A case for increased private sector involvement in Ireland's national animal health services

Simon J. More
Centre for Veterinary Epidemiology and Risk Analysis
UCD School of Agriculture, Food Science and Veterinary Medicine
University College Dublin
Belfield, Dublin 4, Ireland
Email: Simon.More@ucd.ie

Non-regulatory animal health issues, such as Johne's disease, infectious bovine rhinotracheitis (IBR) and mastitis will become increasing important, with ongoing globalisation of markets in animals and animal products. In response, Ireland may need to broaden the scope of its national animal health services. However, there have been concerns about the respective roles and responsibilities (both financial and otherwise) of government and industry in any such moves. This paper argues the case for increased private sector involvement in Ireland's national animal health services, based both on theoretical considerations and country case studies (the Netherlands and Australia). The Dutch and Australian case studies present examples of successful partnerships between government and industry, including systems and processes to address non-regulatory animal health issues. In each case, the roles and responsibilities of government are clear, as are the principles underpinning government involvement. Furthermore, the roles and responsibilities (financial and otherwise) of the Dutch and Australian industry are determined through enabling legislation, providing both legitimacy and accountability. There are constraints on the use of EU and national government funds to support non-regulatory animal health services in EU member states (such as Ireland and the Netherlands).

Irish Veterinary Journal
Volume 61 Number 2 92-100, 2008

Key words: animal, funding, health, industry, veterinary

Introduction

The quality and safety of Irish agricultural product will become increasingly important, if Ireland is to remain competitive in a global trading environment. Animal health is an important contributor to on-farm profitability, as well as food quality and safety, and the international competitiveness of livestock and livestock products. The health status of the national herd, now and into the future, is an important issue for consideration.

This paper argues the case for increased private sector involvement, including funding, in Ireland's national animal health services.

Animal health services have both local and national components. This paper specifically focuses on national animal health services, which encompasses the systems (including organisations and infrastructure) and processes (for example, policy development, programme formulation and delivery) that facilitate national coordination of efforts towards improved animal health in the national herd.

In the past 12 months, there has been growing interest in the work of Ireland's national animal health services (McCarthy, 2007; More, 2007). In particular, it has been suggested that the scope of this work be expanded, to address a range of non-regulatory animal health issues, including Johne's disease, infectious bovine rhinotracheitis (IBR) and mastitis. However, as part of this discussion, there has been concern from within both government and industry as to the respective roles and responsibilities (both financial and otherwise) of government and industry in any such moves. Drawing on theoretical considerations and country case studies (from Ireland, the Netherlands and Australia), this paper argues the case for increased private sector involvement in Ireland's national animal health services. The Netherlands and Australia, like Ireland, are each heavily reliant upon the export of livestock and livestock products. Ireland and the Netherlands operate within the protections and constraints afforded by the European Union, whereas Australia does not.

Public and private sector involvement in national animal health services: theoretical considerations

a. Criteria for public and private sector involvement

Public funds are finite, and governments need objective criteria to enable the equitable and appropriate allocation of these funds. Generally, these criteria are based on the concept that public funds are used to support public goods and services (Umali *et al.*, 1994), but not those of a private nature. Public goods and services (for example, national institutions for law and order, public roads, education, hospitals etc.) are generally funded through compulsory taxation and are, therefore, available to all. In economic terms, public and private goods are distinguished using the principles of excludability and rivalry. Purely public goods are those goods from which it is not possible to exclude one consumer without excluding all (non-excludability) and of which the consumption by one person does not reduce its availability for consumption by others (non-rivalry) (Ahuja, 2004). Conversely, purely private goods are fully excludable and rivalrous. Some goods and services lie between these extremes; in particular, goods and services with externalities (or spillover effects) (Umali *et al.*, 1994).

The concepts of public and private good are applicable to animal health services, since each service can be classified according to its economic character (Umali et al., 1994). Using these criteria, several authors have defined public and private sector roles in the provision of animal health services (Holden, 1999; Ahuja, 2004). As an illustration, veterinary epidemiological services are primarily considered a public good (the information provided is of benefit to the community, and cannot be appropriated by a single individual), whereas diagnostic services may provide elements of both private and public good, depending on the degree to which externalities are produced (Umali et al., 1994). A national mastitis programme has the potential to provide benefits to dairy farmers and processors, but with limited additional benefits to the broader human population. Therefore, this programme would primarily be considered a private (or industry) good.

It is widely accepted that the public and private sectors each have a role to play in improving animal health (Ekboir, 1999; Holden 1999; Sen and Chander, 2003). However, there is considerable debate about the balance between the two (Ekboir, 1999). In a recent submission to DG Sanco, the Swedish Ministry of Agriculture, Food and Consumer Affairs suggested that public measures should be limited to animal diseases with public health risks, an environmental dimension and/or symptoms similar to dangerous animal disease, diseases that are highly contagious, diseases where knowledge is lacking and diseases that can be widely spread without detection (Anon., 2006a). Similarly, Ekboir (1999) suggested that public intervention in the development and implementation of animal health policies should be guided by:

- Whether the targeted disease can affect humans;
- Its degree of contagiousness;
- Whether it is endemic or epidemic; and,
- The economic costs associated with the disease.

Bicknell *et al.* (1999) highlight issues faced by a centralised animal health service (the Animal Health Board, responsible for the control of bovine tuberculosis in New Zealand) within a market-oriented economy; in particular, identification and implementation of policies to simultaneously encourage farmer participation and increased cost-recovery. Prompted in part by the rising costs associated with TB control, 'responsibility- and cost-sharing' is an increasingly important issue in the United Kingdom (Anon., 2007a). Several authors have examined factors relevant to the transition from an exclusively-public model of veterinary services, with primary emphasis on the developing world (Schillhorn and de Haan, 1995; Sen and Chander, 2003; Brückner, 2004; Leonard, 2004).

Although efforts towards privatisation are being made (Sen and Chander, 2003), the national animal health services in many developing countries remain essentially a government responsibility (Schillhorn and de Haan, 1995). In most developed countries, however, the allocation of public funds is increasingly guided by the principle of *'who benefits, pays'*. Using this approach, benefit flowing primarily to industry is distinguished from the broader public benefit. As a result, animal health services in developed countries are increasingly performed in partnership with, or have been transferred to, the private sector (Umali *et al.*, 1994).

b. Models of public and private sector involvement

National animal health services have frequently been regulated by government using the 'command and control' approach (Baldwin and Cave, 1999). The bovine tuberculosis control programme in Ireland is an example of this. Characteristics of this approach to governance (the rules, processes and behaviour that affect the way in which powers are exercised; Anon., 2004a) and regulation (primary and secondary legislation of government, rules and regulations of self-regulating bodies; Anon., 2004a) include 'legal bindingness', a rigid approach to implementation, predominantly public actors in policy-making and a central locus of authority (Treib et al., 2007). However, this approach has a number of inherent weaknesses, including the potential for undue influence (regulatory capture) by the regulated on the regulator, a tendency towards excessive legalism (a proliferation of unnecessarily complex and inflexible rules), creative compliance (the practice of avoiding the intention of a law without breaking its terms; Knill and Lenschow, 2003) and the problems (including cost) of enforcement (Baldwin and Cave, 1999).

Government involvement in national animal health services need not equate to government control. There are many possible models of governance and regulation, ranging from government intervention (such as the 'command and control' model) through to societal autonomy (Treib et al., 2007). In some governance and regulation models, government plays no role (Egan, 2001). The 'open method of communication' (OMC) of the EU is one example of an alternative governance and regulation model (Knill and Lenschow, 2003), a second is co-management of natural resources (Pomeroy and Berkes, 1997; Carlsson and Berkes, 2005), and a third is self-regulation (Baldwin and Cave, 1999). The OMC is a relatively new form of governance that relies on the voluntary cooperation of EU member states. Using 'soft law' rather than treaty-based legislation, the OMC involves:

- *Guidelines and indicators:* policy guidelines for the EU as a whole, with short, medium and long term goals;
- *Benchmarking:* quantitative and qualitative indicators for benchmarking national performance against the best in the world; and,
- *Sharing of best-practice:* periodic monitoring, evaluation and peer review of member states (Room, 2005).

In Ireland, 'social partnership' is one example of an inclusive partnership-based approach by the public and private sectors to governance and regulation (Anon., 2007b). The national agreements, first introduced in 1987, have been an important contributor to Ireland's recent economic success (Hardiman, 2002). The farming community has been one of the social partners in each national agreement (Anon., 2007b).

Public and private sector involvement in national animal health services: case studies

a. Ireland

In Ireland to this point, national animal health services have been a government responsibility, through the Department of Agriculture, Fisheries and Food (DAFF). DAFF implements EU policy and has responsibility for international trade, field operations, list A diseases and public health. It manages several disease eradication programmes, including bovine tuberculosis (More and Good, 2006), bovine brucellosis (Sheahan *et al.*, 2006) and bovine spongiform encephalopathy (Sheridan *et al.*, 2005). The role of industry in policy development and the enforcement of EU regulation etc. is limited. Farmers contribute financially to the bovine and tuberculosis eradication programmes through compulsory disease levies (€0.0006 per litre of milk processed and €1.27 per animal slaughtered or exported alive; Anon., 2006b), equivalent to €210 per typical Irish dairy farm (70 cows, annual production 5,000 litre per cow) or approx. €3.2 million from the national dairy farming sector. Each farmer also pays for the private veterinary costs associated with one whole-herd tuberculin test each year. National laboratory support is provided through DAFF's Veterinary Laboratory Service, which operates one central research and six regional laboratories. Farmers pay for non-regulatory diagnostic work. Ireland's national animal health services have some input into non-regulatory diseases of cattle and sheep (such as Johne's disease, IBR and mastitis). Teagasc (the Irish Agriculture and Food Development Authority) provides advisory and research support for mastitis and fertility. In collaboration with the pig and poultry industries, government is coordinating a national Aujeszky's disease control and eradication programme and enhanced *Salmonella* control through the Egg Quality Assurance Scheme, respectively.

Limited funding is available to support applied animal health research in Ireland, from both government and industry. The Research Stimulus Fund Programme supports 'public good' agri-production related research, using National Development Plan (2007-2013) funding. Industry provides support to Teagasc's dairy research programme through the voluntary dairy research levy (€1.2 million in 2004) (McGuinness, 2004). This programme predominantly focuses on production, rather than health, issues.

There are a large number of industry organisations in Ireland representing farmers (e.g., Irish Farmers Association, Irish Creameries Milk Suppliers Association, Irish Cattle and Sheep Farmers' Association), cooperatives (e.g., Irish Cooperative Organisation Society) and commodity-related businesses (e.g., Irish Dairy Industries Association). Further, national organisations are in place for product promotion, both nationally (e.g., National Dairy Council) and internationally (e.g., Irish Dairy Board).

b. The Netherlands

In the Netherlands, national animal health services are best understood by first considering the concept of product boards. Product boards (also known as commodity and industrial boards) were first established to contribute to post-war reconstruction, based on the principle that added value could be achieved through collective effort. Each product board operates under national legislation within a legal framework of a 'statutory trade organisation', and is authorised by government to formulate statutory rules in specific areas. They have the legal authority to establish regulations and impose levies, but are not government agencies. Each board acts in the interest of their sector as a whole and of society in general, adding value by raising standards in industry, addressing sector-wide issues, improving working conditions, providing an alternative to government regulation, providing linkages with government, ensuring market transparency and encouraging innovation (Anon., 2004b). There are national commodity boards for primary production, including milk (Productschap Zuivel, PZ; the Dutch Dairy Board) and

livestock, meat and eggs (Productschappen Vee, Vlees en Eieren, PVE) and industrial boards in manufacturing, trade and logistics. Within each sector of primary production, the product board covers all relevant trade and product activities, from farmyard through to retail.
Established in 1956, the Dutch Dairy Board is a vertical organisation, incorporating bodies that represent dairy farmers, the dairy industry, traders, retail and trade unions. It also has close links with specialist organisations that provide services in animal health (GD Animal Health Service Deventer) and in milk quality assurance and control. With a workforce of approx. 100 people, the Dutch Dairy Board coordinates all national activities relating to the industry, including national dairy policy, international trade regulations (import and export) and sector regulations (quota, superlevy, milk premia). The organisation is financed through levies and payments. In 2007, levies of approx. €18 million were collected from dairy farmers (47%; €8.5 million in total), on-farm processors (1%) and the dairy processing industry (52%) and used to finance activities relating to research (dairy products, 26%; dairy farming, 31%), information and communication (25%) and cattle healthcare (18%). The Board is also reimbursed by the government for operating costs associated with implementation of European market regulations (approx. €7.2 million in 2007) (Anon., 2007c).

GD Animal Health Service is the primary provider of non-regulatory animal health services in the Netherlands. Initially founded by and for farmers in 1919, GD is now an autonomous and independent operating enterprise. During 2005, GD had a turnover of €47.1 million, and a staff of 420 (full-time equivalent) (Anon., 2005a). GD is highly respected internationally, particularly in the areas of animal health diagnostics, animal health programmes and animal disease monitoring. Through the activities of GD, the Netherlands is leading international efforts in the implementation of voluntary animal health programmes (such as Johne's disease; Kalis *et al.,* 2004; Weber *et al*., 2006). GD is coordinating Uier Gezondheids Centrum Nederland (UGCN; the Dutch Udder Health Centre), a national five-year programme to decrease mastitis incidence. This work is funded by the Dutch Dairy Board, and coordinated by GD under a steering committee, comprising farmers (Dutch Organisation for Agriculture and Horticulture; LTO, Land- en Tuinbouw Organisatie Nederland), industry (Dutch Dairy Association; NZO, De Nederlandse Zuivel Organisatie) and the Dutch Dairy Board.

The contribution of the Dutch government to national animal health services is essentially limited to activities in fulfillment of EU and international regulatory obligations. This work is coordinated through the national Ministry of Agriculture, Nature and Food Quality (LNV; Landbouw, Natuur en Voedselkwaliteit). The Food and Consumer Product Safety Agency (VWA), an independent agency of LNV, has a range of responsibilities including notifiable animal disease control, export certification, regulatory control of the meat sectors, and oversight of the work of the Netherlands Controlling Authority for Milk and Milk Products (COKZ) (Anon., 2006c). Since mid-2007, COKZ has formed part of Qlip (Kwaliteitsborging in de Zuivelketen), the central organisation for quality assurance in the Dutch dairy sector (Anon., 2007d). In the area of notifiable disease control, VWA works closely with other organisations including the Central Institute for Animal Disease Control (CIDC-Lelystad, the national reference laboratory) and GD Animal Health Service. Testing for export certification is conducted by both CIDC-Lelystad and other laboratories, such as GD Animal Health Service.

Cost-sharing is a key principle underpinning the funding of animal health services in the Netherlands. In a recent position paper, the ministry stated that *"farmers and others who create income (from) animals… must make a substantial contribution to the costs incurred by government for the monitoring and control of animal diseases"* (Anon., 2006d). Given its contribution to both public and private good, animal disease surveillance activities are funded 50% each by government and industry. In contrast, non-regulatory animal health issues are considered the sole responsibility of industry. At times, government does provide some contribution to the development of new non-regulatory animal health programmes, however, in all cases these contributions is restricted to defined projects, and used to support innovation (as opposed to operations). On-farm costs relating to voluntary animal health programmes, including the cost of sample collection and laboratory testing, are borne by individual farmers. Although financial details are commercial-in-confidence (confidential information), the operating model of GD Animal Health Service is essentially full cost-recovery.

c. Australia
Government is responsible for defined aspects of the national animal health services in Australia. The federal government (through the national Department of Agriculture, Fisheries and Forestry) has responsibility for quarantine, international animal health matters and the formulation and coordination of national policy. The Australian Quarantine and Inspection Service (AQIS), as part of the Department of Agriculture, Fisheries and Forestry, is responsible for the delivery of quarantine import requirements and export health certification. Most aspects of this service are operated on a full cost-recovery basis. State and territory governments are responsible for disease control, surveillance and eradication within their own borders. Consultative committees ensure that these bodies work together (Anon., 2006e).

Industry plays a key role in many aspects of the national animal health services, either through industry/government partnership bodies (e.g., Animal Health Australia) or essentially independent of government (e.g., Dairy Australia).

Animal Health Australia (AHA) is a not-for-profit public company established in 1996 by the federal, state and territory governments and major national livestock industry organisations. It is a key contributor to national policies in animal health, and in the facilitation of partnerships between government and industry. Through AHA, the livestock industries participate in national policy development, provide substantial financial support to targeted activities and contribute to emergency responses (Anon., 2006e). Currently, AHA services runs eight major programme areas, including animal disease surveillance, emergency animal disease preparedness, animal health services, special programmes, Johne's disease control programmes and training. As part of emergency disease preparedness, AHA has developed detailed contingency plans (AUSVETPLANs) focusing on disease strategies, as well as operational, enterprise and management manuals. Further, an Emergency Animal Disease (EAD) Response Agreement was negotiated between government and industry in 2001, clearly defining obligations (financial and otherwise) in the event of an exotic disease outbreak. EADs are classified according to their impacts on human health, the environment and livestock industries (trade losses, national market disruption, production losses) and cost-sharing (covering salaries and wages, operating expenses, capital costs and compensation) varies accordingly.

AHA's industry partners include a range of national producer-owned industry organisations (for example, Australian Pork Limited, Dairy Australia and Meat and Livestock Australia). These organisations operate under national legislation, and have a broad range of responsibilities including marketing, export development, research, innovation and strategic policy development. For example, the goal of Dairy Australia is:
"to deliver the services needed by the Australian dairy industry for its ongoing and future development as a competitive, innovative and sustainable dairy industry that contributes to the overall prosperity of Australian and regional economies."
Each organisation is managed by industry, and owned by its members (farmers and industry bodies). The organisations are subject to periodic independent review (Hassall and Associates, 2006). They are primarily supported by industry levies, which are collected under national legislation by the Levies Revenue Service. During 2005/06, AUD32.3 million (approx. €19.4 million; based on AUD0.026448 per kg fat plus AUD0.064438 per kg protein) was collected from dairy farmers, to support Dairy Australia, including its contribution to AHA's animal health programmes. This is equivalent to AUD1,194 (approx. €714) per typical Irish dairy farm (70 cows, annual production 5,000 litre per cow, average 3.4% fat and 3.9% protein). Similarly, approx. AUD81 million (based on AUD5.00 per head [grass and feedlot cattle], AUD0.90 per head [bobby calves], 2% of sale price to a max. AUD0.20 for sheep and AUD1.50 for prime lambs, AUD0.377 per head [goats]) was collected in transaction levies from beef and sheep producers in 2005/06 to fund Meat and Livestock Australia, including its contribution to AHA's animal health programmes. On January 1, 2006, the cattle transaction levy was raised from AUD3.50 to AUD5.00 per head. This decision was taken by the beef industry, based on an assessment of future programmes and funding needs (Anon., 2005b) and following a ballot (with 57.7% in favour) of its members. Levies are recognised as an effective mechanism to pool effort and resource thereby enabling industries to collectively address priority issues.

The genesis of current national structures for animal health services in Australia, and particularly the key role of industry, can be traced back to 1983 (Lehane, 1996). To this point, the national Brucellosis and Tuberculosis Eradication Campaign (BTEC) had progressed smoothly in southern Australia, and a number of areas had achieved disease freedom. By 1983, eradication efforts were increasingly focused on northern Australia. In these areas, however, there were limited facilities for cattle management, and eradication efforts were greatly hampered by difficulties associated with the clean (complete) muster of cattle from many outback properties. To progress eradication, key decisions were made by the central (Canberra-based) technical committee which raised increasing concern among northern producers. Indeed, at the time, Lehane (1996) recalls comments in one newspaper:
"Cattlemen fear for their future as the bureaucrats ride in. Right across northern Australia… there is a galloping sense of fear at the looming prospect of the destruction of the northern cattle industry."
The national stalemate that ensued was eventually resolved following the decision of the national Minister of Primary Industries, who indicated that programme management would be based on equal representation from industry and government. From that point, the roles and responsibilities (both financial and otherwise) were shared and clearly defined for both industry and government. In a recent review, Radunz (2006) suggested that the involvement of industry in both funding and policy development was seen as a critical factor in the eventual success in this programme. Similarly, Whittem (1998) highlighted the key role of industry leadership in the financing and oversight of the program, suggesting that it was a *sine qua non* for its success.

The performance of the national animal health services

a. Regulatory animal health issues

The export of animals and/or animal products is a critical contributor to the national economies of Ireland, the Netherlands and Australia. In 2005, these countries were the fifth, third and first largest international beef exporters, and the fourth, second and eighth largest butter exporters, by value, respectively (International Trade Centre UNCTAD/WTO, 2005). International regulatory obligations (in the case of Ireland and the Netherlands, also EU obligations) are fundamental to unhindered international trade and a central priority for the national animal health services in each country. Given this background, there are many examples among each of the national services of international leadership and research innovation in the area of regulatory animal health (Bouma *et al*., 2003; More *et al.,* 2006; Martin *et al.,* 2007a,b). Under international and EU legislation, government is considered the competent central authority, and these activities must be conducted by government, or under its direction. In Ireland, this work is funded primarily by government. In contrast, in both Australia and the Netherlands, industry contributes to (in some circumstances covers the full cost of) government regulatory activities (e.g., surveillance in the Netherlands, quarantine and inspection in Australia).

b. Non-regulatory animal health issues

The Netherlands and Australia are each making rapid progress in addressing a range of issues concerning non-regulatory animal health. The national mastitis and Johne's disease programmes in the Netherlands and Australia, and the InCalf (fertility) programme in Australia, are each considered international leaders, and each is effectively translating knowledge into substantial progress on the ground.

Progress in non-regulatory animal health issues in Ireland is limited to the pig and poultry sectors, through the Aujeszky's and enhanced salmonellosis control programmes, respectively. In the cattle and sheep industries, equivalent programmes have not been established.

Addressing non-regulatory animal health issues: potential lessons from the Netherlands and Australia

The above-mentioned discussion highlights limitations with the scope, but not the quality, of Ireland's national animal health services. In those areas within the current remit of the Irish animal health services (that is, regulatory animal health), Ireland's progress is not dissimilar to that achieved in comparable countries. However, it will be in Ireland's long-term interest to broaden the scope of these services, given the increasing impact of non-regulatory animal health issues in global trade (More, 2007). In both Australia and the Netherlands, this gap has been addressed through a very substantial increase in industry involvement in the national animal health services. I contend that similar moves are needed here.

a. Public sector involvement

In both the Netherlands and Australia, the allocation of public funds in the national animal health services is guided by the principle of *'who benefits, pays'*. The Dutch position is reflected in a recent position paper (Anon., 2006d), where the authors argue that government funding for disease control should be considered on a sliding scale: *"the greater the external effects on monitoring and control, the greater the justification for government involvement (direct and financial)*." In this situation, 'external effects' can be equated with 'public good'. Australia has reached almost identical conclusions, as reflected in the cost-sharing arrangement between government and livestock industry within the Emergency Animal Disease Response Agreement (**Figure 1**). Industry bodies also reflect a clear commitment to the

Category 1 (100% government) (rabies, Japanese encephalitis, Australian lyssaviruses, Nipah virus, the equine encephalitides)
Emergency animal diseases that predominantly seriously affect human health and/or the environment (depletion of native fauna) but may only have minimal direct consequences to the livestock industries.
Category 2 (80% government: 20% industry) (e.g., highly pathogenic avian influenza, bovine brucellosis, BSE, classical swine fever, foot and mouth disease)
Emergency animal diseases that have the potential to cause major national socioeconomic consequences through very serious international trade losses, national market disruptions and very severe production losses in the livestock industries that are involved. This category includes diseases that may have a slightly lower national socio-economic consequences, but also have significant public health and/or environmental consequences.
Category 3 (50% government: 50% industry) (e.g., African Horse Sickness, bovine tuberculosis, scrapie)
Emergency animal diseases that have the potential to cause significant (but generally moderate) national socio-economic consequences through international trade losses, market disruptions involving two or more states and severe production losses to affected industries, but have minimal or no affect on human health or the environment.
Category 4 (20% government: 80% industry) (e.g., Aujeszky's disease, contagious equine metritis, sheep scab)
Diseases that could be classified as being mainly production loss diseases. While there may be international trade losses and local market disruptions, these would not be of a magnitude that would be expected to significantly affect the national economy. The main beneficiaries of a successful emergency response to an outbreak of such a disease would be the affected livestock industry(s).

Figure 1: The cost-sharing arrangement between government and livestock industry within Australia's Emergency Animal Disease Response Agreement (Source: http://www.animalhealthaustralia.com.au/programs/eadp/eadra.cfm).

division between public and private good. As one example, it is the responsibility of Dairy Australia (an industry body), and not government, to help *"the (national) dairy industry to be collaborative, innovative, sustainable and competitive against both international dairy industries and substitute products*". This organisation is funded entirely through industry levies, apart from government contributions (with government matching industry funds on a 50:50 basis) to research and development.

There are substantial constraints on the use of EU and national government funds to support the national animal health services in the Netherlands. As an EU member state, these constraints are also relevant to Ireland. Three key issues are important:

- There is substantial government support (through the European Commission for Agriculture; DG Agriculture) for the agricultural sector through the common agricultural policy (Anon., 2004c). The stated aims of the policy are to "*provide farmers with a reasonable standard of living, consumers with quality food at fair prices and to preserve Europe's rural heritage*".

- Further, through the European Commission for Health and Consumer Protection (DG SANCO), the Community Animal Health Policy (CAHP) provides EU-level support for strategies to prevent the introduction of exotic diseases and to eradicate and monitor some animal diseases that are still present in some areas of the community. A strategy document for 2007-2013 was recently released (Anon., 2007e), with particular emphasis on policy coordination, the refinement of integrated risk management strategies for disease prevention and a harmonised EU framework for public-private cost-sharing (Food Chain Evaluation Consortium, 2006).
- Beyond this, support is constrained by EU competition policy, which seeks to prevent distortion of the EU internal market through unfair competition, whilst respecting international commitments through the World Trade Organization (WTO). The WTO's Agreement on Agriculture provides a negotiated framework for increased market orientation in international agricultural trade, including provisions that encourage the use of less trade-distorting domestic support policies to maintain the rural economy (Anon., 2007f). Detailed EU guidelines have been developed for the application of government support (so-called 'state aid') in the livestock sector. State aid can only be used to combat animal diseases *"of concern (to) public authorities",* and *"not measures for which farmers must reasonably take responsibility themselves"* (Anon., 2002, 2006f). These provisions may be reviewed, as part of the current CAHP review (Anon., 2006f). Provisions are made for the use of state aid in technical support and in research and development (Anon., 2000, 2006f).

These findings highlight a number of issues, which may be relevant to Ireland as it considers broadening the scope of its national animal health services. The roles and responsibilities of government in the national animal health services, and the principles underpinning this involvement, must be clearly stated. These principles should be clearly communicated to relevant stakeholders, as should the boundaries of government involvement. The involvement of government, beyond current regulatory animal health issues, is constrained by EU policy.

c. Private sector involvement

Co-management by government and industry is a key feature in the Dutch and Australian national animal health services. Under national legislation, industry organisations have national responsibility for a broad portfolio of sector-level issues, including national policy development, sector-relevant research and development; information collection, analysis and dissemination; issues management; national marketing; and international trade development. In other words, industry plays the leading role in shaping its own future. Although a range of industry organisations are involved, each has defined roles and responsibilities. In each country, non-regulatory animal health issues are essentially a remit of industry. In the Netherlands, this is primarily conducted by GD Animal Health Service; in Australia, Animal Health Australia is responsible for multi-sector issues and defined industry organisations (such as Dairy Australia) for single-sector issues. Strategic planning is a key feature in each country; as an example, Dairy Australia is guided by a five-year (2007-2011) strategic plan, which is translated into operational plans annually. This organisation must comply with published principles of corporate governance, and is evaluated independently every three years against both its strategic and annual operational plans and the value for money it provides levy payers (Hassall and Associates, 2006). Industry financial support, through compulsory industry levies, has evolved into a key component of centralised animal health service in each country. In Australia, the imposition of levies, and the level at which they are applied, is determined by respective industry groups. The sole role of government, through the Levies Revenue Service, concerns the administration, collection and disbursement of these monies.

These findings highlight a number of additional issues, which are of potential relevance to Ireland. Within clear limits, which are predominantly defined by international and (as relevant) EU legislation, the Dutch and Australian industries have the ability to shape their own future. The national animal health services are co-managed by government and industry, each with clearly defined roles and responsibilities. Non-regulatory animal health issues are primarily the responsibility of the private sector, in both countries with substantial technical support from appropriate organisations and people. Financial support for these activities is almost exclusively from industry, through compulsory levies. In these countries, industry structures facilitate whole-of-sector cooperation.

Conclusion

This paper has considered the role of the private sector in national animal health services, based on both theoretical considerations and country case studies. Each supports the case for increased private sector involvement in Ireland's national animal health services. Furthermore, the Dutch and Australian case studies present examples of successful partnerships between government and industry, including systems and processes to address non-regulatory animal health issues. It will be in Ireland's long-term interest to broaden the scope of its national animal health services, through increased private sector involvement, given the increasing impact of non-regulatory animal health issues in global trade.

Acknowledgements

I gratefully acknowledge constructive feedback from a range of colleagues, including Douwe Bakker, Marijke Beltman, Mary Canty, Ann Derwin, Rob Doyle, Rob

Furneaux, Liz Lane, Joe O'Flaherty, John O'Gorman, Luke O'Grady and Francisco Reviriego-Gordejo, as well as the anonymous referees.

References

Anon. (2000). Community guidelines for state aid in the agriculture sector. *Official Journal of the European Communities* **C28:** 2-24. February 1, 2000.

Anon. (2004a). Regulating better. Department of the Taoiseach, Dublin. http://betterregulation.ie/. [Online]. Accessed on September 10, 2007.

Anon. (2004b). Commodity and industrial boards: a means of raising standards in industry. Social and Economic Council of the Netherlands, The Hague. http://www.ser.nl

Anon. (2004c). The Common Agricultural Policy explained. European Commission Directorate General for Agriculture. http://ec.europa.eu/agriculture/publi/capexplained/cap_en.pdf. [Online]. Accessed on August 2, 2007.

Anon. (2005a). Annual Report 2005. GD Animal Health Service Deventer. http://www.gddeventer.com/. [Online]. Accessed on August 3, 2007

Anon. (2005b). Funding for the future. The report of the beef industry funding steering committee. http://www.mla.com.au/headerandfooter/aboutmla/howwearefunded/funding%2Bfor%2Bthe%2Bfuture.htm. [Online]. Accessed on August 3, 2007

Anon. (2005c). Annual report 2004/05, Dairy Australia. http://www.dairyaustralia.com.au/content/view/15/35/. [Online]. Accessed August 7, 2007.

Anon. (2006a). Community animal health policy 2007-2013 and thereafter. http://ec.europa.eu/food/animal/diseases/strategy/theirviews_en.htm. [Online]. Accessed on August 3, 2007.

Anon. (2006b). S.I. No. 673 of 2006. Bovine diseases (levies) regulations 2006. http://www.agriculture.gov.ie/legislation/SI2006/SI673-2006.pdf. [Online]. Accessed on August 30, 2007.

Anon. (2006c). Final report of a mission carried out in the Netherlands from January 30 to February 10, 2006 in order to evaluate official controls related to the safety of food of animal origin, in particular meat, milk and their products as well as animal welfare at the time of slaughter or killing. Food and Veterinary Office, DG(SANCO)/8146/2006-MR-Final. http://ec.europa.eu/food/fvo/index_en.htm. [Online]. Accessed on August 3, 2007.

Anon. (2006d). Position of the Netherlands on European Animal Health Policy Strategy. http://ec.europa.eu/food/animal/diseases/strategy/theirviews_en.htm. [Online]. Accessed on August 3, 2007.

Anon. (2006e). Final report of a mission carried out in Australia from October 17 to 27, 2006 in order to evaluate measures concerning bovine spongiform encephalopathy (BSE). Food and Veterinary Office, DG(SANCO)/8081/2006-MR-Final. http://ec.europa.eu/food/fvo/index_en.htm. [Online]. Accessed on August 3, 2007.

Anon. (2006f). Community guidelines for state aid in the agriculture and forestry sector 2007-2013. *Official Journal of the European Communities* **C19:** 1-33. December 27, 2006.

Anon. (2007a). Crunch time on cost sharing. *Veterinary Record* **161:** 705.

Anon. (2007b). Social partnership. Department of the Taoiseach. http://www.taoiseach.gov.ie. [Online]. Accessed on September 12, 2007.

Anon. (2007c). Productschap Zuivel. The Dutch Dairy Board. http://www.prodzuivel.nl/Engels/dutchdairyboard.pdf. [Online]. Accessed on 16 January 2008.

Anon. (2007d). Dutch dairy sector, Productschap Zuivel. www.prodzuivel.nl/Engels/dds2007/dutch_dairy_sector.htm. Accessed on 2 December 2007.

Anon. (2007e). The new Animal Health Strategy (2007-2013): 'prevention is better than cure'. http://ec.europa.eu/food/animal/diseases/strategy/index_en.htm. [Online]. Accessed on December 2, 2007.

Anon. (2007f). The Results of the Uruguay Round of Multilateral Trade Negotiations, Annex 1A, Multilateral Agreements on Trade in Goods, Agreement on Agriculture, World Trade Organization, pp43-71. http://www.wto.org/english/docs_e/legal_e/14-ag.pdf. [Online]. Accessed on September 4, 2007.

Ahuja, V. (2004). The economic rationale of public and private sector roles in the provision of animal health services. *Revue scientifique et technique - Office International des Epizooties* **23:** 33-45.

Baldwin, R. and Cave, M. (1999). *Understanding regulation: theory, strategy and practice*. Oxford University Press, Oxford.

Bicknell, K.B., Wilen, J.E. and Howitt, R.E. (1999). Public policy and private incentives for livestock disease control. *Australian Journal of Agricultural and Resource Economics* **43:** 501-521.

Bouma, A., Elbers, A.R.W., Dekker, A., de Koeijer, A., Bartels, C., Vellema, P., van der Wal, P., van Rooij, E.M.A., Pluimers, F.H. and de Jong, M.C.M. (2003). The foot-and-mouth epidemic in The Netherlands in 2001. *Preventive Veterinary Medicine* **57:** 155-166.

Brückner, G.K. (2004). Working towards compliance with international standards. *Revue scientifique et technique - Office International des Epizooties* **23:** 95-107.

Carlsson, L. and Berkes, F. (2005). Co-management: concepts and methodological implications. *Journal of Environmental Management* **75:** 65-76.

Egan, M.P. (2001). *Constructing a European market: standards, regulation, and governance.* Oxford University Press, Oxford.

Ekboir, J.M. (1999). The role of the public sector in the development and implementation of animal health policies. *Preventive Veterinary Medicine* **40:** 101-115.

Food Chain Evaluation Consortium (2006). Evaluation of the Community Animal Health Policy (CAHP). 1995-2004 and alternatives for the future. Final Report (Part I: Main report; Part II: Pre-feasibility study on options for harmonised cost-sharing schemes for epidemic livestock diseases), European Commission. http://ec.europa.eu/food/animal/diseases/strategy/final_report_en.htm. [Online]. Accessed on August 3, 2007.

Hardiman, N. (2002). From conflict to co-ordination: economic governance and political innovation in Ireland. *West European Politics* **25:** 1-24.

Hassall and Associates (2006). Three-year review of Dairy Australia, summary report. In association with Dr Bernie Bindon, Peter Frawley and Dr Bruce Standen. http://www.dairyaustralia.com.au/content/view/346/296/. [Online]. Accessed on August 7, 2007.

Holden, S. (1999). The economics of the delivery of veterinary services. *Revue scientifique et technique - Office International des Epizooties* **18:** 425-439.

International Trade Centre UNCTAD/WTO (2005). International Trade Statistics 2001-2005. http://www.intracen.org/tradstat/welcome.htm. [Online]. Accessed on August 16, 2007.

Kalis, C.H.J., Collins, M.T., Barkema, H.W. and Hesselink, J.W. (2004). Certification of herds as free of *Mycobacterium paratuberculosis* infection: actual pooled faecal results versus certification model predictions. *Preventive Veterinary Medicine* **65:** 189-204.

Knill, C. and Lenschow, A. (2003). Modes of regulation in the governance of the European Union: towards a comprehensive evaluation. *European Integration online Papers (EIoP)* **7.** http://eiop.or.at/eiop/texte/2003-001a.htm. [Online]. Accessed on September 10, 2007.

Lehane, R. (1996). *Beating the odds in a big country: the eradication of bovine* *brucellosis and tuberculosis in Australia.* CSIRO, Melbourne.

Leonard, D.K. (2004). Tools from the new institutional economics for reforming the delivery of veterinary services. *Revue scientifique et technique - Office International des Epizooties* **23:** 47-57.

Martin, P.A.J., Cameron, A.R., Barfod, K, Sergeant, E.S.G. and Greiner, M. (2007a). Demonstrating freedom from disease using multiple complex data sources 2: Case study—Classical swine fever in Denmark. *Preventive Veterinary Medicine* **97**: 98-115.

Martin, P.A.J., Cameron, A.R. and Greiner, M. (2007b). Demonstrating freedom from disease using multiple complex data sources 1: A new methodology based on scenario trees. *Preventive Veterinary Medicine* **97:** 71-97.

McCarthy, J. (2007). Why eradicate IBR and BVD in Ireland? *Irish Farmers Journal*, March 17, 2007. http://www.farmersjournal.ie/2007/0317/farmmanagement/beef/feature.shtml. [Online]. Accessed on December 2, 2007.

McGuinness, M. (2004). Future shape of Teagasc to be decided this week. *Irish Independent* January 6, 2004.

More, S.J., Collins, J.D., Gormley, E., Good, M., Skuce, R. and Pollock, J.M. (2006). Special issue: 4th International Conference on *Mycobacterium bovis*. *Veterinary Microbiology* **112:** 89-394.

More, S.J. (2007). Shaping our future: animal health in a global trading environment. *Irish Veterinary Journal* **60:** 541-549.

More, S.J. and Good, M. (2006). The tuberculosis eradication programme in Ireland: A review of scientific and policy advances since 1988. *Irish Veterinary Journal* **112:** 239-251.

Pomeroy, R.S. and Berkes, F. (1997). Two to tango: the role of government in fisheries co-management. *Marine Policy* **5:** 465-480.

Radunz, B. (2006). Surveillance and risk management during the latter stages of eradication: Experiences from Australia. *Veterinary Microbiology* **112:** 283-290.

Room, G. (2005). Policy benchmarking in the European Union: indicators and ambiguities. *Policy Studies* **26:** 117-132.

Sen, A. and Chander, M. (2003). Privatization of veterinary services in developing countries: a review. *Tropical Animal Health and Production* **35:** 223-236.

Sheahan, M., O'Hagan, G., Power, S. and Kenny, K. (2006). Brucellosis in cattle in Ireland 1998-2005: Progress towards eradication continues. *Irish Veterinary Journal* **59:** 217-221.

Sheridan, H. A., McGrath, G., White, P., Fallon, R. Shoukri, M.M. and Martin, S.W. (2005). A temporal-spatial analysis of bovine spongiform encephalopathy in Irish cattle herds, from 1996 to 2000. *Canadian Journal of Veterinary Research* **69:** 19-25.

Shillhorn van Veen, T.W. and de Haan, C. (1995). Trends in the organization and financing of livestock and animal health services. *Preventive Veterinary Medicine* **25:** 225-240.

Treib, O., Bähr, H. and Falkner, G. (2007). Modes of governance: towards a conceptual framework. *Journal of European Public Policy* **14:** 1-20.

Umali, D.L., Feder, G. and de Haan, C. (1994). Animal health services: finding the balance between public and private delivery. *The World Bank Research Observer* **9:** 71-96.

Weber, M.F., van Roermund, H.J.W., Vernooij, J.C.M., Kalis, C.H.J. and Stegeman, J.A. (2006). Cattle transfers between herds under paratuberculosis surveillance in the Netherlands are not random. *Preventive Veterinary Medicine* **76:** 222-236.

Whittem, J. (1998). Book review (Beating the odds in a big country: the eradication of bovine brucellosis and tuberculosis in Australia). *Australian Veterinary Journal* **76:** 701.

Analysis of factors influencing prognosis in foals with septic arthritis

Nicolas J. Vos[1] and Norm G. Ducharme[2]

1 Unit of Veterinary Surgery, University Veterinary Hospital, School of Agriculture, Food Science and Veterinary Medicine, University College Dublin, Belfield, Dublin 4, Ireland

2 College of Veterinary Medicine, Cornell University, Ithaca, New York 14853, United States of America

The purpose of this paper was to identify factors that would positively or negatively affect the short-term survival rate of foals with septic arthritis. Medical records of 81 foals (≤ seven months of age) with a clinical diagnosis of septic arthritis, referred to the equine hospital at Cornell University Hospital for Animals, between 1994 and 2003 were reviewed. Signalment, age at presentation, number of affected joints, joint fluid parameters, bacterial agents, treatment modalities and year of treatment were compared between survivors and non-survivors. Sixty-two of 81 foals (77%) were discharged from the hospital and classified as 'survivors'. Multiple joint involvement and detection of intra-articular Gram-negative, mixed bacterial infection and degenerate neutrophils were negatively associated with short-term survival. Initiation of treatment within 24hrs of onset of clinical signs and combination of treatment modalities were positively correlated with survival. Further investigation is needed to determine if these two factors have a similar influence on athletic performance.

Corresponding author:
Nic Vos, University Veterinary Centre Camden, Faculty of Veterinary Science, The University of Sydney, 410 Werombi Road, Camden, New South Wales 2570, Australia
Tel: 0061 24654 6729
Fax: 0061 24655 1212
Email: nvos@mail.usyd.edu.au

Irish Veterinary Journal
Volume 61 Number 2 102-106, 2008

Keywords: arthritis, foals, septic, treatment

Introduction

Septic arthritis is a potentially debilitating condition associated with significant morbidity and mortality in foals (Martens *et al*., 1986). The source of infection may be haematogenous, extension from adjacent soft tissue or bony infection, or it may be caused by perforating trauma, either accidental or iatrogenic in origin (Martens *et al*., 1986; Schneider *et al*., 1992a; Schneider, 2006). Clinical signs of affected foals include moderate to severe lameness, joint distension and pain on flexion of the affected joint. Additional clinical abnormalities observed may be related to the infection's origin, which can be localised near the joint (adjacent infection, trauma, laceration), more remote (infection of umbilical structures, enteritis, lower airway infection), or systemic in nature (septicaemia) (Leitch, 1985; Martens *et al*., 1986; Schneider *et al*., 1992a; Meijer *et al*., 2000). Final diagnostic confirmation is obtained by positively identifying bacterial agents on cytology or from cultures of synovial fluid or membrane (Bertone, 1996). Clinical case documentation shows that bacterial culture results from synovial fluids are negative in 33-60% of septic arthritis cases (Madison *et al*., 1991; Honnas *et al*., 1992; Schneider *et al*.,1992b; Meijer *et al*., 2000). A recent study demonstrated that both incubation of synovial fluid in a blood culture medium (BCM) and a polymerase chain reaction test (PCR) are more specific and sensitive methods of confirming synovial infection in horses. Therefore, diagnosing septic arthritis in clinical practice is based on the aforementioned clinical signs combined with a synovial fluid cytology which shows a white blood cell count (predominantly neutrophils) greater than 5,000 cells/µl (Mahaffey, 2002) and total protein concentration above 2.5 g/dl (Steel *et al.,* 1999).

The principles of treatment of septic arthritis are early recognition, removal of infected tissue/fluids (thorough joint lavage, arthroscopy, arthrotomy, closed suction drainage) and appropriate antimicrobial therapy (Ross *et al*., 1991; Bertone *et al*.,1992; Honnas *et al*.,1992; Schneider *et al.,* 1992a, 1992b; Baxter, 1996; Meijer *et al*., 2000; Wright, 2003) The high mortality rate (22-58%) associated with septic arthritis despite treatment emphasises its clinical importance (Schneider *et al*., 1992b; Steel *et al*., 1999; Meijer *et al*., 2000). Treatment survivors can have persistent osteoarthritis and lameness (Martens *et al*., 1986; Goodrich and Nixon, 2004) with a reduced likelihood of ever starting in a race compared to controls (Smith *et al*., 2004).

The authors of this paper hypothesised that there is a positive effect of the combination of treatment modalities such as arthroscopy, arthrotomy, regional deposition of antibiotics (intra-articular and regional perfusion) to improve chances for short-term survival as compared to treatment consisting of joint lavage and systemic antibiotics alone. In addition, the authors wished to identify factors negatively associated with short-term survival in a population of foals with septic arthritis diagnosed by practitioners and subsequently referred to a university hospital.

Materials and methods

Medical records of 81 foals (≤ seven months old) with a recorded diagnosis of septic arthritis referred to the Cornell University Veterinary Hospital between January 1, 1994 and January 1, 2004 were retrieved and reviewed. Foals were included in this study if two or more of the following criteria were met: clinical signs of septic arthritis (e.g., joint distension, lameness); positive results for bacterial culture from synovial fluid; synovial fluid protein concentration >2.5 g/dl; >5,000/µl nucleated cells in synovial fluid; and, radiographic evidence of osteomyelitis affecting the epiphysis or physis on initial radiographs. The following information was retrieved from the medical records: year of admission; age; gender; breed; duration of condition prior to admission; number of swollen joints and anatomical location; rectal temperature at admission; records documenting the presence of umbilical infection, pneumonia, and/or enteritis; cytological examination of synovial fluid (total protein concentration, nucleated cell count, percentage of macrophages and degenerate neutrophils and red blood cell count); and, results of bacterial culture (aerobic and anaerobic). In addition, type and frequency of treatments, as well as days of hospitalisation, were recorded. Treatments performed included through-and-through needle joint lavage, arthrotomy, arthroscopy, regional intravenous perfusion, local implantation of antibiotic-impregnated polymethylmethacrylate (AIPMMA) beads and intra-articular antimicrobial treatment. The presence of associated diseases following diagnosis of septic arthritis was recorded, for example septicaemia or an infectious process at a remote site (umbilical and urachal infection). Finally, an epiphyseal or physeal infection was recorded as present if radiolucent areas were seen on initial radiographs. Survival was defined as discharged from the hospital alive.

For statistical purposes, the foals were classified in two groups. Group one consisted of foals that were discharged from the hospital alive (survivors). Group two consisted of foals that, despite treatment in the hospital, did not survive (non-survivors). The data realting to the foals were compared by using the Chi Square test or Fisher's exact test, as appropriate, for qualitative (dichotomous) parameters (sex, breed, rectal temperature [fever or not], presence of osteomyelitis, treatment combinations performed per foal and duration of condition prior to admission [greater than or equal to 24hrs or not]). The Mann Whitney U test and Student's t-test, as appropriate, were used for comparison of quantitative (continuous) parameters (number of survivors/non-survivors, age, year of admission, number of swollen joints per foal, number of hind limbs/front limb joints infected, number of single/multiple joints infected, number of pure Gram-positive/pure Gram-negative infections, number of multiple/single bacterial infections, number of invasive treatments such as needle-through-and-through joint lavages, arthroscopies and arthrotomies, and number of days of hospitalisation). The synovial fluid cytology results (total protein level, nucleated cell count, red blood cell count, percentage of degenerate neutrophils and percentage of macrophages) were compared between both groups, using the Wilcoxon rank sum test and Student's t-test. Statistical comparisons were performed using computer software (SPSS®12.0; SPSS Inc., Chicago, IL, USA). The level of significance was set at $P \leq 0.05$.

Results

Sixty-two (77%) of the 81 foals were discharged from the hospital. The number of survivors was significantly larger (n=62) than the non-survivors (n=19) ($P<0.0001$). There were no sex or breed differences between the survivor and non-survivor groups. The median age of the survivors (24 days; range 1-207) was not significantly different from the non-survivors (15 days; range 3-127). Although the number of foals brought to the hospital increased significantly towards the end of the 1990s, there was not a significant effect on the overall survival rate in foals admitted in the first half of the study compared to the second half.

The total number of infected joints in all 81 foals was 151. The group of survivors had significantly more single joint infections (43 out of 62 foals; 69%) compared with the non-survivor group (four out of 19 foals; 21%) ($P<0.0001$). Conversely, the mean number of infected joints per foal was significantly larger in the non-survivor group (2.84 joints; range 1-8) compared to the survivors (1.56 joints; range 1-6) ($P<0.05$). **Table 1** shows the number and anatomical location of the septic joints in the foal population. The location of the infected joints did not differ between survivors and non-survivors. Osteomyelitis was diagnosed more often in the non-survivor group (53%), when compared to the survivor group (13%) ($P=0.001$).

The results of synovial fluid analysis are summarised in

Table 1: Location of affected joints in 81 foals with septic arthritis

Joint affected	Number of infected joints in survivor group	Number of infected joints in non-survivor group	Total number of infected joints
Tarsus	37	15	52
Femoropatellar/femorotibial	24	13	37
Metacarpo/metatarso-phalangeal	13	8	21
Distal interphalangeal	2	1	3
Carpus	17	13	30
Scapulohumeral	1	0	1
Coxofemoral	2	2	4
Cubital	1	2	3
Total	97	54	151

Table 2. A significantly greater percentage of degenerate neutrophils were seen in the joints of non-survivor foals (70%), as compared to survivors (50%) (P=0.028). The mean red blood cell count in the infected joints of survivors (243.87 X10^3 cells/µl) was greater than in the non-survivors (94.90 X10^3 cells/µl) (P=0.018). However, the nucleated cell count, percentage of macrophages and total protein concentration were not significantly different between the two groups.

Overall, more pure Gram-positive bacterial infections (26) were confirmed than Gram-negative infections (8) (P=0.043). Pure Gram-positive cultures were seen more often in the survivor group (22 out of 46; 48%) than in the non-survivor group (four out of 13; 31%) (P=0.045). In contrast, pure Gram-negative cultures were seen more often in the non-survivor group (six out of 13; 46%) compared to the survivor group (two out of 46; 4%) (P<0.0001). Multiple bacterial species cultures were more numerous in the non-survivor group (three out of 13 submitted synovial fluid samples; 23%) compared with the survival group (three out of 46 submitted synovial fluid samples; 7%) (P=0.05). Only one was positive on anaerobic culture, a *Clostridium perfringens* infection within the non-survivor group of foals. Within the group of survivors, *Streptococcus zooepidemicus* and *Staphylococcus aureus* were more commonly isolated (10 out of the 46 submitted samples. Within the non-survivor group, *Enterobacteriaceae* (especially *Escherichia coli*) were most commonly isolated (4 out of 13 submitted samples).

Time of initiation of treatment in relation to onset of clinical signs was documented in 50 of the foals. All but one of the 15 foals (93%) that were treated at the hospital within 24hrs of recognition of clinical signs survived, while 23 (66%) of the 35 foals whose treatment was delayed (range 24hrs to 10 days) survived. After 24 hours, the time of initiation of treatment after onset of clinical signs was not significantly different between survivors (mean 6.6 days; range 1-42 days) and non-survivors (mean 4.5 days; range 2-10 days).

All the foals were treated with systemic antibiotics upon arrival. In general, a combination of sodium penicillin G (22.000 IU/kg IV, every 6hrs) and amikacin sulphate (21 mg/kg IV, every 24hrs) or gentamicin sulphate (6.6 mg/kg IV, every24hrs) was initiated as a broad-spectrum antibiotic treatment before identification of the causative agent was established. Multiple other treatment modalities were often used in combination: through-and-through needle joint lavage (n=66), arthroscopy (n=12), arthrotomy (n=16), regional intravenous perfusion (n=6), intra-articular antibiotic administration (n=34) and implantation of an antimicrobial carrier beads (AIPMMA) (n=6). The number of joint lavage treatments (4.71; range 1-18) and joint lavages per joint (2.99; range 1-8) was greater in the survivor group and lower in the non-survivor group (7.45, range 1-36; and 4.05, range 1-15, respectively) (P<0.05). Significantly more survivors (15 out of 62; 24%) were treated with arthrotomy than non-survivors (one out of 19; 5%) (P=0.048). Twelve out of 62 (19%) survivors were treated with arthroscopy but none of the 19 non-survivors were (P=0.038). Within the survivor group, 52 foals (84%) received a combination of invasive procedures, for example a joint lavage and an arthrotomy or an arthroscopy and local perfusion techniques, whereas only one combination (joint lavage and arthrotomy) was carried out in the non-survivor group (P<0.001). The median hospitalisation time for survivors was 10 days compared to three days for the non-survivors (P=0.01).

Table 2: Results of 174 joint synovial fluid analyses obtained from 81 foals with a clinical diagnosis of septic arthritis stratified within hospital survivor and non-survivor foal groups.

Parameters	Survivors	Non-survivors
	Mean (± s.d.) n=number of samples	
Total protein (g/dl)	3.74 (5.9) (n=172)	3.55 (4.1) (n=40)
Nucleated cells count (10^3cells/µl)	42.83 (313) (n=170)	45.57 (165) (n=34)
Degenerate Neutrophils* (%)	50.4 (50) (n=49)	69.7 (55) (n=7)
% Macrophages	16.7 (31) (n=23)	13.8% (44) (n=6)
Red blood cell count *(10^3cells/µl)	243.87 (3271) (n=169)	94.90 (410) (n=40)

*Significantly different at P<0.05.

Discussion

Interpretation of the results of this study must be informed by the certainty of diagnosis, because joint infections are difficult to confirm through bacterial culture. Many reports have established a range of 0 to 60% for the false negative rate from bacterial culture of synovial fluid (Madison *et al*., 1991; Honnas *et al*., 1992; Schneider *et al*., 1992b; Meijer *et al*., 2000). Therefore, the diagnosis was made based on a combination of clinical signs and cytological examination of the synovial fluid. It is therefore possible that some joints were inflamed and not septic or no longer infected at the time of presentation. Retrospective studies, such as this one, allow assessment of the usefulness of diagnostic procedures developed over time. Relatively new diagnostic techniques, such as PCR, show a far better sensitivity than previously available methods (Pille *et al*., 2007). However, as Pille *et al*. (2007) reported, even these new diagnostics do have shortcomings in sensitivity, specificity, costs and the sheer complexity of the techniques described. In addition, interpretation of the present study's findings should be made in the knowledge that treatments were not randomly assigned and other factors, such as perceived value of the animal or financial limits of the owner and surgeon's individual treatment preference, might have influenced treatment selection and/or survival rate. Finally failure, or partial failure, of passive transfer of immunity is a major risk for septicaemia, multi-systemic disease and septic arthritis and responses to treatment (Becht and Semrad 1992; Raidal 1996). In this study, the failure of passive transfer was not documented reliably in the medical records. The mortality rate of 23% and survival rate of 77% in this study compared favourably with previous reports (22-58%) (Schneider *et al*., 1992a, 1992b; Meijer *et al.,* 2000) and was very similar to the report of Steel *et al*. (1999) with a 78%

survival rate in a 93-foal population. As previously reported, the age at admission to the hospital, gender, and breed were not statistically significant in relation to prognosis (Martens *et al*., 1986; Schneider *et al*., 1992a; Meijer *et al*., 2000; Smith *et al*., 2004).

The authors did, however, identify several factors that were associated with survival rate. As others have reported, the number of infected joints was important, as foals with only one joint affected were more likely to survive (Schneider *et al*., 1992a, 1992b; Steel *et al*., 1999; Meijer *et al*., 2000). This may reflect the animal's systemic condition (e.g., septicaemia, immune status), rather than the difficulties associated with the successful local treatment of more than one infected joint. Furthermore, the decreased activity associated with multiple joint infections may lead to formation of decubital sores, decreased appetite and, hence, sub-optimal nutritional support.

Septic arthritis has been termed a medical emergency (Koch, 1979; Madison *et al*., 1991; Bertone *et al*.1992). The present study revealed an increased chance of survival when treatment was initiated within 24hrs. As far as the authors are aware, no other data have been reported that relate to the timing of treatment. It is thought that other factors came into play when the time lapse before initiation of treatment was extended beyond 24hrs, as the survival rate decreased (from 93% to 66%) after that period. Perhaps this is because appropriate treatments were only initiated in some foals after 24hrs. One should also consider that the more valuable the foals were, the more likely they were to be admitted to the hospital within 24hrs of recognition of clinical signs and perhaps had environmental conditions superior to foals presented after 24hrs.

The results of synovial fluid (**Table 2**) show a range with regards to the mean values. The range clearly shows a large overlap in individual parameters between the two groups and points out that synovial fluid parameters ideally should be used in combination with each other in order to have any predictable value. The percentage of degenerate neutrophils in relation to nucleated cells was higher in non-survivors than survivors, making it a negative indicator for survival. An increase in nucleated cells (> 5,000 cells/µl (Mahaffey, 2002) is clearly a hallmark of septic arthritis in any species, but especially in horses. The toxic effects of bacteria on neutrophils make degenerate neutrophils typical in septic exudates. Indeed, degenerate neutrophils are more numerous surrounding a microcolony in a septic joint (Bertone *et al*., 1992; Mahaffey, 2002). The elevated percentage of degenerate neutrophils in non-survivors likely indicates a more advanced or virulent infection, which is consistent with the negative association finding for survival in this study (Mahaffey, 2002).

The finding that Gram-positive infections were more frequent in this study differs from previous reports (Bertone *et al*., 1992; Schneider *et al*., 1992a; Steel *et al*., 1999). The reason for this difference is unknown but might reflect regional geographic differences. This study agreed with previous reports that Gram-negative infections were more prevalent in non-survivors and are associated with a poor prognosis (Wright and Scott, 1989; Schneider *et al*., 1992a, 1992b; Meijer *et al*., 2000). Additionally, infection with multiple bacterial-type species in the synovial fluid worsens the prognosis for foals with septic arthritis (Madison *et al*., 1991; Bertone *et al*., 1992; Schneider *et al*., 1992a). Finally**,** osteomyelitis is often seen in foals with septic arthritis (Trotter, 1996). This study suggests that the presence of osteomyelitis worsens the prognosis, since the incidence of osteomyelitis was significantly higher in the non-survivor group.

It is difficult to assess which treatment has more value in managing septic arthritis since randomisation was not performed in this study. However, supplemental treatments beyond joint lavage and systemic antibiotics, such as arthrotomy, arthroscopy and regional intravenous perfusion, were performed more frequently in survivors, suggesting an added value. The study also suggests that higher morbidity was not associated with more aggressive therapies. This is consistent with other authors who have advocated the use of arthrotomy (Bertone *et al*., 1992), arthroscopy (McIlwraith and Fessler, 1978; Wright and Scott, 1989; Wright, 2003), regional perfusion (Whitehair *et al*., 1992; Santschi *et al*., 1998; Schneider, 2006) and antibiotic-impregnated beads (Calhoun and Malder 1989; Farnsworth *et al*., 2001; Ducharme and Mitchell, 2004) to facilitate in the treatment of septic arthritis in horses.

Conclusion

In conclusion, initiation of prompt treatment within 24hrs is of particular significance in foals with signs of septic arthritis. Lack of response to joint lavage and systemic antibiotics should lead to consideration of additional treatment modalities such as regional delivery of antibiotics, arthroscopy and/or arthrotomy, since these treatment modalities significantly improved chances for survival.

Acknowledgments

The authors would like to express their gratitude to Ms. Lisa Mitchell and Ms. Anne Littlejohn for their assistance in compiling the digital medical records and follow-up information and Dr Elisabeth de Klerk PhD for the statistical analysis.

References

Baxter, G.M. (1996). Instrumentation and techniques for treating orthopaedic infection in horses. *Veterinary Clinics North America Equine Practice* **12**: 303-335.

Becht, J.L. and Semrad, S.D. (1992). Hematology, blood typing, and immunology of the neonatal foal. *Veterinary Clinics of North America Equine Practice* **1** (1): 91-116.

Bertone, A.L., Davis, M. and Cox, H.U. (1992). Arthrotomy versus arthroscopy and partial synovectomy for treatment of experimentally induced septic arthritis in horses. *American Journal Veterinary Research* **53**: 585-529.

Bertone, A.L. (1996). Infectious arthritis IN: C.W. McIlwraith and G.W.Trotter (eds.) *Joint disease in the horse*. Philadelphia, Saunders Company. pp 397-409.

Calhoun, J.H. and Malder, J.T. (1989). Antibiotic beads in the management

of surgical infections. *American Journal of Surgery* **157**: 443-449.
Ducharme, N.G. and Mitchell, L. (2004). Advances in the treatment of bone and joint infections in foals. *Proceedings 13th Annual Scientific Meeting ECVS*. Prague, Czech Republic. (July) 181-184.
Farnsworth, K.D., White, N.A. and Robertson, J. (2001). The effect of implantation of gentamycin impregnated polymethylmethacrylate beads in the tarsocrural joint of the horse. *Veterinary Surgery* **30**: 126-131.
Goodrich, L.R. and Nixon, A.J. (2004). Treatment options for osteomyelitis. *Equine Veterinary Education* **16** (5): 267-280.
Honnas, C.M., Welch, R.D. and Ford, T.S. (1992). Septic arthritis of the distal interphalangeal joint in 12 horses. *Veterinary Surger.* **21** (4): 261-268.
Koch, D.B. (1979). Management of infectious arthritis in the horse. *Compendium Continuous Education Veterinary Practitioners* **1**: 545-550.
Leitch, M. (1985). Musculoskeletal disorders in neonatal foals. *Veterinary Clinics of North America Equine Practice.* **1** (Apr): 189-207.
Madison, J.B., Sommer, M. and Spencer, P.A. (1991). Relations among synovial membrane histopathologic findings, synovial fluid cytologic findings, and bacterial culture results in horses with suspected infectious arthritis: 64 cases (1979-1987). *Journal American Veterinary Medical Association* **198** (9): 1655-1661.
Mahaffey, E.A. (2002). Synovial fluid. IN: R.Cowell, R.Tyler (eds.) *Cytology and Haematology of the horse.* Missouri, Mosby Inc. pp 163-170.
Martens, R.J., Auer, J.A. and Carter, G.K. (1986). Equine paediatrics; septic arthritis and osteomyelitis. *Journal American Veterinary Medical Association* **88**: 582-585.
McIlwraith, C.W. and Fessler, J. (1978). Arthroscopy in the diagnosis of equine joint disease. *Journal American Veterinary Medical Association* **172**: 222-269.
Meijer, M.C., Van Weeren, P.R. and Rijkenhuizen, A.B.M. (2000). Clinical experiences of treating septic arthritis in the equine by repeating joint lavage: a series of 39 cases. *Journal of Veterinary Medicine* **47**: 351-365.
Pille, F., Martens, A., Schouls, L.M., Dewulf, J., Decostere,A., Vogelaers, D. and Gasthuys, F. (2007). Broad range 16S rRNA gene PCR compared to bacterial culture to confirm presumed synovial infection in horses. *The Veterinary Journal* **1**: 73-78
Raidal, S.L. (1996). The incidence and consequences of failure of passive transfer of immunity on a Thoroughbred breeding farm. *Australian Veterinary Journal* **73** (6): 201-206.
Ross, M.W., Orsini, J.A. and Richardson, D.W. (1991). Closed suction drainage in the treatment of infectious arthritis of the equine tarsocrural joint. *Veterinary Surgery* **20**: 21-29.
Santschi, E.M., Adams, S.B. and Murphy, E.D. (1998). How to perform equine intravenous digital perfusion. *Proceedings American Association Equine Practitioners* **44**: 198-201.
Schneider, R.K, Bramlage, L.R. and Moore, R.M. (1992a). A retrospective study of 192 horses affected with septic arthritis/tenosynovitis. *Equine Veterinary Journal* **24**: 436-442.
Schneider, R.K., Bramlage, L.R. and Moore, R.M. (1992b). Open drainage, intra-articular and systemic antibiotics in the treatment of septic arthritis/ tenosynovitis in horses. *Equine Veterinary Journal* **24**: 443-449.
Schneider, R.K. (2006). Orthopaedic infections. IN: J. Auer, J Stick (eds.) *Equine Surgery*. Pennsylvania, Saunders Company. pp 1121-1130.
Smith, L.J., Marr, C.M. and Payne, R.J. (2004). What is the likelihood that Thoroughbred foals treated for septic arthritis will race? *Equine Veterinary Journal* **36** (5): 452-456.
Steel, C.M., Hunt, A.R. and Adams, P.L. (1999). Factors associated with prognosis for survival and athletic use in foals with septic arthritis: 93 cases (1987-1994). *Journal American Veterinary Medical Association* **215** (7): 973-977.
Trotter, G.T. (1996). Osteomyelitis. IN: A. Nixon (ed.) *Equine fracture repair.* Philadelphia, Saunders Company. pp 359-366.
Whitehair, K.J., Bowersock, T.L. and Fessler, J.F. (1992). Regional limb perfusion for antibiotic treatment of experimentally induced septic arthritis. *Veterinary Surgery* **21**: 367-373.
Wright, I.M. (2003). Arthroscopic surgery in the management of contamination and infection of joints, tendon sheaths and bursae. *Clinical Technology Equine Practitioners* **1**: 234-244.
Wright, I.M. and Scott, M. (1989). Management of penetrating wounds in joints, tendon sheaths and bursae. *Equine Veterinary Education* **1**: 15-22.