

Guidelines for the veterinary care of laboratory animals: report of the FELASA/ECLAM/ESLAV Joint Working Group on Veterinary Care

Members of the Joint Working Group on Veterinary Care: Hanna-Marja Voipio* (Convenor), P Baneux[†] (USA), I A Gomez de Segura[‡] (Spain), J Hau[§] (Denmark) and S Wolfensohn[¶] (UK)

*Laboratory Animal Centre, PO Box 5000, FIN-90014 University of Oulu, Finland; [†]Center for Comparative Medicine, Northwestern University, Chicago, IL, USA; [‡]Department of Animal Medicine and Surgery, Veterinary Faculty, University Complutense, Madrid, Spain; [§]Department of Experimental Medicine, University of Copenhagen, Denmark; [¶]Veterinary Services, University of Oxford, Oxford, UK

Summary

Veterinary professionals working in partnership with other competent persons are essential for a successful animal care and use programme. A veterinarian's primary responsibilities are defined by their own professional regulatory bodies, but in this area of work there are further opportunities for contribution, which will assist in safeguarding the health and welfare of animals used in research. These guidelines are aimed not only at veterinarians to explain their duties, and outline the opportunities to improve the health and welfare of animals under their care, but also at employers and regulators to help them meet their responsibilities. They describe the desirability for postgraduate education towards specialization in laboratory animal medicine and detail the many competencies necessary to fulfil the role of the laboratory animal veterinarian. They detail the need for veterinary expertise to promote good health and good welfare of animals used in biomedical research during husbandry as well as when under experimental procedures. Regulatory and ethical aspects are covered as are the involvement of the veterinarian in education and training of others working in the animal care and use programme. Managerial aspects, including occupational health and safety, are also areas where the veterinarian's input can assist in the successful implementation of the programme.

Introduction and aims of the report

The care and use of laboratory animals impose responsibilities on various professionals with different backgrounds. Frequently, there is overlap in the functions and responsibilities of these different professionals. Clarification on the degree of overlap is necessary, since some of these functions can only be performed by competent persons with adequate knowledge and training. The veterinarian is undoubtedly the

appropriate person to provide, and take responsibility for, the veterinary care, which is provided to laboratory animals.

This document is to provide guidelines for the veterinary care of laboratory animals and was prepared by the Federation of European Laboratory Animal Science Associations (FELASA), the European Society of Laboratory Animal Veterinarians (ESLAV) and the European College of Laboratory Animal Medicine (ECLAM). It is aimed not only at veterinarians, but equally at employers and regulators. The professional judgement of a veterinarian trained and experienced in laboratory animal science and medicine is essential in the application of

Correspondence: H-M Voipio, Laboratory Animal Centre, PO Box 5000, FIN-90014 University of Oulu, Finland. Email: Hanna-Marja.Voipio@oulu.fi

Accepted 6 August 2007

these guidelines to the specific institution's animal care and use programme.

Veterinarians have specific legal responsibilities and professional obligations as defined by their professional regulatory bodies.

Beyond statutory responsibilities, there are additional roles for the laboratory animal veterinarian, which are advisory. The degree of regulatory authority which the veterinarian has to ensure compliance with varies between countries, but this variation should not be used as a reason to reduce the level of veterinary involvement or the level of seriousness with which the advice is received. This document does not detail the differing legal authorities, responsibilities and duties for the veterinarian working in laboratory animal facilities across the many EU member states; rather it is a guideline to assist in the establishment and the continued development of an ethos of improving animal health and welfare of the animals used in the research, testing and education, a process, which is facilitated by closer involvement of the veterinarian.

Traditional veterinary care such as acute medical treatment, while still important, takes up a relatively small proportion of the laboratory animal veterinarian's time. Adequate veterinary care in laboratory animal science encompasses several aspects which all reflect the complexity of the veterinarian's role in this specialty. These include the following:

- All activities directly related to the animals to promote their welfare, such as during transportation, health monitoring and health management, husbandry, selection of environmental enrichment, surgery, anaesthesia, analgesia and euthanasia.
- Scientific activities often as a scientific collaborator and adviser in laboratory animal science.
- Activities related to regulatory and administrative compliance. The veterinarian must be knowledgeable about relevant legislation, including any appropriate ethical review process.
- Education and training of personnel and guidance of administrative staff, animal-

care staff, and scientists to the benefit of the animals, the science and the institution.

The operations of an animal care and use unit are often referred to as a programme of animal care and use, of which a key component is veterinary care to ensure good animal health and welfare. Elements of this programme may be carried out by other competent persons than veterinarians.

However, the programme must include veterinary expertise in laboratory animal science and attribute to the veterinarian's function the appropriate directive and influential role. The veterinarians should not accept the responsibility beyond their competencies. However, this document describes the areas where the veterinarian might make additional contributions, which will promote the welfare of animals under their care, going beyond a minimalist approach.

The core veterinary responsibilities of diagnosis and prescription of treatment are governed by national and European laws, but the veterinarian can delegate several other activities to a suitably competent person.

The present recommendations elaborate the key elements relating to the veterinarian's involvement in the programme and indicate the expected level of knowledge and responsibility. Recommendations, wherever possible, should be made on an evidence-based approach. The appreciation of the veterinarian's unique understanding of the inter-relatedness of all the different components of the programme must be reflected by the degree of authority held by the veterinarian, either in the national legislation or in the management structure and attitudes prevailing in the institution.

Veterinary educational requirements and competencies

Veterinary education provides the basic knowledge and enables a person to work as a veterinarian although legal requirements and professional obligations vary between countries. However, an undergraduate education emphasizes companion and farm

animal species and the common laboratory animals are given less consideration. Therefore, a laboratory animal veterinarian must obtain specific education, training and competencies if dealing with these species. In small units, the attending veterinarian may not have significant experience in laboratory animal care, in which case such veterinarians should have access to a mentor – a veterinarian who does have such experience and can provide advice and support. Encouragement should be given to joining relevant laboratory animal science associations or similar networks for professional as well as high-level scientific information exchange.

The European legislation does not currently specify further educational requirements for a veterinarian with legal responsibilities for laboratory animal care. However, the Multilateral Consultation of Parties to the Convention has adopted a resolution on education and training of persons working with laboratory animals. This resolution is based on the FELASA recommendations for the education and training of persons involved in animal experiments. In these recommendations, two categories give some specialization for those who have completed a bachelor's or master's degree or equivalent: category C is for those responsible for directing animal experiments and category D is for laboratory animal science specialists. Although there are no regulations for mandatory postgraduate training, the absolute minimum requirement for a person conducting veterinary duties in laboratory animal units should be the category C course.

Laboratory animal medicine is a specialty that is open only to veterinarians whereas laboratory animal science is a specialty open to those with a relevant biological education. Since the category C course gives only an introduction to laboratory animal science, it is strongly advised that the veterinarian undertake specific training to obtain a specialist competence in laboratory animal medicine. FELASA category D for laboratory animal science specialists is available as a Master's course in several European universities. It is generally a two-year full-time education consisting of taught modules and a small research project. Category D

education is not restricted to veterinarians, but available to scientists with a relevant first degree. For veterinarians wishing to achieve specialization in laboratory animal medicine, there may be national guidelines or educational programmes. These are not detailed in this document since they do not apply internationally. Specialization, which is recognized in many countries, can be accomplished by achieving ECLAM diplomate status. The topics covered by FELASA category D may constitute an important component of the ECLAM specialization, but there is an additional requirement for documentation of veterinary skills and relevant laboratory animal clinical practice as well as a documented research activity to obtain specialization in laboratory animal medicine.

Laboratory animal science and medicine is an area with rapid development. Therefore, it is necessary that the veterinarian takes part in continuing professional development (CPD) which can be achieved by participating in courses, symposia and conferences. Veterinarians are encouraged to promote the Three Rs (Replacement, Reduction and Refinement) by presenting their own initiatives at these meetings. Institutions should support veterinarians in their efforts to pursue CPD.

Within the field of laboratory animal science and medicine, it might also be necessary for the veterinarian to acquire knowledge specific to the activities performed at the animal care and use unit s/he is associated with. This could consist, e.g. of practices related to conducting studies with infectious agents at an Animal BioSafety Level 3 or 4, or the regulatory environment associated with conducting safety or toxicity studies requiring adherence to Good Laboratory Practice(s) regulations or principles and their concurrent documentation needs, and all the concepts encompassed in the field of quality assurance.

Animal health and welfare

In general, animal health and welfare are the responsibilities of the veterinary profession, but when dealing with laboratory animals

the potential effects on research should also be considered. Within a laboratory animal facility, the implementation of an effective animal care and use programme is based on the combined skills of all the competent persons, which will include the veterinarian and animal care and research staff. An assessment of the animal's welfare, which will include an evaluation of behavioural parameters, will be an essential component and early recognition of the signs of pain and suffering of the individual animal is essential to their alleviation. The veterinarian is pivotal to diagnosis and treatment of disease and necessary to its minimization and prevention. S/he can improve animal health and welfare by implementing disease control in addition to involvement in the animal care and use programme, which will also address such issues as environmental enrichment.

Introducing new animals or biological materials into the facility is a common means of introducing a disease vector. The veterinarian should advocate that all animals entering the facility come from a licensed or approved breeder or from an appropriate institute. Only healthy animals not harbouring infections potentially hazardous to other animals or humans, or detrimental to the scientific procedure, should be used in research. Disease prevention should be considered as the best way to keep the animals in the facility healthy. Methods and management of animal breeding and production, which can impact on animal welfare, will also require veterinary oversight.

Re-derivation or quarantine should be considered for some animals entering the facility; depending, among other considerations, on the accompanying health screening report, method of transportation and intended use. The management of subsections of a facility, which may have differences in health status, must not compromise animal health by activities such as inappropriate movement of personnel or equipment and it is desirable for the veterinarian to advise on how to achieve this.

An appropriate health monitoring programme should be adopted according to the species and veterinary as well as scientific criteria. The recommendations of

FELASA can be followed in establishing a health monitoring programme. In addition to a health monitoring programme which controls infectious agents, the veterinarian, or other competent person, should review other factors that affect animal health and welfare. Adequate guidance and training of appropriate personnel to recognize early signs of disease and suffering should be provided and supervised by the veterinarian.

When dealing with diseased or injured animals and animals on procedures, the animal health programme should include clinical evaluation and the provision of immediate emergency treatment, if considered necessary. The veterinarian should be able to instigate promptly the appropriate treatment of the animals, preferably including discussion with the researcher. When communication with the researcher is not possible, the veterinarian's decision on treatment or euthanasia of the animal, at her/his professional discretion, must be respected.

Disease diagnosis should be performed by the veterinarian and appropriate analytical services should be available. Disease in individuals should be treated accordingly, but when a disease affects several animals and may become a hazard to the colony or the research, the veterinarian should have the authority or the institutional support to decide on the best method of control and treatment in accordance, whenever possible, with the researcher. Emergency care should be provided and preventive measures should be adopted to deal with anticipated effects of research protocols. Research models of disease should be developed with the knowledge and advice of the appointed veterinarian so as to minimize discomfort or suffering to the animals, in particular relating to anaesthesia, analgesia and surgical techniques. Genetically altered animals and those with naturally occurring mutations which may negatively affect health and welfare often require veterinary attention to develop systems of monitoring and methods of alleviation of potential suffering. The most appropriate intervention, treatment or experimental endpoint, should be defined.

The veterinarian should keep records of all scheduled animal health programmes under

her/his direct supervision as well as all cases of control and treatment of diseases. Medical records should include the identification of the animal(s), the date, preventive measures, the description of the problem and clinical findings when appropriate, the diagnosis and the treatment including all clinical interventions. Records may be individual (e.g. dogs, cats, non-human primates) or grouped when appropriate. Recording of treatments, observations and assessments can also be delegated to other staff, such as animal care technicians.

Veterinary care of animals undergoing procedures

Animals should preferably be trained, habituated or conditioned to research procedures and personnel and acclimatized to the laboratory environment. This will facilitate their management, reduce stress and improve welfare and the science. Appropriate handling and restraint of animals by researchers and animal-care staff should be done with the guidance of the veterinarian or other competent person. When chemical restraint is to be used, appropriate guidance from the veterinarian is necessary.

The expertise with which a procedure is carried out will have a significant effect on animal welfare. The veterinarian should be involved in the training and assessment of competence of researchers and animal-care staff performing common procedures that may influence animal welfare. Refinements in procedures should be implemented whenever possible and professional veterinary advice is particularly encouraged when those requiring surgery and anaesthesia or analgesia are considered.

Anaesthesia is commonly used not only for surgery, but also for restraint and for any potentially painful or highly stressful procedure. Professional judgement includes adjusting the anaesthetic method to the procedure to ensure the necessary level of anaesthesia and also compatibility with the purpose of the research. The veterinarian should be involved in the regular review of all anaesthetic protocols at the institution

and should have the necessary authority to ensure proper methods of anaesthesia are employed, monitoring is correctly carried out and appropriate action is taken to ensure adequate depth of anaesthesia.

Pain may be one of the major causes of suffering in research animals and it should be appropriately alleviated. Whenever possible, pain should be appropriately anticipated and adequate analgesia should be provided in advance. Researchers should consult the veterinarian on the best methods of recognition of pain in the different species of laboratory animals, so as to ensure adequate relief can be provided. It is recommended that suitable analgesic protocols, reviewed by the veterinarian, should be available to research staff and animal-care staff. The veterinarian must have the necessary authority to take appropriate action, if there is an unacceptable level of suffering. If the suffering is easily avoidable, strategies should be put in place to prevent it recurring with advice from the veterinarian.

Surgery is a potential cause of severe pain and suffering. Therefore, refinements in surgical procedures can have a substantial effect on improving animal welfare. There should be a consultation about planned surgical procedures with the attending veterinarian who should be an integral part of the surgical team and contribute in varying degrees to the review and oversight of aspects of the procedure. This includes ensuring the provision of adequate surgical facilities and their proper use, as well as preoperative, intraoperative and postoperative care, and record keeping (perioperative care).

A surgery programme should include preparation, techniques, anaesthesia and analgesia and perioperative care. Surgical guidelines and facilities suitable for the species should be established and managed under veterinary supervision. Competent, surgically-trained personnel should be available and the veterinarian should provide advice and training in surgical procedures and perioperative care and also assess the knowledge and skills of the team members. The inadequacy of competence is a major concern since the skills of people performing surgery on laboratory animals vary widely,

thereby having the potential to severely affect animal welfare. Based on legislation in some countries, the veterinarian may have the authority to prevent surgery, if it may be inadequately performed; if such legislation is not in place, the institution should draft and implement internal policies to that effect. Evaluation of records including retrospective reviews of surgical success and failures should be made, in order to assist with developing improvements to the procedures.

The primary responsibility for the adequate perioperative care of the animals lies with the researcher, but with advice from the veterinarian. Appropriate care includes frequent monitoring of the animal, since prompt monitoring allows early detection of unexpected complications, which, if properly addressed, may facilitate a successful outcome. The veterinarian must have either the authority, or the institutional support to adopt corrective measures so as to minimize distress, in consultation with the researcher. If agreement cannot be reached, the opinion of the veterinarian must prevail.

Euthanasia is the most common procedure performed on laboratory animals. Currently accepted methods of euthanasia are periodically revised, updated and published and should be carried out appropriately to minimize or avoid any stress, suffering or pain. The veterinarian should be involved in providing advice, training and oversight. Euthanasia methods should be selected based on species, individual, procedural and scientific requirements. The veterinarian must have the authority or the institutional support to modify the euthanasia technique if it may be improperly performed.

Research staff is responsible for the proper completion and storage of records of the procedures they have performed. Procedural records will be dictated by local regulations, but should include at least the procedure, identification of the animal concerned, the person performing the procedure, drugs and doses given with special reference to the anaesthetics and analgesics employed, the date and any relevant complication or observation.

Many drugs used on laboratory animals are controlled by medicines legislation and in

these cases will be under the veterinarian's control. These include prescription-only or other controlled substances. Legal or institutional requirements or both may include keeping detailed records of the drug used, amount given, animal(s) treated and procedure performed. The legislation controlling use of prescription medicines varies between countries. Although the scientist is responsible for medicines used during the course of a research protocol, the veterinarian is responsible for the prescription and use of medicines and controlled drugs when they are used in the prevention or treatment of disease or alleviation of suffering in the animals outside of the scientific protocols; and will have the authority or the institutional support to review procedural records to ensure that there is no inappropriate use of such drugs. Their administration may be delegated, for example, to animal-care staff, but the veterinarian is responsible for ensuring that the person has the necessary competence and experience to accomplish the task in a satisfactory manner.

Regulatory and ethical aspects

The use of animals in biomedical research and toxicity testing raises ethical issues because the promotion of public health and the advancement of medical knowledge has to be balanced against the potential distress and suffering of the animals used for this purpose. An increasing number of countries either have or are establishing an ethical review process. This review process varies between countries and the veterinarian may be a member of the ethics committee by statute. As an expert in animal health and welfare the veterinarian is in a key position in this process and will then be involved in the review and approval of all animal care and use in the institutional programme and in the implementation of the Three Rs. This includes advising on the design and performance of experiments using animals as related to model selection, endpoint determination, and methods and techniques proposed or in use. For an acceptable veterinary care programme, there should be

a commitment to foster and support enhancement of the institution's research programme through the identification and adoption of techniques, procedures and policies that ensure good laboratory animal health and good welfare.

The EC Directive 86/609 (The Directive) and the European Convention ETS 123 (The Convention) require that a veterinarian or other competent person should be responsible for regular inspection of laboratory animals and supervision of their accommodation, care and health. Diagnosis and veterinary treatment of diseased or injured animals are the roles of members of the veterinary profession. National legislation in European countries usually requires that an institutional veterinarian be appointed with statutory responsibility for the care and health of the institution's animals. In some countries, this responsibility can be that of a 'welfare officer' who does not necessarily have a veterinary degree, but has demonstrated sufficient competence to satisfy the national authorities. In practice, the overwhelming majority of laboratory animal facilities will employ one or several veterinarians with responsibility for the health and welfare of the animals. This allows the institutions to comply with the comprehensive 'veterinary cover for the animals for all hours of the day and every day of the week', which is a mandatory requirement in several countries. Whether employed full-time or part-time, the veterinarian's statutory duties are the same and it is strongly advised that the veterinarian who accepts an appointment with this type of obligation undertakes specific training in order to obtain specialist competence in laboratory animal science.

The experimental protocols should detail the expected or potential effects of the experimental procedures on the animals allowing the veterinarian to determine whether ill health of an animal or other clinical signs of poor wellbeing are a justified yet unavoidable consequence of the experiment, or whether it is beyond the licence in which case the condition should be alleviated. It is therefore necessary that the veterinarian has direct access to all current

licences and project protocols in the institution.

Routine and regular visits to animal facilities at an agreed minimum frequency constitute part of a laboratory animal veterinarian's core responsibility, being necessary to judge health and welfare. It is therefore recommended that the veterinarian conduct regular inspections of the animals and their accommodation. Sometimes, for example due to restrictions from the varying health status of animal units the veterinarian will not be able to attend in which case s/he should be briefed frequently by the animal-care staff on the wellbeing of the animals. When relevant, the findings of these inspections should be communicated to the scientists or other institutional representatives, or both, promptly to ensure appropriate action is taken. Written records of these inspections and communications should be maintained. The veterinarian must maintain up-to-date health records on all animals under her/his care in accordance with local regulations. Examination and certification by the veterinarian with respect to health and welfare may be a legal requirement for animals intended for re-use in experiments, transportation or at certain other specified events.

In some countries, the ultimate responsibility for decisions concerning experimental procedures on, and euthanasia of, animals rests with the veterinarian, but in others it remains with the researcher. This may lead to conflicts and institutional management systems should enable these conflicts to be resolved with adequate protection for the welfare of the animals and the professional responsibilities of the veterinarian.

It is a cause of public concern that animals continue to be used for the advancement of medicine and public health. The veterinarian is ideally placed to play an active role in educational programmes and contact with the community explaining why the use of animals is necessary for continued medical progress, how the ethical review process works, how animal use is regulated and how the scientific community strives to safeguard the wellbeing and welfare of the animals used for this purpose.

Managerial aspects and occupational health and safety

For an animal care and use programme to deliver optimal animal health and welfare, effective management of that programme is essential. The understanding of laboratory animal science and medicine that comes from being a laboratory animal veterinarian provides a good combination of academic and practical background aptitudes on which to build managerial skills. In order to be effectively involved in the wider issues of running an animal care and use programme, the veterinarian will benefit from acquiring additional skills to add to the traditional clinical education and experience. This will require managerial education and the ability to develop strategic thinking on aspects of optimal care and use.

When new facilities are planned the design, the facility management and the process management, will all influence the level of veterinary care that can ultimately be delivered and therefore will affect the health and welfare of the animals. If the overall care and use programme has not been designed adequately, the veterinary care may become compromised. The veterinarian should therefore be actively involved, together with other key staff in the animal care and use programme, in the development and adoption of the management systems, which will affect the overall care programme, including the planning of new facilities.

The Convention requires that personnel working with laboratory animals are appropriately educated, regardless of their position. For this education, the programmes of FELASA are recommended for all staff within category levels A–D. The teaching syllabi include several topics where the teacher requires veterinary expertise. This educational role includes providing information on animal health and welfare, as well as conduct of animal experiments with maximal implementation of the Three Rs. The veterinarian has specialist education and training in many aspects of animal care, welfare and research, and can have an essential role in the education of persons working with laboratory animals by

participating in the education and training of animal care and research staff.

The consultation and advisory role of the veterinarian is important when planning and performing animal experiments and is an opportunity to provide training and information. S/he will have a complete overview of the projects in place, those under consideration and planning, the level of care that animals on such projects will require and considerations affecting the health of animals and staff that will impact on training requirements, number of staff and any special skills required. The veterinarian, as well as contributing to the delivery of training, is therefore able to ensure that the training is integrated with the management of the organization.

To ensure good animal welfare, an open, confident and direct relationship between animal-care staff and veterinarians is a necessity. The veterinarian is well placed to contribute to the culture of care by promoting a team approach and facilitating communication. The veterinarian, with management responsibility and the total overview of the system, can provide input which will benefit the whole organization, balancing the efficiency without compromising animal welfare.

The field of occupational health and safety is a constantly changing one. The emergence of new hazards presents challenges to employers who must protect their employees and the development of new methods of working with animals presents challenges to users who must improve animal welfare. It is incumbent on those who are responsible for animal facilities to develop, improve and implement a programme that is the appropriate balance of the two, and the veterinarian is well placed to achieve that end.

The major potential hazards to animal handlers can be divided into allergy, infection and injury. Allergies are the major hazard affecting staff and can have serious consequences for individuals in terms of health and future careers. The risk of infection from research animals, animal secretions and tissues can be minimized by obtaining them from satisfactory sources and implementing preventive measures. Many

injuries are also preventable by good handling and being aware of the animal's biology and behaviour will assist in reducing the risk. Personnel are often unaware of the hazards associated with animal bites, such as infection, zoonotic diseases or contamination that could cause disease or be spread to others. The veterinarian's involvement in the education and training of personnel can assist in the risk assessment and risk management programme. The involvement of the attending veterinarian can significantly contribute to making management decisions that require a combination of background information. Evaluation of hazards posed by the animals and/or by materials used with the animals will depend on observation, experience, published reports and veterinary professional judgement.

Every unit should also have an emergency plan for dealing with disasters or other emergency such as attacks on property or personnel. There should be a specific plan to deal with animal escape, which will minimize any risks to employees. The emergency action plan should identify the responsibilities of personnel and provide readily accessible contact numbers for additional expertise and resources. The very real problem associated with animal rights extremist groups worldwide poses a considerable threat to the personal security of staff in laboratory facilities and may require high levels of entrance/exit control. The veterinarian is uniquely placed to provide input to the emergency management plan, because of her/his overview of the institution's laboratory animal science programme including facilities, people and animals.

Acknowledgements The Working Group wishes to acknowledge the support of the Universities of Copenhagen, Complutense of Madrid, Oulu, Oxford and Uppsala in the production of this document.

Further reading

- ACLAM Position Statement on Adequate Veterinary Care. See http://www.aclam.org/education/guidelines/position_adequaticare.html (last accessed 12 January 2008)
- ACLAM Position Statement on Pain and Distress in Laboratory Animals. See http://www.aclam.org/education/guidelines/position_pain-distress.html (last accessed 12 January 2008)
- ACLAM Position Statement on Rodent Surgery. See http://www.aclam.org/education/guidelines/position_rodentsurgery.html (last accessed 12 January 2008)
- Advisory Committee on Dangerous Pathogens. *Categorisation of Pathogens According to Hazard and Categories of Containment*. London: HMSO, 1990
- Advisory Committee on Dangerous Pathogens. *Working Safely with Research Animals: Management of Infection Risks*. London: HMSO, 1997
- AVMA Guidelines on Euthanasia. See http://www.avma.org/issues/animal_welfare/euthanasia.pdf (last accessed 12 January 2008)
- Brown MJ, Pearson PT, Tomson FN (1993) Special report: guidelines for animal surgery in research and teaching. *American Journal of Veterinary Research* **54**, 1544–59
- Carlsson HE, Hagelin J, Hau J (2004) Implementation of the 'three Rs' in biomedical research. *Veterinary Record* **154**, 467–70
- Close B, Banister K, Baumans V, *et al.* (1996) Recommendations for euthanasia of experimental animals: Part 1. DGXI of the European Commission. *Laboratory Animals* **30**, 293–316
- Close B, Banister K, Baumans V, *et al.* (1997) Recommendations for euthanasia of experimental animals: Part 2. DGXI of the European Commission. *Laboratory Animals* **31**, 1–32
- Committee on Occupational Safety and Health in Research Animal Facilities, Institute of Laboratory Animal Resources, Commission on Life Sciences, National Research Council (1997) *Occupational Health and Safety in the Care and Use of Research Animals*. Washington, DC: National Academy Press
- Committee on Regulatory Issues in Animal Care and Use, Institute for Laboratory Animal Research, National Research Council (2000) *Definition of Pain and Distress and Reporting Requirements for Laboratory Animals. Proceedings of ILAR Workshop held 22 June 2000*. Washington, DC: National Academy Press
- Cooper DM, McIver R, Bianco R (2000) The thin blue line: a review and discussion of aseptic technique and postprocedural infections in rodents. *Contemporary Topics in Laboratory Animal Science* **39**, 27–32
- Diehl K-H, Hull R, Morton D, Pfister R, *et al.* (2001) A good practice guide to the administration of substances and removal of blood, including routes and volumes. *Journal of Applied Toxicology* **21**, 15–23

- Directive 2000/54/EC of the European Parliament and of the Council of 18 September 2000 on the protection of workers from risks related to exposure to biological agents at work. See <http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2000:262:0021:0045:EN:PDF> (last accessed 12 January 2008)
- Directive 86/609/EEC on the approximation of laws, regulations and administrative provisions of the Member States regarding the protection of animals used for experimental and other scientific purposes. See http://europa.eu.int/comm/food/fs/aw/aw_legislation/scientific/86-609-ec_en.pdf (last accessed 12 January 2008)
- ECLAM, European College of Laboratory Animal. See <http://www.eclam.org/>
- ESLAV, European Society of Laboratory Animal Veterinarians. See <http://www.eslav.org/>
- European Convention for the Protection of Vertebrate Animals used for Experimental and Other Scientific Purposes. See <http://conventions.coe.int/treaty/en/treaties/html/123.htm> (last accessed 12 January 2008)
- FELASA, Federation of European Laboratory Animal Science Associations. See <http://www.felasa.eu/>
- FELASA recommendations on the education and training of persons working with laboratory animals: Categories A and C (1995) Reports of the Federation of European Laboratory Animal Science Associations Working Group on Education accepted by the FELASA Board of Management. *Laboratory Animals* 29, 121–31
- FELASA Working Group on Pain and Distress (1994) Pain and distress in laboratory rodents and lagomorphs. Report of the Federation of European Laboratory Animal Science Associations (FELASA) Working Group on Pain and Distress accepted by the FELASA Board of Management, November 1992. *Laboratory Animals* 28, 97–112
- Flecknell PA (1994) Refinement of animal use – assessment and alleviation of pain and distress. *Laboratory Animals* 28, 222–31
- Hagelin J, Carlsson HE, Hau J (1999) Increased efficiency in use of laboratory animals. *Lancet* 353, 1191–2
- Hagelin J, Hau J, Carlsson HE (2003) The refining influence of ethics committees on animal experimentation in Sweden. *Laboratory Animals* 37, 10–18
- Hau J, Carlsson HE, Hagelin J (2001) Animal research – ethics committees have influenced animal experiments in Sweden. *British Medical Journal* 322, 1604
- Hau J, Van Hoosier GL, eds (2003) *Handbook of Laboratory Animal Science: Volume I: Essential Principles and Practices*. 2nd edn. Boca Raton, FL: CRC Press
- Hawkins P (2002) Recognizing and assessing pain, suffering and distress in laboratory animals: a survey of current practice in the UK with recommendations. *Laboratory Animals* 36, 378–95
- Health and Safety Commission (1992) *Health and Safety in Animal Facilities. Education Services Advisory Committee*. London: HMSO
- Health and Safety Commission (1993) *Control of Substances Hazardous to Health. General Approved Code of Practice*. 4th edn. London: HMSO
- Health and Safety Executive (2002) *Control of Laboratory Animal Allergy. Guidance Note EH76*. Suffolk: HSE Books
- Health monitoring of non-human primate colonies (1999) Recommendations of the Federation of European Laboratory Animal Science Associations (FELASA) Working Group on non-human primate health accepted by the FELASA Board of Management, 21 November 1998. *Laboratory Animals* 33, S1–18
- Holland C, ed (1997) *Modern Perspectives on Zoonoses*. Dublin: Royal Irish Academy
- Morton DB, Jennings M, Buckwell A, et al. (2001) Joint Working Group on Refinement. Refining procedures for the administration of substances. Report of the BVAAWF/FRAME/RSPCA/UFAW Joint Working Group on Refinement. British Veterinary Association Animal Welfare Foundation/Fund for the Replacement of Animals in Medical Experiments/Royal Society for the Prevention of Cruelty to Animals/Universities Federation for Animal Welfare. *Laboratory Animals* 35, 1–41
- Nevalainen T, Berge E, Gallix P, et al. (1999) FELASA guidelines for education of specialists in laboratory animal science (Category D). Report of the Federation of Laboratory Animal Science Associations Working Group on Education of Specialists (Category D) accepted by the FELASA Board of Management. *Laboratory Animals* 33, 1–15
- Nevalainen T, Dontas I, Forslid A, et al. (2000) FELASA recommendations for the education and training of persons carrying out animal experiments (Category B). Report of the Federation of European Laboratory Animal Science Associations Working Group on Education of Persons Carrying out Animal Experiments (Category B) accepted by the FELASA Board of Management. *Laboratory Animals* 34, 229–35
- Nicklas W, Baneux P, Boot R, et al. (2002) FELASA (Federation of European Laboratory Animal Science Associations Working Group on Health Monitoring of Rodent and Rabbit Colonies). Recommendations for the health monitoring of rodent and rabbit colonies in breeding and experimental units. *Laboratory Animals* 36, 20–42

- Poole T (1997) Happy animals make good science. *Laboratory Animals* **31**, 116–24
- RCVS certificates. See <http://www.rcvs.org.uk/Templates/Internal.asp?NodeID=94988&int1stParentNodeID=94964?NodeID=94988> (last accessed 12 January 2008)
- RCVS Guidance for Named Veterinary Surgeons employed in Scientific Procedure Establishments and Breeding and Supplying Establishments under the Animals (Scientific Procedures) Act 1986 (issued November 2004). See <http://www.rcvs.org.uk/Templates/PreviousNext.asp?NodeID=89766&int2ndParentNodeID=89738&int1stParentNodeID=89642> (last accessed 12 January 2008)
- Rehbinder C, Alenius S, Bures J, *et al.* (2000) FELASA recommendations for the health monitoring of experimental units of calves, sheep and goats. Report of the Federation of European Laboratory Animal Science Associations (FELASA) Working Group on Animal Health. *Laboratory Animals* **34**, 329–50
- Rehbinder C, Baneux P, Forbes D, *et al.* (1998) FELASA recommendations for the health monitoring of breeding colonies and experimental units of cats, dogs and pigs. Report of the Federation of European Laboratory Animal Science Associations (FELASA) Working Group on Animal Health. *Laboratory Animals* **32**, 1–17
- Rehg JE, Toth LA (1998) Rodent quarantine programs: purpose, principles, and practice. *Laboratory Animal Science* **48**, 438–47
- Russell WMS, Burch RL, eds (1959) *The Principles of Humane Experimental Technique*. London: Methuen. Reprinted by UFAW (Universities Federation for Animal Welfare) 1992, South Mimms, Potters Bar
- The National Academies (2003) Occupational Health and Safety in Biomedical Research. *ILAR Journal* **44**, 1
- Vickers (1965) *The Art of Judgement*. London: Chapman Hall
- Weber H, Berge E, Finch J, *et al.* (1997) Sanitary aspects of handling non-human primates during transport. Report of the Federation of European Laboratory Animal Science Associations (FELASA) Working Group on Non-human Primate Health accepted by the FELASA Board of Management, April 1997. *Laboratory Animals* **31**, 298–302
- Wolfensohn SE, Lloyd MH (2003) *Handbook of Laboratory Animal Management and Welfare*. 3rd edn. Oxford: Blackwell Science