factors spreading along generations. Progeny health, in fact, includes

Corresponding author: Dr Chiara Frazzoli,
External Relations Office, Istituto Superiore di Sanità, Via Giano della Bella 34, 00162 Rome, Italy. Tel: +39(0)649904133;
E mail: chiara.frazzoli@iss.it

pre- and post-natal development as well as their impact on the ability to lead a healthy adulthood; thus, it is inherent to sustainable development [3]. Food safety features prominently to guarantee and promote health and wellbeing of populations, and especially of such vulnerable groups as the unborn and the child. When dealing with chronic diseases, including congenital malformations and long-term effects, the definition of environmental exposure broadly include not just chemical environmental pollutants, but also diet, pharmaceuticals, stress, pre-existing disease, and use of addictive substances [4]. Following this assumption, the definitions of preventive intervention stages (primordial, primary, secondary and tertiary prevention) pivot on the broadest sense of the term "environmental" as non-genetic (although interacting with genetic factors), encompassing physical, chemical, biological and social factors, and concentrating on factors which are potentially *modifiable*.

Public health has to deal with the global issue of the epidemiological transition versus chronic diseases, which calls for an up-to-date approach to quality and safety of the environments, foods and dietary habits [5]. In this frame, scientifically sound and time- and cost-effective governance strategies and activities should be envisaged to a global scale rather than being restricted to national levels (Sustainable Global Development).

The international community (UN member states) is presently developing the *Sustainable Development Goals* (SDGs), assumed as universal targets and indicators for agendas and political policies over the next 15 years. The SDGs follow, and expand on, the millennium development goals (MDGs), which were agreed by governments in 2000. In particular, the proposed health agenda encompasses both communicable and non communicable diseases basing on the *determinants of health*. Determinants of health are factors outside the health sectors that, combined together, affect the health of individuals and communities.

The determinants of health include the sustainable development pillars such as i) the social and economic environment, ii) the physical environment, and iii) the person's individual characteristics and behaviours. While genetics should never be overlooked, whether people are healthy or not is largely determined by circumstances like where we live, the state of our environment, our income and education level, and our relationships with friends and family; conversely, more commonly considered factors such as access and use of health care services often have less of an impact [6].

Main global health challenges include also the increasing burden and spread of zoonotic diseases, involving environmental, socio-economic and ecological factors that, in their turn, are deeply influenced by globalization-driven changes [7]. Many zoonotic diseases are foodborne. According to the definition of "foodborn zoonosis" proposed by Adriano Mantovani (*Any detriment to the health and/or quality of human life deriving from relationships with (other) vertebrate or edible or toxic invertebrate animals*), toxicologically relevant chemical exposures through foods of animal origin are foodborne zoonoses. Foodborne zoonosis affect hundreds of thousands of people especially in developing countries, although most of them can be prevented. The contamination of food may occur at any stage in the process from food production to consumption ("farm to fork"), and can result from either agro-farming practices and/or -environmental contamination, including pollution of water, soil or air [7]. The prevention and control of "foodborne diseases" that are defined by WHO as *diseases of an infectious (e.g. microorganisms) or toxic (e.g. chemicals) nature caused by, or thought to be caused by, the consumption of food or water* is a pivotal step for Sustainable Food Safety (SFS), that we defined and discussed in our previous papers as *the complex of actions intended to minimize adverse health impact on future generation associated to today's safety of foods and nutritional quality of diet* [3].

Ecological, economic, and social systems, are interlinked and indivisible. Multidisciplinary researches on "social-ecological systems" show that human communities are component of and characterize ecosystems. In turn, people and societies need "socio-ecological systems" to supply resources and provide services [8-10]. Moreover, health in socio-ecological systems is influenced by the determinants of health; the control of determinants that more and more affect health by factors outside the control of the health sector (e.g. education, environment, socio-economic status, etc.), cannot be assured through actions at national level alone, since such determinants are influenced by the global context [11].

Present globalization processes as people migration, trade, spread (and "melting") of information, life styles, dietary habits and consumers' preferences, etc. are occurring in a very much faster ways than before. Poorly communicating systems are now linked through multifaceted "socio-ecological factors", and actions taken in (geographically, culturally) far scenarios are now affecting the global "socio-ecological systems" in unexpected ways [12, 13]. Certainly, the relationship and reciprocal dependence also in term of space and time between human and ecological systems are greatly changing [14]. For instance, it is recognized how the levels of

many toxic and persistent organic pollutants are affected by the degree of socioeconomic development, e.g. the rapid economic growth and implementation of information and communication technologies (ICT), whose waste and residues are not appropriately managed [15].

To succeed in realizing the global health agenda, the international and global community needs to undertake five challenges [16]:

1) ensure guidance for inter-sectoral collaboration and coordination on the social, economic and political drivers of health;

2) shift the attention from treatment to prevention through bottom-up approaches;

3) identify effective processes to deal with the commercial determinants of health;

4) ensuring integration of rights-based methods; and

5) identify and strengthen governance approaches.

2. Transgenerational sustainability of health: the global health Milieu

As discussed in Frazzoli *et al*. [3], the concept of SFS fosters the concept of sustainable development in food safety. The concept of "sustainable" should clearly include the needs of future generations in term of unimpaired potential for growth, development and health. Mother-to-child transgenerational diet includes the diet of women in childbearing age building their body burden of nutrients and toxicants as well as the diet of pregnant and breastfeeding women (Fig. 1). Evidence-based assessments indicate that the burden of endocrine, metabolic and reproductive diseases is related not only to individual lifestyles but also to "living environment" factors, and that the developmental window critically influences the risk in adult life; hence, such disease burden is also a SFS issue [3; 17].

For instance, the use of chemicals that may solve short-term problems, such as pest control, but that can also accumulate into the environment along time must be carefully assessed. Similarly, activities that produce in the long run a significant output of significant toxic waste should be kept under control in a timely way. Indeed all sort of practices that may have adverse impacts in the long term, may also eventually result in a wider gap between developed and developing countries, hence increasing global inequality. Developed countries have systems in place that protect the safety of environments and foods; however, undesirable products, substances and wastes may be marketed or dumped to countries

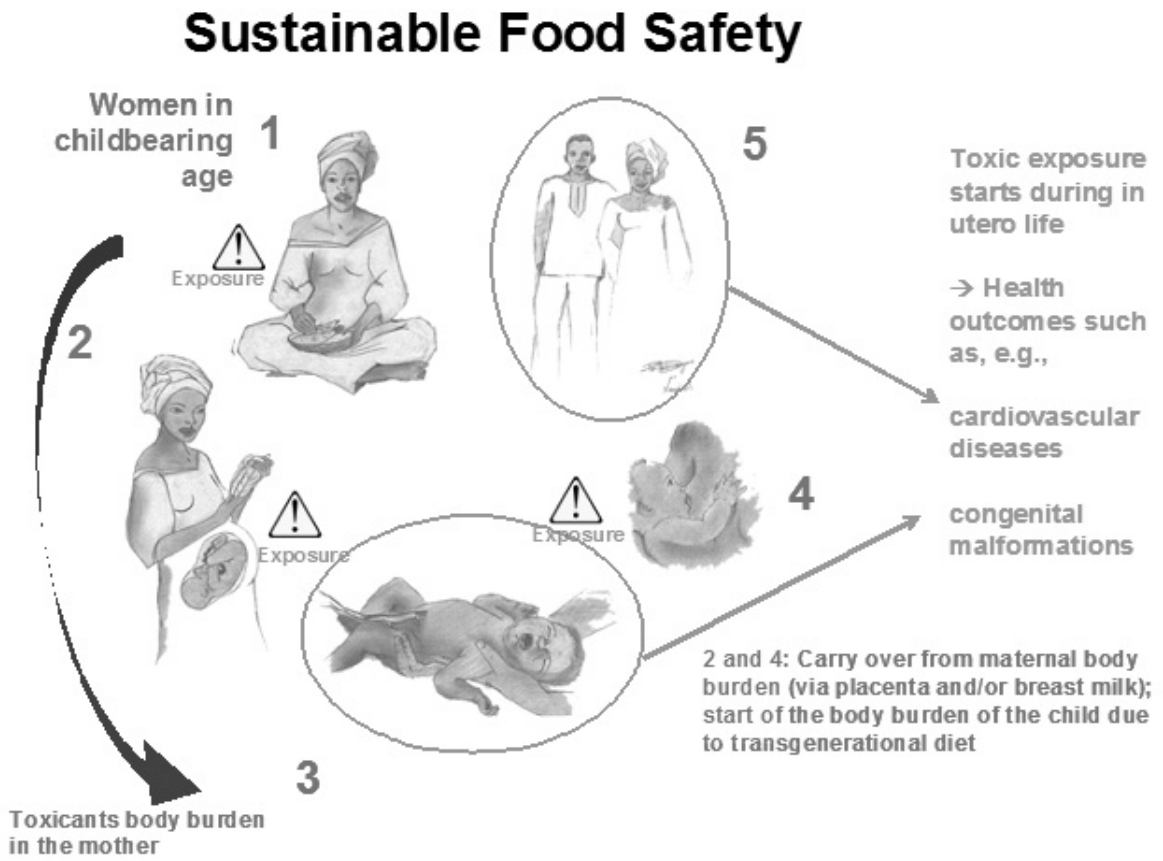


Figure 1 - Sustainable food safety: life cycle phases of particular importance for prevention and transgenerational health outcomes © Noodles.Onlus.

where such systems have still to be set [18, 19]. The application of the sustainability concept means devoting knowledge and resources to control programmes of food and environment that take into account also long term risks for the next generation. Endocrine disrupting compounds (EDCs), defined as substances or mixtures that can cause adverse health effects through hormone-related mechanism(s) in an intact organism, or its progeny, are the current major example of toxicological hazards eliciting long-term effects upon intrauterine exposure [20, 21]. The potential of EDCs for multiple exposure through the food chains as well as for multiple developmental targets is exemplified by their heterogeneity [22, 23].

Indeed, EDCs include persistent organic pollutants that are able to bioaccumulate (dioxins, polychlorinated biphenyls - PCBs, DDT and related pesticides), compounds used in plant and/or animal production (pesticides and antiparasitic drugs such as dicarboximides, triazoles, triazines and some organophosphorus insecticides), chemicals still widely present in industrial and/or consumer products (brominated flame retardants, phthalates, bisphenol A, etc). Anabolics used in cattle production, and currently forbidden in the EU, are also EDCs. Moreover, concern is increasing towards hormone-related effects of heavy metals chemical forms/species (especially arsenic and cadmium) as well as of plant-derived compounds that can be present in foods as natural components (e.g., soil phytoestrogens used in supplements) or undesirable substances (e.g., the mycotoxin zeralenone). EDCs may contaminate food chains according to several scenarios: some are forbidden in industrialized Countries but still persist in the environment (e.g., DDT), others are allowed and monitored in food control programmes even though current maximum residue limits may need an update (e.g., several pesticides), yet others are widespread but control over dietary exposure is still limited (e.g., bisphenol A). Another example is the use of PCBs, that is prohibited in OECD countries but, due to their past widespread use in Electrical and Electronic Equipments (EEEs), can be still found in e-waste from past generation of EEEs. According to the European "from farm-to-fork" approach, the safety of the whole food chain contributes to the dietary intake of chemicals. In this context, the possible presence of EDCs in feeds (mycotoxins, pesticides, bioaccumulating chemicals, components of feed ingredients or additives) may lead to consumer's exposure as well as to reduced production of foods of animal origin due to impaired animal health; according to several scientific papers [24-26] as well by the FAO/WHO [27].

EDCSs in feeds calls for assessment and management strategies driven by both "One Health" and SFS conceptual frameworks [23].

To put this in action, there are some requirements, including: joint projects for transfer of technologies and strategies; training of personnel in methodologies as well as in risk assessment; transnational collaboration programmes to control global pollution issues, e.g., dioxins. Protecting the population as well as the next generation from long term risks associated with food needs updating of animal health and food and feed control plans; the key words are integration of different data collection in order to assess the environment-animal food chains as well as the development of relevant indexes and indicators to be adopted in routine control of food derived hazards. Along with this, toxicological risk-to-nutritional benefit approach is required; as exemplified by seafood and aquaculture, attempts to reduce chemical exposures only through monitoring and control may decrease the access to valuable dietary resources. Conversely sound approaches based on the prevention and reduction of contamination sources (e.g., feed ingredients) may support the availability of fish with its content of nutrients [26, 27].

Risk-to-benefit analysis has to take into account the specific scenarios and needs (in terms of nutritional and food security) of each country and no fixed rules can be given, but only a general guidance.

The interdisciplinary approach to food safety and nutrition fosters the collaboration with a discipline as geomedicine. For instance, in African countries during the past decades the national strategies on essential nutrients focused on direct supplementation (iodized salt, Iron and vitamin A) in pregnant women. Whereas the benefits of nutrient supplementation are undeniable, a more comprehensive involvement and empowerment of the farming and livestock system has been overlooked until now, thus limiting the potential of local animal farming in supporting - through improved animal health- nutritional security and the health of the general population, including the promotion of next generation's health. Geomedicine shows substantial scientific evidence supporting a protective action by geonutrients naturally present in the soil towards infectious and chronic diseases. When soils do not ensure an adequate supply of essential trace elements to the feeding of food producing animals the risks related to nutrients' deficiencies or unbalances may substantially increase. For instance, Total Diet Studies may disclose a specific problem of deficiency in the human diet, thus indicating a deficient soil and a poor intake by food producing animals. Different essential chemical elements present in the soil are essential for reproduction and intrauterine

development, in particular for thyroid function and body systems coping with environmental hazards such as immune function and response to oxidative stress. Examples include iodine, selenium, Zinc and Copper. Moreover, a balanced intake through a healthy food chain is more effective than supplementation with individual oligonutrients; for instance, a high intake of a specific trace element may worsen the deficiency of another essential element, as it occurs between Copper (Cu) and Zinc (Zn). The potential interference by major toxic elements (Cd, Hg and Pb) should also be considered: these environmental pollutants accumulate in feeds and living animals and may increase nutritional requirements in humans by affecting nutrients metabolism. The measurable health outcomes that can be relevant to primary or secondary deficiency [28] in the mother-child dyad are:

- Birth defects, e.g. Neural Tube Defects (NTDs) and heart anomalies, that are considered a global health problem by WHO [29, 30]
- Congenital hypothyroidism (I but also Se are essential for the biosynthesis of thyroid hormones) which can range from the severe forms to slight but much more widespread impairments of neurobehavioural developments
- Children cardiomyopathies (including myocardial necrosis, as from the example of Keshan disease in China associated with Se deficiency)
- Increased risk of paediatric lymphomas such as Burkitt's lymphomas, which might be related to impaired development of immune function [31, 32]
- Increased risk of vertically-transmitted HIV or malaria [33].

2.1. The levels of prevention

A modern and more scientific approach to prevention emerged with the development of "public health" principles during the middle of 19th century in England, Europe and USA. The public health concept evolved as a component of social reforms and from the progresses of the understanding of biological and medical cause and management of infectious diseases. In its modern definition, that follows the first one given by Winslow (1920), public health is *one of the efforts to protect, promote and restore the people's health. It is the combination of sciences, skills and beliefs that is directed to the maintenance and improvement of the health of all the people through collective or social actions* [34].

More recently, with the significant increase of international transports, trade, relationships among countries and development aids it has been defined a new term "international health" to respond to the new needs of prevention. Merson *et al.* [35] define "international health" as *the application of the principles of public health to problems and challenges that affect low and middle-income countries and to the complex array of global and local forces that influence them.*

The increased pace of the globalization process during the last years required the development of new mechanisms and concepts to ensure prevention at national, regional and global level: the "global health" [36]. "Global health" deals with population's health in a global setting and health issues that go beyond the borders of the single nations and have a global impact at political and economic levels. "Global health" emphasizes health improvement and equity to achieve "health for all" worldwide.

The new "global health" concept [36] has similarities with areas of public health and international health. The three concepts share the following features: i. focus on populations and on prevention, ii. emphasize on underserved populations, iii. multidimensional, transdisciplinary and trans-sectoral approaches, iv. stress the importance of health as a good for the society, and of systems and structures, v. participation of multiple actors and stakeholders. The common features characterize the main principles of the present approaches to prevention. Finally, Koplan *et al.* [37] directly compare the features of public health, international health and global health, i.e. geographic boundaries, cooperation level, health intervention on populations, access to health, and trans-disciplinary level to clarify the different ranges of action. In particular, geography ranges from specific communities or countries (public health), to issues outside of one's own country (international health), to health issues that transcend national boundaries (global health); cooperation ranges from national (public health), to bi-national (international health), to global (global health); intervention ranges from prevention (public health), to prevention and clinical care (international health and global health); access to health ranges from equity within a nation or community (public health), to help to other nations (international health), to equity among nations (global health); trans-disciplinary ranges from the particular focus on health and social sciences (public health), to few disciplines (international health), to highly interdisciplinary and multidisciplinary (global health) [37].

Interestingly, this useful clarification of public health, international health, and global health features also highlights how local and global are combined and possibly subject to governance.

2.2. The stages of prevention

Prior of any discussion on strategies to effectively identify and manage prevention activity, the stages of prevention should be defined. In particular, *primordial (or primal) prevention* consists of actions to inhibit the establishment factors (environmental, economic, social, behavioural, cultural, ethical) known to determine hazards to health or increase the risk of disease). It addresses broad health determinants and advocating for them, e.g. legislation and enforcement to ban or control the use of hazardous products (e.g. asbestos), outlawing hazardous products, environmental remediation, routine biomonitoring, Total Diet Studies, evidence-based fortification of agricultural soils, feeds and/or foods, promotion of a healthy lifestyle in childhood; the new knowledge in molecular biology (in particular epigenetics) points to how much physical as well as affective environments during foetal and newborn life may determine adult health [3]. Differently from primordial prevention, that is passive, *primary prevention* pivots on the individuals' proactivity and non-clinical life choices. It includes a wide range of interventions aimed at reducing diseases occurrence, risks or threats to health by preventing exposures to hazards by both altering unhealthy or unsafe behaviours, awareness raising and/or increasing resistance to disease (e.g. dietary integrations, nutrients to contaminants interactions, see [28]). Empowerment is the step following awareness and implies the knowledge and adoption of health-promoting behaviours; important examples are the empowerment of women at childbearing age towards healthy and safe diets and lifestyles [38] and that of farmers toward good production practices [39]. On the following stage, *secondary prevention* aims to reduce the impact of a disease that has already occurred. This is done by early detecting pre-clinical pathological changes and promptly treating disease as soon as possible to contain its progress, encouraging personal strategies to prevent reinjury or recurrence, and implementing programs to return people to their original health and function to prevent long-term problems. Finally, *tertiary prevention* aims to soften the impact of an ongoing illness that has lasting effects. This is done by helping people manage long-term, often-complex health problems in order to improve as much as possible their ability to function, their quality of life and their life expectancy. Healthy environment is still important to support secondary and tertiary prevention; for instance, cigarette smoking and high body burden of the bioaccumulating PCB both significantly increased the risk of breast cancer recurrence in a cohort of US women [40].

Prevention requires knowledge of environmental health factors affecting potentially more vulnerable groups (e.g., more exposed groups or children, in utero life, subject with disease), or susceptible groups (e.g., socio-economically disadvantaged communities). Food is one living environment factor that is shared by the whole general population; food safety is connected with environmental health, lifestyles and socio-economic status [3].

2.3. One Health (OH): a sustainable development strategic tool

The American Veterinary Medical Association defines OH as the *joint effort of different discipline and sectors working at national, regional and global level, to achieve the best possible health for communities, animals and the environment* [41]. The OH concept acknowledges that the human and animal health and environment are linked and interrelated. Only during the last ten years, the world went through many major biological threats as SARS and Mers-CoV, H5N1 and H7N9 avian influenza, the influenza pandemic by H1N1 in 2009, Ebola disease virus outbreaks, rabies, etc. The present OH approach is a constructive development that followed the exceptional response to the Highly Pathogenic Avian Influenza by H5N1 influenza virus threat in 2005. About 60% of the human infectious diseases are of animal origin (the so called classical zoonosis), and 70% of the modern emerging infectious diseases (EID) are also of animal origin and their number is escalating considerably over time. EID and zoonotic infectious diseases are a substantial burden on the world economies and people health. Furthermore, since the globalised ways of transportation and commercialization allow an unprecedented and exponential increase of contacts between people and animals around the world raising number of infective contacts, many EIDs constitute serious Emerging Pandemic Threats (EPTs), e.g. the recent Ebola outbreak in West Africa, and represent real challenges to health, economics and security.

The continue emergence of health threats with pandemic high risk requires strategic cross-sectoral and multi-disciplinary approaches to ensure societal resilience (i.e. socio-economic security). The validity of the OH approach is recognised not just in the infectious diseases context, but also in dealing with toxicant-related human health threats [7]. Accordingly, the concept of zoonoses is currently extended to all human health effects related to noxious factors from animals and animal products; therefore, zoonoses now includes food-borne health disorders linked to chemical exposures. Differences and similarities between infectious and toxicant-related foodborne zoonoses have been analysed by Frazzoli and Mantovani [7]: among differences the authors discuss such aspects as: i) surveillance plans

for toxicant related zoonoses, that often point at quantifying the agent level in foods without paying attention to relevant health effects on both animals and humans), ii) detected levels of toxicant zoonoses agents are generally compared with 'safe' (acceptable/tolerable) limits, which are, in most cases, established on the basis of toxicological experiments using a precautionary approach; as a consequence, levels of potential toxicants may be detected that are of no concern for consumer safety, as they are below the 'safe' limits, iii) toxic hazards may arise from the (incorrect) intended use of chemicals such as antibiotics, antiparasytic drugs or feed additives, whereas any 'intended' use of infectious zoonotic agents is most unlikely, and iv) specific concepts and terms, such as incubation and reservoir for infectious zoonoses and residues and bioaccumulation for toxicant-related zoonoses, v) in general, toxicant-related zoonoses are not readily discernable neither on animal nor human populations; no acute foodborne illness is to be expected, whereas they may reveal their health effects in the long time. Thus, toxicant-related zoonoses are much less amenable to effective diagnosis and treatment. Among similarities, the authors highlight how:

i) the noxious agent is transmittable from the animal to the consumer; therefore the physiology and metabolism of the living animal organism are critical components of human exposure;

ii) the onset and extent of the risk is strongly associated with characteristics of the productive chain (feed, living environment of farm animals, social and cultural features); therefore, both infectious and toxicant-related zoonoses are prone to be managed within the same prevention and control framework;

iii) the basic conceptual framework of risk assessment is the same, where effects have to be identified and their relationship with dose established, exposure/ carry over scenarios have to be outlined as well as worst cases have to be characterized; indeed, toxicant-related zoonoses may be considered as communicable due both to carry over from food producing animals to human, and the mother-child transmission of several major pollutants;

iv) critical agent/animal (or animal product) pairs are identifiable: examples are Campylobacter/ poultry, Campylobacter/milk and perfluorinated organic compounds/fish. Thus, in both cases such pairs are major determinants for the exposure management and hence, for risk prevention and control.

3. Global Health Governance

The complex picture of a globalised world requires improved governance of health at regional and worldwide level. Therefore, new rules, mechanisms, actors and probably even new institutions are required to manage and govern health polices at local, national, regional and global levels. There is a widespread conviction that the present system of international health governance is inadequate to deal with the present global multidimensional needs and instead a new order around a concept of "global health governance" (GHG) need to be introduced. Global Health Governance concerns the activities and mechanisms that a society can adopt to promote and protect people health [42]. Critical elements of GHG are [43]:

1. need of engaging in issues that ignore national boundaries and even sub-regional and regional geographical areas and become global (e.g. GH issues as contaminated areas, ethics in global trade of products and animals, etc.)
2. need of tackling the determinants of health with multi-sectoral and trans-disciplinary approaches (e.g. OH) by engaging and collaborating with a wider range of players as civil society, business, etc.
3. need of updating the global health agenda with multidimensional challenges posed by (often interrelated) diffusion of exposures to infections and toxicants and their related health outcomes.

While there is a wide agreement on OH concept, definition and, with less evidence, operational approach, the definition of GH is still object of discussion and there is still no clarity on its conceptualization. Global Health has been defined as *an area of study, research, and practice that places a priority on improving health and achieving equity in health for all people worldwide* [36], but a successive revision clarifying and including the following factors is the most accepted [37]:

i) Health care actions across all sectors, and multiple disciplines;

ii) Collaborative actions among different actors and institutions addressing health topics with a wide range of health and non-health determinants;

iii) Actions that go beyond national boundaries;

iv) Research and evidence based actions;

v) Actions focused on prevention and public health initiatives;

vi) "Health for all" referring to equity issues and primary health care.

The modern global world has drastically reduced some major health threats, either infectious (pox, rabies, poliomyelitis, etc.) and non-infectious (endemic goiter, pellagra, occupational poisonings): infant mortality, education, availability of proteins and lifespan have overall increased. Yet, new, more complex and even previously challenges for people health do arise. Examples are the epidemiological transition from infectious diseases (IDs) to non-

communicable diseases (NCDs) in high income countries, the multiple epidemiological transitions with co-existence of IDs and NCDs in low income countries experiencing also under-nutrition and reproductive health problems, the - climate changes, the environmental disruption; in addition the interplay among such factors as regulations (much more advanced in some world areas like the EU, compared to other areas, like sub-Saharan Africa), trade policies, faster transportation, and globalization of products may favour the spread of hazardous products in less safeguarded world area, e.g. plastics products in contact with food [19] and plastic and metallic waste in contact with the environment [20].

For instance, as discussed by Frazzoli and Mantovani [7], communicable and non-communicable food-borne zoonoses do elicit different global health scenarios. The spreading of communicable zoonoses -classically related to infectious agents- is characterized by the space-dimension perspective (and epidemics); the spreading of non-communicable food-borne zoonoses -related to toxic agents- is more likely to imply the time-dimension perspective, with increased health risks in the long-term as well as for the next generation. Indeed, the widespread, combined and repeated exposure to dietary toxicants such as EDC may require to broaden the population to be protected, in order to reduce the detrimental heritage to future generations [3, 7].

Growing evidences demonstrate how health is heavily affected by factors outside the traditional control of the health sector (non-health determinants of health). As mentioned in the definition of primordial prevention, both health and non-health determinants of health (e.g. social, environmental, economics, cultural, etc.) must be taken in close consideration as governance factors.

The dissemination of science-based and sound approach should be implemented among regulators and policy makers in developing/emerging Countries, to decrease the gaps in healthy life expectancy between developing and developed countries, and to foster the global efforts to protect the chance for a healthy adulthood for all newborns, also through improved animal and environmental health. Common barriers to accessing information includes lack of education, language barriers, and lack of information and communication technology supporting information as faster and useful preventive measure.

3.1. Global Health and One Health: commonalities in governance

Relationships and commonalities/cross over issues exist between the concepts and definitions of GH and OH, and these impact on how they can features in health governance at global level. Governance of both concepts requires mechanisms of science-based interventions that are: i. supranational, ii. multidisciplinary, iii. multisectoral, iv. multi-actors and setting equity.

Also, their definition should be clarified in respect to the definition of GHG to define strategies, needed skills and rebuilding priority settings and resource allocation as well as to properly evaluate the expected results by addressing knowledge and resources towards innovative intervention approaches and updated control strategies. In particular, the OH approach is crucial in the prevention and control of zoonotic diseases and its implementation can be even more effective if a broader GH and GHG framework is taken into consideration. Finally, recognised benefits of policies combining top down/downstream and bottom up/upstream interventions based on participative communication at community level are pivotal to foster effective public perception of long-term and transgenerational health effects of novel zoonoses.

CONCLUSION

The attention to environmental and food-borne chemical risks is not a "luxury" reserved to industrialized Countries: the increasing obesity and infertility incidence is only an example of how the health risk patterns are changing worldwide. The discussion shows how the concepts of GHG, GH and OH are strongly related: they are embedded within the same reality, a globalised world. Elements that strongly characterise the three concepts are mainly the "trans-disciplinary and multi-sector approach", focusing on the health determinants and the necessity to involve multiple "actors". All these elements are feature of global dynamics and are strongly required in any strategy to be implemented in a global context, from the prevention and control of EID to toxicants zoonosis. Weak points are definition of strategies and possible activities to be undertaken: indeed, the discussion on new and more affordable impact indicators and health indicators are currently under study. Among the three concepts, the conceptualisation and operationalization of OH are the most advanced and can constitute the framework for the broader concepts of GH and GHG. A more methodical approach the "health in social-ecological systems" (HSES) should be considered. HSES is an interdisciplinary study of multifaceted relations among all health-related areas and sectors goes beyond OH and so it is more "global". Sustainable food safety is a new interventions framework for

prevention policies that, by targeting women in childbearing age, addresses transgenerational health sustainability and meets the Millennium Development Goal of both reducing infant morbidity and mortality and increasing life expectancy at birth worldwide. This is a particular emergence issue in many low–income countries where legislation and infrastructure for the management of food safety is still immature or even non-existent: here, both know how in risk analysis and the development of institutional frameworks are imperative.

ACKNOWLEDGEMENTS

The paper stems from the activities of the North-South and South-South network NOODLES (Nutrition & food safety and wholesomeness. Prevention, education and research network, www.noodlesonlus.org) and has been developed in the frame of the One Health activities of the project ALERT (www.alert2015.it) funded by the Italian Ministry of Economic Development under the Call "Industria 2015".

REFERENCES

1. World Commission on Environment and Development's, the Brundtland Commission. Report Our Common Future. Oxford: Oxford University Press; 1987.

2. United Nations. Prototype Global Sustainable Development Report (Online unedited ed.). New York: United Nations Department of Economic and Social Affairs, Division for Sustainable Development; 2014.

3. Frazzoli C, Petrini C, Mantovani A. Sustainable development and next generation's health: a long-term perspective about the consequences of today's activities for food safety. Annali dell'Istituto Superiore di Sanità 2009; 45:65-75.

4. National Institute of Environmental Health Sciences. Advancing Science, Improving Health: A Plan for Environmental Health Research (Strategic plan 2012-2017); 2012.

5. Magnusson RS. Non-communicable diseases and global health governance: enhancing global processes to improve health development. Globalization and health 2007; 3: 2.

6. CSDH. Closing the gap in a generation: health equity through action on the social determinants of health. Final Report of the Commission on Social Determinants of Health. Geneva, World Health Organization; 2008.

7. Frazzoli C, Mantovani A. Toxicants Exposures as Novel Zoonoses: Reflections on Sustainable Development, Food Safety and Veterinary Public Health. Zoonoses and Public Health 2010; 7-8:e136-e142.

8. Berkes F, Folke C. Linking social and ecological systems: management practices and social mechanisms for building resilience. Cambridge: Cambridge University Press, UK; 1998.

9. Ostrom, E. A general framework for analyzing sustainability of social-ecological systems. Science 2009; 325:419-422.

10. Folke C, Jansson Å, Rockström J, Olsson P, Carpenter SR, Chapin FS, Crépin AS, Daily G, Danell K, Ebbesson J, Elmqvist T, Galaz V, Moberg F, Nilsson M, Österblom H, Ostrom E, Persson Å, Peterson G, Polasky S, Steffen W, Walker B, Westley F. Reconnecting to the biosphere. Ambio 2011; 40: 719-738.

11. Krumeich A, Meershoek A. Health in global context; beyond the social determinants of health? Global Health Action 2014; 7: 1-8.

12. Biggs D, Biggs R, Dakos V, Scholes RJ, Schoon M. Are we entering an era of concatenated global crisis. Ecology and Society 2011; 16:27.

13. Meyfroidt P, EF Lambin, KH Erb, TW Hertel. Globalization of land use: distant drivers of land change and geographic displacement of land use. Current Opinion in Environmental Sustainability 2013; 5: 438-444.

14. Helbing D. Globally networked risks and how to respond. Nature 2013 ; 497: 51-59.

15. Luzardo OP, Boada LD, Carranza C, Ruiz-Suárez N, Henríquez-Hernández LA, Valerón PF, Zumbado M, Camacho M, Arellano JL. Socioeconomic development as a determinant of the levels of organochlorine pesticides and PCBs in the inhabitants of Western and Central African countries. Science of the Total Environment 2014; 12:97-105.

16. Dodgson R, Lee K, Drager N. WHO, Dept of Health and Development, Centre on Global Change and Health, London School of Hygiene and Tropical Medicine, Global Health Governance, A Conceptual Review, 2002.

17. Heindel JJ,vom Saal FS, Blumberg B, Bovolin P, Calamandrei G, Ceresini G, Cohn BA, Fabbri E, Gioiosa L, Kassotis C, Legler J, La Merrill M, Rizzir L, Machtinger R, Mantovani A, Mendez MA, Montanini L, Molteni L, Nagel SC, Parmigiani S, Panzica G, Paterlini S, Pomatto V, Ruzzin J, Sartor G, Schug TT, Street ME, Suvorov A, Volpi R, Zoeller RT, Palanza P. Parma Consensus Statement on Metabolic Disruptors. Environmental Health 2015; 14:54.

18. Pouokam GB, Ajaezi GC, Mantovani A, Orisakwe OE, Frazzoli C. Use of Bisphenol A-containing baby bottles in Cameroon and Nigeria and possible risk management and mitigation measures: community as milestone for prevention. Science of the Total Environment 2014; 481:296–302.

19. Frazzoli C, Orisakwe OE, Dragone R, Mantovani A. Diagnostic health risk assessment of e-waste on the general population in developing countries' scenarios. Environmental Impact Assessment Review 2010; 30:388–399.

20. Mantovani A. Risk assessment of endocrine disrupters. The role of toxicological studies. Annals of the New York Academy of Sciences 2006; 1076: 239-252.

21. Latini G, Knipp G, Mantovani A, Marcovecchio ML, Chiarelli F, Söder O. Endocrine disruptors and human health. Mini-Reviews in Medicinal Chemistry 2010; 10: 846-855.

22. Mantovani A, Proietti I. Occurrence of endocrine disrupters in food chains. In: Pongratz I, Bergander L (Eds.) Hormone-Disruptive Chemical Contaminants in Food. Issues in Toxicology, n. 9. RSC Press; 2011. p. 199-215.

23. Frazzoli C, Asongalem EA, Orisakwe OE (Eds.). Cameroon-Nigeria-Italy scientific cooperation: veterinary public health and sustainable food safety to promote "One Health/One Prevention. Roma: Istituto Superiore di Sanità; Rapporti ISTISAN 12/49; 2012.

24. Mantovani A, Frazzoli C, La Rocca C. Risk assessment of endocrine-active compounds in feeds. Veterinary Journal 2009; 182: 392-401.

25. Mantovani A, Frazzoli C. Risk assessment of toxic contaminants in animal feed. CAB Reviews: Perspectives in Agriculture, Veterinary Science, Nutrition and Natural Resources 2010; 5: 1-14.

26. Mantovani A, Ferrari D, Frazzoli C. Sustainability, security and safety in the feed-to-fish chain: focus on toxic contamination. International Journal of Nutrition and Food Sciences 2015; 4: 6-24.

27. Food and Agriculture Organization of the United Nations (FAO) and the World Health Organization (WHO). Executive summary of the report on Joint FAO/WHO expert meeting on hazards associated with animal feed (12-15 May 2015, FAO). Codex Alimentarius Commission CAC/38 CRD/34.

28. Frazzoli C, Bocca B, Mantovani A. The one health perspective in trace elements biomonitoring. J Toxicol Environ Health B Cri Rev 2015; 18(7-8): 344-70.

29. Zhang BY, Zhang T, Lin LM, Wang F, Xin RL, Gu X, He YN, Yu DM, Li PZ, Zhang QS, Zhao J, Qin YF, Yang XF, Chen G, Liu JF, Song XM, Zheng XY. Correlation between birth defects and dietary nutrition status in a high incidence area of China. Biomedical and Environmental Sciences 2008; 21:37-44.

30. Martín I, Gibert MJ, Pintos C, Noguera A, Besalduch A, Obrador A. Oxidative stress in mothers who have conceived fetus with neural tube defects: the role of aminothiols and selenium. Clinical Nutrition 2004; 23:507-514.

31. Sumba PO, Kabiru EW, Namuyenga E, Fiore N, Otieno RO, Moormann AM, Orago AS, Rosenbaum PF, Rochford R. Microgeographic variations in Burkitt's lymphoma incidence correlate with differences in malnutrition, malaria and Epstein-Barr virus. British Journal of Cancer 2010; 103: 1736-1741.

32. Cavdar AO, Gözdasoglu S, Babacan E, Mengübas K, Unal E, Yavuz G, Taçyildiz N. Zinc and selenium status in pediatric malignant lymphomas. Nutr Cancer 2009; 61(6): 888-90.

33. Kupka R, Msamanga GI, Spiegelman D, Rifai N, Hunter DJ, Fawzi WW. Selenium levels in relation to morbidity and mortality among children born to HIV-infected mothers. European Journal of Clinical Nutrition 2005; 59: 1250-1258.

34. Last J. A dictionary of epidemiology. New York: Oxford University Press; 2001.

35. Merson MH, Black RE, Mills AJ. International public health: diseases, programs, systems, and policies, 2nd edn. Sudbury MA: Jones and Bartlett Publishers; 2006.

36. Beaglehole R, Bonita R. What is global health? Global Health Action 2010, 3: 13-23.

37. Koplan JP, Bond T, Merson M, Reddy K, Rodriguez M, Sewankambo N. Towards a common definition of global health. Lancet 2009; 373: 1993-1995.

38. Taruscio D, Arriola L, Baldi F, Barisic I, Bermejo-Sánchez E, Bianchi F, Calzolari E, Carbone P, Curran R, Garne E, Gatt M, Irgens L, Latos-Biele_ska A, Khoshnood B, Mantovani A, Martínez-Frías ML, Neville A, Rißmann A, Ruggeri S, Wellesley D, Dolk H. European recommendations for primary prevention of congenital anomalies: a joined effort of EUROCAT and EUROPLAN projects to facilitate inclusion of this topic in the National Rare Disease Plans. Public Health Genomics 2014; 17: 115-123.

39. Frazzoli C, Mantovani A, Dragone R. Local role of food producers' communities for a Global One-Health framework: the experience of traslational

research in an Italian dairy chain. Journal of Agricultural Chemistry and Environment 2014; 3: 14-20.

40. Muscat JE, Britton JA, Djordjevic MV, Citron ML, Kemeny M, Busch-Devereaux E, Pittman B, Stellman SD. Adipose concentrations of organochlorine compounds and breast cancer recurrence in Long Island, New York. Cancer Epidemiology, Biomarkers & Prevention 2003; 12: 1474-1478.

41. The American Veterinary Medical Association, One Health initiative task force. Final report, One Health: A New Professional Imperative; 2008.

42. Jones KE, Patel NG, Marc A, Levy MA, Storeygard A, Balk D, Gittleman JL, Daszak P. Global trends in emerging infectious diseases. Nature 2008; 451: 990-993.

43. Norström AV, Dannenberg A, McCarney G, Milkoreit M, Diekert F, Engström G, Fishman R, Gars J, Kyriakopoolou E, Manoussi V, Meng K, Metian M, Sanctuary M, Schluter M, Schoon M, Schultz L, Sjöstedt M. Three necessary conditions for establishing effective Sustainable Development Goals in the Anthropocene. Ecology and Society 2014; 19: 8.v).