THE ROLE OF VETERINARIANS IN THE PREVENTION AND MANAGEMENT OF FOOD-BORNE DISEASES, IN PARTICULAR AT THE LEVEL OF LIVESTOCK PRODUCERS

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Summary: A questionnaire-based survey was distributed to OIE Member Countries to assess the role of veterinarians in contemporary food safety risk management, particularly at the level of livestock producers. Almost all countries reported that food safety was a priority public health issue, and veterinarians in animal health authorities, food safety authorities, private practice, academia and industry all provided essential inputs. Evidence of systematic application of a generic framework for managing food-borne risks was sporadic. Veterinarians involved in making risk-based decisions will increasingly have to work within multidisciplinary teams, and food safety regulatory reform in a number of countries is providing new opportunities and responsibilities. The study revealed marked differences in the range and intensity of food safety programmes in different countries, including the extent of veterinary involvement. At the level of international standard setting, developing countries were markedly less represented than developed countries.

1. INTRODUCTION

In recent years the development of risk-based concepts has led to fundamental changes in approaches to food safety. The emergence of risk assessment as an objective scientific process offers new opportunities to risk managers and other interested parties in the design and implementation of optimal food safety programmes. Further, the systematic application of a generic framework for managing risks is increasingly being recognised at the international and national level as the most appropriate means of bringing about an on-going reduction in risks to human health. These improvements must be brought about in the face of ever-changing patterns of primary production, processing technology, and consumer expectation.

Changes in approaches to food safety are especially apparent at the international level. The Codex Alimentarius Commission (CAC) elaborates standards, guidelines and related texts that collectively contribute to both export and import food safety programmes. The OIE has the parallel responsibility of developing standards, guidelines and related texts for the international trade in animals and animal products, and developing guidelines for the prevention, control and eradication of zoonoses (17).
Ensuring consumer safety in this contemporary environment is a multidisciplinary responsibility. Effective management of food-borne hazards requires a ‘production-to-consumption’ approach involving all interested parties. The objective of this paper is to describe the contemporary food safety environment and illustrate the rapidly changing role of veterinarians in the prevention and management of food-borne diseases of animal origin. Veterinary involvement at the level of livestock production is a particular focus. A questionnaire was sent to all OIE Member Countries. A total of 96 responses were received from the following countries:

Albania, Algeria, Andorra, Argentina, Australia, Austria, Armenia, Azerbaijan, Bangladesh, Belarus, Belgium, Bhutan, Bolivia, Bosnia and Herzegovina, Brazil, Burkina-Faso, Canada, Central African Republic, Chile, Colombia, Congo, Costa Rica, Côte d’Ivoire, Croatia, Cyprus, Czech Republic, Denmark, Dominican Republic, Ecuador, El Salvador, Egypt, Eritrea, Estonia, Finland, France, Germany, Ghana, Guatemala, Honduras, Hungary, India, Iraq, Iran, Ireland, Israel, Italy, Jamaica, Japan, Jordan, Kazakhstan, Kenya, Kuwait, Latvia, Libya, Lithuania, Luxembourg, Malawi, Malaysia, Mali, Malta, Mauritius, Mexico, Morocco, Mozambique, Myanmar, Namibia, Nepal, Netherlands, New Caledonia, New Zealand, Norway, Oman, Panama, Paraguay, Peru, Qatar, Romania, Singapore, Slovakia, South Africa, Sudan, Swaziland, Sweden, Switzerland, Syria, Taipei China, Tanzania, Tajikistan, Togo, Turkey, Uganda, Ukraine, United Kingdom, United States of America, Vietnam and Yugoslavia.

2. CONTEMPORARY KNOWLEDGE ON FOOD-BORNE HAZARDS

The spectrum and prevalence of hazards in the food chain is subject to constant change. For many years, chemical hazards were considered to represent the most significant health risks to consumers. Now, better monitoring and surveillance demonstrates that the main burden of food-borne disease is due to microbiological pathogens. Further, many of the pathogens that are of concern today were not even recognised as causes of food-borne illness just 20 years ago (15).

Recent reviews of food-borne risks to human health identify hazards of animal origin as causing the majority of illnesses (14, 15, 22). Most of these are primarily carried by healthy animals (9, 10) and therefore do not fit the classical understanding of zoonoses as diseases of animals transmissible to humans, e.g. *Salmonella enteritidis, Campylobacter jejuni, Escherichia coli* O157:H7, *Clostridium perfringens, Yersinia enterocolitica* and *Listeria monocytogenes*. Knowledge recently gained from microbiological risk assessment reveals that the median infectious dose for different food-borne pathogens may range from a few cells, e.g. *E. coli* O157:H7, to relatively high numbers, e.g. several *Salmonella* spp. This has obvious implications in the design of food safety measures.

Hazards entering the food chain at the level of primary production include: residues of veterinary drugs and pesticides, environmental and industrial contaminants, illegal growth promotants, marine biotoxins and antimicrobial-resistant pathogens. In the latter case, there is now world-wide interest in reducing the overuse and misuse of antimicrobial agents in relation to food animals, while at the same time providing for their safe and effective use in veterinary medicine (20).

The recent ability to distinguish specific subtypes among relatively common food-borne pathogens by molecular biological techniques, e.g. pulsed-field gel electrophoresis (PFGE) patterns for *S. typhimurium* and *E. coli* O157:H7, together with electronic communication links for data sharing between laboratories, can markedly enhance monitoring and food safety. On the other hand, the recent discovery that genetic material that encodes virulence factors can be found in food-producing animals and the human gastrointestinal system can significantly complicate design and implementation of food safety measures (14). Changing practices at the level of the livestock producer, food processing or food storage and preservation can further impose new selective pressures on microbial agents in relation to virulence.

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1 For the purposes of this paper, food of animal origin includes meat, game, poultry, fish and milk products.
The infectious agent of bovine spongiform encephalopathy (BSE) is an example of a newly emergent food safety issue. Determining the human risk of variant Creutzfeldt-Jakob disease (vCJD) from consumption of contaminated food of animal origin, and the optimal implementation of preventative measures throughout the food chain, is a multidisciplinary task involving a range of professional groups.

Response to the questionnaire

Almost all respondents reported that food safety was a priority public health issue in their countries. At the government level, 48% of countries considered that microbiological hazards were a more important food safety problem than chemical hazards. Only 7% had the opposite view. A significant proportion of countries (45%) do not separate the two classes in terms of food safety importance. The large majority of countries reported that foods derived from animals were a more important source of hazards than foods from other sources. The overall understanding of hazards was very similar at the government and the consumer level.

Countries reported a wide array of specific food-borne risks as being of most importance. Risks arising from microbiological hazards dominated the listings, especially those due to *Salmonella*, *Campylobacter* and *Listeria* spp., and *E. coli*. Countries also cited *Clostridium*, *Yersinia* and *Staphylococcus* spp., and ‘tuberculosis’ and ‘brucellosis’ as being of importance. Important risks arising from chemical compared to microbiological hazards were reported at a rate of approximately 1:3, and specifically included residues of veterinary drugs (13 countries), residues of pesticides (seven countries), residues of hormones (two countries) and radionuclides (three countries). Food-borne risks from parasites were considered to be important by eight countries, and included cysticercosis, trichinellosis and hydatidosis. There were further listings of poor food handling practices (ten countries), lack of inspection of fresh meat (three countries), antibiotic resistance (ten countries), physical hazards (seven countries), biotoxins (four countries) and BSE (one country).

3. RISK ASSESSMENT

Quantitative standards for chemical hazards in foods, for example maximum residue limits, have been available for many years. Data needs for international standards are well served by global data-gathering systems, and other sources specific to the class of chemical hazard under consideration, e.g. industry registration packages for veterinary drugs. Most maximum residue limits for chemicals in foods are developed by a ‘safety evaluation’ process. In the absence of acute toxicity scenarios, maximum residue limits set in this way are arguably more relevant as monitoring tools than health standards (9). Although quantitative risk assessment (QRA) models for chemical hazards in foods are applied by a few national governments, they have rarely been used by the CAC.

QRA as a means of establishing food safety measures for microbial pathogens in foods is a new science that is receiving considerable impetus at both the international and national levels. The Codex Committee on Food Hygiene is currently considering the preliminary results of risk assessment of *Salmonella* spp. in broiler chickens and eggs and *Listeria monocytogenes* in ready-to-eat foods, and has commissioned further QRAs on *Campylobacter* spp. in poultry and *Vibrio* spp. in seafood (5).

In the context of international trade, the CAC has mandated that health and safety aspects of Codex decisions and recommendations ‘should be based on a risk assessment, as appropriate to the circumstances’ (3). The CAC has also recommended that risk assessment ‘should be based on global data, including that from developing countries’ (5). Competent authorities in an increasing number of countries are also focusing on risk assessment as the basis for national food safety measures that satisfy the provisions and obligations of the WTO SPS Agreement (the Agreement on Sanitary and Phytosanitary Measures of the World Trade Organization).
Response to the questionnaire

A general awareness of risk-based approaches to food safety was reported from 71 of 86 countries (82%). Competent authorities responsible for setting and/or implementing food safety standards were ranked as 1 on a discrete scale of 1 to 5 for awareness of risk-based approaches to food safety. Veterinary teaching and other science institutions, the primary processing industry, consumer groups and the livestock industry were all ranked as 2.

A total of 46 countries (53%) reported that they had implemented microbiological standards specifically derived from QRAs. However, none of the examples that was listed could be independently confirmed. A total of 41 countries (49%) reported that they had implemented microbiological criteria and other guidelines specifically derived from QRA. Given that national governments and the CAC are only beginning the process of specifically determining microbiological standards from QRA models, the information presented in the questionnaires most probably reflects a mixture of ‘qualitative’ rather than quantitative approaches to standard setting.

4. GENERIC FRAMEWORK FOR MANAGING FOOD-BORNE RISKS

Frameworks for managing food-borne risks to consumers have recently been described by international bodies such as the Food and Agricultural Organization of the United Nations, the World Health Organization and the CAC, and a number of national governments. Establishing an ‘appropriate level of consumer protection’ (ALOP) is a defining concept. Effective communication between all interested parties is arguably the most important single issue in application of a generic framework for managing risks. The four components of a framework for managing risks are as follows:

- **Risk evaluation** is the preliminary process. It includes the establishment of a risk profile to place the issue within a particular context, and provides as much information as possible to guide further action. The risk manager may commission a qualitative or quantitative risk assessment as an independent scientific process to inform decision making.

- **Assessment of risk management options** is the balancing of available food safety options in light of scientific information on risks, and may include reaching a decision on an ALOP. The statement of ALOP may be quantitative or qualitative. Optimisation of food control in terms of the efficiency, technological feasibility and practicality of selected food safety measures throughout the food chain is an important goal. Risk managers dealing with microbial hazards in foods may need to arrive at a risk management decision on an ALOP that does not represent ‘notionally zero’ risk, e.g. *Salmonella* and *Campylobacter* are often ubiquitous in the food supply and food safety measures will seek to minimise but not necessarily eliminate risks to consumers.

- **Implementation of the risk management decision** will usually involve regulatory food safety measures of one form or another, with a particular focus on hazard analysis for the control of critical points (HACCP). Flexibility in choice of individual measures applied by industry is a desirable element, as long as the overall programme can be objectively shown to achieve stated goals – the ALOP. On-going verification of food safety measures will assure that this occurs on an on-going basis.

Food safety objectives are specific food safety measures that are primarily developed from QRA. The concept of food safety objectives is founded on the need for an objective measure of the level of control of hazards in food that is required to achieve the ALOP, and represents an expression of that level at the time of consumption. In most cases, performance criteria upstream in the food chain will be established by competent authorities and international agencies, and will be implemented by industry (2, 7, 12).

2 Throughout this paper, a score of 1 is of highest ranking.
Monitoring and review is the on-going gathering and analysing of data from appropriate points in the production-to-consumption continuum so as to give an overview of food safety and consumer health. Risk management strategies and food safety programmes should be shown to achieve their stated goals, and monitoring and surveillance should also identify new food safety problems as they emerge. In many recent human outbreak investigations associated with microbiological agents in foods, epidemiology has been shown to be more sensitive and timely than microbiological testing for identifying the mechanisms of food contamination (13).

Monitoring also may be targeted to enumerate hazards in food supplies, water and the environment at the level of livestock production. Where there is evidence that the required level of consumer protection is not being achieved, redesign of food safety measures will be needed. Significant changes in food processing procedures, increasing hazard levels in food, identification of newly emerging pathogens, data indicating that human health is deteriorating and unsatisfactory compliance may all initiate review and redesign of a food safety programme.

Response to the questionnaire

The majority of countries (67%) reported that public policy documents had been published that advocated a risk-based ‘production-to-consumption’ approach to food safety. Of these 63 countries, 93% reported that the policy documents provided for inclusion of all interested parties in managing risks. Of these 59 countries, 81% reported that there were special consultative mechanisms in place to include consumer opinion. (Overall, this represented only 51% of countries.) Developed countries were far better represented in the above statistics than developing countries.

5. COMPETENT AUTHORITIES

Maintenance of effective national food safety systems and public confidence in them is of critical importance in public policy, especially in view of the ever-increasing trade in food (1, 19). National governments are strengthening both institutional structures and regulatory frameworks, and incorporating ‘shared responsibility’ for food safety.

5.1. Regulatory reform

In the 1990s, the focus of regulatory reform in many developed countries shifted from deregulation to regulatory quality management, i.e. improving the efficiency, flexibility, simplicity and effectiveness of individual regulations and non-regulatory instruments. Regulatory reform is now entering a further phase, the management of regulation, where the goal is to improve the total impact of regulatory systems in achieving their social and economic goals (18).

The trend towards shared responsibility for food safety risk management is leading to much greater co-ordination between national competent authorities, and a number of countries have consolidated food safety regulation under the umbrella of one competent authority – Canada, Denmark, Ireland, New Zealand and the United Kingdom. Consumer expectations, in terms of food safety and acceptability, demand high levels of transparency and communication in all aspects of contemporary management of food-borne risks.

In response to changing public policy, animal health authorities in a number of countries are increasingly focusing on protection of consumer health, and are developing both formal (legislative) and informal partnerships to achieve this goal.

5.2. Shared responsibility for food safety

New regulatory infrastructures offer marked advantages over traditional frameworks. On the other hand, effective risk management places much higher demands on appropriate communication and co-ordination among all interested parties.
Providing information on costs and benefits to guide risk management decisions is an important public policy issue. The potential gap between monetary accounting of economic activity and measures of well-being makes policy choices on food safety a difficult issue, and this can go well beyond the consideration of the initial payers (e.g. industry implementing HACCP) and beneficiaries (e.g. consumers) (8, 19). Any decisions on ALOP should be made in consultation with all interested parties, including consumers.

Having embraced risk assessment and a ‘production-to-consumption’ approach to optimising food safety, competent authorities in many countries are beginning to operate across traditional legislative boundaries. This can provide considerable opportunities, for example: collection and integration of monitoring data, sharing of diagnostic facilities and methodologies, verification and enforcement of regulatory requirements in an integrated manner throughout the food chain, and pooling of technical expertise such as that needed for QRA. Additionally, the primary role of industry in ensuring food safety can be better specified, allowing cost-effective structural adjustments.

Competent authorities have a wide range of regulatory instruments available, and regulatory food safety requirements can be set throughout the food chain. An optimal regulatory programme will require application of all the components of the generic framework for managing food-borne risks. Ensuring compliance with regulatory requirements is a vital function – it is considered that BSE-related problems in the meat industry in Europe ‘are due, at least in part, to regulatory compliance failures’ (18).

Competent authorities are increasingly cognisant of the provisions and obligations of the WTO SPS and Technical Barriers to Trade Agreements in their management of food safety at the national level. Representation of national interests requires appropriate participation in the international standard-setting activities of the CAC and the OIE. The costs and benefits of new and increasingly complex regulations, such as on traceability, labelling and identity preservation systems, are currently important topics of international debate. This is especially the case for developing countries that must successfully compete in the international marketplace.

Response to questionnaire

Collaborative networks between animal health authorities and food safety authorities were judged as effective in 63 of 91 countries (69%). The examples that were provided varied greatly among countries, and included formal links with industry at the livestock production and processing levels, academia, authorities responsible for establishing standards for chemical residues and contaminants in food, and national Codex committees. Different levels of collaboration were documented at the federal compared with the state level in a number of countries.

The WTO SPS Agreement was considered to have had a significant impact on food safety strategies in 69% of countries. Success in application of WTO SPS concepts were ranked on a continuous scale of 1 to 5 as follows: compliance with export certification requirements (1.9), judgement of equivalence (2.2), achieving consistency in food safety measures (2.2), and development of risk assessment capability (2.5). Success at the national level in defining ALOP and implementing systems for traceability of foods were ranked as 2.5 and 2.6, respectively.

Participation in the work of the CAC was reported by 71% of countries. Developing countries were represented at a much lower rate than developed countries. A total of 72 countries were in favour of OIE complementing the food safety work of the CAC, with only two countries having an adverse opinion. The need for joint standards, guidelines and related texts, or at least a higher level of collaboration in their separate development by the two agencies, was a common theme. Many countries stated that the OIE and CAC should work together in capacity building and harmonisation of all aspects of risk analysis, and provide joint technical training on food safety to developing countries. Specific collaboration was also sought in the development of joint technical publications on food safety, codes of hygienic practice for the use of veterinary drugs and pesticides, model health certificates, laboratory methods, guidelines on the use of antimicrobial agents, quality assurance systems, and microbiological monitoring of foods during primary processing. Formal links between the OIE and the CAC in the establishment of international food safety standards, guidelines and related texts were favoured by 70 of the countries, with three being opposed.
‘No change’ was listed by 17 countries as best describing veterinary involvement in food safety research over the past 5 years. ‘Some increase’ was listed by 48 countries, and a ‘marked increase’ was listed by 24 countries. Animal health research was listed as dominant at veterinary institutions by 51 countries. Animal health and food safety research were listed as having similar rank by 31 countries, and eight countries listed food safety research as dominant.

Food safety research at veterinary institutions that incorporated the ‘production-to-consumption’ continuum was described as occurring to a high degree by 21 countries, as occurring to some degree by 54 countries, and as non-existent by ten countries. Microbiological QRA modelling was reported at veterinary institutions in 27 of 92 countries (29%). However, very few examples were provided. Microbiological QRA modelling was reported at other science institutions in 46 of 92 countries (50%). Veterinarians were reported as being actively involved in QRA at the majority of these institutions (63%). Again, few examples were provided. Collectively, reports of QRAs completed or underway covered _L. monocytogenes_ in ready-to-eat foods, _E. coli_ O157:H7 in ground beef, _S. enteritidis_ in eggs and egg products, the agent of BSE in red meat products, _Campylobacter_ spp. in broiler chickens, small round viruses, _Brucella_ spp., _Mycobacterium bovis_ and several antibiotic resistant pathogens. Three countries noted contributions to the international microbiological QRA projects being carried out on behalf of the Code Commission on Food Hygiene.

Only 37 of 92 countries (40%) had statutory monitoring programmes for assessing the antimicrobial resistance of food-borne pathogens isolated from animals. The large majority of these programmes (86%) included testing of pathogens from healthy as well as clinically ill animals.

### 6. VETERINARY INVOLVEMENT IN THE FOOD SAFETY ACTIVITIES OF COMPETENT AUTHORITIES AT THE NATIONAL LEVEL

Veterinary knowledge and skills are valuable at all levels of food safety risk management at the national level. Veterinarians are well represented in competent authorities dealing with food safety; in addition industry and self-employed veterinarians provide essential inputs at the level of livestock producers and primary processing.

Certification of live animals and food commodities derived from animals as meeting requirements for international trade is an important veterinary responsibility. For example, the OIE International Animal Health Code chapter on BSE presents criteria for determining the BSE status of a country for the purposes of trade in animals and animal products. Regardless of the BSE status of a country, ‘Veterinary Administrations’ authorise importation of milk and milk products and some other products used for food, and protein-free tallow, without restriction. The Code also lays down the fundamental principles regarding the organisation of ‘Veterinary Services’ and provides guidance to these services to develop and document appropriate procedures and standards for reliable international veterinary certification for animals and animal products.

The importance of science-based welfare standards for food-producing animals is widely promoted by competent authorities. However, it is generally agreed that international trade measures based on animal welfare objectives are not permitted under the WTO SPS and Technical Barriers to Trade Agreements. Industry-led quality assurance programmes for animal welfare are well established in a number of countries, and are preferable to prescriptive regulatory approaches. The OIE Third Strategic Plan for 2001–2005 envisages extended work in the area of animal welfare. This would be a multidisciplinary task involving veterinary expertise as well as other sources of expert advice, e.g. on animal science, food microbiology, law and ethics.

**Response to the questionnaire**

Ranking on a continuous scale of 1 to 5 for veterinary involvement in country delegations to the CAC and/or any of nine subsidiary bodies dealing with foods of animal origin was very similar (range of 2.5 to 3.0). It was clear from the range of rankings given by each country that there was a considerable difference in focus between subsidiary bodies. The lowest level of veterinary involvement was in the Codex Committee on Fish and Fish Products.
The level of veterinary involvement in design and implementation of national chemical residue programmes for foods of animal origin was listed as ‘limited’ (35 countries), ‘significant’ (20 countries) and ‘leading the programme’ (35 countries).

7. VETERINARY INVOLVEMENT IN THE FOOD SAFETY ACTIVITIES OF COMPETENT AUTHORITIES AT THE LEVEL OF LIVESTOCK PRODUCTION

Food safety measures implemented by competent authorities at the level of livestock production should be the result of the systematic application of a framework for managing risks. Clear, prioritised and risk-based objectives need to be set, and prescriptive measures that are only established on the basis of general linkages to human health will be increasingly questioned by all interested parties. Veterinarians employed by competent authorities have much to offer in the multidisciplinary development of food safety measures according to this risk-based approach.

Decisions on food safety measures to be implemented at the level of livestock production may involve specific measures for particular hazards (e.g. maximum residue limits for residues of veterinary drugs in bulk milk), generic options (e.g. codes of hygienic practice and hazard monitoring programmes), or interim measures applied on a case-by-case basis (e.g. zoonotic disease outbreak situations or chemical contamination events). Competent authorities should develop strategies that reduce the need for antimicrobial substances in animals and their contribution to antimicrobial resistance, and to ensure their prudent use (20).

Veterinarians employed by competent authorities are variously involved in implementation of regulatory food safety measures and related activities, e.g. traceback from human food-borne disease incidents. Most competent authorities apply statutory food safety programmes at the level of livestock production, e.g. for control and elimination of S. enteritidis and S. typhimurium from poultry breeding flocks, and monitoring programmes for specific hazards, and these will be a primary focus of veterinary involvement.

Monitoring and surveillance activities should be specifically designed to service effective management of food-borne risks. However, many current programmes applied at the level of livestock production have the following disadvantages:

- They are based on clinical disease in animals,
- They do not include monitoring of the denominator population for asymptomatic carriage of hazards,
- They are not prioritised relative to risks to human health – the emphasis is on hazards identifiable in live animals,
- They may demonstrate the impact of control measures on hazard levels, e.g. animal infection rates, but this is not linked to actual reduction in food-borne risks,
- They are very limited in terms of data on chemical hazards.

The importance of welfare standards for food-producing animals is widely recognised by competent authorities. Animal welfare on the farm, during transport and at the time of slaughter can have an impact on food safety, and also is of increasing concern to consumers in terms of the ‘acceptability’ of foods of animal origin. Although it is generally agreed that international trade measures based on animal welfare objectives are not permitted under the WTO SPS and Technical Barriers to Trade Agreements, science-based national measures are actively promoted by competent authorities. Industry-led quality assurance programmes are well established in a number of countries, and are preferable to prescriptive regulatory approaches for ensuring appropriate animal welfare.

Response to questionnaire

The large majority of countries (72%) viewed animal health authorities at the level of livestock production as having a dual responsibility for public health and animal health. The remaining countries (28%) considered that their primary role was animal health. No country considered the primary role to be public health alone.
Veterinary activities carried out by animal health authorities at the level of livestock production solely for public health purposes were reported by 70 of 91 countries (77%). Government veterinarians involved in statutory schemes for prevention and control of zoonotic diseases, e.g. *Salmonella* in poultry breeding flocks and hatcheries, were the most commonly cited examples. Further examples of veterinary involvement related to: statutory monitoring and control programmes for animal feeds (66% of countries), milk and eggs, ante-mortem inspection of slaughter animals, targeted surveillance for chemical residues and antimicrobial-resistant microorganisms, traceback from human food-borne disease incidents and/or identification of specific hazards by public health laboratories; and advice on environmental hygiene. Tracebacks associated with food-borne disease incidents were carried out in collaboration with food safety authorities in 71% of countries.

A lesser percentage of countries (59%) reported veterinary activities carried out by food safety authorities at the level of livestock production. The disparity in response was primarily due to the situation existing in many developing countries. Examples were very similar to those of animal health authorities.

Veterinary involvement in the design and implementation of specific food control programmes by the food safety authority at the level of livestock production was reported by 71 of 95 countries (75%). Codes of good hygienic practice were the most common outputs (65% of countries), e.g. for milk, egg, and feedlot cattle hygiene and for the use of veterinary drugs. Involvement in HACCP and industry-led quality assurance programmes were also commonly reported (36% and 42% of countries, respectively).

Veterinarians employed by, or contracted to, the food safety authority were reported by many countries to be involved in providing of food safety information on groups of animals forwarded for slaughter. Individual health certification of groups of red meat animals and poultry for zoonotic diseases, veterinary drug residues and vaccination regimes was a common practice in a number of countries. Veterinary ante-mortem inspection was provided at the level of livestock production for large domestic animals (59% of countries), small domestic animals (54% of countries), farmed game and game birds (46% of countries) and poultry (67% of countries). In a small number of countries, veterinarians were responsible for certification of groups of animals for ‘free movement’ between places of livestock production, and for certification of the specific health status of animals for slaughter, e.g. for *Trichinella spiralis* and BSE status.

Involvement of veterinarians in general activities related to food safety traceback at the level of livestock production, e.g. food-borne disease investigations, animal identification, raw milk hygiene, certification of animal feed ingredients and batch certification of eggs, was reported by 63 of 95 countries (66%).

Statutory veterinary reporting of food-borne infectious diseases and chemical intoxications of animals at the level of livestock production occurred in the majority of countries (69% and 48%, respectively). This reporting was primarily based on signs of clinical disease (71% and 69%, respectively).

Although most countries reported veterinary involvement in the milk hygiene activities of competent authorities at the level of livestock production, 14 countries reported a lack of such involvement. Veterinary activities included: registration of farms and milking parlours, hygiene inspections, animal health interventions, and monitoring of the safety and quality of bulk milk. A small number of countries reported statutory involvement of food safety authorities in the registration and monitoring of fish farms and fishing vessels.

A total of 46 of 88 countries (52%) reported cases where veterinary epidemiological studies had led to significant reductions in food-borne risks as a result of food safety measures implemented at the level of livestock production. Prevention and control of *S. enteritidis* in poultry was the most often cited example. Other examples were: prevention and control of BSE and brucellosis in cattle; salmonellosis, cysticercosis and trichinellosis in pigs; and brucellosis in other species. Some examples that were provided did not appear to bear out the claim of significantly reducing risks to human health, e.g. prevention and control of *M. bovis* in cattle, and national residue monitoring programmes.
8. VETERINARY PRACTITIONER INVOLVEMENT IN FOOD SAFETY ACTIVITIES AT THE LEVEL OF LIVESTOCK PRODUCTION

There is widespread but often discontinuous involvement of veterinary practitioners in food safety at the level of livestock production. Involvement in risk evaluation and assessment of risk management options is generally limited to inputs into formal risk assessment projects carried out by competent authorities and industry. Practitioners should also contribute to national strategies and formulation of regulations regarding prudent use of veterinary drugs and other substances administered to animals or feeds and that may enter the food chain.

Veterinary practitioners also have a range of independent food safety responsibilities. They must ensure proper use and recording of veterinary drugs for treatment purposes, and should not substitute routine prophylactic use of antimicrobial agents for good animal health management. Prudent use of antimicrobial substances is now a world-wide food safety priority (20).

Response to the questionnaire

Veterinarians in private practice were identified as carrying out food safety activities related to clinically ill animals at the level of livestock production in 42 of 86 countries (49%). The disparity in response was primarily due to the situation existing in many developing countries. Examples of such activities were: contractual arrangements for statutory food safety activities with relevant competent authorities; treatment and control of zoonotic diseases (including testing and vaccination), mastitis and chemical intoxications; and reporting of notifiable zoonotic diseases.

Food safety activities related to healthy animals were also commonly reported. Examples included: contractual arrangements for statutory food safety activities with relevant competent authorities (including emergency preparedness); routine ante-mortem inspection of slaughter animals; good veterinary practice in the use of antibiotics, hormones and other animal treatments; health status inspection as part of quality assurance programmes and certification of animals for emergency slaughter; and advice on environmental hygiene.

Veterinary practitioner involvement in the design and implementation of documented food safety programmes at the level of livestock production was commonly reported. Codes of good hygienic practice were the most common outputs (36% of countries). Involvement in HACCP and industry-led quality assurance programmes were also reported (28% and 27% of countries, respectively). However, a total of 51 countries reported no involvement of veterinary practitioners in any of these activities (51%).

Veterinarians were also reported to be involved in provision of food safety information on groups of animals forwarded for slaughter. Contractual arrangements with competent authorities provided for individual health certification of groups of red meat animals and poultry in some countries, as well as ante-mortem inspection (see above). In a small number of countries, veterinary practitioners were contracted by industry to provide quality assurance certification for groups of animals sent for slaughter.

Veterinary practitioners were involved in statutory reporting of food-borne infectious diseases and chemical intoxications of animals at the level of livestock production in the majority of countries (see above). Practitioners contracted to competent authorities were also reported to be involved in general activities related to food safety traceback at the level of livestock production, e.g. food-borne disease investigations, raw milk hygiene, and certification of animal feed ingredients.

9. VETERINARY INVOLVEMENT IN THE FOOD SAFETY ACTIVITIES OF INDUSTRY AT THE LEVEL OF LIVESTOCK PRODUCTION

Veterinarians employed by industry have diverse food safety roles. As well as implementing regulatory food safety measures, industry-led solutions to food safety problems are important, e.g. in the case of BSE, the meat industry has to work with competent authorities at the national and international level to improve regulatory compliance. The veterinary pharmaceutical industry has an important role in the post-approval surveillance of antimicrobial resistance that may be due to particular compounds.
Design and implementation of HACCP-based food control systems that achieve regulatory performance targets and ‘in-house’ targets based on statistical process control are important functions. Industry-led quality assurance systems can make an important contribution to food safety, and they are increasingly being taken into account in verification activities carried out by competent authorities (6). Production systems should promote animal health and welfare, and there should be effective sharing of food safety information between industry and competent authorities. In some countries, industry veterinarians have a wider role in restoring and maintaining consumer confidence in the wake of recent problems associated with foods of animal origin, e.g. public consultations and crisis management systems.

Consumer concerns are increasingly having an influence on industry attitudes to broad animal welfare issues. Retailers responding to consumer concerns may include particular conditions of animal husbandry as part of food supply contracts, whether or not they are ‘science-based’ (16). In this way, consumers may be the most potent force for change to current animal welfare aspects of intensive farming systems.

Response to the questionnaire

Veterinarians employed by industry were identified as carrying out activities solely for public health purposes at the level of livestock production in 50 of 81 countries (62%). Provision of technical advice in the case of intensive livestock industries and design of HACCP plans were cited as the most common examples.

Veterinary involvement in the design and implementation of documented food control programmes by industry at the level of livestock production was reported by 61 countries (64%). Codes of good hygienic practice (48% of countries) and quality assurance programmes (48% of countries) were the most common outputs. Involvement in HACCP was reported by 38 countries (40%).

10. VETERINARY INVOLVEMENT IN FOOD SAFETY ACTIVITIES AT THE LEVEL OF PRIMARY PROCESSING

Veterinarians in all occupational groups have extensive involvement in all components of food safety risk management at the level of primary processing of foods of animal origin.

Veterinary activities fall into the same general categories as those occurring at the level of livestock production (see above), except that food safety requirements are likely to require more continual veterinary involvement. They are also likely to be much more complex in nature.

Design of specific food control systems will likely be based on HACCP principles, and tailor-made to the particular raw material, processing premises and type of food produced. Some aspects of veterinary inspection and certification may be different for exported foods compared with foods produced for domestic consumption.

Some countries require the presence of a veterinarian at all times during the slaughter and dressing of animals, and post-mortem inspection has a high level of veterinary involvement in most countries. Food safety authorities may themselves undertake on-going veterinary food safety duties at the level of primary processing, or may use contractual arrangements with other providers of veterinary services, e.g. private practitioners and ‘third-party’ inspection agencies. Access to laboratory diagnostic services is an important requirement.

Monitoring of food safety hazards at the level of primary processing is an essential function, and should be integrated with the design and implementation of food safety measures throughout the food chain. Statutory monitoring for chemical hazards is likely to be part of a national chemical residue programme. A number of countries are moving towards risk-based performance standards for microbiological hazards in red meat and poultry meat, and achievement of these must be verified on an on-going basis (11).

It is likely that veterinary supervision of humane slaughter of food-producing animals plays a significant role in reducing microbial cross-contamination of carcasses during dressing.
Response to the questionnaire

The ranking of veterinary involvement in primary processing of foods on a continuous scale of 1 to 5 was as follows: red meat (1.9), poultry (2.2), milk and milk products (2.3), farmed game and game birds (2.4), eggs (2.7), fish (2.7) and wild game (2.8).

A continuous veterinary presence in slaughterhouses producing red meat and poultry meat for domestic consumption was reported in 50 of 61 countries (82%) and 45 of 58 countries (78%) respectively. A number of countries reported that a continuous veterinary presence was not required in slaughterhouses with ‘lower throughput’.

Veterinarians employed by food safety authorities were involved in the design and implementation of specific food control programmes at the level of primary processing in 78 of 95 countries (82%). Codes of hygienic practice were the most common output (88% of countries), followed by HACCP plans (82% of countries) and industry-led quality assurance systems (55% of countries).

Veterinary practitioner involvement in the design and implementation of specific food control programmes at the level of primary processing was reported by 52 of 95 countries (55%). Codes of hygienic practice were the most common output (63% of countries), followed by HACCP plans (62% of countries) and industry-led quality assurance systems (50% of countries).

Involvement of industry veterinarians in the design and implementation of specific food control programmes at the level of primary processing was reported by 72 of 95 countries (76%). HACCP plans were the most common output (89% of countries), followed by codes of hygienic practice and industry-led quality assurance systems (both 83% of countries).

Personnel other than veterinarians were involved in ante-mortem inspection of poultry and red meat animals in 37% and 31% of countries, respectively. Personnel other than veterinarians were involved in post-mortem inspection of poultry and red meat animals in 60% and 59% of countries, respectively.

Veterinarians at slaughterhouses were involved in analysis and reporting of meat hygiene data back to the livestock producer on an on-going basis in 57 of 87 countries (66%). Statutory veterinary reporting of food-borne hazards detected at the level of primary processing was reported in 69 of 90 countries (77%). Animal health authorities provided for on-farm veterinary investigations following detection of specific food-borne hazards during ante- or post-mortem inspection in 78 of 90 countries (87%). These were carried out in collaboration with food safety authorities in 70% of countries.

In the case of red meat hygiene, livestock husbandry was ranked as ‘medium’ by the majority of countries in terms of contributing to reducing food-borne risks to consumers (47% of all rankings). Ante-mortem inspection, post-mortem inspection and process control were ranked as ‘high’ by the majority of countries (58%, 76% and 63% of all rankings, respectively). Post-mortem inspection was ranked as low by only nine countries (10% of all rankings).

In the case of poultry meat hygiene, livestock husbandry was ranked as ‘high’ by the majority of countries in terms of contributing to reducing food-borne risks to consumers (52% of all rankings). Ante-mortem inspection, post-mortem inspection and process control were ranked as ‘high’ by the majority of countries (46%, 52% and 67% of all rankings, respectively).

Most countries (84%) reported veterinary involvement in the milk hygiene activities of competent authorities at the level of primary processing. Veterinary activities included: registration of premises, hygiene inspections, monitoring of the safety and quality of milk and milk products, and certification.

Only 30 of 80 countries (38%) reported veterinary involvement in the hygiene of fish and fish products. A further 17 countries reported marginal involvement. Inspection and certification of imported and exported fish appeared to be the dominant activity, however a number of countries reported statutory requirements for hygiene inspection of processing premises.
11. DISCUSSION

This study demonstrated that food safety is a priority public health issue in the large majority of countries. Although most competent authorities had a good general awareness of risk-based approaches and were moving towards a ‘production-to-consumption’ approach to designing and implementing food safety measures, evidence of systematic application of a generic framework for managing food-borne risks was sporadic. In particular, sharing of food safety responsibilities and resources between animal health authorities, food safety authorities, industry and other interested parties, so as to optimise consumer protection, was still at an early stage in many countries.

Different food safety priorities were very evident among countries; only 40% of countries reported statutory monitoring for antibiotic-resistant pathogens in animals and/or foods. Some animal health authorities still viewed ‘traditional’ zoonoses, tuberculosis, brucellosis, trichinellosis and cysticercosis, as priority food safety issues. The majority of countries ranked ante- and post-mortem inspection of red meat animals and poultry as making a ‘high’ relative contribution to food safety, whereas recent scientific studies are increasingly documenting unseen microbiological contamination as more important (18).

Veterinarians can bring overarching skills and knowledge to food safety risk assessment, and provide specialised technical input in respect to livestock production and primary processing. However, microbiological QRA requires specific types of high-quality data. Full cognisance must be given to quantifying the actual pathway for exposure of humans to food-borne hazards, e.g. animals clinically affected with zoonotic diseases may only enter the food chain in small numbers, even after treatment.

Effective food safety risk management requires multidisciplinary scientific and technical inputs, and a high level of communication and consultation with all interested parties. Veterinarians have a major role to play in this process and this was well illustrated in the responses to the questionnaire. However, veterinarians involved in making risk-based decisions will have to work increasingly within multidisciplinary teams, e.g. efforts in intensive animal-rearing systems to develop mechanisms to intervene against *E. coli* O157:H7 infection before slaughter are likely to comprise veterinary microbiologists, veterinarians, food microbiologists, animal scientists and epidemiologists (14).

Implementation of risk-based approaches to food safety by competent authorities may require redirecting of veterinarians to make better use of their knowledge and skills. For example, traditional monitoring and surveillance activities carried out by animal health authorities at the level of livestock production need redesign if they are to contribute properly to achieving contemporary food safety goals.

Veterinarians employed by competent authorities, veterinary practitioners and veterinarians employed by industry were all involved in a wide range of food safety activities in most countries. Further, veterinary involvement in food safety research and QRA was reported to be increasing. Irrespective of this, veterinary inputs to milk and fish hygiene were considerably less than for red meat animals and poultry. This was particularly marked in developing countries, where 13 reported no involvement.

Veterinary practitioners implement food safety measures ranging from statutory regulatory requirements to technical advice. Many food safety activities are delivered through contractual arrangements with competent authorities and industry. As countries undergo regulatory food safety reform, ‘self-regulation’ and certification carried out by industry at the level of livestock production, e.g. commercial food control requirements, should be co-ordinated with regulatory requirements so as to achieve more effective overall compliance (18).

Food safety regulatory reform in some countries is changing the traditional roles of different parties involved in food safety programmes. In these countries, industry has the primary responsibility for implementing food safety programmes, and competent authorities are increasingly moving towards verification and audit of outcome-based regulatory requirements. This provides new opportunities and responsibilities for veterinarians, e.g. design and implementation of HACCP-based food control systems that achieve regulatory performance targets is a rapidly expanding field. It is also likely that integration of HACCP plans with industry-led quality assurance systems will provide on-going opportunities. In some countries, ante- and post-mortem inspection of slaughter animals is already provided by independent ‘third-party’ inspection agencies.
Different countries had contrasting arrangements for delivery of ante- and post-mortem inspection of slaughter animals. Lay personnel were involved in the majority of countries, however others required statutory delivery of these services by veterinarians. This disparity further illustrates the need for internationally harmonised regulatory standards that specify food safety outcomes rather than processes. It is noteworthy that the CAC does not assign specific food safety roles to particular occupational groups, and is in fact moving towards recognition of competence rather than profession (4, 6). Specific veterinary roles are only assigned to supervision of slaughter, inspection and primary processing of animals.

The study revealed marked differences in the range and intensity of food safety programmes in different countries, and the extent of veterinary involvement at the levels of livestock production and primary processing. It was clear that developing countries were often under-resourced in terms of food safety, and lacked scientific capacity. International food safety agencies should increase their efforts to address this need, so as to enhance food safety and facilitate export of foods from developing countries.

At the international level, there was a high level of veterinary involvement in the activities of the CAC. However, representation of developing countries was markedly less than that of developed countries. This situation needs to be redressed if the positions of developing countries are to be properly represented in the development of international food standards, guidelines and related texts.

The vast majority of countries favoured increased involvement of the OIE in food safety. In this respect, the various requirements laid down in the International Animal Health Code of the OIE regarding the organisation and evaluation of veterinary services to set up international certification procedures for animals and animal products could provide an interesting tool to harmonise the approach of veterinarians in the prevention and management of food-borne diseases.

REFERENCES


The role of veterinarians in the prevention and management of food-borne diseases


