
Refining dog husbandry and care

Eighth report of the BVAAWF/FRAME/RSPCA/UFAW Joint Working Group on Refinement

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Preface

Wherever animals are used in laboratories, the minimizing of pain and distress should be as important an objective as achieving the experimental results. This is important for humanitarian reasons, for good science, for economic reasons and also for satisfying broad legal principles. In recent years, considerable attention has been focused on the need to recognize and control the adverse effects of scientific procedures on animals, and similarly on the need to improve and enrich the environment in which laboratory animals spend their lives. Such improvements not only benefit animal welfare, but can also enhance the quality of scientific research, since suffering and distress in animals can result in physiological changes which are, at least, likely to increase variability in experimental data and, at worst, may even invalidate the research.

It is possible to make significant and immediate improvements to animal husbandry and scientific procedures in a number of ways, and these improvements can be greatly facilitated by ensuring that up-to-date information is readily available. The present report is the eighth in a series of reports produced by Joint Working Groups on Refinement convened by the British Veterinary Association Animal Welfare Foundation (BVA/AFW), the Fund for the Replacement of Animals in Medical Experiments (FRAME), the Royal Society for the Prevention of Cruelty to Animals (RSPCA) and the Universities Federation for Animal Welfare (UFAW). The report addresses refinements in laboratory dog husbandry and care and is relevant to all those responsible for the welfare of dogs bred for and used in research and testing, including scientists, veterinarians and animal care staff. Much of the report is also relevant to companion dog breeders and to those responsible for dogs in quarantine, boarding, rescue and rehoming establishments. Although the report was produced in the UK, it is intended for an international readership. It therefore makes reference to international legislation and guidelines on laboratory animal use and care as well as to the UK Animals (Scientific

Procedures) Act 1986 (A(SP)A) (UK Government 1986).

Many factors other than scientific procedures themselves can have an adverse effect on laboratory dog welfare. For example, inadequate or unempathetic handling, transport, husbandry, socialization, habituation and euthanasia can all cause avoidable pain, suffering, distress and lasting harm that may even be serious enough to exceed that caused by experiments. The present report aims to minimize adverse effects from any of these sources by encouraging the application of the five freedoms developed for farm animals (see Farm Animal Welfare Council 1993) to laboratory dogs wherever this is possible. These are freedom from hunger and thirst; freedom from discomfort; freedom from pain, injury or disease; freedom from fear and distress; and freedom to express normal behaviour.

It should be noted that some organizations participating in the Working Group are opposed to the use of animals in experiments that cause pain, suffering, distress or lasting harm. However, they share with many in science the common aim of ensuring that where animals are used, every effort should be made to avoid or minimize suffering and to improve welfare. The reports of the refinement workshops are intended to help achieve this aim, particularly if they are read in conjunction with other recent reports on the recognition, measurement and alleviation of pain and distress in animals.

Summary

An estimated 140 000 dogs are used worldwide in research and testing every year. Although there is a growing trend of providing more complex environments for laboratory dogs, worldwide much dog husbandry and care fails to incorporate what is known about their natural behaviour and their behavioural and welfare needs. With this in mind, the BVA/AFW/FRAME/RSPCA/UFAW Joint Working Group on Refinement set out to identify and document ways in which dog husbandry and care can

be refined to make significant reductions in suffering and improvements in animal welfare.

The Working Group's report contains recommendations on housing and on physical environment, food and feeding, environmental enrichment and exercise, health and hygiene, identification and record keeping, breeding, balancing supply and demand, grouping, transport, handling and restraint, procedures, long-term use, rehoming, staff training, and areas for future research for refining dog husbandry and care. Advice is also given on interpreting dog signals, preventing and managing aggression, and controlling noise in dog facilities. Particular emphasis is placed on providing an enriched environment for dogs which permits them to express a wide range of normal behaviour and to exercise a degree of choice, and on combining this with a socialization, habituation and training programme. Together these measures should significantly reduce and/or eliminate fear-related behavioural responses and stereotypic behaviours. They will also have a positive effect on the behavioural development of the dogs, helping to ensure that calm, confident, and well-adjusted individuals are issued to the end-use areas. This in turn

will assist in the collection of reliable and accurate experimental data from dog studies and will avoid unnecessary wastage of life.

The report represents a valuable resource for staff training. It should be read and thought about, and the recommendations acted upon, by all those involved with the management, care and use of dogs bred and used for research and testing. Where standards fall below those detailed here, a programme of improvement should be put in place. This should aim to achieve a proper balance between conspecific and human social interaction for dogs, and provide pens and other environments developed with an understanding of the natural behaviours of the dog, and empathetic personnel trained and competent to care for them. Employing a canine behaviour specialist can help to achieve these aims. It may be necessary for managers of facilities to rethink the way that dog husbandry and care has been practised in the past in order to allocate the time, staffing and funding required to implement the programme. Only through sincere commitment, adequate resources and sufficient will to change can significant reductions in suffering and improvements in animal welfare be guaranteed.

Part 1

1 Introduction and aims of the report

This report provides guidance on refining the husbandry and care of laboratory dogs. It recommends improvements to current guidelines and practice, focusing especially on the need for appropriate environmental stimulation and exercise, socialization and habituation, and for pens and other environments which are designed with reference to the natural history and behaviour of the dog.

Although there is a growing trend for more complex environments for laboratory dogs, worldwide much dog housing falls seriously short of this ideal. Since the animals spend the greatest proportion of their lives in their pens, not undergoing procedures, improving or enriching this environment provides a significant opportunity to improve their overall well-being. Better husbandry and care should also result in the development of better quality animals which may subsequently be needed in smaller numbers, so effecting reduction through refinement.

The information and recommendations in this report are focused upon the beagle, the breed of dog most commonly used in the laboratory, although reference is made to other dog breeds where appropriate. Individual breed characteristics (morphological, behavioural and social) should, of course, be taken into account if other breeds are to be used. Aside from breed differences, there will be inevitable variation in the temperament of individual dogs and in their responses to housing conditions and husbandry practices (Hetts 1991), which in turn may influence their responses to scientific procedures. Ideally, one should be aiming for levels of housing and husbandry which take this variation into account. The animals' requirements will also depend on whether they are breeding animals, post-weaning stock or animals undergoing scientific procedures.

There have been many detailed studies of dog behaviour, but the significance of the results in relation to laboratory dog welfare

is not always clear. The information in current national and international legislation and guidelines on laboratory animal husbandry and care (e.g. Council of Europe 1986, European Community 1986, Home Office 1989, 1995, National Research Council 1996) is minimal, and ideas have evolved since most of these were published. The guidance contained in this report was drawn up by considering current good practice in combination with the professional experience and views of the Working Group members and a review of the current literature on dog behaviour, husbandry and care, health and use in research. The table of minimum space allowances (Table 4), in particular, reflects what the Working Group considers to be good practice. In circumstances where there is no scientifically validated practical information on laboratory dogs' needs, a guiding principle has been to consider factors which may compromise their welfare based on the experience of members of the Working Group.

The Working Group recognizes that it may not be possible to provide dogs in the laboratory with housing and husbandry that will fully meet all their needs. It should be possible, however, to design a practical and workable husbandry system that will provide them with a good standard of welfare. The effects of any system of husbandry and associated manipulations should be considered as part of the experimental protocol and be taken into account when potential adverse effects are weighed against predicted scientific benefits by ethics committees (e.g. the US Institutional Animal Care and Use Committee (IACUC), or the UK local Ethical Review Process (ERP) and Home Office Inspectorate).

Finally, the economic impact of an experiment which fails through bad planning, faulty or outmoded equipment, poor husbandry or poor practice is an enormous waste of valuable resources, both in economic terms and sometimes in loss of life. Therefore, it is important that attention is paid to provide the best available resources for a research project, and also to ensure that staff are well-trained, empathetic, competent and well-versed in the latest developments

in their field. The Working Group hopes that its report will help in this regard.

How to use the report: The report is divided into six parts. Part 1 introduces the report and provides background on the use of dogs in research and testing. It includes comments from the Working Group concerning legislation on the husbandry and care of dogs. Part 2 provides the relevant academic background on the natural history and behaviour of the dog, upon which much of the rest of the report is based. Since good husbandry and care depend on a sound understanding of the dog, considerable attention is given in Part 2 to the perceptual abilities of the dog and to interpreting dog signals. Aggressive behaviour in dogs can be considered normal species-specific behaviour and so extensive information is given in this part on preventing and managing aggression. Information on abnormal behaviours, stereotypies and temperament is also given in this part. Part 3 provides information on the management of laboratory dogs, including housing and the physical environment, food and feeding, environmental enrichment and exercise, health and hygiene, and identification and record keeping. Part 4 is concerned with breeding and balancing supply and demand. Part 5 focuses on what is done to dogs in preparation for, during, and after experimental use. This part includes information on socialization, habituation and training, grouping, transport, handling and restraint, procedures, long-term use and rehoming. The final part (Part 6) gives information on staff training and also identifies areas for future research for refining dog husbandry and care. The Working Group's recommendations are highlighted at the end of each section in **bold**. A glossary of technical terms and five appendices are given at the end of the report.

2 Dog use in research and testing

2.1 Numbers used

The USA, together with Japan, is the main world user of dogs in research and testing. The United States Department of Agriculture

(USDA) collects annual statistics on the use of some laboratory animals. The most recent statistics show that at least 69 516 dogs were used in research, testing and teaching in the USA in 2000 (United States Department of Agriculture 2000). There are no mandatory reporting requirements on the use of animals for experimentation in Japan, so accurate figures for the numbers of dogs used are unavailable. The Japanese Association for Laboratory Animal Science nevertheless collects statistics on a voluntary response basis. In the latest poll, for which 58% of the 880 organizations polled replied, 21 571 dogs were reported as being used in 1998 (cited in House of Lords 2002).

In Canada, 8789 dogs were used during 2000 (Canadian Council on Animal Care 2000) and 231 dogs were used in New Zealand in 2002 (New Zealand National Animal Ethics Advisory Committee 2002). Experiments on animals in Australia are the responsibility of the individual states, so there are no national data on laboratory animal use. A conservative national estimate is 2735 dogs, using data for 1996 from the five states which publish annual statistics (i.e. New South Wales, Victoria, Western Australia, South Australia and Tasmania) (Edwards 1998).

The UK, France and Germany, together with Belgium and The Netherlands, are the main users of dogs in research and testing in the European Union. At least 88% of reported dog use was conducted in these countries in 1999, the most recent year for which pan-European statistics are available (European Commission 2003). Recent data on the use of dogs for scientific purposes in EU Member States are given in Table 1. (Note that the methods used to collect the data and the formats in which they were subsequently presented differ between countries).

2.2 Breeds used

Most dogs used in research and testing in the UK are purpose-bred beagles. For example, a total of 5746 dogs were used in the UK in 2002 of which 5656 were purpose-bred beagles, and 90 were other breeds or cross-bred dogs (Home Office 2003).

Table 1 Use of dogs for scientific purposes in EU Member States

Country	Year	No. of dogs used
UK	2002	5746
France	2001	5516
Germany	2000	5002
Belgium	2001	1036
Netherlands	1999	803
Italy	1999	745
Spain	1999	725
Sweden	2001	547
Ireland	1999	312
Denmark	2001	287
Portugal	1999	94
Austria	1999	68
Finland	2001	57
Greece	2001	27
Luxembourg	1999	0

Elsewhere in Europe, other large purpose-bred breeds are available and used, as are pound (shelter) dogs.

The beagle was originally chosen for use in the laboratory probably because of its relatively small size and placid temperament (and hence ease of dosing and of measuring body responses), ease of access to the cephalic vein for blood sampling, and because it can easily be housed in kennels. In addition, beagles are easy to breed and keep in groups, and were thought to have no obvious genetic defects (which has subsequently turned out not to be entirely true). They are still used today for the same reasons and in preference to many other breeds which have various disadvantages. Today there is a significant body of background data for the beagle, which increases its value as a defined research animal.

The use of other breeds and cross-bred dogs has been required for reasons of genetic diversity in transplantation studies, or for research into specific breed-related diseases. In every case where dogs are used, the choice of breed should be justified from a scientific (and welfare) point of view and not simply on the basis of economics.

2.3 Purposes of use

The vast majority of experiments on dogs are conducted during the research, development

and testing of new pharmaceuticals (human and veterinary medicines and vaccines). For example, the UK Home Office annual statistics classify scientific procedures according to field of research: of the 7964 procedures carried out on dogs in the UK in 2002, 84% (6697) were in pharmaceutical research, development and testing (Home Office 2003) (Fig 1). Dogs are used to test for both the intended beneficial effects (efficacy tests) and the adverse effects (safety tests) of pharmaceuticals. The majority of these tests are for human medicines, and are required by regulatory authorities before authority can be granted to test the medicine in human volunteers. Broadhead *et al.* (1999) discuss the use of dogs in pharmaceutical research, development and testing, along with the reasons advanced for the routine use of the dog.

Non-pharmaceutical products such as agricultural products (mainly pesticides and biocides), food additives and industrial chemicals are also tested extensively for safety according to legal requirements. Dogs are occasionally used for these tests, although the numbers used are small in comparison to the numbers used to test pharmaceutical products (Fig 1). In addition, dogs are used in the development of new methods of testing for chemical safety (i.e. all classes of chemicals including pharmaceuticals).

Pharmaceutical research, development and testing can be divided into toxicology and non-toxicology procedures. In 2002, 74% (5869) of all procedures on dogs in the UK were for toxicology tests (or other

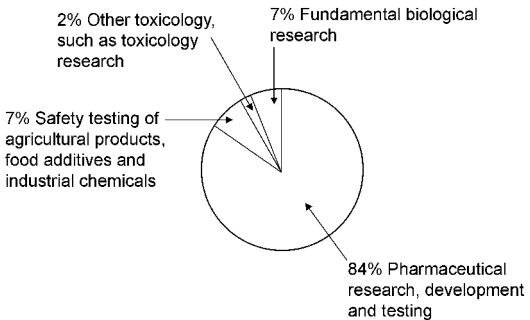


Fig 1 Purposes of procedures using dogs in the UK, 2002 (Home Office 2003)

safety/efficacy evaluation), most of which (96%) were conducted to satisfy UK or other legislative requirements (Home Office 2003). For a summary of the regulatory requirements relating to dogs (and other non-rodent species), see Broadhead *et al.* (1999). In regulatory toxicity testing, dogs are usually used as the second, non-rodent species. Groups of dogs are administered a test compound and clinical parameters are measured at various time-points throughout the study, after which the dogs are killed and their organs removed for examination.

A recent International Life Sciences Institute (ILSI) study and workshop (Olson *et al.* 2000) indicate that around 70% of the human toxicities observed in clinical studies for pharmaceuticals were predictable from one or more pre-clinical animal toxicology studies. Non-rodents (primarily the dog) predicted 63% and rodents (primarily the rat) predicted 43% of observed adverse effects in humans.

The remaining experiments on dogs have a multiplicity of purposes. These include fundamental biological research, which may be done to study dog biology in its own right or to contribute to human or animal medical knowledge (Fig 1).

The husbandry and care of laboratory dogs may be influenced by the particular research use, but whatever the purpose of the investigation, the needs of the animal, including normal behaviour and social interactions, should be paramount. These can be accommodated in most circumstances, provided they are recognized and understood by animal care staff and investigators (see Sections 4.3 and 20). Kennels should always be designed, dogs housed and studies conducted, in such a way that the behavioural and welfare needs of the dog are not unnecessarily compromised by the requirements of the investigation.

Some current regulatory requirements for toxicology studies are rather prescriptive in terms of what may be provided for the animals, and so their rigid interpretation may limit the application of some of the recommendations made in this report. The justifications for such requirements should always be questioned and a degree of

compromise should be introduced wherever possible. For example, a decision made to house dogs in groups instead of singly, at the expense of individual food consumption data (see Section 6.1.5).

Recommendations:

- **Kennels should always be designed, dogs housed and studies conducted, in such a way that the behavioural and welfare needs of the dog are not unnecessarily compromised by the requirements of the investigation.**
- **Everyone involved with dog use should question any study that restricts the potential to provide a good quality environment for the animals.**

2.4 Source

Dogs may either be purpose-bred for research in licensed establishments, or be acquired from stray dog homes or pounds. There are scientific and welfare reasons for using purpose-bred dogs (see Table 2). In Europe there is a legal requirement that dogs provided for scientific use are bred in, and obtained from, a designated or registered breeding establishment where standards are maintained through a process of licensing and inspection (European Community 1986). These correspond to class-A dealers in the USA.

Information on the *source* of dogs used in research and testing is usually not given in the annual statistics on animal use compiled by European Member States. The UK Home Office annual statistics do give such information; in the UK, all beagles used in laboratories are purpose-bred, mostly in breeding and supplying establishments licensed by the Home Office. Greyhounds and a variety of other breeds are acquired from non-designated sources within the UK (which requires special authorization from the Home Office) but the numbers used are very small (less than 2% of dogs used in 2002: Home Office 2003).

In 2002, over 85% of all procedures on dogs were performed on animals either bred in-house or bought from designated breeders or suppliers within the UK (Home Office

Table 2 Comparison of purpose bred and pound dogs

Criterion	Purpose bred	Pound
Genetic definition	Known to a considerable degree	Often ill-defined and unknown
Health status	Defined	Ill-defined—may interfere with study results
Risk of infection, including zoonoses	Virtually non-existent	Real potential for cross infection, e.g. campylobacteriosis, dirofilariosis, leishmaniosis, leptospirosis, rabies
Temperament	Predictable	Unpredictable and potentially dangerous for human safety as well as for other dogs
Impact of confinement	Used to kennelling	May have been a companion animal or a stray/feral animal and not used to confinement—may therefore be distressed, which may impact on the research data
Impact of procedures	Trained to procedures and acclimatized to rooms	May be less easy to train to procedures. Will have to be acclimatized
Close contact with humans and other dogs	Socialized to humans and other dogs	May not be socialized to humans or other dogs
Background data	Considerable	Generic only and may be confounded by background pathology—not obvious until experiment completed, leading to a potential for economic loss and waste of personnel time
Cost	Relatively expensive in relation to other dogs but not as an overall factor in the real costs of an experiment	Inexpensive
Public perception	Preferable in that companion animal theft should be eliminated	Scientific community lays itself open to charge of using companion animals in research and encouraging companion animal theft
Mortality	Low	Death rates may be higher due to stress of confinement, poor acclimatization, and sub-clinical disease
Reliable scientific data	More certain	Less certain and variance likely to be higher, so numbers of animals used may be greater

2003). In past years, the use of dogs from sources outside the UK has been at around one per cent of scientific procedures, with occasional annual increases. However, this figure was nearly 10% in 2000, nearly 12% in 2001, and nearly 14% in 2002, despite the fact that the number of dogs used per year in the UK has remained relatively constant throughout the past decade. The causes of these recent increases in UK imports are likely to be multi-factorial, reflecting the many changes that have taken place within the industry over the past decade. Continuing rationalizations within merged multinational pharmaceutical companies

have led to the closure of many breeding colonies and this has been accompanied by a trend towards sourcing dogs from commercial breeders. The avoidance of over-production has been addressed in some depth in the UK; and measures taken to avoid UK surpluses are likely to lead to shortages, particularly when dogs are required at short notice.

Whenever dogs are sourced from overseas, checks should be made to ensure that they have been bred under conditions that, as far as possible, provide equivalent welfare standards to those in the UK, that journey times are minimized, and that any stress associated

with international transport is reduced to the absolute minimum (see Section 15).

Of the 7444 dogs used in Canada in 2000, 44% of these were purpose bred (i.e. bred specifically for research, teaching and testing, by either a commercial supplier or an institution), 50% were from a random source (i.e. not bred specifically for research, teaching or testing, e.g. pound dogs/strays), and for the remainder the source was not specified (Canadian Council on Animal Care 2000). Several Canadian provinces have passed laws regulating the acquisition of dogs from municipal pounds. In the USA, 14 states prohibit the use of pound dogs, two states mandate their use, and the remainder either regulate the way animals can be acquired, or remain neutral (Baker & Broadhead 2000).

A workshop held in 1999 raised the issue of using pound dogs versus purpose-bred animals (Baker & Broadhead 2000). Some participants argued that many stray and unwanted animals are killed in animal shelters, and that researchers should be allowed to use these animals, thereby reducing the number specifically bred for research. However, others argued that the use of pound animals was inappropriate and might lead to an overall increase in the use of dogs due to decreased financial costs. The Working Group believes that dogs should only be obtained from designated or registered breeding establishments.

Recommendations:

- **The choice of dog used in research and testing should be based on considerations of what produces best science and good animal welfare and not simply on the basis of economics.**
- **Dogs for scientific research and testing should only be obtained from designated or registered breeding establishments.**
- **National statistics on animal use should provide details of source (i.e. purpose-bred in user country, purpose-bred elsewhere, or random source).**
- **Careful consideration should be given to balancing supply and demand within establishments so that surplus animals are not produced.**

3 Legislation on the husbandry and care of dogs

There are a number of pieces of legislation and codes of practice which deal with the husbandry and care of dogs (see Appendix 1). Although the various guidelines all contain similar general principles, the level of detail provided to facilitate interpretation of these varies significantly. This can make the interpretation of minimum standards extremely difficult. In some countries, interested organizations have produced additional guidance to assist this interpretation (e.g. the guidelines produced by the Institute for Laboratory Animal Research (ILAR) in the USA: National Research Council 1994). For example, regarding exercise, Annex II to the European Directive states that it is advisable to take every possible opportunity to let animals take exercise, but offers no guidance on how this should be interpreted (European Community 1986). In contrast, the New Zealand animal welfare code of practice for dogs recommends that: each dog should be allowed out of the run for at least 30 min per day (small breeds), with freedom to explore the environment; that exercise should not be given after feeding; and that all reasonable steps should be taken to prevent fighting between dogs during exercise periods (Animal Welfare Advisory Committee 1998).

Among the various recommendations and codes of practice there are also large differences in what are considered to be minimum standards. Although this may to some extent be a consequence of differing attitudes towards animals between countries there are, even within the UK, significant differences in minimum standards within the various pieces of legislation on dog welfare and care. For example, varying requirements for minimum space allowances for dogs can be seen in Table 3. For an average size beagle of around 15 kg, the minimum floor area for this animal undergoing scientific procedures in the UK would be 4.5 m² (Home Office 1989), whereas in the USA this would be 0.72 m² (National Research Council 1996). A puppy in a UK scientific breeding establishment

Table 3 Minimum pen floor area per dog (m²) recommended in existing guidelines (values in brackets are for an adjacent exercise area)

Guideline	Notes	Weight (kg)			
		<10	<15	>20	>30
Home Office 1989 ^a	Housed singly	4.50	4.50	–	6.50
	Housed in groups	1.90	2.25	–	3.25
Home Office 1995 ^b	Post-weaned stock	1.50	2.00	2.25	–
Draft proposals for revision of Council of Europe 1986 ^c	For 1–2 dogs	–	4.00	8.00	–
	Each additional animal	–	2.00	4.00	–
	Post-weaned stock	1.50	2.00	4.00	–
Council of Europe 1986 ^c /European Community 1986 ^d		0.70 (1.4)	1.20 (1.6)	1.70 (1.9)	2.00 (2.0)
CCAC 1993 ^e	Housed singly	0.75	–	1.20	2.23
	Housed in groups	1.50	–	2.00	3.00
NRC 1996 ^f		–	0.72	1.08	>2.16
DEFRA 2002 ^g		1.10 (3.7)	–	1.40 (5.5)	1.40 (7.4)
CIEH 1995 ^h		–	–	–	1.90 (3.34)
UK Government 1983 ⁱ	Housed singly	1.00	–	–	–
	Each additional animal	0.25	–	–	–

^aHome Office (1989) Code of Practice for the Housing and Care of Animals Used in Scientific Procedures
^bHome Office (1995) Code of Practice for the Housing and Care of Animals in Designated Breeding and Supplying Establishments
^cEuropean Community (1986) Council 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
^dCouncil of Europe (1986) European Convention for the Protection of Vertebrate Animals Used for Experimental and Other Scientific Purposes, ETS No. 123
^eCanadian Council on Animal Care (1993) CCAC Guide to the Care and Use of Experimental Animals, Vol. 1, 2nd edn
^fNational Research Council (1996) Guide for the Care and Use of Laboratory Animals
^gDepartment for Environment, Food and Rural Affairs (2002) DEFRA Voluntary Code of Practice for the Welfare of Dogs and Cats in Quarantine Premises
^hChartered Institute of Environmental Health (1995) Model Licence Conditions and Guidance for Dog Boarding Establishments: Animal Boarding Establishments Act 1963
ⁱUK Government (1983) Pet Animals Act 1951 (Amendment) Act 1983

must be provided with a pen of minimum dimensions of 4.5 m² and 2 m in height (Home Office 1995), whereas the same puppy could be held in a pen of 1 m² and 0.5 m in height in a UK pet shop (UK Government 1983). However, boarding establishments typically hold dogs for a few weeks only, whereas the various experimental establishments may hold dogs for their lifetimes. Note that dogs used in laboratories vary in size, age, health status, physical conformation of the breed, behavioural characteristics, and experience; therefore no minimum standard of husbandry is likely to be optimal for all animals.

Care is needed with some published guid-

ance to ensure that the dog's needs can be adequately addressed within the proposed space allowances. For example, the Working Group is concerned that guidance on the UK Breeding of Dogs Acts 1973 and 1991 and the Breeding and Sale of Dogs (Welfare) Act 1999 suggests that the transport container dimensions in the International Air Transport Association (IATA) Live Animals Regulations provide useful guidance on space allowances for caging dogs (British Veterinary Association/British Small Animal Veterinary Association/Chartered Institute of Environmental Health/Local Government Association 2000). The IATA dimensions are only adequate for transporta-

tion, and are considered by the Working Group to be totally inadequate for housing of dogs, even for short periods.

There are also differences in the legal status of the various guidelines and in how these are enforced. For example, within the European legislation, both Appendix A to the Convention ETS 123 and Annex II to the Directive 86/609/EEC are guidelines offering advice to Member States on how aspects of the legal documents could be interpreted. Annex II offers guidance on the interpretation of Article 5 of the Directive which sets out the principles of accommodation in very broad terms, namely that 'all experimental animals shall be provided with housing, an environment, at least some freedom of movement, food, water and care which are appropriate to their health and well-being'. In some Member States the guidance in Annex II has been incorporated into national legislation, enabling the minimum recommendations to be enforced, whereas other countries have not adopted these guidelines. In the UK, breaches of the codes of practice for housing and care can lead to withdrawal of the licence to keep animals.

Recommendations:

- **National legislation should set standards for the housing and care of dogs, and these should be enforced. Such legislation should provide detailed guidance on the interpretation of the legislative requirements, but not be so prescriptive as to impede the development and adoption of innovative husbandry or care practices of demonstrable welfare benefit to the animals.**
- **Efforts should be made to harmonize minimum standards at a national and international level. This should be done in Europe through the Council of Europe Convention ETS 123 and European Community Directive 86/609/EEC, and more internationally through the Organisation for Economic Co-operation and Development (OECD), the International Conference on Harmonisation of Technical Requirements for Registration of Pharmaceuticals for Human Use (ICH), and the World Health Organization (WHO).**

Part 2

4 The natural history and behaviour of the dog in relation to its husbandry and care

The process of domestication makes the dog a tractable and therefore convenient animal for use in the laboratory. Its status as a companion animal and the particular relationship the species has with humans have resulted in it being given special protection in some countries' legislation on animal experiments. For example, special justification is required for dog use in the UK (UK Government 1986). However, the fact that the dog is so familiar to humans can lead to problems regarding its welfare in

the laboratory. Assumptions about its needs based on so-called 'common sense' and past practice may be flawed. Therefore, as with all other laboratory animals, there is a continuing need to reassess dog husbandry and care in line with natural history and behaviour and continuing advances in the scientific literature.

4.1 Ancestry and domestication

The domestic dog (*Canis familiaris*) is probably derived from the Asiatic wolf (*Canis lupus pallipes*) and hybrids with other races of wolf (Hemmer 1990), and it is likely that the process of domestication began at least 14 000 years ago (Clutton-Brock 1995). It has been suggested that domestication leads to suppression of

the animal's perceptual world so that fear and stress responses become reduced or tolerated and docility is increased (Hemmer 1990), and that these changes are associated with reductions in the size of the body and head (Clutton-Brock 1995). There is little evidence, however, that domesticated animals are less intelligent than their wild counterparts (Nicol 1996). Artificial selection has produced dramatic changes to the anatomy and behavioural repertoire of various dog breeds (Coppinger & Coppinger 1998). As a consequence, some breeds have partially lost their ability to communicate (Goodwin *et al.* 1997), which could lead to increased aggression in kennels (see Section 4.4 for ways of preventing and managing aggression).

Little is known about the social habits of *C. lupus pallipes*, but studies of dog behaviour in feral conditions indicate that, while they may appear solitary (Bernman & Dunbar 1983), feral dogs form loose and changeable social associations strongly influenced by food supply (Scott & Causey 1973, Daniels & Bekoff 1989, Macdonald & Carr 1995). However, prior to birth and during early development of their pups, feral bitches distance themselves from their conspecifics (Macdonald & Carr 1995) and parturition takes place within a den or a hidden area (see Section 11.3). Unlike wolves, feral dogs show no evidence of cooperative care of young or hunting, but they apparently do cooperate in defence of territory and do interact as social groups (Boitani *et al.* 1995, Macdonald & Carr 1995). It is well established that social contact is extremely important for domestic dogs, which need to be reared and kept in a social environment in order to develop and behave normally (see Section 13). That said, as a carnivore, the risks of aggression are high so particular attention is needed to maintain dogs in harmonious social groups (see Sections 4.4 and 14).

As a feeding and survival adaptation, dogs are inquisitive and actively seek information about their surroundings. Pens should therefore be designed to allow good vision out of them (see Section 6.1.2). In common with other carnivores, dogs spend much of their time resting (Hubrecht *et al.*

1992) but this should not lead to an under-estimation of their requirement for physical and social stimulation during their active period (see Sections 5, 6 and 8).

4.2 Senses and communication

In order to understand dogs and provide them with a good husbandry system, it is important to understand how they perceive the world and communicate between themselves. The following two sections contain information on dog senses and the interpretation of dog signals.

4.2.1 Olfaction and taste

Dogs have a highly developed sense of smell compared with humans, which is used in hunting and communication. Like many other mammals, they inhabit a perceptual world where things are as likely to be understood and remembered by their smell as by their sight. Excellent reviews of dog olfaction and taste can be found in Fox and Bekoff (1975) and Thorne (1995); Alderton (1994) also discusses the subject.

All canids examine the faeces, urine, and anal, genital, ear and mouth regions of conspecifics (Fox 1971). Dog urine, as well as the secretions of the scent glands between the digits and in the anal region, may have a unique identity and therefore be individually recognizable (Doty & Dunbar 1974, Simpson 1997). Bitches in oestrus release a pheromone, possibly methyl p-hydroxybenzoate, which is attractive to male dogs (Sommerville & Broom 1998).

Dogs and bitches scent-mark to transmit information about identity and social status. Social marking clearly takes place in kennels, even in groups as small as two. Hubrecht *et al.* (1992) showed that investigative sniffing of the ground was more frequent in group housing compared with single housing, and hence it would seem that social housing in addition to its other benefits is a valuable method for increasing interest in the physical environment (see Section 6.1.4). Visual displays such as scratching of the ground or lifting of the hind leg may accompany urine or faecal marking (Bekoff 1979), although

scratching may also add odour from the interdigital scent glands (Simpson 1997). Scratching is not effective on kennel flooring and Hubrecht (unpublished data) did not observe it in beagles housed on slatted floor or solid floor laboratory accommodation. Canids often prefer to urinate and defaecate in a discrete area in captivity, away from their sleeping area (Fox 1971); hence this is an argument for providing dogs with enclosures which allow adequate space for separate sleeping and activity areas (see Section 6.1.3).

The dog has a rhinarium, kept moist by secretions from the lateral nasal glands, which serves to increase the humidity of inhaled air with associated scents. Its bilateral vomeronasal (Jacobson's) organs are well developed. The elongated snout with its interior scrolls of bone (turbinates) provides a large area for the olfactory epithelium (75 cm² in the beagle compared with 3 cm² in humans) which contains around 20 to 40 times as many primary receptor cells as the human nose (Syrotuck 1972). Also, the absolute number of olfactory nerve cells per specific receptor type is greater in dogs than in humans (more than 100 fold) and the olfactory bulb in the dog is dramatically larger than it is in man. These adaptations result in the dog being sensitive to compounds at one thousand to one hundred million times lower concentrations than are detectable by man. It is known that dogs respond to odours such as oil, tobacco and other animal's excreta (von Heimburger 1959, reviewed by Fox & Bekoff 1975). It is unfortunate that human insensitivity to odour has meant that the study and application of appropriate osmotic enrichment of the dog's captive environment has been much neglected (see Section 8.2).

More impressive than their remarkable sensitivity to trace odours, is the ability of dogs to pick out odours of interest from a welter of competing smells and to match and distinguish them. Thorne (1995) reviews evidence showing the astonishing ability of dogs to track men by odour, and Steen and Wilsson (1990) and Thesen *et al.* (1993) show that dogs can determine the direction of tracks, possibly by comparing concentrations. Although dogs are clearly

able to identify odours from different individuals, it may be important in animal husbandry to remember that odours from different parts of the body vary and dogs are not able to generalize scents from different parts of the body to identify an individual (Brisbin *et al.* 1991). There is some evidence that dogs sample odours from different parts of the human body for different purposes. Millot *et al.* (1987) presented familiar and unfamiliar clothes on a dummy to dogs, and suggested that anogenital sniffing is used to identify strange humans, whilst sniffing the face may be an attempt to determine the human's emotive state or behavioural intentions. Fox (1986) mentions that dogs may respond sexually to certain perfumes, and although there are no research data on this, the potential response of dogs to novel odours on animal handlers should be considered by animal care staff.

Olfaction is used in food selection and is an essential component of taste. Dogs have four main groups of taste receptors that respond to sugars, acids, nucleotides and furanols (Thorne 1995). The last two probably respond to meaty and fruity-sweet compounds in the diet respectively. Unlike cats, dogs are insensitive to salt. Dogs' food preferences and their implications for laboratory diets and feeding in the laboratory are discussed in Section 7. Diets in laboratories may not be as palatable as those of wild dogs, or even of those provided to companion dogs, and variety is much more likely to be restricted.

4.2.2 Hearing and vocalization

Dog hearing has a wider frequency range and is more sensitive than that of humans; dogs are most sensitive to sounds between 1–20 kHz, compared with 1–5 kHz in humans, and they can hear sounds up to 50 kHz compared with an upper limit of 15–20 kHz in humans (Sander *et al.* 1977, Heffner 1983, Fay 1988). Their hearing range may reflect a predatory adaptation to finding small rodents. Below 250 Hz dog hearing sensitivity is similar to that of man, but in the range of 500 Hz to 16 kHz their threshold of sensitivity can be 24 dB lower

than that of humans (Fay 1988). This means that they can hear sounds that are up to four times quieter than the human ear can detect. It is probably no coincidence that the peak energy of a bark falls within this range (Sales *et al.* 1996).

Dogs, like most predators, possess a fairly precise ability to tell the direction a sound is coming from. Their sound localization ability corresponds to an ability to distinguish arrival times in the left and right ears of as little as 55 microseconds (Kalmykova 1981). The mobility of the ears allows them to scan the environment for sound and then to collect the sound waves.

Dogs bark to communicate (see Fox & Bekoff 1975, Simpson 1997), but there are differences between breeds. Husbandry staff should be adept at identifying the meaning of various vocalizations, from distress calls similar to the whines or whimpers of puppies to the high-pitched bark of a dog separated from its owner or conspecifics (see Section 4.3).

It is possible that some dog vocalizations may have become partially divorced from their communicatory function. It is a common finding that aroused or excited dogs bark, and this may be due to selection by humans for a behaviour which would serve as an early warning of danger or allow hunting dogs to be followed. It has also been suggested that barking may become stereotyped when dogs are housed in suboptimal conditions (see Section 5). Social facilitation often results in the barking spreading to other dogs (Fox 1971, Adams & Johnson 1994), and in some animals the act of barking may act as a stimulus to further barking (Scott & Fuller 1965).

4.2.3 Vision

Dogs have good eyesight that is in some ways inferior but in other ways superior to human vision; their visual system is optimized to exploit a different environmental niche than humans. Dogs are not as able to discriminate form and pattern as well as humans, although their performance is improved when the patterns move rather than when they are static (Fox & Bekoff

1975). Nonetheless, herding dogs can respond to hand signals at distances of one mile, so vision is evidently an important sense.

A number of studies have been conducted, using a variety of different methodologies to examine visual acuity in dogs. Generally, dogs cannot see clearly anything narrower than about a sixteenth of a degree of arc, which corresponds to 20/75 vision on the Snellen fraction; what a normal human can see clearly at 75 feet (22.86 m), a dog would generally need to be 20 feet (6.10 m) away to see in detail (Miller & Murphy 1995, Murphy *et al.* 1997, Tanaka *et al.* 2000).

Dogs have a much more limited power of accommodation than humans, generally not more than two or three diopters (Duke-Elder 1958, Murphy *et al.* 1992). This means that they can focus and accurately image close objects only if they are no nearer than around 33 to 50 cm; anything closer will be a blur. This may explain why dogs generally try to sniff or touch objects at close range; they simply cannot see them very well and so augment vision with other senses.

Dogs have a wider field of view than humans do, increasing their ability to scan the horizon, but the range of overlap of the two eyes is smaller, limiting three-dimensional vision to a narrower sector (Miller & Murphy 1995). Dogs are probably more aware of activity occurring around them than humans are because of this wider field of view. Also, simply by virtue of visual perspective, the world will look very different to a beagle which stands at around 33 to 41 cm at the withers.

The retina of the dog's eye is composed primarily of rod photoreceptors and they also possess a tapetum giving them good night vision, although probably at the expense of visual acuity (Miller & Murphy 1995). The minimum light threshold of dogs is well beyond that of humans, allowing dogs to function in both bright and dim light (Walls 1963, Kemp & Jacobsen 1992).

Dogs, like most mammals, possess and use colour vision. They are dichromatic and have difficulty in discriminating between middle and long wavelength lights (Jacobs 1983, 1993, Neitz *et al.* 1989, Jacobs *et al.*

1993). The two photoreceptor cone cells in the dog retina have their peak response at light wavelengths that correspond to the colours perceived by humans as violet (429 to 435 nm) and yellow-green (about 555 nm). Although it is not known whether dogs perceive these two colours in the same way humans do, the canine visual spectrum may be divided into two hues; one in the violet to blue-violet range (430 to 475 nm), which is probably seen as blue by dogs, and a second in the range seen by humans as greenish-yellow, yellow and red (500 to 620 nm), which is probably seen as yellow by dogs (Neitz *et al.* 1989). Dogs also appear to have a narrow band in the blue-green range (475 to 485 nm) that is without colour and likely seen simply as shades of white or grey.

A practical consequence of these findings is that many of the toys manufactured for dogs may be the wrong colour. A bright red-orange dog toy stands out dramatically against a green lawn to trichromatic humans, but to a dog its colour is presumably far less readily distinguishable from the green grass; a blue-violet object would be a much better choice when the background is green. Similarly, it may be problematic to teach dogs to distinguish among red, orange, yellow and green objects solely on the basis of colour (Miller 2001).

Dogs use visual signals to communicate, and posture is an important component in communicating emotional state. It is important that laboratory staff are able to interpret visual signals as they provide an indication of the dog's emotional state and social status (see Section 4.3).

From the point of view of husbandry, it is a common observation that dogs will make considerable efforts to gain visual information about their surroundings. This is an adaptive behaviour for many carnivores to ensure that vision of approaching threats or prey is not overly obstructed. There is some evidence that wolves use high vantage points (Murie 1985), and many zoos now provide mounds or platforms in carnivore enclosures. Raised platforms have been found to be beneficial for laboratory dogs (see Section 6.1.2).

4.2.4 Touch

Touch is the primal sense in dogs and extremely important for well-being. Touch can have dramatic effects on the emotional state and physiological responses of a dog, and tactile experiences are important in the context of socialization and habituation, especially in the very early days and weeks of life when other senses are not yet functional (see Section 13). The tactile experiences of the dam during pregnancy are reported to affect the development of the hypothalamic-pituitary-adrenal (HPA) axis of the unborn puppies and their subsequent ability to deal with stress as adult dogs. It is therefore important to consider tactile interaction with pregnant bitches and ensure that such interaction is positive and rewarding from their perspective.

Dogs rest in contact and this is probably a means of maintaining social cohesion in canine groups. This behaviour may be associated with pleasant sensations experienced during puppyhood. Hubrecht *et al.* (1992) found that beagles aged between 6–8 months averaged up to 10% of their day resting in contact. Even adult dogs in relatively unestablished social groups spent an average of more than 2% of their day resting in contact. It is likely, however that this behaviour can be influenced by social status.

Stroking or petting dogs is good for both dog and handler. Odendaal and Lehmann (2000) found that phenylethylamine plasma concentrations changed significantly during positive interaction in both humans and dogs. They concluded that it is possible that, during stroking, dogs experience the same feeling of elation from the amphetamine-like neurotransmitter as do humans stroking dogs. Hennessy *et al.* (1998) found that stroking can reduce dog cortisol levels during sequential blood sampling. They therefore propose that sympathetic handling/stroking can be a valuable technique to reduce the dog's stress during aversive procedures (see Section 16). Lynch and Gant (1968) showed that the dog's heart rate also fell during stroking and that the response was easily conditioned to a tone. However, human social contact can also be aversive to individual animals that have not

been adequately socialized during their primary socialization period and therefore adequate attention must be paid to the level of social interaction with puppies between 3 and 14 weeks of age (see Section 13).

Recommendation:

- **The way in which dogs use their sensory and perceptual abilities to interpret and assess physical environments and social interactions should always be considered when designing all aspects of dog housing and husbandry within a laboratory context.**

4.3 Interpreting dog signals

It is important that laboratory staff are able to recognize and accurately interpret dog signals, not only in order to assess the welfare of the dogs in their care but also to ensure that they respond appropriately when interacting with the animals. See Simpson (1997) for an in-depth appraisal of canine communication.

Olfaction, one of the most important means of communication in the dog is, unfortunately, the sense that humans have most difficulty comprehending. Visual signals (i.e. body postures and facial expressions) and vocalizations will therefore be the most important signals in terms of human–dog interactions. These methods of communication provide an indication of a dog's emotional state and can provide information about the relative social status of dogs within the same social group. They can also provide information about the dog's intended action in response to a situation or interaction, and accurate interpretation is instrumental in minimizing pain and distress. For example, a relaxed dog will show an alert facial expression with ears carried high and forward (Fig 2), whereas a dog that adopts a low posture with head and ears held low is indicating a lack of self-confidence (Fig 3). Such an individual may require extra habituation to a procedure or more specific training in order to minimize its fear responses. It may be instinctive for staff to offer reassurance to these individuals, but care must be taken not to inadvertently reinforce fear in this way.



Fig 2 An alert facial expression with ears carried high and forward is indicative of a relaxed emotional state

Since dogs are only capable of using canine communication systems, the signals that they use in interactions with other dogs are also used to communicate with humans (but the potential role of conditioning in the modification of these signals must be appreciated). The success of interspecies communication is dependent on the way in which humans interpret and respond to dog signals, as well as the way in which dogs interpret and respond to signals, intentional or otherwise, given to them by humans via their use of body posture and eye contact.

During social interactions with conspecifics and humans, dogs will frequently use communication signals to test the response of the receiver and will

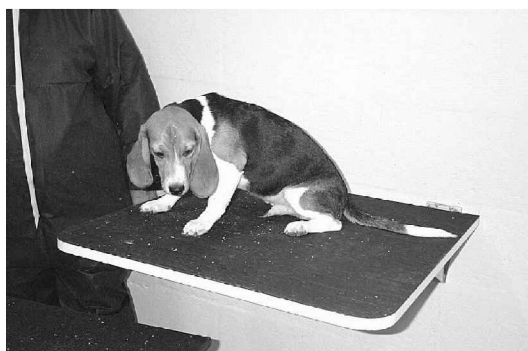


Fig 3 A crouched body posture and lowered head is indicative of a fearful emotional state. The dog is also showing anticipation of getting off the table

then react accordingly. The expected response will be one which is based on the original motivation for the signal, for example a fearful body posture would be expected to result in a response of retreat on the part of the person or other dog. In dog–dog communication, there is usually a common understanding of the signals used and deference on the part of one dog will lead to an assumption of higher social status on the part of the other. Unfortunately, dog–human interactions often result in responses that the dog considers to be unexpected and unjustified; this can lead to problems of miscommunication and a breakdown in the relationship between the two parties. An example would be the continuation of a scientific procedure, which the dog interprets as potentially harmful, when there has been clear canine signalling of pain and distress which should, from the dog's perspective, have resulted in termination of the interaction.

When interpreting dog signals it is important to remember that they are context-specific and that their meaning will be influenced by the response of the receiver as well as the intent of the sender. As a consequence of this it is impossible to attach one rigid meaning to each signal and inappropriate to adopt inflexible responses to signals that are given. We should bear in mind also that breed differences can have a significant effect on forms of communication, and since beagles are relatively small dogs it can be easy to miss subtle changes in their body posture.

4.3.1 Visual signals

Staff responsible for the day-to-day care of dogs need to be able to recognize canine visual signals and understand the function of such signals in demonstrating rank and testing the hierarchy within a group of dogs. In addition, the role of canine visual signals in conveying information about the dogs' emotional states must also be considered.

Demonstrating rank and testing the hierarchy: The relative rank structure of canine society, which is often referred to as

a hierarchy, is designed to remove the need for confrontation and conflict; aggression is therefore less likely to occur within a stable social group. Staff need to understand their own role in maintaining canine social stability and controlling stress within and between cages or pens, through the provision of calm and confident signalling (see Section 4.4). It is important to appreciate that rank is a dynamic concept and that a state of dominance is given to an animal by the subordinate actions of another individual, rather than taken through their use of so-called dominant signalling. Consequently, bullying tactics are unnecessary and unsuccessful in terms of establishing social hierarchies, and confrontational communication has no place in stabilizing social groups.

When dogs are kept in confined spaces they are under increased social pressure and the range of defence strategies at their disposal may be limited. For example, the defence strategy of flight in reaction to a situation of potential conflict may not be physically possible, and dogs, of any rank, which would normally opt to walk away from potential confrontation may be unable to do so. It is important also to realize that subtle visual signals, which are used by dogs to diffuse conflict at a distance, may be of limited use within a confined space and therefore more exaggerated (or frequent), and potentially challenging signals are likely to be used. As a consequence of losing flight as a potential response, dogs rely on the alternative defence strategies of freezing, appeasing or fighting to resolve conflict, and this may be significant when considering the issue of aggression in group housing (see Section 4.4).

Emotional confidence or lack of behavioural inhibition in dogs is shown by an increase of physical presence indicated by a high body posture, raised tail, fully stretched front legs, upright head and neck, and erect and forward-pointing ears (Fig 4B). When a confident individual is challenged, or threatened, intense eye contact and exposure of the canine teeth may be seen as additional signals (Fig 4F). When an inhibited or less confident individual is challenged he/she

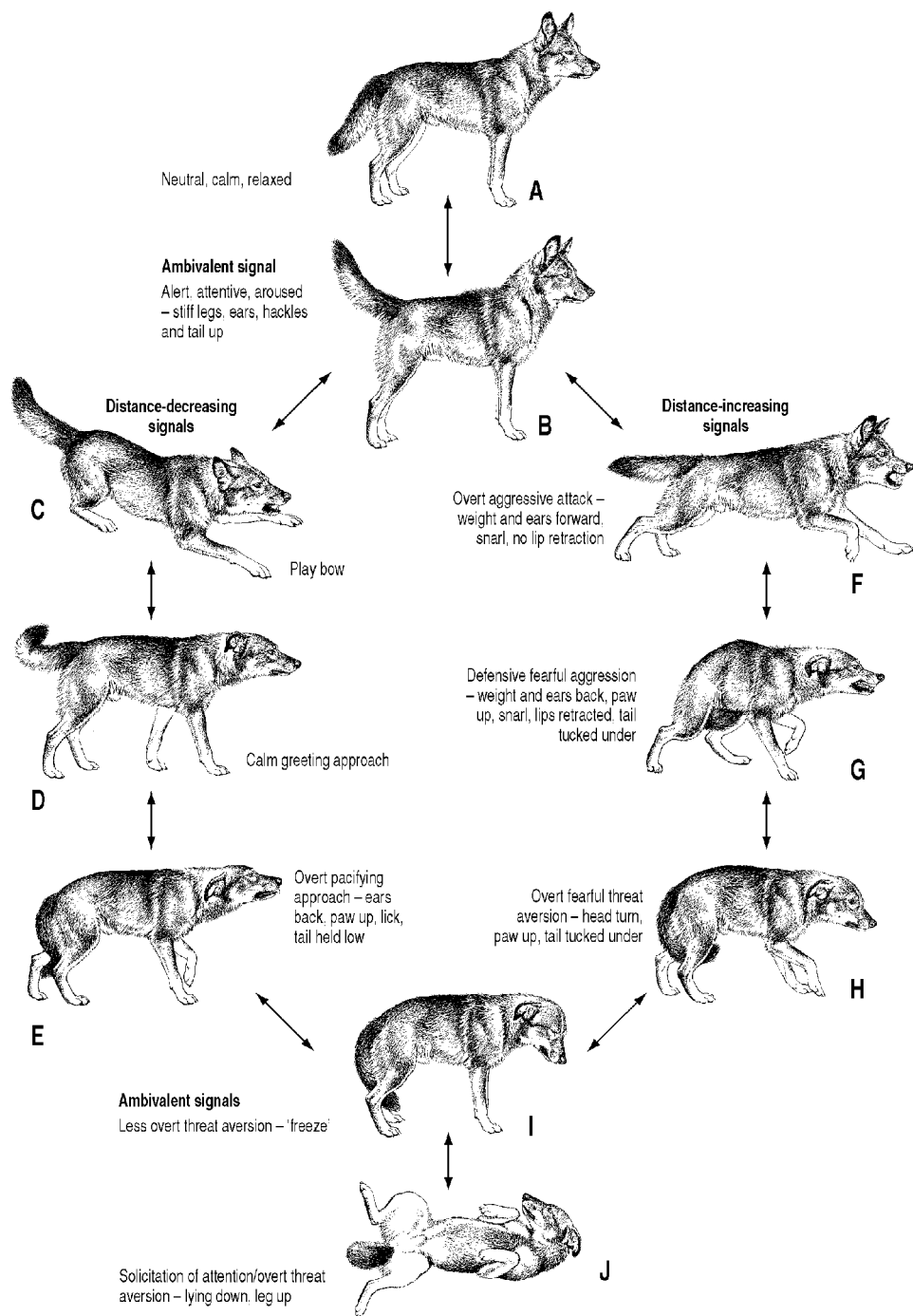


Fig 4 Expressive social responses in the dog (Reproduced from Shepherd (2002) in *BSAVA Manual of Canine and Feline Behavioural Medicine*, with permission from the British Small Animal Veterinary Association)

will respond by adopting a lowered body posture, or cowering, the head and neck can be tilted, eyes are averted, ears folded back, and the tail is tucked in under the belly (Fig 4H).

Two behaviours that are often interpreted as the ultimate gesture of passive surrender to a superior are rolling over and lying belly-up (Fig 4J). Whilst these signals are extreme forms of appeasement behaviour, which are designed to diffuse conflict, they do not indicate that the individual has given up completely. If the threat or challenge continues, individuals in these positions will still respond with aggressive defence, and can snap and bite if pushed too far. The normal canine response to an individual which has rolled over to expose its belly would be to sniff the inguinal region and then turn away, thereby confirming the relative rank of the individuals and avoiding escalation into confrontation.

When two dogs approach one another obliquely rather than head on, the signal appears to be one of calm social interaction but there is no evidence of any value of this signal in terms of social status or relative rank.

Both uninhibited and inhibited individuals can use vocalization and piloerection as part of their signalling repertoire and this can make interpretation of these signals difficult. In addition, facial expressions can appear very similar between the two groups. Differentiation can rely on subtle differences, including the degree to which the mouth is opened, the angle and shape of the corner of the mouth, how far back the lips are pulled, how the nose and face are creased and how the teeth are presented (Feddersen-Petersen 1986). Dogs lacking in confidence may retract the corners of their lips, pulling their mouths into a shape that often looks to us like a 'smile' (Fig 5). It can even result in the teeth showing, which can be confusing; but the dog 'smile' is invariably accompanied by other appeasement gestures, such as lowered, flattened ears or a bowed neck. In contrast the fang-bearing threat of a confident individual involves raising the forelip to expose the canine teeth, which does not happen in the appeasing 'smile'.

Fear: Fearful dogs may exhibit behaviours which are designed to avert potential threat, be that real or perceived, and these may include not only visual signals of apparent appeasement but also signs of aggression. Problems arise when these signals, which are a response to the perception of threat, are misinterpreted as signs of relative status. As part of a canine fear response individuals will carry their ears down and back and their heads down with the eyes wide (Figs 4H and 6). Fearful individuals have a heightened startle response and will usually attempt to flee. If this is not possible they may freeze in place, with stiffened forelimbs and their weight distributed to the back of the body (Figs 4I, 6 and 7). Sometimes they face what frightens them (Fig 8); when reached for or approached by a human, such dogs are likely to bite, particularly when unable to escape. In extremes of fear, some dogs may urinate, defaecate or empty their anal glands. See Simpson (1997) for techniques to reduce fear in dogs and other useful responses to dogs in a care-giving or veterinary setting.

Anxiety: Anxious dogs may show a combination of greeting signs, tail wagging and approach, while at the same time showing signs of trying to avoid the individual or situation. This is sometimes referred to as a state of approach-avoidance conflict and it demonstrates a very unstable emotional state. These individuals may show signs consistent with fear, such as a low head carriage and raised hackles. They might roll over and urinate, which is an extreme sign of appeasement, or show more subtle signs such as lip smacking and yawning.

Dogs that are traditionally referred to as excitable often lack confidence and signs such as exuberance, barking, and jumping up may be learned attention-seeking behaviours which are being used as appeasement gestures in the context of greeting human beings.

Tail wagging: Tail wagging is an indicator of arousal and of intention to interact. In a domestic context the tail wag is often conditioned as a greeting behaviour and it is



Fig 5 This head posture with lowered ears and concentrated facial expression is often accompanied by lip smacking and is indicative of an anxious emotional state



Fig 7 A fearful dog with a lowered head posture and stiffened forelimbs avoids eye contact with the handler



Fig 6 Fearful dogs may attempt to avoid eye contact. This facial expression is accompanied by a stiffened body posture, which can make it difficult to place the dog in a sitting position on the table



Fig 8 Fearful dogs may retreat from people entering the home pen and attempt to get into the corner of the pen or under the platform

a behaviour which is generally viewed as a sign of 'happiness' and well-being in the dog. However, tail wagging alone does not give any indication of motivation and it is dangerous to always interpret a wagging tail as a friendly gesture. Instead it should be interpreted alongside other communication signals, and factors such as the height of tail as it is wagged should also be taken into consideration. A medium tail carriage in conjunction with steady wagging and confident approach is interpreted as a general expression of friendly greeting (Fig 4D), while a tail held high and waving steadily along its length indicates confident interaction and may even be used as part of a threat display. A tail held in a low position

and wagging rapidly and erratically, particularly towards the tip, indicates a lack of confidence and is often associated with other clear signs of fear and appeasement (Fig 4E).

Play bow: Play is a lifelong activity in dogs. Dogs that want to engage another in play will bow down with the front legs outstretched and hindquarters elevated in the 'play-bow' position (Fig 4C). This is understood to signal that the interaction that follows is not to be taken seriously, and during the play that follows, dogs often engage in aggressive signalling and ambiguous social gestures.

Raised paw: The raised paw is often interpreted as a positive signal and seen as an attention seeking behaviour or an indication of intent to play. However, unless there are other clear signs of play behaviour it is more likely that the elevated paw is being used as sign of appeasement (Fig 4E). When it is seen in combination with other signs of behavioural inhibition and low levels of confidence its purpose is to avert a threat and indicate a desire for the present interaction to be terminated (Fig 4H). In contrast, a confident individual who is tolerant of approaches and handling will be more likely to remain sitting or standing with all four feet on the floor.

4.3.2 Vocalizations

Dog vocalizations can involve whines, whimpers, growls, barks and howls, or some complex combinations (Cohen & Fox 1976). These are all fairly non-specific signals unless they are evaluated within the social context in which they occur. Their meaning is best understood by considering what they accomplish (e.g. growling causes the perceived threat to retreat and is therefore highly effective as a defence strategy).

Husbandry staff should be experienced enough to be able to identify the meaning of various dog vocalizations and to understand the role of vocalizations in their recognition and monitoring of pain and distress (see Section 17.6). For example, differentiation between the constant vocalization of an individual demanding social interaction and the intermittent howl of a dog that has been separated from his or her social companions is important if staff are to take appropriate action. It is important also to understand the role of vocalization in dog-dog communication, both in the context of play and within confrontational encounters. Misinterpretation of barking as a form of threat or conflict can lead to premature human intervention in dog-dog interactions and may even lead to an increase in the incidence of aggression within pens (see Section 4.4).

Whines and growls: A whine is a high-pitched pure-toned sound, rising slightly

then falling quickly. Whines are used when the aim is to signal a non-threatening status and to seek the non-violent approach of a social partner. They are used in friendly or care-soliciting contexts. Dogs can also whine when frustrated (such as when desired movement is prevented) or when experiencing pain (see Section 17.6).

A growl is a low-pitched, acoustically rough, harsh tone. Growls are usually used in hostile contexts or distance-provoking contexts where the aim is to repel an impending threat. Growls are often used in conjunction with warning facial and body expressions (see Section 4.3.1) and should be interpreted as early-stage threats, which could be followed by more intense signs of aggression if they go unheeded.

Whines and growls vary in intensity and pitch, and there is a correlation between the urgency of underlying motivation and the pitch of the signal. Whines shade into whimpers, and growls into snarls, as urgency grows. Dogs use whines and growls and all their variants in many different circumstances, and accurate interpretation will rely on observation of all concurrent signalling including body posture and facial expression.

Barks: Barks are probably the most noisy and disruptive of the canine vocalizations and are acoustically almost precisely halfway between growls and whines, in both pitch and structure. Dogs produce distinguishable barks in a number of different contexts, including territorial defence, aggression, altering of others, anxiety, individual identity, social facilitation and play solicitation (Simpson 1997, Yin 2002). Studies of companion animals indicate that hounds, such as beagles, or sporting dogs bred for high activity are particularly prone to barking when their owner is absent (Niego *et al.* 1990). Similarly, Hetts *et al.* (1992) found that socially isolated laboratory beagles (i.e. dogs having only auditory contact with other dogs and contact with people only during routine husbandry procedures) vocalize more than dogs that have social contact.

Howls: Howls are long, melodious sounds that sweep through many different pitches. Wolves howl under many different circumstances, and the full range of meanings of this vocalization are still not understood. However, it is certainly a form of long-distance communication and has been associated with such diverse situations as the location of other pack members when the social group becomes dispersed and the deterring of members of a rival social group who are encroaching on established territory. Howling may indeed be a natural response of dogs separated from their social group or owners (Lund & Jørgensen 1999).

Moans and yelps: Some dogs moan in pleasurable contexts. Moans seem to be learned vocalizations, used only in communication with humans and never with other dogs. Yelps are indicative of distress or actual pain (see Section 17.6).

Recommendations:

- **Care-giving staff should be trained to recognize and interpret canine visual signals and vocalizations and to respond appropriately. They should be aware that accurate interpretation of these is instrumental in the minimization of pain and distress.**
- **Fearful dogs should be identified early and behavioural modification techniques should be used to reduce their fear.**
- **Accurate interpretation of visual signalling should be used to determine the stability of a social group.**
- **Visual signalling should never be interpreted in isolation and should be monitored for changes over time.**

4.4 Aggression

Aggressive behaviour in dogs can be considered normal species-specific behaviour and is a function of a number of components including the health of the animal. Veterinarians and canine behaviour specialists have classified many types of aggression according to the context in which they occur.

Such labels may be helpful in some situations, but the most important factor to consider when faced with a problem of canine aggression is the underlying motivation for the behaviour and the emotional state of the individuals involved (see Section 4.3.1). Defensive aggression is far more common than offensive aggression, and aggressive responses are far easier to provoke in insecure and fearful individuals (Overall 1997). Emphasis should therefore be placed on avoiding fearful animals by careful selection of breeding stock (see Section 11.2) and suitable socialization and habituation (see Section 13).

Preventing and managing aggression: Since aggression is exhibited under many different circumstances, effective management can vary depending on the motivation for the behaviour and the stimuli that trigger aggressive responses in the particular dog. Attention should therefore be paid to the timing of aggressive incidents through the day and to any potential link with levels of arousal in the dogs. For example, activities within the pens, such as feeding and cleaning, may lead to increased levels of arousal and decreased thresholds of tolerance toward other dogs. If dogs are allowed to run freely in the central corridors during these procedures, it is also possible that dogs may come into visual and even tactile contact with individuals from different social groups; and the resulting arousal from these encounters could increase tension within the pens. Care-giving staff should adapt their routines where possible to avoid any circumstances, such as moving and mixing dogs, that trigger or exacerbate social conflict. In addition, it would be beneficial to take steps to decrease levels of arousal at feeding and cleaning times, which could contribute to the onset of aggressive incidents. Increased visibility has been found to reduce the level of arousal within units when there is activity in the central corridor (see Section 6.1.2); this may help reduce aggression at these times.

Whatever its proximate or ultimate cause, aggression can have serious complications when dogs are housed in a group (e.g. injury

or shock). It is therefore critical to ensure that there is an adequate husbandry routine to monitor the animals and forestall potential problems. A video and sound remote monitoring system can be very helpful in this regard, and alarms can be used to alert personnel to particular instances of fighting. However, these should not be used as a substitute for an adequate husbandry routine and appropriate staff-to-dog ratio. Video is also helpful for investigating stereotypies in the absence of an observer (see Section 5).

Territory can be defined as a space that contains important resources, such as food, shelter, resting areas and social interaction, and in the laboratory context the home pen fulfils this function. The potential for conflict between individuals in relation to gaining and maintaining access to those resources is something that needs to be considered when designing pens (see Section 6.1) and when selecting individuals to be housed together (see Section 14). Large, complex pens with plenty of enrichment may help reduce the frequency of aggression within the unit in the first instance through increasing the availability of high value resources, such as resting places, in order to decrease their perceived value. It is also possible that increasing the size of pens could help foster and permit more effective canine signalling and therefore decrease aggression (Beback & Beck 1993). Canine communication signals are likely to be exaggerated in pen-housed dogs due to the close proximity resulting from the confined space that the dogs are in (see Section 4.3.1). Defensive signals are aimed at maintaining or increasing the distance from a perceived opponent or threat, and effective communication will result in a decrease in aggressive incidents. If retreat to a safe distance is not possible within the confines of the pen, this may lead to an increased incidence of aggression.

Increasing the level of human contact is sometimes suggested as a means of controlling aggression. However, this can also lead to increased value being given to human interaction and therefore increased conflict when human contact is available or anticipated (e.g. at the start of the day or at the first sight of human companions). It

must be recognized that dogs within a laboratory environment have certain restrictions on the availability of social interactions with people, and therefore care should be taken not to raise the expectations of human contact to levels that are unrealistic. Doing so may result in anxiety related to separation from humans and can be detrimental to the welfare of individual animals (see Section 13).

The supply of dogs in pre-existing groups before they enter the research establishment and the avoiding of regrouping on arrival may help to create stable groups and thereby reduce the risks of aggression (see Section 14). The potential for conflict may also be reduced by the housing of individuals of different ages and/or body weights together. Dogs of like age, size and sex are more likely to fight because of unclear demarcation between their respective resource holding potential (Wickens *et al.* 2001). Housing males and females in separate rooms and paying particular attention to reproductive seasonality may also help prevent aggression.

Dealing with aggressive incidents:

Aggressive incidents resulting in physical injury are relatively rare within well-managed laboratory environments. It is vital to have accurate records of exactly what is occurring and when, in order to implement techniques to deal with aggressive incidents when they do occur. Records should include details of when the incidents occurred, who was present in the unit at the time, what activity was taking place (e.g. cleaning, feeding, worming, weighing), the level of injury to the individuals involved, and the behaviour of those individuals and other members of the social group before, during and after the incident.

Where aggression arises in an established group of animals it may be possible to subdivide the group such that the sub-groups can continue to live in harmony. Where possible, it is advisable to put physical space between the pens of such sub-groups and to move the groups into separate units, rather than across the aisle of the same unit, in order to avoid continuing displays of social conflict (Canadian Council on Animal Care

1993). Alternatively, individuals that have been removed from a group because of aggression can be introduced to dogs from other social groups; such regrouping should initially be done in large, novel pens that are interesting to the dogs and away from the home pen. Interactions between dogs should be carefully supervised by suitably trained staff. When there is a history of aggression between particular dogs, steps should be taken to avoid exercising them together.

While a stable hierarchy within a group prevents actual fights (and thus injuries) resulting from ritualistic displays, the development of such a hierarchy is often undermined by the lack of understanding in humans. In the case of dog-dog aggression, human interference often inadvertently encourages aggressive behaviour, and inappropriate support for a naturally low ranking individual against a perceived 'bully' may destabilize the hierarchy within a social group and inadvertently increase the risk of aggressive behaviour. It is important for staff to be trained in the recognition of canine signals so as to avoid premature interference, which can lead to an escalation of aggressive signalling (see Section 4.3).

Animal care staff should be confident in their ability to interpret canine communication and to deal with aggressive dogs in an appropriate and safe manner. It is important to maximize the stability of the group by reinforcing the natural social order within the group. Giving attention to the more confident individuals first when greeting the dogs, and allowing these dogs to be the first of the group to go through doorways and receive treats or food, may be beneficial. Resisting the temptation to intervene prematurely in agonistic interactions between individuals within a social group may also help to stabilize the situation.

Recommendations:

- **Animal care staff should be trained to recognize aggressive signals and interpret them accurately.**
- **Managers of dog units should establish husbandry routines which allow the adequate monitoring of aggression**

within social groups and enable staff to forestall potential problems. A video and sound remote monitoring system can be very helpful in this regard.

- **Pens should be of an adequate physical size and provide enough complexity, both physical and social, to reduce the frequency of aggression.**
- **Care-giving staff should look carefully at their husbandry routines, identify possible causes of conflict, and then adapt their routines where possible to avoid any circumstances that may lead to aggression.**
- **Staff should keep accurate records of aggressive incidents and ensure that dogs which are known to be aggressive to each other are not exercised together.**
- **Attention should be paid to reproductive seasonality in order to reduce the risk of aggression. It may be necessary to house male and female dogs in separate rooms.**
- **Dogs should be supplied to user premises in pre-existing stable groups to help avoid aggression. The potential for conflict may be reduced by housing together individuals of different ages and/or body weights.**
- **Where aggression arises in an established group of animals, consideration should be given to subdividing the group such that the sub-groups can continue to live in harmony. Where possible, the pens of such sub-groups should be distant from one another.**
- **When a decision is made to introduce an individual to an alternative social group, such regrouping should initially be done in large, novel pens that are interesting to the dogs and away from the home pen.**
- **Direct contacts between dogs should be carefully supervised by suitably trained staff who are confident in their ability to interpret canine communication and to deal with aggressive dogs in an appropriate and safe manner.**
- **The veterinarian, animal care staff and canine behaviour specialist should periodically review the mechanisms in place for monitoring and dealing with aggression.**

5 Abnormal behaviours, stereotypies and temperament

Although dogs spend much of their day resting, they require a varied and stimulating physical and social environment during their active phase (Morris 1970). Housing environments that do not meet their physical and/or social needs are therefore likely to lead to changes in physiology and to abnormal behaviour as the animals attempt to adapt to stress. A good laboratory environment should prevent abnormal behaviour from developing (see Sections 6 and 8).

Abnormal behaviour in the dog may take the form of a reduced behavioural repertoire and/or the development of apparently functionless behaviours or 'stereotypies', defined as repetitive, invariant behaviour patterns with no obvious goal or function (Mason 1991). Stereotypies observed in kennelled dogs include circling, pacing, whirling, jumping, wall bouncing, repetitive grooming or self-biting, polydipsia or polyphagia, compulsive staring and an excessive propensity towards certain behaviours such as barking (see Hubrecht *et al.* 1992, Hubrecht 1995b). Such behaviours indicate poor welfare and may also increase the likelihood of injury or susceptibility to disease.

It has been shown that animals exhibiting stereotypical or compulsive behaviour patterns not only demonstrate changes in function of certain areas of the brain, such as the basal ganglia and prefrontal cortex, but also show increased variation in behavioural responses, which could affect the reliability of data collected (Garner 2002). The studies to date have been carried out in species other than the dog, but there is no reason to suppose that similar results would be obtained in corresponding canine studies.

There are apparently individual differences in dogs' responses to stress and propensities to develop abnormal behaviour, although the longer dogs are kept in kennelling the more likely they are to develop stereotypies (Hubrecht unpublished data). Individual differences may be related to the dogs' experiences during development

or may be genetic. Breeding for a stable temperament and low reactivity in conjunction with appropriate socialization and habituation should be the main objective in improving the situation (see Sections 11.2 and 13).

Dogs that are not able to adapt to the unnatural conditions of the laboratory are particularly likely to show stereotypical locomotory behaviours. Moreover the behaviours can be intermingled so that, for example, circling is interrupted by standing on hind-legs or wall bouncing. In some cases these can be extreme, so that individuals can use up to three times their normal daily food ration to sustain the metabolic expenditure resulting from the stereotypy. Clearly such abnormal behaviour has consequences for certain scientific outcomes. While extreme cases such as this are easy to detect from patterns in the sawdust (Fig 9: Hubrecht 2002), others are often missed because the dog ceases to perform the stereotypy when animal care staff enter the pen.

Hubrecht *et al.* (1992) found significant stereotypies in four different types of kennelling, and at three of the sites more than 10% of the dogs were spending more than 10% of their time in such behaviours. Nonetheless, care staff were not particularly aware of the problem. Dog stereotypies are often not as obvious as those in some other species, but their detection can be made easier by watching recordings of behaviour played back at fast speed. Remote monitoring using closed circuit television (CCTV) and one-way viewing panels can be used to detect and monitor such behavioural abnormalities in the absence of humans.

Abnormal behaviours such as stereotypies should be regarded as unacceptable and the situation should be addressed immediately if they occur: for example, by obtaining expert advice on improvements in the animals' environment (see Sections 6 and 8), by changing housing or by providing more socialization with humans or other dogs, as appropriate. If animals are persistently unable to cope with their environment, they should be issued for short-term studies, rather than long-term use, as quickly as possible, or be humanely killed (see Section



Fig 9 Sawdust on floor showing pattern of circling stereotypy—this is a cause for concern and the housing design and management practices should be re-assessed. Stereotypies might not always be the product of current housing, as once established they can be hard to eradicate

17.7) or rehomed (see Section 19). In addition to the ongoing poor welfare of the individual, the use of such animals in some areas of research and testing may skew scientific data.

Single housing and abnormal behaviour:

Single housing and social isolation (see Section 6.1.5) are closely associated with an increased incidence of behavioural abnormalities in dogs. For example, singly-housed laboratory beagles have a reduced behavioural repertoire, sleep less and tend to vocalize more than dogs with social contact (Hetts *et al.* 1992). Solitary dogs are more inactive, passive, and spend more time in non-social repetitive locomotory behaviour categories than group-housed dogs (Hubrecht *et al.* 1992). It should be noted that animals that

appear confident when pair-housed may not tolerate single housing.

Singly-housed dogs tend to be housed in smaller pens which are associated with stereotyped circling rather than pacing behaviour (Hubrecht *et al.* 1992). This is likely to be essentially the same behaviour modified by cage size, and probably represents an attempt to increase sensory input or, in other words, offset boredom. In impoverished and abnormal conditions animals may become bored (Wemelsfelder 1985) or frustrated (Appleby 1991). Dogs should be housed in socially harmonious groups or pairs unless compelling welfare, veterinary or scientific reasons make this impossible (see Section 6.1.5).

Recommendations:

- All dog housing should aim to meet the physical, physiological, behavioural and social needs of all the dogs housed within it.
- Stereotypies should be regarded as unacceptable and should be prevented from arising in the first instance rather than ameliorated when they occur.
- Behaviour of dogs should be monitored in order to detect behavioural abnormalities as these are signs of poor welfare. Remote monitoring using CCTV or one-way viewing panels can be useful for this purpose.
- If dogs develop behavioural abnormalities, housing and husbandry practices should be examined and changed so that such behaviours are eliminated.
- Housing dogs in socially-compatible groups or pairs is recommended as a means of reducing abnormal behaviour.
- The need to retain dogs showing marked abnormal behaviour or stereotypies should be seriously questioned. In addition to the ongoing poor welfare of the individual, the possibility that such animals may skew scientific data when used in some areas of research and testing should be considered.
- Care should be taken not to breed from animals showing marked and/or persistent abnormal behaviour or stereotypies.

Part 3

6 Housing and husbandry

All laboratory animal housing is the result of a compromise between the needs of the researcher, the needs of the animal care staff and the needs of the animal. Although the design of laboratory dog housing and the space given to laboratory dogs varies widely between establishments, ease of husbandry by care-giving staff and maintenance of the animals' physical health have typically been given higher priority over features that would suit what is known about the natural history and behaviour of dogs and of their behavioural and welfare needs (Hubrecht 1995a, 2002). Some establishments face economic constraints. As a result, some laboratory dog pens are small, barren, simple affairs that bear no relation to, say, the typical ranging behaviour of feral dogs or indeed the daily exercise and stimulation enjoyed by many companion dogs. It should be borne in mind that all researchers and research establishments live in an increasingly demanding public world that is becoming less tolerant of care standards that differ from those the public demand in the care of their own companion animals.

The dog is the prime user of the pen and spends far greater periods of time in it than do the staff who service it. It is vital, therefore, that the dog's normal behaviour and the extent to which the pen might restrict such behaviour are considered at the design stage. The aim is to provide housing and husbandry that allows the animal to perform the widest possible range of normal (but not necessarily entirely 'natural') behaviour, and to exercise a degree of choice in its environment (e.g. to socialize with or avoid its kennel mate; to listen to environmental noise or avoid it; to be seen by neighbouring dogs or not seen) (Poole & Stamp Dawkins 1999). This is important both in terms of animal welfare and good science. Factors to consider for good dog housing are given in this section and summarized in Appendix 2. It is recommended that the advice of an appropriately qualified canine behaviour

specialist be sought when designing accommodation for dogs.

Recommendation:

- **As a guiding principle, housing and husbandry should be managed in order to allow animals to perform a wide range of normal behaviours and to exercise a degree of choice in their environment.**

6.1 Pens

6.1.1 Pen construction

Dog pens should be constructed so as to provide a safe, comfortable and hygienic environment. Materials used to construct dog pens include concrete, stainless steel, galvanized metal and wood. It is better to use materials that are independent of the primary structure of the facility because this enables refurbishment and remodelling for improvements with minimal disruption and cost. Concrete pens have the disadvantage that they are not easily modified or changed. Stainless steel is readily available and is preferable to galvanized metal which may damage the feet or flake away if the quality of the galvanization is poor. (Flaking galvanized metal may have toxic effects due to the zinc being absorbed during licking: MacArthur Clark 1999.) However, stainless steel reflects bright light and is noisy. Since the pen environment is often busy, one disadvantage of metal pens is that their frequent opening and closing can cause a great deal of noise. Noise levels can be reduced by inserting drop-down plastic or wooden plugs between metal fixtures and fittings. Wooden pens absorb sound but are difficult to sanitize (which may be necessary in a disease outbreak) and can be damaged by chewing.

Materials used for the walls and divider panels of dog pens should be such as to prevent dogs from injuring each other. Plastics have the benefits of being relatively warm to the touch (and hence comfortable for the dogs) and of absorbing more noise generated by barking. Transparent plastic and glass also make it easier for the staff to observe the animals and for the animals to survey their surrounding environment (see Section 6.1.2).

Flooring: The preferred flooring for dog accommodation is a solid continuous floor with a smooth non-slip finish with adequate drainage. The surface material should be resistant to corrosion, denting, cracking or chipping. Modern epoxy finishes are suitable. The provision of substrate, such as heat-treated dust-free sawdust, shavings, wood-chips or shredded paper, on a solid floor will facilitate cleaning and help the animal maintain a clean and healthy coat free of faeces and urine (see Section 9).

Slatted flooring systems are sometimes preferred over solid floors because they are easier to maintain and clean, but the majority of the Working Group members recommend solid, or at least only partly-slatted, floors and agree that dogs prefer solid flooring (also see Gärtner *et al.* 1994). Pre-weaned puppies and peri-parturient and suckling bitches should not be held on an open-floor system. Wire mesh flooring systems are not recommended.

Where open-flooring systems are used, the highest level of attention should be given to their design and construction in order to avoid pain and injury (e.g. from pressure sores or entrapped toes, dew claws or collars) or disease, and to allow the animals to express normal behaviours. Strict attention needs to be paid to the materials used and the surface finish should be smooth and not likely to wear or flake. Slats are recommended as having a width of 20 mm, a depth of 15 mm, made from stainless steel with radiused (rounded) corners and with gaps between them of 19 mm. The top surface should have a slight slope to either side to prevent pooling of water. The overall proportion of the solid area should be at least 55% of the total area. The use of slatted floors is also dependent upon well-controlled heating, ventilation and, if necessary, air-conditioning, to closely control the environment.

Dogs on open-flooring systems should be provided with a comfortable solid surface over at least part of the living area for resting and sleeping, for example, by the use of pen furniture such as raised beds or platforms (see Section 6.1.2). This should be of sufficient size for all dogs in the pen to

comfortably and simultaneously lie down. Where existing open-flooring systems are not needed, they can be covered with smooth, soft plastic for tactile comfort, warmth and improved ease of cleaning. If any problems arise relating to flooring, veterinary advice should be sought and, if necessary, dogs should be relocated onto solid flooring.

Recommendations:

- **The materials used to construct pens should be independent of the primary structure of the facility because this enables refurbishment/remodelling for improvements with minimal disruption and cost.**
- **Noise from pens should be reduced through a careful selection of materials, including plastic or wooden drop-down plugs in metal pens.**
- **The recommended flooring for dog accommodation is a solid, continuous floor with a smooth non-slip finish. Pre-weaned puppies and peri-parturient and suckling bitches should not be held on an open-floor system.**
- **Dogs on open-flooring systems should be provided with a comfortable solid surface for resting and sleeping.**
- **If any problems arise related to flooring, veterinary advice should be sought immediately.**

6.1.2 Pen design

The design of dog pens should facilitate social group formation and dog-dog and dog-human human interaction, as well as comfort and sanitation. Pens should provide an open and light environment, giving the dogs comprehensive sight of staff outside of their pen and visual, auditory and olfactory contact with other dogs. They should also incorporate features that are stimulating to the occupants (Fig 10: Novo Nordisk, Denmark).

Flexibility of pen design is extremely important and a well-designed dog pen should be large enough and flexible enough to house dogs socially in harmonious groups and to allow them to be separated where necessary (e.g. for feeding separately).



Fig 10 Dog pens designed to meet the behavioural needs of the dog. The pens are linked in pairs with access to an outdoor area through the pop-hole at the back of the pen. Pen subdivisions allow complexity and choice. Raised platforms offer visibility across the room. Suspended chews are provided as means of environmental enrichment. A dog bed with fleecy bedding offers a comfortable resting place

Groups of pens within a room should be arranged in such a way that it is possible to move dogs to another pen temporarily during wet cleaning, so as to avoid exposing the occupant(s) to buckets of water, high-pressure hoses or other aversive stimuli (see Section 9).

The use of modular pens that can be converted according to need is desirable. It should be possible to remove panels or open doors or pop-holes between adjacent pens so that larger pens can be created as desired, either to allow the animals more space and complexity or to allow groups of dogs to run together (Hubrecht 2002). It is advisable to design a dog unit with separate exercise/activity areas (see Section 8.2), but home pens should also be spacious in order to provide animals with the opportunity for exercise within them when the separate exercise/activity areas are not available (for example, due to the requirements of the experiment or because of problems with aggression) (see Section 6.1.3).

Traditionally, dog pens have been designed in order to allow staff easy access to, and sight of, all dogs. Whilst this is important, it is also important that the dogs are able to exercise control over their social interactions by moving out of sight of each other (Beback & Beck 1993). Accordingly,

indoor (and outdoor) pens for dogs should be designed so that the occupants can retreat to an area that provides them with a sense of privacy. This need not be a problem for the day-to-day caregiver, as it can simply involve the provision of an area with a few visual barriers or kennel-like structures shielding an animal from view on two or three sides (see below). These are particularly important for dogs housed in large social groups, for the whelping bitch, and for the nervous dog (in order that he/she may retreat from events that he/she considers alarming). That said, the aim should be to remove nervous dogs from the population through appropriate breeding programmes and rearing practices (see Section 11.2).

Dogs are by nature inquisitive about their environment and therefore pens should not overly restrict the animals' ability to obtain information about the surroundings. If they are unable to see much of their rooms and the entrances to the rooms because of high walls or partitions, they may spend a lot of time on their hind legs or in an apparently repetitive, possibly stereotypical, jumping behaviour in order to observe areas of interest (Hubrecht 1993a, 2002). Obvious ways around this problem include reducing the height of any solid partitions between pens for at least a portion of their length, particularly towards the front of the pen so as to give as wide a field of view as possible, or providing raised platforms accessible by steps (see below). Reducing the height of the front of the pen to human chest height enables the care-giving staff to stroke the dogs as they pass; this facilitates socialization with humans but may encourage jumping. To prevent jumping it is better to design pens such that dogs can be approached at their own level.

Raised platforms: Increased visibility has been found to reduce the level of arousal within units when there is activity in the central corridor. After adding platforms to pens of sufficient height to allow all dogs a clear view of the door to the room, Hubrecht (personal observation) found dogs to be markedly more relaxed when people passed along a corridor outside the dog

room, or entered the room. Four months after the introduction of the platforms, dogs were more approachable and were perceived by their caregivers as being more confident, friendly and playful (Hubrecht 1993a). No problems were encountered in cleaning out the pens, and platforms were found not to pose any risk, even for dogs with gastric fistulas.

Raised platforms, and pen subdivisions, are also important in offering a degree of environmental complexity and choice (e.g. of location and height), allowing separate areas for different activities (e.g. resting and sleeping, playing, observing the environment), and providing additional scope for exercise. Raised platforms in whelping pens allow post-parturient bitches to get up away from their puppies.

Kennels: The provision of a 'kennel' (an enclosed refuge) also allows dogs to exercise choice, providing extra control over the physical environment and over social interactions. Hubrecht *et al.* (1992) found kennels to be favoured by dogs housed in groups of five on a slatted floor system. The dogs spent an average of 35% of their time in their kennels, compared with 3% for dogs housed in pairs on a solid floor system of a more complex pen (Hubrecht 1993a). The kennel was used as a refuge from other dogs, for resting, and during social play. In the later study, care-giving staff felt that the kennel might allow some dogs to cope with a possibly threatening situation, by providing a retreat when an animal care person or stranger entered or stood in front of the pen.

Beds: All dogs should be provided with a warm, dry, draught-free, area for resting and sleeping. Pen furniture such as raised beds or platforms can serve this function and permit dogs to escape the floor where temperature control, draughts and wetting may be a problem. Where beds (sometimes called resting apparatuses) are provided these should allow dogs to lie comfortably and should be made of non-permeable materials, capable of being easily and adequately cleaned and sanitized (Chartered Institute of Environmental Health 1995).

Beds, especially those made of high-density polyethylene (Britz 1990) are useful for minimizing loss of body heat from dogs in post-operative recovery, dogs in ill health, and young pups with poorly developed heat-control mechanisms (see Section 6.2.2).

Bedding: A study has recently been carried out into the preferences displayed by laboratory beagles when provided with beds and bedding materials within the kennel environment (Heath, in preparation, a). First indications confirm that when they are provided, beds are utilized well by dogs, and are preferentially used for resting when they contain bedding. Preliminary results suggest that soft, shredded material is preferred by most individuals. There is also some indication that the dogs utilize the beds as a form of environmental enrichment and gain benefit from their presence through the provision of mental stimulation and opportunities for play. Where substrate is provided as bedding it should be non-toxic, able to be sterilized if necessary, and maintained in a clean and dry state.

Aside from the comfort and enrichment provided, bedding also prevents some veterinary problems. Prolonged lying on unbedded, hard surfaces can lead to pressure-related hyperkeratotic areas on pressure points (e.g. elbows and hocks) in some breeds. Ulceration can then result from boredom and consequent licking at these points. Fleecy bedding such as Vetbed® or soft shredded bedding such as Enviro-dri® should be provided for older dogs requiring support and comfort, for peri-parturient bitches, sick dogs, suckling puppies, and for breeds prone to pressure sores such as greyhounds (Loveridge 1994, Eisele 2001).

Recommendations:

- **Advice should be sought from an appropriately qualified canine behaviour specialist when designing accommodation for dogs.**
- **Separate exercise/activity areas should be provided.**
- **Pens should be spacious because separate exercise/activity areas may be**

contraindicated due to experimental requirements or aggression.

- **Pen additions such as visual barriers should be provided since they enable dogs to have greater control over their social interactions. Pens should allow their occupants the choice of visual contact with other dogs and humans or concealment.**
- **Pens and rooms should be designed so that dogs have good vision out of the pens and can see as much of the room and its entrances as possible.**
- **Dogs should have good quality space that is structured to permit a wide range of normal behaviours. Provide raised platforms, pen subdivisions and kennels (enclosed refuges).**
- **All dogs should be provided with a warm, dry, draught-free area for resting and sleeping.**
- **Facilities should consider providing beds and bedding for all dogs, both for comfort and environmental enrichment.**
- **Beds are recommended for sick dogs, dogs in postoperative recovery and young pups.**
- **Fleecy or soft shredded bedding should be provided for older dogs, peri-parturient bitches, sick dogs, suckling puppies and breeds prone to pressure sores such as greyhounds.**
- **Pens should be large and flexible enough to house dogs socially in harmonious groups and to allow them to be separated where necessary.**

6.1.3 Pen size

The amount of space provided for dogs is of paramount importance because it dictates not only their ability to perform species-typical behaviours, but also the size of social group possible and the capacity to provide environmental enrichment. In some countries it is still legal and common practice to house dogs in very small cages (e.g. United States Department of Agriculture 2001). These are too small to permit a wide range of normal behaviour and to provide adequate socialization and enrichment. For this reason, the Working Group considers

the housing of dogs in such cages to be unacceptable. Moreover, such housing is likely to lead to osteopaenia and may therefore affect the quality of some research.

It is known that small enclosures for dogs are associated with a higher prevalence of circling and other stereotypies than relatively large enclosures (see Section 5). This indicates that living areas that are too small affect the behavioural health of dogs and hence their general well-being. Small enclosures not only discourage exercise, because there is no possibility of travelling to another location, but also restrict the type of locomotion and communication that is possible (Hubrecht 2002). Confinement also intrinsically restricts the dog's ability to adjust social contact with other dogs; and this may lead to fighting (see Section 4.4). Large enclosures, on the other hand, allow for separate sleeping and activity areas so that the dog(s) can defaecate and urinate away from the sleeping area. This makes the environment more complex and interesting and gives the animal(s) the option of exercising some choice. Most importantly, a large enclosure permits housing in socially harmonious groups (see Section 6.1.4).

There are official guidelines which recommend minimum pen sizes for laboratory dogs of various weights in single and group housing (See Table 3, Section 3). Table 4 provides minimum pen dimensions as recommended by an expert group charged with revising the dog housing recommendations in Appendix A to the Council of Europe Convention ETS 123 (Council of Europe 1986). These recommendations provide a compromise between the need to gradually improve current welfare standards and the requirement not to overly disadvantage research in one particular region of the world. Members of the Working Group have observed dogs with behavioural abnormalities even in slightly larger pens. Therefore the Working Group considers the dimensions in Table 4 to be the *minima* that should be provided. These dimensions encourage pair-housing because the minimum sizes for single pens provide enough room for two dogs. The height of the pen allows the dog(s) to stand on hind legs

Table 4 Minimum space allowances for dogs used in scientific procedures

Body weight of dog (kg)	Minimum floor area per dog (m ²)		Minimum height (m)
	Housed singly	Housed in groups*	
<20	4.0	2.0	2.0
>20	8.0	4.0	2.0

*Floor area must not be less than that specified for a singly-housed dog

without touching the roof and the caregiver to stand in the pen without having to stoop.

Criteria for determining space requirements should not just relate to floor area per body weight of animal. The amount of space required will depend on many factors—namely breed-specific behaviour and body conformation, age, reproductive status, group size and compatibility, and the activities being performed in the pen. For example, an active puppy of say 8 weeks old may need more generous space than a mature, relatively inactive dog in order to facilitate the play behaviours that affect his/her development. Pen sizes should also be considered in relation to existing opportunities for out-of-pen activity (see Section 8.2). In the case of breeds other than the laboratory beagle, space allowances should be decided in consultation with a canine behaviour specialist, veterinary staff and the responsible authority.

Dividing pens for a few hours using temporary partitions is a common practice (e.g. to separate pair-housed dogs post-dose in toxicology studies). However, this results in reduced space in which to provide a structured and enriched environment. Therefore, pens should be designed that permit subdivision yet still allow for adequate enrichment (e.g. by the use of removable partitions and toys, or by using partitions as part of the pen furniture when not in use as dividers). Ideally, housing should be designed such that the floor area per dog is never reduced below the minima given in Table 4.

Any further physical or social constraint, such as in a metabolism cage or in a sling, may severely compromise the welfare of the animals. Constraint in a metabolism cage, or any similar type of housing for scientific purposes, should be within the space that is as close as possible to that defined above and no less than that required for the animal

to stretch fully, lie down and turn around (see Section 17.3).

Recommendations:

- **Even the more generous pen sizes given in current official guidelines should be considered as minimal and additional space should be provided.**
- **Pens should be large enough to allow for separate sleeping and activity areas and the inclusion of suitable enrichment such that the occupants can perform a wide range of different behaviours. Quality of space is more important than quantity.**
- **The minimum dimensions of all primary enclosures should be sufficient to house two dogs together in a space that allows them to express most of their normal behavioural repertoire.**
- **Floor area per body weight per animal should not be the only criterion for determining space requirements. Others include: breed-specific behaviour and body conformation, age, reproductive status, group size and compatibility, and the activities being performed in the pen.**
- **Housing of dogs in small cages should not be considered acceptable.**

6.1.4 Pen stocking density

Many authors have stressed the benefits to dogs of canine (and human) social contacts, particularly during puppyhood (e.g. Fox & Stelzner 1966, Fox 1986, Campbell *et al.* 1988, Wolfle 1987, 1990). Therefore, dogs should be housed in socially harmonious pairs or groups and housing should be designed to enable this.

There are no clear data indicating what the optimum number of dogs housed together might be and the most appropriate stocking

density. This will depend on the individual dogs and their degree of socialization. Pair housing seems a reasonable minimum, as dogs in pairs spend a similar proportion of their time interacting with each other as do dogs kept in groups of five to eleven animals (Hubrecht 1993b).

Housing dogs in pairs or groups has two important consequences: not only are the dogs provided with a more complex social environment, but also, generally a larger pen size. Group housing obviously enables dogs to behave socially (e.g. through grooming or social play), and has the side effect of making the olfactory environment more interesting. Hubrecht *et al.* (1992) found that substantially more time was spent sniffing the ground in group housing than with single housing, presumably for olfactory traces from other dogs. This may help to alleviate boredom by encouraging exploration and investigation. Social companions might also buffer the effects of a stressful situation.

Hubrecht *et al.* (1992) found that group housing is associated with lower cumulative totals of repetitive or stereotyped (locomotor) behaviour patterns, such as circling and pacing. In pens with relatively high stocking densities this may be because the development of such behaviour patterns is prevented through physical interference (i.e. individual attempts to circle or pace are interrupted by some form of direct interaction with another dog). Hubrecht further suggested that while this outcome of high stocking density may be thought valuable, the denial of space to run during exercise may have welfare implications for an active, cursorial species, known to range over 0.26 km² under urban feral conditions (Beck 1975) and 28.5 km² in a wildlife reserve (Nesbitt 1975).

Although pair or group housing is recommended, it is important to be aware that this increases the potential for aggression, especially in small pens. However, with good housing, husbandry and staff, aggression can be properly managed and controlled (see Section 4.4).

Recommendation:

- **Dogs should be housed in socially harmonious pairs or groups, except**

where there is compelling justification for single housing on welfare, veterinary or scientific grounds.

6.1.5 Single housing

Experimental practices may require temporary (perhaps a few hours daily) or permanent single-housing of dogs, where they may see, hear, smell and possibly touch conspecifics but are unable to interact with them. Common reasons cited include telemetry and metabolism studies, some surgical models, and monitoring of food consumption, as well as ill health, pregnancy and the prevention of the risk of injury resulting from aggression. No requirements for social isolation of dogs (i.e. an inability to communicate in any modality with other dogs) were identified by the Working Group.

Most breeds of dogs used in scientific procedures are highly gregarious animals such that single housing for even short periods can be a significant stress factor (Beaver 1981, Hubrecht 1993b, MacArthur Clark 1999). The stress caused by single housing can lead to the development of abnormal behaviours (see Section 5). Single housing on experimental grounds should therefore be determined in consultation with the animal care staff and competent persons should be charged with advisory duties in relation to animal welfare. The justification for single housing should be included in any cost-benefit analysis of a proposed programme of research by the local Ethical Review Process (ERP) or Institutional Animal Care and Use Committee (IACUC). These should weigh carefully the possibility of, say, accidental injury when housed in pairs or groups against a possible lifetime of single housing. Study design should be examined very carefully for possible ways of avoiding single housing.

Where single housing is unavoidable, measures must be taken to ameliorate its negative effects. The Working Group identified a number of possible methods for doing this, or for avoiding the requirement for single housing in the first place. For example, telemetered dogs are often singly-housed if telemetry devices that transmit at the same frequency must be used simultaneously

(although it should be noted that external ECG telemetry systems are now commercially available that allow simultaneous multi-frequency acquisition over a 100 m transmission range using up to eight independent channels). Ways of avoiding single housing for such dogs include pair housing with a naïve (non-instrumented) companion (although an important ethical question is the source and eventual fate of these companion animals), or the use of devices that can be switched on and off *in situ* and used one at a time in group-housed animals. Data loggers (either implanted or worn externally) allow several animals to be monitored simultaneously. It is important to ensure that animals are thoroughly habituated to partly- or wholly-external devices in order to prevent them from interfering with and damaging the devices. Careful selection of surgical models may have some bearing on the potential for providing social housing for dogs. For example, a carotid loop may be replaced by a raised carotid, or by the use of subcutaneous access ports attached to implanted catheters.

Toxicology studies have been carried out in the UK for many years now with pair-housed or group-housed dogs, including good laboratory practice (GLP) studies (Hubrecht 1995c) (also see Mack *et al.* 2003), although it remains common practice to separate dogs for feeding and post-dose observations in such cases (see Section 7.3). Single housing in routine toxicology studies should therefore only be carried out when scientifically justified. Each study should be considered separately to examine the necessity for this separation and to minimize the period in each case when it is deemed necessary. For example, it may be appropriate to conduct chronic studies without temporary separation where neither notable post-dosing effects nor effects on food consumption have been recorded in dose ranging studies.

Pregnant bitches need not be housed singly until such time as the bitch herself decides she wishes to be alone to whelp (see Section 11.3). Adaptable pop-holes in the whelping enclosure can be used to permit (and control) interaction between bitches (see Section 11.3). Wherever possible, stud

dogs should be housed in socially harmonious pairs or groups or with bitches. In the case of single housing as a consequence of aggression, prevention is better than treatment (see Section 4.4).

The duration of single housing should always be kept to an absolute minimum and singly-housed animals should be closely supervised. Additional resources should be targeted to the welfare and care of such animals to compensate for the absence of social companions. All dogs need a rich and varied environment but singly-housed dogs do so even more. They should be housed in large, complex pens with additional physical enrichment and, if possible, visual, auditory, olfactory and tactile contact with other dogs. Movement of an individual(s) away from compatible animals can be disruptive. Therefore individuals that are removed from their social group should ideally remain in the same room, as close as possible to the same social group, and should be returned to the same group (Canadian Council on Animal Care 1993). Mesh divides between pens allow for increased visual and olfactory contact, and the provision of cantilever-type toys (which span two pens) allow the inhabitants of adjacent pens to engage in play without being in physical contact.

Dogs which are permanently singly-housed should be given additional human socialization time and, where possible, tactile contact with other dogs on a daily basis. Unless contraindicated on veterinary or welfare grounds, they should also be allowed, if possible, to exercise in a separate area with other dogs, and with staff supervision and human interaction daily. Of all laboratory animals, dogs seek and therefore need human company the most. Socialization is particularly important for dogs destined to be singly-housed because it creates an attachment and trust of people, which assists in the development of coping strategies that serve to bridge periods of adaptation to new environments and procedures, thereby reducing stress (see Section 13).

Recommendations:

- **Justification for single housing should be considered on a case-by-case basis. The**

ethics committee or similar should establish policy, but individual cases must be discussed by the relevant staff. If single housing is necessary for scientific reasons, it should be considered as a harm in any cost–benefit analysis.

- **Alternative procedures and study designs to those requiring single housing should be explored.**
- **Telemetered animals should be paired with naïve (non-instrumented companions) or staff should use devices that can be switched on or off *in situ* or use data loggers.**
- **Pregnant bitches need not be housed singly until such time as the bitch herself decides she wishes to be alone to whelp. Adaptable pop-holes in the whelping enclosure should be used to permit interaction between bitches.**
- **The duration of single housing should always be kept to an absolute minimum and singly-housed animals should be closely supervised.**
- **Additional resources should be targeted to the welfare and care of singly-housed animals. They should be housed in large, complex pens with additional physical enrichment and visual, auditory, olfactory and tactile contact with other dogs.**
- **Additional human socialization time must be provided for all permanently singly-housed dogs on a daily basis. Unless contraindicated on veterinary or welfare grounds, such dogs should be allowed to exercise in a separate area with, if possible, other dogs, and with staff supervision and human interaction daily.**
- **Social isolation should always be avoided.**

6.1.6 Access to an outdoor area

Offering dogs access to outdoors, in both breeding and research establishments, can be beneficial in terms of providing an enriched environment that is more complex than their home pen (see Section 8.2). Dogs are outdoor specialists, evolved to survive in complex and varied outdoor environments. They are active and inquisitive animals that actively seek information about their

surroundings, and confinement is unnatural for them. Therefore, it is unfortunate that many dogs are housed entirely indoors because it is believed that housing outdoors will attract attention and possibly cause a nuisance. If housing entirely indoors is felt necessary, some available daylight is desirable, either through windows or skylights, for the benefit of the dogs and their carers (MacArthur Clark 1999).

Dogs should never be forced to spend their entire lives outside and should always have access to an internal enclosure that meets all their needs. It is crucial that dogs in outdoor runs have access to a sheltered place to find protection against unfavourable weather conditions.

Recommendation:

- **Outdoor runs should be provided wherever possible as these provide good opportunity for environmental enrichment. They should include access to a sheltered place.**

6.2 Physical environment

An important part of maintaining the health and welfare of laboratory animals, and of obtaining reliable scientific data, is to control the physical environment. This will include optimum ranges for environmental factors such as light, temperature and sound. Details of approved laboratory conditions for dogs are given in various publications (e.g. Home Office 1989, 1995, Canadian Council on Animal Care 1993, National Research Council 1994, 1996). Since noise is a particular problem in dog units, extensive information on controlling noise is given in this section.

6.2.1 Lighting

In general, lighting should be diffused throughout any animal holding area and should provide sufficient illumination for the well-being of the animals and to allow good husbandry practices and safe working conditions for personnel (National Research Council 1996). Holding of dogs under a natural 24 h light–dark cycle is acceptable.

Where the light part of the photoperiod is provided by artificial lighting, this should be within a range of 10 to 12 h daily. If natural light is totally excluded, low-level night lighting should be provided to allow dogs better night vision and to take account of their startle reflex.

6.2.2 Temperature

Dogs are extremely adaptable in their temperature requirements, provided they have appropriate amounts of food and water and sufficient time to acclimatize to their environment. Nevertheless, extremes of temperature and dramatic changes in temperature are best avoided since at higher and lower temperatures dogs must use more energy for cooling and warming, respectively. A temperature range of 15°C to 21°C should be maintained when precise control is required for dogs undergoing scientific procedures. In all other circumstances, dogs may be maintained within a wider temperature range provided that welfare is not compromised. Ambient temperature must not fall below 10°C for dogs not acclimatized to lower temperatures, for breeds that cannot tolerate lower temperatures, and for young, old, sick and infirm dogs.

Puppies have limited thermoregulatory control, particularly in the first 10 days or so of life. Experimental evaluation suggests they develop homeothermic capability by 3 weeks of age (Jones & Joshua 1988). As a consequence, additional heating should be provided at this time. Although they are in common use, infrared heat lamps suspended over the whelping box are not the best way of heating the puppies' environment. It is better either to provide local warmth beneath the puppies or to ensure that the total environment for both bitch and her puppies is within a comfortably warm temperature range of approximately 26°C to 30°C. The feel, behaviour and demeanour of the puppies is a good indicator of the suitability of their environment. Healthy newborn pups are normally firm and plump, quiet, sleepy, and warm to touch. They make contented, low murmuring noises interspersed with only an occasional sharp

cry. Abnormal pups are limp to pick up, with damp, wrinkled, cold skin, and may either utter a persistent, plaintive, cry or remain silent and chilled.

6.2.3 Relative humidity and ventilation

Guidelines on acceptable limits of relative humidity for dogs vary. Maintaining relative humidity at 30% to 70% throughout the year should provide a comfortable zone that does not adversely affect a dog's welfare (National Research Council 1985). High humidity can impair efficient body cooling, and prolonged exposure to high and low humidity may contribute to respiratory distress and infections (National Research Council 1994, MacArthur Clark 1999).

Indoor facilities must be sufficiently ventilated to provide for the dogs' comfort and well-being and to minimize odours, ammonia concentrations, and moisture condensation. Ten to 15 volumetric changes per hour with outside air is sufficient.

6.2.4 Noise

Sound levels within the human hearing range in dog kennelling regularly reach values of between 85 and 122 decibels throughout the working day and often well into the evening (Ottewill 1968, Kay 1972, Peterson 1980, Milligan *et al.* 1993, cited in Sales *et al.* 1997). Such levels can cause annoyance, stress and damage to human hearing. (Noise from dog facilities can also constitute a nuisance to people living near them: van der Heiden 1992.) At high frequencies a dog's auditory acuity is substantially greater than that of a person (see Section 4.2.2) so it is highly likely that noise has similar effects on dogs and their welfare (Sales *et al.* 1997). The effects of sound at frequencies outside the human hearing range might also be a welfare problem; research is needed to investigate this.

There is some empirical evidence that sound can be a stressor for dogs. For example, increases in blood glucose levels were recorded from a litter of dogs (strain not specified) when exposed to a 5–10 min sound at 80 dB (scale not specified). After seven

trials the dogs were showing anticipatory rises in blood sugar level, but had habituated by the 20th trial (Treptow 1966, cited in Gamble 1982). Even if it could be shown that dogs do not find these high noise levels aversive, any physiological damage would certainly reduce their welfare, and in scientific studies this may be an uncontrolled variable. It is therefore essential for dog facilities to have an effective noise control programme.

There is currently a lack of adequate guidelines for noise levels in dog kennels that take into account the frequency sensitivity curve of dog hearing. Nor is there any impetus either for regulatory authorities to make such recommendations or for commercial establishments and shelters to tackle the acknowledged high noise levels (Sales *et al.* 1997). Research and guidelines are needed. An effective noise control programme will require a holistic, coordinated approach.

Ideally, sound control should be a priority at the design stage of dog facilities so that consideration is given to reducing the egress of sound from the building, the entry of sound into the building and the levels of sound within it. Facilities with well-designed dog housing and well-socialized dogs are dramatically quiet in comparison with facilities with poorly socialized and housed dogs. Sales *et al.* (1996) and Hubrecht *et al.* (1997) give a number of methods for controlling sound in dog facilities. These are discussed below.

Facility design and construction: The siting of the building (e.g. away from external sources of noise) should be considered in order to reduce excess noise entering the building from the environment. If noise egress is likely to be a problem, any sound baffling designed to reduce sound propagation from the site (e.g. earth mounds around the site) should not reflect sound back into the facility and so exacerbate the problem for the dogs. The layout of the building can also have an effect on sound levels within it. Sound travels less efficiently around corners and so facility designs should avoid long straight corridors between different sections, particularly between a noisy area and dog

pens or between two sets of pens. The nature of intervening walls should also be considered; double-skinned, cavity walls and acoustic doors reduce the transmission of sound between areas.

Hard, smooth surfaces tend to reflect sound, causing it to reverberate around the room and so increase overall sound levels. In the design of a new dog facility, materials that reflect sound should be avoided and sound-absorbent materials should be incorporated (e.g. concrete or wood). In existing facilities, sound absorbent materials (e.g. plastic tiles or resin coating) can be added to the walls to absorb some of the noise, and prevent reflection and reverberation. These must be capable of being cleaned and should either be out of reach of the dogs or resistant to destruction. Sound-absorbing baffles suspended from the ceiling may also be helpful. The provision of extra pen furniture may also absorb sound and, by addressing the dogs' behavioural needs in the facility design, decrease the level of vocalization.

With a large number of dogs in an open room, there is more opportunity for the social spread of barking and more sources of barking so that overall levels are increased. There is also a greater likelihood of one or more dogs barking at any one time. Consideration should be given to limiting the total numbers of animals in any one room which may help control the spread of barking; around 20 may be a reasonable number. It is also possible that partition height could be a factor in stimulating or inhibiting barking (see Section 6.1.2).

Husbandry practices: As barking often occurs during activities involving human contact (e.g. feeding and cleaning), and while in outside pens, there is the potential to reduce noise in kennels by changing husbandry practices within the facility. However, there is possible conflict between the welfare benefits of such practices and any changes in these in an attempt to reduce noise. It is, therefore, important to consider all aspects of dog welfare before making changes to husbandry practices, and to carefully weigh the potential harms against the benefits.

A suitable socialization, habituation and training programme and structured activity periods at designated times can help dogs identify those contexts in which calm, quiet behaviour is required and this can lead to a reduction in noise levels (see Section 13). Also, with adequate staffing levels, dogs become more used to human activity and are less inclined to bark for attention or when disturbed or startled by human activity. It is also possible to reward silent interaction with people from an early age and thereby decrease the tendency to use vocalization to gain human attention.

Studies at some sites have shown that personnel entering or leaving a room with a dog (i.e. moving dogs along corridors in front of pens) can be a major stimulus for barking. In new facilities it may be possible to design a service corridor that does not allow the other dogs to observe these events. Dogs unaccustomed to frequent human disturbance (e.g. those housed in dead-ends as opposed to off busy corridors) would benefit from habituation to human activity. In facilities where the dogs can see members of the public off-site or outside working hours, some form of solid fencing that would prevent the dogs seeing visitors to the site in the evening may reduce sound levels after the staff have gone home. Turning lights on in the morning can be a predictor for dogs of human interaction and attention, which can lead to increased arousal, barking and sometimes aggression. Turning the lights on closer to the time that staff actually interact with the dogs may reduce sound levels (and aggression) early in the day.

Equipment and husbandry procedures, such as cleaning, as well as the ingress of external noise all add to the acoustic environment of dog units. Noise-producing equipment should be sited as far away from the animals as possible.

There is potential for dog breeders to selectively breed for dog strains that are less likely to bark when aroused. However, it must be remembered that vocalization is a natural form of canine communication and selective breeding to reduce such a behaviour may be accompanied by other changes in communication and signalling which are not desirable.

Debarking: At one time, there was an attempt to control the noise levels of dog kennels by debarking dogs. Since there are many other ways in which to reduce noise in kennels, there should not be a need for debarking. The view of the Working Group is that debarking is unethical and unacceptable—we can see no circumstances in which it is justified.

Music: Music has long been used to reduce stress in many laboratory animal facilities, perhaps because of its initial stress-reducing effect on the attendant. However, few definitive data exist to recommend its use for dogs (but see Wells *et al.* 2002). If used, the volume should be placed at conversational level. Audio systems are beneficial in that they can be used to relay a range of noises to puppies within their socialization period for the purposes of auditory complexity and habituation (see Section 13). The wider the range of sounds experienced as a puppy, the more accepting a dog is of new sounds later in life.

Recommendations:

- **Expert advice should be taken when designing and modifying dog accommodation in order to minimize sound production, transmission, reflection and reverberation.**
- **Extra pen furniture should be provided as it may absorb sound and, by addressing the dogs' behavioural needs, decrease the level of vocalization.**
- **Noise-producing equipment should be sited as far away from the animals as possible.**
- **A suitable socialization, habituation and training programme should be implemented, and structured activity periods provided, in order to reduce noise levels.**
- **Adequate staffing levels should be provided such that dogs become used to human activity and are less inclined to bark for attention.**
- **Lights should be turned on in the morning closer to the time that staff actually interact with the dogs in order to reduce sound levels (and aggression) early in the day.**
- **Debarking should never be carried out.**

7 Food and feeding

Food is a highly significant resource for dogs and feeding should not be seen simply as an essential husbandry procedure. By nature dogs are hunters, but they are also opportunistic feeders (Kleiman 1967). They spend a long time foraging and feeding in the wild, and consume a varied diet. As 'diet generalists' they are more likely to crave novelty in their environment (Morris 1970). Therefore, consideration should be given to providing variety in the composition and method of presentation of their food.

7.1 Diet

Palatable, uncontaminated and nutritionally adequate food should be fed daily. A subcommittee of the National Research Council (NRC) of the USA on Animal Nutrition has prepared a comprehensive treatment of the nutrient requirements of dogs (National Research Council 1985). However, note that many NRC recommendations are minimal nutrient requirements to prevent clinical signs of deficiency, and that some minima are derived from studies in which semi-purified diets are used (hence they do not take into account the reduced availability of nutrients from complex food matrices such as dry diets).

Dogs show clear taste preferences for meat rather than cereal diets, canned to fresh meat, ground meat to cubed, cooked to raw meat and moist to dry food preparations (Haupt & Smith 1981). Generally novelty is associated with increased palatability. Providing a variety of food types can prevent 'the monotony effect' (i.e. reduced food intake) that occurs with prolonged feeding of any one food. The dog's experience is also a factor, as it has been suggested that limited exposure to variety early in life can restrict preferences for food as an adult (Thorne 1995).

When new dogs arrive at the user establishment, try to ensure that they are fed the same diet as at the breeding establishment, particularly for young animals shortly after weaning. Alternatively, request that the breeding establishment introduce the diet that the user wishes to feed. If a change in diet is required, ease the transition with a

gradual, structured change over a period of 4 to 7 days. This will help to prevent gastrointestinal disturbance, which may result in diarrhoea and/or vomiting.

Where possible, try to provide variation to the standard laboratory diet or use treats and food rewards to introduce different odours, flavours, textures, shapes and sizes into the diet. These can increase physical and mental stimulation and provide additional complexity in the environment to compensate for the time budget that is no longer spent on food sourcing, capture, preparation and consumption. Where diets cannot be varied or supplemented, varying the complexity of the feeding experience by presenting food in different ways can be enriching (see Section 7.3).

When feeding palatable foods, rewards and treats, monitor dogs for signs of weight gain (see Section 7.2) and resource-related aggression (see Section 4.4). A low-value food resource may be a good idea in a small, restricted environment, in order to avoid problems related to food guarding (the dogs being allowed a greater amount of food if the diet is low in energy). However, note that food guarding can occur even with a low-value food resource if the food is the principal interest of the dog.

Diet aversion will occur to foods that produce negative physiological consequences. Therefore, it is important to remember that diet aversion can occur if a diet becomes associated with a drug dose with unpleasant side effects. This can have important consequences for the dog(s) and study outcome. A pilot study to test the acceptability of the substances, measuring food consumption and body weight, may be necessary. Using a low drug dose may help avoid diet aversion.

Water: It is best to provide dogs with unrestricted, clean drinking water throughout their lives. Dogs will rapidly learn to drink from automatic drinking valves which have the advantage of providing water at all times but require scheduled observations to ensure proper function. 'Non-spillable' water bowls can also be used and can be advantageous in helping to tempt sick dogs to drink.

However, they have the disadvantages of being easily fouled by the dogs and of being labour intensive as they require regular washing and refilling. In a temperate environment, dogs will require around 70–80 ml of water per kg of body weight per day.

Recommendations:

- Try to ensure that new dogs arriving at a user establishment are fed the same diet as at the breeding establishment. If a change in diet is required, ease the transition with a gradual, structured change over a period of 4 to 7 days.
- If possible, provide variations to the standard laboratory diet to incorporate foods with different odours, flavours, textures, shapes and sizes, but monitor animals for adverse effects.

7.2 Feeding requirements

Feeding requirements will differ according to breed, age, sex, weight, health status, environment and according to the demands of pregnancy and lactation. Animals should not be allowed to become too thin or too fat. Judge by eye and by running the palm of your hand along the dog's flank—for a healthy animal you should be able to feel the ribs but not see their outline through the coat of short-haired breeds.

Estimates of daily calorific requirements (and hence the amount of food needed to meet these requirements) can be obtained from several sources (e.g. Willis 1996a,b, Willis & Morris 1996), including the manufacturer of the specific food being used. Estimates of feeding requirements might need substantial modification because of the variations in metabolic rates of individual dogs and the calorific value of their food. On average, adult beagles (12 kg) require around 400 g of standard laboratory diet per day. However, this will vary from colony to colony; in colonies where larger beagles are being produced (i.e. where the average adult male reaches 15 kg or more) some individuals may require 500 g or more per day. Where smaller beagles are being produced, 300 g per day may suffice.

Brood bitches: During the later stages of pregnancy and during lactation the breeding bitch should be fed a diet formulated to meet the nutritional demands placed upon her during this period. In the last third of pregnancy, a bitch's demand for food may gradually increase to around 50% more than her normal daily nutritional requirement. Bitches underfed during this period tend to have a higher incidence of stillbirths than bitches fed appropriate amounts, and their pups often weigh less at birth (Holme 1982). Bitches must not, however, be permitted to become obese during gestation and lactation because this condition can increase the risk of dystocia and post-parturient metabolic disorders (Johnston 1986).

Lactation represents the greatest nutritional challenge that bitches experience during their lifetime. For the first 3 weeks after parturition, nutritional requirements change rapidly, and the bitch may require two to three times her normal daily nutritional requirement, especially if raising a large litter. During this period it is probably advisable to feed *ad libitum* to ensure that her nutritional needs are met, but keep in mind the risk of her gaining excess weight.

Growing pups: Pups feed exclusively on their dam's milk up to around 3 weeks old. At this age they should be offered small amounts of moistened diet. At between 6–8 weeks of age pups can be weaned away from the dam completely (see Section 11.4). Pups that, for whatever reason, cannot be nursed by their dam or a foster dam, can be fed with commercially available complete milk replacement. This should be fed little and often (e.g. every 2 h) by bottle, but feed until the pups are satiated up until weaning is complete. The bottles must be kept thoroughly clean.

After weaning, pups should be fed a diet that is designed to support normal growth. See Andersen (1970) for expected weight gain for beagle pups. Particular attention should be paid to ensuring that pups receive adequate levels of calcium and phosphorus in the correct ratio if bone defects and soft tissue deposition of calcium phosphate are to be avoided.

Older dogs: Older dogs may decrease their food intake and also may take longer to eat their food; allowances should be made for this within any feeding regime. Two things to particularly monitor with older dogs are their body weight and the condition of their teeth. Regular weighing should ensure that their food intake is adequate. Obesity can also be a problem at this stage, so overfeeding should be avoided. In old age, dogs can also suffer from problems with their gums and teeth, especially if they have been fed soft or wet food over many years. Significant gingivitis can develop as early as 2 to 3 years of age, and in some dogs this will progress to periodontal disease. Periodontal disease can result in oral pain and may contribute to systemic disease, particularly of the heart and kidneys. Feeding dry food and providing hard objects for chewing (e.g. synthetic bones) (see Section 8.1) can help in the long-term management of dental problems.

Sick dogs: Loss of appetite can occur when dogs are sick, and sick animals may refuse to eat the normal diet provided (see Section 9). In cases such as this, dogs can be tempted with a wet mash with some cooked or tinned meat or rice mixed in. When adding novel foods to a diet, be aware that this may cause digestive upsets; veterinary advice should be sought.

Recommendations:

- **Animals should be monitored for signs of weight gain with any diet, and food intake reduced if weight gain occurs.**
- **Veterinary advice should be sought immediately if dogs refuse to eat. A dramatic reduction in food consumption should be carefully monitored and veterinary advice should be sought as necessary. Monitor the condition of the animals as well as their food intake.**

7.3 Feeding methods

There are a number of different methods of feeding dogs in the laboratory, each of which has advantages and disadvantages:

Ad libitum: This system means that dogs have diet available to them at all times.

- *Advantages:* Simple to manage; labour saving; ensures that the dogs have enough to eat. It may also be beneficial in terms of reducing competition over food and consequently the risk of fighting.
- *Disadvantages:* Can be wasteful of diet; can lead to 'boredom feeding' resulting in dogs becoming overweight. Also, research has been done which appears to show that the continual ingestion of small amounts of food stimulates oral bacterial growth and might promote gingivitis and periodontal disease (Saidla, cited in National Research Council 1994). To prevent teeth problems, provide hard items for the dogs to chew (e.g. commercially available dental devices). The presence of food at all times can limit the potential for the use of food for rewarding appropriate behaviour, since it is no longer viewed as a valuable resource. It is therefore important to use food treats from an early age so that puppies learn the significance of reward (see Section 13).

Restricted feeding: This can mean restriction in either the volume of diet offered, the length of time that the diet is offered to the dogs, or both. Often dogs are housed separately for the period that the food is made available to them, then allowed to run with their pen-mates again after feeding. However, it is possible, and perhaps preferable, to avoid separating the dogs during the feeding period. If, for example, three dogs are housed in one pen together, three food bowls may be placed in different 'feeding zones' within the pen. Dogs quickly adapt to this routine and outright aggression is rare, especially once the hierarchy within the pen is established. If dogs must be separated for feeding, the interval of separation should be as short as possible to allow food to be consumed; 2 to 4 h is normally plenty of time for all animals to consume their food. Regrouping should be done on a rolling basis within a room; each group of dogs

being regrouped as soon as they are finished eating. Care should be taken to ensure that separation for feeding does not restrict the ability to provide enrichment.

- *Advantages:* No wastage of diet; can control the amount of diet consumed and therefore more easily avoid overweight dogs (see Kendall & Burger 1980). This method of feeding may be more mentally stimulating for the dogs, with the feeding period becoming a period of excitement for them as it would be in nature.
- *Disadvantages:* Can be more labour intensive; there may be greater risk of aggressive posturing and possibly fighting, especially if the dogs are not managed properly from an early age; individual food intake cannot be monitored unless the dogs are separated for the feeding period; the food restriction may increase the perceived value of the food and thereby encourage competitive interactions.

The selection of an appropriate feeding method might help to alleviate boredom in captivity and fill the dogs' day. The feeding method should be adequate for all the dogs to eat their fill. Dried diet has the advantage that it can be fed from a hopper, where it will remain fresh for several days. Hubrecht *et al.* (1992) found that dogs fed dry pellets from a hopper spent over 7% of their time feeding compared with less than 1% when fed softer food from bowls. The dogs took small quantities from the hopper and carried the food away for chewing. There was some limited feeding interference between the dogs, so that those that were presumably subordinate had to wait until the others had finished.

There are other situations in a laboratory context where food and treats can be used to provide environmental enrichment. For example, commercially available toys and activity feeders in which food can be concealed (e.g. Kong® toys) stimulate mental and physical activity and help satisfy the dog's sniffing and searching instincts. These are likely to be particularly beneficial for singly-housed dogs. It is important to consider the effect of such items on competition

between pen-mates and to provide a sufficient number of these items in order to avoid physical confrontation.

Recommendations:

- **If dogs must be separated for feeding, the interval of separation should be as short as possible to allow food to be consumed.**
- **Appropriate feeding methods should be selected to help alleviate boredom and fill the dogs' day. Toys and activity feeders in which food can be concealed are recommended as enrichment.**
- **Appropriate hard items should be provided for the dogs to chew to prevent gingivitis and periodontal disease.**

8 Environmental enrichment

Enriching the environment of laboratory dogs by increasing the physical and temporal complexity of their pens or the opportunity for social contact offers a significant chance to improve their overall well-being.

Furthermore, dogs exposed to a complex environment show physiological changes such as more rapid brain maturation as well as changes in responsiveness (Fox & Stelzner 1966). Enrichment can also be a means of producing a desired change in behaviour (e.g. a reduction in abnormal behaviour or destructive behaviour).

In order to properly improve dog well-being through environmental enrichment, the animals' physical, behavioural and social needs must be understood. It is therefore beneficial to employ an appropriately qualified canine behaviour specialist to devise and develop an enrichment programme. Such a person can also advise on a wide range of other aspects of husbandry and care (see Appendix 4). The aim is to provide dogs with an environment that meets their needs by allowing them to exhibit normal, and preferably natural behaviours, and to use suitable coping strategies in the inevitably restricted laboratory environment. Enrichment for dogs falls into two main areas: the pen environment and out-of-pen activities.

8.1 The pen environment

Size of pens and space is important, but large pens lacking in interest are not necessarily sufficient to provide good welfare. Therefore, items should be added to a dog's pen to increase variety and complexity and to offer outlets for normal canine behaviours. For example, low, wooden boxes open on one side have proven popular with young dogs as nest boxes, something to climb on and to chew. Enrichment items should not be seen simply as a substitute for social contacts, or to compensate for simple and boring accommodation.

Items for chewing: Chewing is a natural canine behaviour and is a rewarding experience for dogs. Dogs explore with their mouths and young dogs in particular when encountering something novel or unusual will both smell and taste it. Giving them the opportunity to chew and tear things up can therefore be beneficial, and putting something as simple as an empty cardboard box or paper diet bag into their pen can provide a great deal of entertainment for them. Alternatively, simple activity boxes can be made by stuffing a cardboard box with a combination of shredded paper bedding and acceptable food treats; these can provide hours of entertainment and mental, as well as physical, activity. Shredded bedding outside of the activity boxes can also provide a source of complexity. Care should be taken to remove any metal clips/staples from boxes before they are put into the pens.

Untreated soft-wood, rawhide or nylon chews can be a great source of interest and enrichment, as well as assisting with dental hygiene. Choose items for chewing carefully to avoid the (rare) risk of mouth ulceration or blocking of the gut. It is recommended that chewable items are regularly examined for excess wear and replaced as appropriate. Dogs are very motivated by food and chews with an appetizing aroma or taste (e.g. certain synthetic bones are particularly favoured). A certificate of analysis can be obtained from the companies manufacturing such items.

Toys: The addition of toys to a pen also increases opportunities for the expression of

species-typical postures and activities. Use of a toy in social play can allow dogs to play more vigorously—toys can be pulled, chewed, stalked, shaken, thrown, carried and guarded. There are a wide variety of toys commercially available that are suitable for laboratory dogs (e.g. balls, ropes, pulls, tug toys, rings, or chains). Preference tests should be used to determine which toys are most acceptable and interesting to the dogs (there is considerable inter-individual variation). Presentation methods may be important, as observation suggests that singly-housed dogs seem to become bored with toys left on the floor of their pen. When toys are being ignored, staff should rotate the toys available in order to maintain interest and activity.

Plastic tunnels: These can be fixed or free-standing. If free-standing, then the dogs can reposition them themselves, thus giving the dogs an element of choice (i.e. of height) as well as adding complexity to their environment.

In some establishments, chews and toys are denied to group-housed dogs on grounds that they make cleaning of the pens more difficult, but this is more than offset by the habituation resulting from the increased time spent with the dogs. There is also a perception that chews and toys can lead to possessive resource-related aggression. Appropriate presentation of enrichment items can overcome both these objections. For example, they can be suspended from the ceiling by sprung chains to avoid aggression and monopolization by individual dogs (Hubrecht 1993a). This method has the advantage of keeping the items off the floor, out of drains and in the pen. The items should be suspended just off the floor of the pen so that the dog can temporarily hold, chew and play with them while lying down in a species-specific fashion. Suspended chews and toys also maintain interest due to their unpredictable movement.

The benefits of enrichment of laboratory beagles' enclosures have been demonstrated by Hubrecht (1993a,b, 1995b). Suspended toys or chews (e.g. rawhide, dowel stick, Gumabone[®] toy, plastic tube) were used by

puppies 64% of their time, and by sub-adult dogs (7–13 months old) 24% of their time (Hubrecht 1995b). Such items not only reduced the dogs' inactive time, but also decreased destructive behaviour aimed at cage fixtures and furnishings. The dogs used the enrichment items for various types of joint play, including tug-of-war play, chase play and ownership play. No habituation effect was noted over a 2-month period. However, novelty did seem to be important since a particularly large amount of play was recorded on one occasion when the dowel stick was pulled loose from its chain. The dog's interest in the Gumabone® toy seemed to be maintained by their ability to bite small pieces from it to chew elsewhere in the pen (Hubrecht 1993a).

Any enrichment device should provide a measurable benefit to the animals. The device which is most compatible with the aims of the research protocol should be chosen. Suitable enrichment items and the numbers supplied should be decided by experienced animal care staff with input from an appropriately qualified canine behaviour specialist. Reactions of individuals to any type of environmental enrichment should be monitored to determine whether the desired outcome is achieved.

Recommendations:

- **Environmental enrichment is crucial in attaining high standards of welfare, and establishments should employ an appropriately qualified canine behaviour specialist to devise and develop an enrichment programme.**
- **Enrichment items (e.g. chews, toys, plastic tunnels) should be provided in dog pens but these should not be seen as a substitute for social contacts, or to compensate for simple and boring accommodation.**
- **Chewing is an important behaviour and items should be provided to meet this need. Chews that taste or smell of food (e.g. certain synthetic bones) will be more enriching.**
- **Enrichment items should be presented in such a way as to maintain interest and activity (e.g. suspended off the floor and/or used on rotation).**

8.2 Out-of-pen activity

Exercise provides physical and mental stimulation (by allowing dogs to explore their surroundings). Exercise also provides additional opportunities to socialize with other dogs and with people. Exercise periods should therefore be provided, ideally on a daily basis, especially for dogs housed in pens that do not permit them to exercise adequately. Note that exercise for dogs is mandated in a 1985 amendment to the USA Animal Welfare Act 1966 which states that 'research facilities shall establish, in consultation with the attending veterinarian, written procedures and systems for exercise of dogs' (United States Department of Agriculture 2001).

The aim of the exercise period is to stimulate the dogs, both physically and mentally, in a separate area from their normal pens. Exercising should be carried out in a designated, specifically designed exercise/activity area, rather than just a corridor outside the dog's pens, because such an area provides a *novel* environment with wider scope for enrichment, thereby increasing environmental stimulation and choice dramatically. In some situations, it may be possible to take dogs for regular walks; most dogs appear to enjoy this activity immensely (consider the excitement most companion dogs show when they are about to go for a walk) and lead-walking can help with rehoming and improve staff morale.

Dogs are contextual learners and the provision of a distinct context for periods of excitement, play and social interaction is beneficial in terms of encouraging calm, quiet and controlled behaviour during procedures and within pen areas (see Section 13). Separate exercise/activity areas also help to decrease the practice of running dogs in front of adjacent pens, for example during cleaning, which can lead to problems of arousal and aggression (see Section 4.4). New facilities should incorporate a purpose-built exercise/activity area and existing facilities should adapt existing rooms, buildings and/or open spaces, or else add new ones. Ideally, the exercise/activity area should never be empty of dogs, and should be used in preference to leaving dogs housed in their pens.

It is reasonable to assume that space *per se* does not stimulate a dog to run around and 'exercise'. Rather the presence of structures or the presence of other dogs or care personnel will entice the dog to explore the available space and make active use of it (see Section 6.1.2). The exercise/activity area should therefore be well equipped with enrichment equipment, such as steps, ramps and tunnels (Fig 11: Harlan UK, and Fig 12). Toys (see Section 8.1) should be provided and varied each day to provide novelty and maintain interest.

An animal care person should be present with the dogs at all times during the exercise sessions for three main reasons:



Fig 11 An outdoor exercise/activity area with enrichment equipment (wooden tunnels, platforms and ramps, plastic toys, and chews)



Fig 12 An indoor exercise/activity area with suspended toys, a plastic tunnel and a sandpit filled with soft shredded bedding (Enviro-dri®) and toys

- To provide opportunity for human socialization in a positive context, and to improve caregiver–dog communication and permit wider and deeper socialization and training of the animal (see Section 13).
- To observe the behaviour of the dogs and assess the benefit of the exercise period to individuals (see Section 4.3). Dogs that are excessively reserved or appear to be the victims of bullying by other dogs may benefit from being exercised in smaller groups and from receiving extra human attention. Exercise periods also provide an opportunity to obtain information about the dogs' movements and postures for health monitoring.
- To monitor any tension between individuals and thereby prevent episodes of aggression or deal promptly and appropriately with physical conflict if it occurs (see Section 4.4).

It is important to ensure that the size of the exercise/activity area is adequate to provide the opportunity for physical exercise but is not too large. In addition, it is important to consider the number of dogs allowed exercise at any one time; around ten is a suitable number. There are four main reasons for this:

- *Ease of supervision*: It is easier to supervise a smaller number of dogs. If a fight did break out amongst a large number of dogs it could be difficult for one person to bring the fight under control.
- *Individual attention*: The person in attendance of the dogs should interact with them during the exercise period. The larger the number of dogs being exercised the less individual attention each dog will get.
- *Levels of excitement*: If dogs are exercised in large groups in very large exercise/activity areas the level of excitement amongst the dogs will be very high. There is a risk that dogs that are over stimulated in this way on a regular basis will become very excitable and difficult to use for scientific procedures or to rehome.

- *Social tension*: Larger group sizes can lead to social tension. The benefit of the exercise session for less confident individuals in the group may thus be diminished since excess space may encourage uncontrollable behaviour in some individuals which may be inhibiting for others.

The length of the exercise session can vary, but there must be sufficient staff time to allow good quality social interaction with the animals since this is vitally important for dog well-being.

Several studies have reported that dogs are more active in the presence of humans (Campbell *et al.* 1988, Hughes *et al.* 1989, Hughes & Campbell 1990, Hetts *et al.* 1992) so dogs should not simply be turned-out and left with toys. Managers of dog facilities should fix a definite length of time for exercise and regularly review staff responsibilities and work levels to maximize this period. Twenty minutes per day is considered by the Working Group to be the minimum beneficial time period. Some establishments give 30–60 min per day. The time allocation should be in addition to interaction specifically devoted to cleaning, feeding and the performance of regulated procedures.

Use a rota system to ensure that all dogs have access to the exercise/activity area. Also, rotating the care-giving staff who interact with the dogs will help socialize the dogs to humans; this is particularly important for young dogs at breeding establishments (see Section 13). That said, there is merit in assigning particular members of staff to particular dogs so that they can become accustomed to the behaviour of individual animals for monitoring their physical and mental well-being (see Sections 9 and 17.6).

It is frequently overlooked that dogs are very exploratory animals whose world is dominated by smell and not sight. Provision of an outdoor exercise/activity area will enable exploration and a wider range of normal behaviours. It will help facilities to more easily meet some of the fundamental behavioural needs of dogs, particularly relating to olfaction (e.g. nosing, ground and air



Fig 13 An outdoor exercise/activity area at Novo Nordisk, Denmark. Dogs have access to this 2000 m² space with enrichment equipment, mounds and trees five times a week for a minimum of 1–2 h daily

scenting, roaming, scent marking by urine, faeces or scratching of the ground, or rolling and digging) and foraging (e.g. running, chasing or ambushing). It also allows the development of communication from a distance, and exposure to a more natural environment as preparation for rehoming (see Section 19). Outside areas can contain concrete or brick structures, earth mounds and trees that the animals can investigate and negotiate during play (Fig 13: Novo Nordisk, Denmark). There is a potential risk of disease infection in some countries (e.g. tick-borne diseases), so effects on health of outdoor activity should always be taken into account, and an appropriate health monitoring programme should be instigated by the veterinarian.

Recommendations:

- **Social enrichment (both dog–dog and dog–human) and adequate physical and mental stimulation are crucial in attaining and maintaining high standards of welfare. Exercise periods should be provided to meet this need, ideally on a daily basis.**
- **Exercising should be carried out in a designated, specifically designed area because this can increase environmental stimulation and choice dramatically. Ideally, the exercise/activity area should never be empty of dogs, and should be used in preference to leaving dogs housed in their pens.**

- **The exercise/activity area should be well equipped with enrichment equipment, such as steps, ramps, tunnels and toys.**
- **The number of dogs allowed to exercise together should ideally be around ten.**
- **Animal care staff should be present during the exercise period. There must be sufficient staff time to allow good quality social interaction with the animals. Fix a definite length of time for exercise and regularly review staff responsibilities and work levels to maximize this period. Twenty minutes per day is a minimum beneficial time period.**
- **Outdoor exercise/activity areas should be provided where possible.**
- **A veterinarian should be consulted on any health risks, and their control, associated with outdoor activity.**

9 Health and hygiene

9.1 Health

Appropriate veterinary care must be continually available for all dog units. Regular veterinary inspection routines should be implemented, as well as additional inspections or examinations when problems may be expected, for example, when a bitch is expected to whelp, or post-surgery.

Numerous standard texts exist giving detailed information on health and disease in dogs, both in general (e.g. Gorman 1998, Bonagura 2000) and in the specific laboratory situation (e.g. Ringler & Peter 1984, Wolfensohn & Lloyd 1998, MacArthur Clark 1999). Such diseases may include, for example, diarrhoea (either non-specific or associated with potential pathogens such as *Campylobacter* spp.), and lesions resulting from aggressive behaviour or from skin parasites such as demodex mites. Specific information regarding causes of disease, diagnosis and current treatment regimes can be obtained from such sources and from a search of the literature.

Some health conditions appear to be more common in laboratory beagles. Examples include polyarteritis or beagle pain syndrome, which is an idiopathic multifocal inflammatory condition thought to have an immune-

mediated aetiology (Hayes *et al.* 1989, Pearce 2001) and idiopathic epilepsy (Edmonds *et al.* 1979, Montgomery & Lee 1983). The onset of epileptic seizures is commonly associated with stressful procedures such as a change in environment, or restraint. Identification and removal of stressors is the logical course of action for affected individuals. These and other examples of disease conditions can be a factor in the selection of breeding stock in breeding establishments (see Section 11.2). Therefore it is important that such information is passed back to breeders.

Breeding and user establishments should have a routine prophylactic regime to control endoparasites and ectoparasites in bitches and pups. In addition a prophylactic vaccination regime should normally be required for dog breeding colonies (unless they are being used in vaccine development). Vaccines are available against several of the common classical diseases of dogs. Therefore, with a known vaccination policy, the exclusion of such diseases as distemper, parvovirus, leptospirosis, canine adenovirus and bordetellosis should be relatively straightforward. In addition, vaccination against rabies is possible, although in many countries rabies is excluded principally by a quarantine or vaccination policy.

Defining the health status of breeding colonies and maintaining records of the health history of the colony is important both for individual animals and for assessing trends in disease, parasite burden, and hereditary physical defects within the colony. The Federation of European Laboratory Animal Science Associations (FELASA) working group on health monitoring of dog colonies (Federation of European Laboratory Animal Science Associations 1998) is a standard basis for the type of health monitoring record which can be maintained for breeding and user establishments. Such records should include details such as date of birth, parentage of the dogs, vaccination and worming dates, behavioural characteristics, clinical observations and records of diseases and treatments, and any experimental use. Where dogs are moved from breeders to user establishments it is important that copies of individual records are routinely passed on (see Section 10).

Health examinations for stock and breeding dogs: In addition to routine veterinary inspections (e.g. every 6 months, or every 3 months for dogs held long term: see Section 18), animal care staff should continuously monitor the health status of dogs. In addition, they should perform a routine superficial examination of dogs on a monthly basis. This should include the following:

- Examine the general appearance of the dog. The dog should adopt a normal posture and display normal movement with no signs or lameness. Movements should be made without reluctance, not favouring a particular limb and not staggering.
- Check the normal general behaviour of the dog in the pen. There should be no abnormal behaviours or stereotypies. Most normal healthy dogs are active, alert and inquisitive. Being gregarious animals, they will often normally be found playing, or resting or sleeping huddled together. Check that the animal is not nervous or withdrawn and shows no reluctance, resistance, or resentment to being picked up or handled by humans. The dog should be responsive to the handler.
- Examine the dog's head to include an examination of the external appearance of the eyes, ears, nose and mouth (especially teeth and mucous membranes). The appearance of each should be normal (e.g. bright, wet eyes; cold, wet nose); there should be no evidence of abnormal discharge(s). Especially examine for excessive dental tartar accumulation, and the presence of papillomas on face, tongue, and the buccal mucosae and oral mucosae.
- Check the skin for signs of normal elasticity. This is best evaluated by gently pinching the loose skin over the back of the animal; this should quickly retract when released. With dehydration the skin will stay in the pinched condition—a sign known as 'tenting'.
- The coat should be clean and shiny. There should be no evidence of hair loss, no lesions, no signs of parasites and no abnormal swelling(s). There should be no signs of inflammatory reaction or irritation, such as scratching, biting or licking. The animal should be in good bodily condition, well-muscled, and should not be too fat or too thin for its age and weight (see Section 7.2).
- Check the rate, rhythm and depth of respiration are normal (observing the animal prior to handling will avoid affecting the respiratory rate). Respiration should be regular and abdominal. Check that there is no evidence of laboured breathing and no evidence of a cough or other abnormal respiratory noises (e.g. wheezing).
- Gently palpate the abdomen. Look for evidence of abnormal swelling. The dog should not appear 'tucked up' and there should be no evidence of pain or discomfort on abdominal palpation. Check that there are no umbilical herniae or inguinal herniae (younger dogs). In males there should be two testicles, fully descended in the scrotum. Check that there is no abnormal discharge from either prepuce or vulva, as appropriate.
- Check all females for signs of oestrus (bloody to clear vaginal discharge).
- Check the legs, feet and tail. There should be no evidence of abnormal swellings or fractures. Check the nails are not overgrown and trim as necessary. Check the footpads, there should be no evidence of cracking or abrasions.
- Check general clinical signs, such as lymph node enlargement, tumours, masses, cataracts, diarrhoea and discharges.

Stud dogs and breeding bitches should be examined periodically by a veterinarian. Stud dogs should be examined at least twice yearly; bitches should be examined prior to each mating. In addition to the above, particular consideration should be given to the following:

- Examination of the buccal mucosa and teeth. This is to detect early signs of gingivitis and the build up of tartar on the teeth. Any dog showing signs of gingivitis and excess tartar should be treated appropriately.
- Examination of the external ear canal to detect any excess wax. Dogs may be examined with an otoscope to assess the

effectiveness of any prophylactic treatment for ear mites.

- Auscultation of the chest, particularly to detect heart murmurs and abnormal respiratory sounds.
- Examination of the feet. There should be no lesions on the pads or in the interdigital space. Check any requirement for nails and dew claws to be trimmed.
- Examination of the teats and other external genitalia, as appropriate, for any visual or palpable abnormalities. There should be no marked discharge. Testes should be descended in males.
- Check the body condition of the dog. The dog should be well muscled and, if bitches are presented for continuing breeding, they should have recovered good body condition following a previous lactation.

Record any abnormalities. Minor abnormalities may require simple treatment (e.g. cleaning of waxy ears) or a second opinion including veterinary assistance. Sick animals should be reported to a veterinarian immediately.

Body weight and food and water intake:

Reduced body weight or poor growth can be a reliable and sensitive indicator of ill health. Animals that are healthy will eat and drink readily. Food intake, rate of eating and their consumption of drinking water will be reasonably consistent from one day to the next, provided of course that the dogs are in conditions of physiological stability (i.e. they are not growing rapidly or are pregnant, or there are no obvious fluctuations in ambient temperature).

Dependent on the method of feeding, reduced food intake may or may not be readily observed. Before weaning this is expressed as a failure to suckle. For group-housed dogs, body weight change is usually assumed to be an indirect reflection of food intake because reliable measurement of an individual's food intake can only be made if an animal is isolated. A lowered food intake will result in a lowered faecal output, so examine the environment as well as the animal.

Reduced fluid intake is often less easy to recognize as daily intake is low in relation

to the volume of water provided. For this reason, automatic watering systems should be avoided for cases causing concern. Reduced fluid intake causes reduced fluid output and, if severe, clinical signs such as tenting. Increased fluid intake is much more common than reduced fluid intake and is usually indicative of serious disease; veterinary advice should be sought at once.

9.2 Hygiene

Maintenance of a high standard of hygiene within dog units is an essential element in minimizing adverse health problems. Use of substrate such as sawdust will help to soak up urine and excreta in pens and therefore help keep dogs' skin clean and dry. Cleaning of food bowls, and dog pens of faeces should be done at least on a daily basis. Much of the cleaning of dog pens can be conducted without the need for water, and it should be remembered that dry cleaning provides an opportunity for interaction between staff and the dogs. Wet cleaning (hosing) is normally also required on a regular basis, but every effort should be made to keep dogs dry during this procedure. Hosing is aversive to many dogs, and the procedure creates aerosols which can result in conditions such as conjunctivitis. Ideally, dogs should be moved to a separate area during wet cleaning of pens, and not returned until the pen floors are dry. This provides an opportunity for exercise or play in the separate area during wet cleaning, which may lead to a reduction of excitable activity (and possibly aggression) in the home pen areas where calm, quiet behaviour is the desired goal.

Recommendations:

- **Veterinary care should be continually available for all dog units with an on-call service. Regular inspection routines should be implemented, as well as additional inspections or examinations when problems may be expected, for example, when a bitch is expected to litter, or post-surgery.**
- **Routines for monitoring of the dogs' health status should be established. Good record keeping is essential in order**

to establish and maintain knowledge of the health status of the colony. Copies of individual health records should be routinely passed to user establishments when dogs are moved from breeding establishments.

- In order to assist in monitoring health status, feedback of adverse health conditions and behavioural problems from users to breeders should be routine.
- Prophylactic treatments to control endoparasites and ectoparasites and vaccination regimes are recommended. Scientific justification should be required for withholding prophylactic treatments.
- Routine superficial health examinations (including behavioural health) should be performed by animal care staff on a monthly basis. Sick animals should be reported to a veterinarian immediately.
- Dog units should be maintained to a high standard of hygiene. Dry cleaning should be used where possible and should be utilized as an opportunity for interaction with the dogs.
- Dogs should be moved to a separate area during wet cleaning, and returned once the room is dry. Husbandry regimes may be designed to allow exercise or play during this time.

10 Identification and record keeping

It is good practice for all dogs in any breeding, supplying or user establishment to be uniquely identifiable, and this is a legal requirement in some countries (e.g. European Community 1986, United States Department of Agriculture 2001). In the case of the UK, this must be by a means of permanent identification acceptable to the Home Office (Home Office 1990).

There are currently a number of methods in use for individual identification of dogs and these are listed below in order of preference. Ideally the method used should not be painful, not cause an adverse reaction, not be uncomfortable and not be likely to catch and cause injury. Non-invasive methods should be the principal method of choice, particularly for pre-weaned animals.

Before using any invasive procedure always establish whether permanent identification of individuals is really necessary. For example, in the USA, Class-A dealers (which correspond to designated breeding and/or supplying establishments in the UK) are required to identify dogs by a tattoo or an official tag affixed to the dog's neck by means of a collar (United States Department of Agriculture 2001).

Non-invasive methods:

- *Coat colour and pattern:* Many dogs have characteristic coat colours and patterns. It may therefore be possible to make a note of these and so avoid having to use an invasive method of identification. This method is most useful for small groups of dogs.
- *Photograph:* It is becoming increasingly popular to photograph the face of the animal, which provides a unique pattern. Although it is not envisaged that this technique would be used in isolation of other methods, it can provide a very quick method of individual identification. This method is well suited to beagles which have distinct coat patterns, but less so to breeds which have solid coat colours.
- *Felt pen marking of the ear:* Study numbers are usually written in marker pen on the inner surface of dogs' ears and similar permanent marks can be used to identify individual animals. Felt pen marks will need to be renewed regularly (every week or two), especially where a group of dogs can groom one another. Felt pen markers can cause dermatitis if animals are kept for long periods. Xylene-free permanent markers may be better; these are less toxic and last longer.
- *Collar and tag:* A unique identifier can be included within a properly fitted dog collar and tag. Although this is a non-stressful alternative to invasive methods, collar and tag can be removed with relative ease and can be caught on pen fixtures, so this method is not recommended or regarded as a viable one within the laboratory environment.

Invasive, permanent methods: Invasive methods should always be carried out by competent, trained staff.

- *Microchip:* The most satisfactory means of permanent identification is through electronic implants. Usually a small microchip is inserted by subcutaneous injection. The microchip is encoded to provide a unique identifier for the animal, which enables subsequent tracking, both in terms of movement and through any experimental period. A microchip reader is used to determine the dog identification number from the chip and these data can be transferred or received on an appropriate personal computer. Data recording can then be directly associated with this unique identifier. To allow reading of the implant, insertion should be performed in the correct position; for example, in the back of the ear or between the scapulae ('scruff' of the neck). In order to minimize translocation of the chip to other body cavities, it is recommended that the back of the ear rather than the 'scruff' is utilized for chip insertion; however, the incidence of total loss of microchips is very low. It should be noted that subcutaneous implants give no external indication of the animals' identity, which may make them unsuitable for some applications.
- *Tattoo:* A unique number can be tattooed onto a relatively hairless part of the body of the dog, usually inside the ear flap (pinnae) or the inside of the thigh. This number is then used to provide a unique identifier, which enables subsequent tracking of the animal. Data recording can then be directly associated with this unique identifier. The technique requires technical expertise and can cause short-term discomfort for the animal. Therefore, it is important to consider whether tattooing is really necessary, and if so whether to use anaesthesia, and of what type. The method of tattooing and anaesthesia should be that which causes the least distress, and the tattoo should be as small as possible. Analgesia

can be provided at the time through the use of local or topical anaesthetics but these can affect the dye uptake.

Analgesia may also be given before and afterwards using NSAIDs (consult the local veterinarian for appropriate drugs and doses). Since it is impossible to tattoo painlessly, and because tattoos can be difficult to read on pigmented skin, tattooing is being phased-out in preference to micro-chipping.

Record keeping: Each dog should have an individual history file (so called 'passport') that gives a detailed biography. The file should record information such as:

- date of birth;
- parentage;
- medical information (see Section 9);
- reproductive information (e.g. bitch heat dates, breeding and mothering ability);
- behavioural characteristics (e.g. temperament, abnormal behaviour and stereotypes);
- social information (e.g. all social partners, rank in the group, moves and events that have occurred in the life of that animal, details concerning the compatibility and incompatibility of individuals);
- records of socialization, habituation and training;
- any experimental use.

The file should accompany that animal if he/she is moved between institutions. Information from these individual files should be used to form part of a database to analyse dog care and use, and to review the adequacy of systems in order to establish good practices. Electronic databases have the advantage that they can be accessed by staff across a number of sites, can enable quick and efficient searching for information (e.g. issue availability, previous use), and can be used to alert staff to the need for action (e.g. concerning vaccination and prophylactic treatment schedules or weaning alerts).

Recommendations:

- **Non-invasive methods of identification should be the principal method of**

choice, particularly for pre-weaned animals.

- An assessment of whether permanent marking of individual animals is really necessary should be carried out.
- Subcutaneous microchip implants provide the most satisfactory method of permanent identification.
- Tattooing is not recommended. If tattooing is to be used as a method of identification, local anaesthesia should be used,

tattoos should be small, and post-procedural analgesia should be provided.

- Each dog should have an individual history file ('passport') that gives a detailed biography. The file should accompany that animal if he/she is moved between institutions. Information from these files should be used to form part of a database to analyse dog care and use in practice, and to review the adequacy of systems in order to establish good practices.

Part 4

11 Breeding

11.1 Breeding systems

It is customary to optimize fecundity within dog breeding colonies supplying animals for research purposes. This is justified both on economic grounds and in order to reduce the number of dogs used for this purpose to the necessary minimum. There should, however, be safeguards to assure the welfare of breeding dogs, particularly bitches, and thus ensure that each dog is first bred at an appropriate stage of maturity and that the frequency of subsequent breeding compromises neither health nor general welfare. For this reason it is strongly recommended that the mating of individual dogs be carried out under veterinary direction and that all breed stock is subject to regularly veterinary clinical health examination (see Section 9).

Decisions on breeding and re-breeding of individual animals should be made by trained and competent staff, supported by professional veterinary input, on a case by case basis. The Working Group believes that tailoring a breeding programme to reflect the individual bitch's ability to breed offers significant welfare advantages over the rather prescriptive limitations set by the UK Breeding and Sale of Dogs (Welfare) Act 1999 (UK Government 1999). For example, the Act states that bitches are not to be

mated if they are less than one year old, and that they should give birth to no more than six litters each and at intervals of not less than one year.

One of two general breeding systems is commonly utilized: observed mating or harems:

Observed mating system: This is a traditional system for breeding dogs, typically used by pedigree breeders and colloquially referred to as 'hand mating'. Bitches are housed separately from the stud males and must be checked periodically for any signs of oestrus. Those to be bred and showing signs of oestrus are then taken to a selected stud dog for mating. Typically, a bitch is first introduced to the stud dog on day 10 to day 12 following the onset of the first signs of proestrus. Precise timing will clearly vary depending on the experience and expertise of individual staff in detecting early signs of oestrus and the nature and extent to which individual bitches display the typical signs. These factors can have a significant influence on the success of this system of management. The behaviour of the bitch and stud dog will normally indicate if the bitch is receptive, and coitus ('tying') is normally taken to indicate a successful mating. Further observed matings may take place periodically over the following 7–10 day period, particularly if the dogs don't 'tie' in this first instance; this will increase the likelihood of a resulting pregnancy. The bitch is

usually returned to her home pen after and between matings, although a variation of this management system involves housing both bitch and stud dog together during the period that she is seen to be in oestrus. Being less dependent on skill in detecting early signs of oestrus, this system is more likely to result in successful pregnancies. However, the dogs may not necessarily be seen to 'tie', and consequently it becomes more difficult to estimate the expected date of whelping (see Harem system).

Harem system: This system, in which breeding bitches are housed as groups with respective stud males, is more commonly employed for the breeding of laboratory dogs. Generally a group of four to seven bitches is housed with a single male, but larger groups, comprising up to 12 bitches, can be maintained in appropriate facilities. Matings are less likely to be observed among dogs housed in harems, which means that the detection and precise timing of pregnancy is not possible using observation alone. Consequently, for harem-mated dogs, pregnancy should be determined normally by routine abdominal palpation or by ultrasound scanning (see Ultrasound scanning). Bitches should be removed from the harem in the later stages of pregnancy and transferred to appropriate accommodation for whelping and should not whelp within the harem (see Section 11.3).

The main advantages of the harem system are that it facilitates the housing of dogs in socially compatible groups and does not rely on the animal care staff detecting signs of oestrus among individual bitches. A major consideration in the use of harem breeding is the tendency for bitches to show aggression towards others in the group, particularly around the time of oestrus. Careful management is required to ensure that aggressive behaviour and, more importantly, any incidence of fight-related injuries is kept to an acceptable minimum (see Section 4.4). There is also the potential for the fertility of the stud male to be compromised in having to serve several bitches that might come into season simultaneously. However, good management practices will normally ensure that such a situation is rare and that females

do not synchronize within harems in such a way as to adversely influence fertility.

Ultrasound scanning: Ultrasound scanning for pregnancy allows for earlier reliable detection of pregnancy with an accurate prediction of the days to parturition to within 2–3 days. It also prevents non-pregnant bitches coming into the whelping area by accurate assessment of non-pregnancy, something not easily accomplished by manual palpation of a gravid uterus with only one or two fetuses or in overweight bitches. Ultrasound also generally allows for better management of pregnant bitches (Hazelwood 2001). For example, for whelping bitches it will provide accurate information on the number of pups still *in utero* and whether they are viable. It is also useful for determining, where doubt exists, whether overweight bitches have completed second stage labour.

Frozen semen and artificial insemination: Frozen semen has been used for breeding dogs, mainly for geographical reasons where the dog and bitch are in different countries. It will still be necessary to observe national rules on quarantine, although these are being relaxed. The use of frozen semen of necessity involves the use of artificial insemination (AI). Artificial insemination is used also in situations where it is inappropriate or impractical to introduce new breeding stock into a colony, or for health reasons, where it may be inappropriate to introduce live animals into an otherwise 'closed colony'. Bitches to be inseminated are housed in single-sex groups and checked visually each week for signs of oestrus. It is important, particularly when using frozen semen, that insemination is performed at the appropriate time to coincide, as far as possible, with the time at which the majority of the eggs are fertilizable, normally towards the end of oestrus. The best time for insemination is when there is a rise in progesterone some 4 days after the surge in luteinizing hormone. For this reason it is customary to take blood samples commencing one week after the onset of proestrus to monitor circulating progesterone levels. Test

kits are available commercially for the purpose. Testing is repeated every 48 h initially and then every 24 h, and when the test shows the critical level of progesterone (10–15 ng/ml) the bitch is inseminated. Semen is cryopreserved in straws in liquid nitrogen and is brought to body temperature in a water bath prior to use. To inseminate the bitch, a specially designed metal catheter is introduced into the uterus via the cervix. The success rate for the process can be as high as 80%, compared to 90% for natural mating. However, considerable technical skill is needed to introduce the catheter into the uterus, and placing the semen in the cranial vagina significantly reduces the success rate.

Recommendations:

- **Bitches should be assessed by a veterinarian before mating; each animal and breed should be considered individually.**
- **Ultrasound scanning should be used in the detection of pregnancy.**

11.2 Selection of breeding stock

There is literature available on the biology of beagle reproduction (e.g. Andersen 1970) and on the management of dog breeding colonies (e.g. National Research Council 1994). When selecting breeding stock the traditional considerations include size, appearance (i.e. free from visible or detectable unwanted abnormalities or characteristics) and reproductive history within the line (e.g. conception rates, number of offspring, size of offspring, evenness of sex distribution, acceptability of litter interval). Information on heritability of physical and other characteristics in dogs, Mendelian genetics of breeding, the incidence and characteristics of diseases that have a genetic basis, and methods for demonstrating heritability is available (Schultz 1970, Patterson 1975, Patterson *et al.* 1989, Willis 1989).

A computerized selection program can be used for selecting new male or female breeding stock and when harems change in order to maximize outbreeding in a closed colony. When an individual bitch's identification is entered, the program calculates the inbreed-

ing coefficient against all stud dogs. A report is produced listing the compatibility of the studs to the bitch. It also provides compatibilities against each male breeder and possible matings for each female.

Attention needs to be paid to behavioural factors in the selection of breeding stock (e.g. temperament, incidence of abnormal behaviour and stereotypies, and mothering ability). In the past, a lack of consideration of behavioural factors within the industry has led to problems in the whelping area with nervous bitches finding it hard to adjust to that environment. This raises concerns about the inheritance of nervous behaviour and about observational learning issues within the whelping area, with puppies observing fearful reactions by the dam toward passing personnel.

In order to assist in the selection of breeding stock in terms of temperament, a short behavioural assessment should be carried out. This can usefully be done at each traditional breeder selection examination such as at 15 weeks of age and 24 weeks of age. The selection procedure is relevant to both bitches and stud dogs.

The assessment procedure should consist of various tests to ascertain the dogs' reaction to novelty. It is perfectly natural for dogs that have been reared in a relatively barren and stable environment to react with fear when first confronted with new situations and objects. That said, it is important to observe the time that it takes for these dogs to recover from their fear and start to show exploratory behaviour. Those that show exaggerated initial fear responses, and/or do not recover quickly from them, are not suitable for selection as replacement breeders. Individuals that exhibit abnormal behaviours and stereotypies should also be discarded as future breeders (see Section 5).

From a welfare perspective, those animals most suitable for use as replacement breeders are those that show the minimum amount of fear and distress on exposure to novelty and isolation and show the fastest recovery rate in these situations (assuming these traits have a high heritability).

During the assessment procedure, the dogs' reaction to the following stimuli

should be assessed. In each category the dogs' initial response should be recorded together with its recovery time.

- *Novel environment*: Dogs should be taken from their home pens to a 'procedure' room for the assessment. This room should have objects not in every day use or part of the socialization and habituation programme, such as brushes or novel toys, scattered on the floor so that the tester can observe an animal's reaction to novelty.
- *Startling stimuli*: An unexpected stimulus should be introduced and the dog's recovery time noted; the aim is to startle the dog rather than frighten it. For example, novel objects such as bunches of keys can be dropped onto the floor (away from the dogs) and the dogs' reaction observed.
- *People*: The dog should be called by the member of staff and its reaction noted. Factors such as how long the dog takes to approach the person and how long he/she will stay in the company of that person once he/she has approached should be recorded. It is important to use a combination of familiar and novel personnel for this test. This part of the selection is especially important for bitches who will need to cope with a much higher level of human interaction than stud dogs. However, it is still a very useful indicator of temperament in potential stud dogs.
- *Examination*: The dog should be placed on the examination table and given a basic health examination. He/she should be restrained in a suitable position for jugular venepuncture and the jugular vein should be raised. Do not release the dog until he/she has relaxed. Although replacement breeders will not be used in future studies, it is nonetheless important to include this factor in the selection process in order to encourage the selection of tractable individuals.

Recommendations:

- **Behavioural assessment should be part of the process of selection of breeding stock.**

- **When selecting suitable replacement breeders, animals that show the minimum amount of fear and distress on exposure to novelty and isolation, and show the fastest recovery rate in these situations, should be chosen.**
- **Individuals that exhibit appreciable levels of fear, long recovery times, abnormal behaviours and stereotypies should not be considered suitable as future breeders.**

11.3 Care of the whelping bitch

Pre-parturient bitches should be moved to the whelping area at least 2 weeks prior to the date of expected parturition where they can be conveniently pair-housed or group-housed to provide them with the appropriate companionship of conspecifics. Bitches seek solitude in a quiet area to whelp their young; but there is no need to isolate pregnant bitches until a day or two prior to whelping. An indication of when a bitch wants to be alone to whelp is given by her behaviour. Toward the end of gestation, she is generally more restless and appears uncomfortable. She may show bed-shredding behaviour (e.g. scratching at the floor). This was once thought to be nest-building behaviour but is probably actually a reaction to pain. It is not unusual for her to pant a great deal, lick her nipples and vulva, and to regularly look apprehensively at her hindquarters (Dunbar 1979).

Whelping can be anticipated by taking the temperature of the bitch for several days prior to the anticipated date of parturition. The bitch's body temperature will decrease usually to an average 36°C (98°F) from a norm of 39°C (101.5°F) approximately 12–24 h prior to whelping. The decrease in body temperature is transient, therefore it is necessary to take the bitch's temperature at least twice daily to assure detection. Once overt signs of whelping appear, body temperature rapidly returns to normal or is raised.

A day or two prior to whelping, the bitch should be singly-housed, but within sight, sound and smell of other pre-parturient and lactating bitches. Adjustable pop-holes between pens can be used to permit varying degrees of social interaction. Social isolation, full social contact, or visual and olfactory

access only (depending on the bitch) can be permitted by opening or closing pop-holes fully or partly, or by using mesh partitions. During the immediate pre-parturient period, the bitch should have daily human contact.

During the immediate 3-day post-parturient period the bitch will be reluctant to leave her puppies, but thereafter may choose to leave the litter for progressively longer periods of time. Short periods of exercise can be of benefit to her at this time, as can raised platforms which allow her to get up away from her puppies (see Section 6.1.2). Once the puppies are well established and more independent, normally at approximately 10–14 days of age, the bitch will frequently choose to leave them, returning periodically to feed and care for them. From this point in time, extended periods of social exercise with conspecifics can resume.

Recommendations:

- **Pre-parturient bitches should be pair-housed or group-housed until a few days prior to whelping. During the immediate pre-parturient period, bitches should have sight, sound and smell of other pre-parturient and lactating bitches and socialization with humans daily.**
- **Bitches should be provided with the opportunity for short periods of exercise from approximately 3 days after parturition.**

11.4 Minimizing losses and care of the newborn litter

Perinatal and especially neonatal losses may be high for dogs. Although precise figures are unobtainable, relatively conservative estimates rate total losses (i.e. stillbirths and neonatal losses combined) as high as 15–30% in routine dog breeding conditions outside the scientific community (Jones & Joshua 1988, Evans & White 1997). These figures indicate the importance that should be placed on monitoring perinatal survival and on reducing losses to the absolute minimum.

Losses of such magnitude should be regarded as unacceptable, in welfare terms, in the context of a laboratory breeding

colony. With high standards of management, husbandry, health and hygiene, stillbirths can be reduced to $\leq 5\%$ of the total born, and neonatal losses (i.e. the proportion of pups born alive that do not survive the first 3 days of life) can be reduced to around 5–7% (Buckwell unpublished data). This gives a comparable figure of around 10–12% for total losses in a laboratory dog breeding colony.

Factors that should be considered for minimizing losses and care of the newborn litter include:

- *The previous reproductive performance of individual bitches:* This should be reviewed prior to each mating. Performance standards should be established that allow the selection of good bitches for breeding.
- *Hygiene in the whelping area:* Whelping pens should be cleaned and disinfected prior to occupancy. In larger colonies, bitches should whelp within facilities where the whole area can be depopulated and cleaned. A daily cleaning regime should be adopted that ensures that surfaces remain uncontaminated and the environment within the pen, and especially the whelping area, remains fresh and dry.
- *Close management of whelping:* The time of parturition should be estimated so that staff are better able to monitor the bitch during the perinatal period. Procedures should be established to accurately estimate and monitor gestation (gestation length in the beagle can vary from 58 to 68 days). It may be appropriate to estimate the time of conception, for example, by use of vaginal cytology and estimations of hormone concentrations; such changes can be used to monitor the oestrous cycle. Pregnancy and the development of the conceptus can be monitored using ultrasound scanning (see Section 11.1). Finally, the onset of parturition can be predicted by monitoring rectal temperature (see Section 11.3), or by detecting basal concentrations of plasma progesterone.

- *Staff education and training:* Staff should be aware of the normal whelping process and be able to recognize the various stages of whelping and the signs of, for example, dystocia and uterine inertia.
 - *Care of the whelping bitch:* Decisions should be made on how closely whelping should be managed (e.g. every 4 to 5 h). Bitches normally whelp in the late evening or early morning and this is when they should be monitored most closely—note that these times are outside the normal working day and therefore adequate provision for supervision needs to be made. The previous performance of a bitch may be an indicator of whether she is able to whelp with little or no assistance, or whether some intervention may be appropriate to optimize pup survival. Where necessary, it may be appropriate to 'whelp' the bitch; delivering and reviving each puppy by removing the placental attachments and fetal membranes, vigorously drying the pup to initiate respiration, and ensuring that each puppy sucks and receives adequate colostrum.
 - *Care of the newborn litter:* The first 36 h after birth are the most critical; this is a time when pups are most likely to die, but neonatal losses can be reduced by good monitoring. The immediate environment of the whelping area should be monitored to ensure appropriate temperature and air quality (see Section 6.2.2). The behaviour of the bitch towards her pups should be observed and monitored; first-time whelping, nervous or insecure bitches may require least disturbance to allow them to settle down and calm their litter. Some inexperienced bitches may require assistance to clean their pups and, by licking them, stimulate the puppies to pass urine and faeces. Puppies instinctively move towards the teat and will hang on to suck; staff should recognize the signs to indicate that the puppies are sucking successfully and that milk is being consumed in appropriate quantities by every puppy in the litter. It is most important that puppies suck adequately during the first 24 h of life, as it is during this time that they receive colostrum from their mother. It is sensible to have stored colostrum or artificial colostrum available. Puppies that are sucking will make paddling movements and will often raise their tail, as a characteristic reflex, when first expressing and ingesting milk from the teat.
 - *Health status of the bitch:* The health and fitness of the bitch throughout the pregnancy and during the lactation period is a major factor in minimizing losses: it is particularly important that bitches should be fed adequately during these nutritionally demanding periods (see Section 7.2).
 - *Age of the bitch:* The age of the bitch can affect breeding performance (Andersen & Simpson 1973). Experience within the Working Group suggests that breeding performance of multiparous bitches is relatively steady after the initial two litters and tends to decline in older bitches, particularly in those exceeding 7 years of age.
- Puppies should be examined for obvious congenital defects during the first day of life (e.g. umbilical and inguinal hernias, and cleft palates). Observations should continue throughout the first week of life. So-called 'swimmers' will be apparent within this period; but other abnormalities, unless gross, will only become apparent as the puppy matures during the later pre-wean period. These include such abnormalities as hydrocephalus and prognathism. A humane welfare policy should be established that ensures that staff know how to deal with such abnormalities. For example, it would normally be humane to euthanize puppies with hydrocephalus, whereas prognathic puppies may make suitable laboratory animals.
- Losses beyond the first 7-day period should be low (<5%) and veterinary opinion should be sought for any unexplained deaths. Such losses should be recorded and, wherever possible, accurate diagnosis should be made of the cause of death. These records should be reviewed periodically with the veterinary staff and a strategy implemented

to reduce consistent findings to an absolute minimum.

Experience within the Working Group suggests that the most appropriate time to separate puppies from the bitch is when they are 6–8 weeks old. Whilst the exact time will be dependent on the individual bitch and litter, it is more common to wean at 8 than 6 weeks.

Recommendations:

- **Performance standards should be established that allow the selection of good bitches for breeding.**
- **During the first week, puppies should be examined for obvious congenital defects. A humane welfare policy should be established that ensures that staff know how to deal with such abnormalities.**
- **Records of losses together with details of the cause of death should be kept. These should be reviewed periodically and a strategy implemented to reduce deaths to an absolute minimum.**
- **Puppies should not be separated from the bitch until 6–8 weeks of age.**

12 Balancing supply and demand

It is essential to try and ensure that the supply of animals does not exceed the demand in order to avoid the generation of surplus animals and the wastage of animals' lives. This requires good communication and coordination between breeders, suppliers and users (which is more feasible with 'in-house' breeding), and also within and between multidisciplinary research teams. It also requires good production planning.

If surpluses do occur it is important to review the causes and take appropriate action to try to prevent the situation recurring. If there is a surplus that cannot be redirected for use in essential procedures then animals should be considered for rehoming as companion animals (see Section 19).

Reasons for surpluses: Surplus animals can result from:

- a preference for a single sex, or specific age or weight-range, for certain type(s) of

research and/or testing;

- animals remaining after allocation and/or experimental selection criteria have been applied; and
- cancellation or postponement of research programmes—this mainly affects 'in-house' breeding, but can also have a knock on effect to external breeders and suppliers where animals have been allocated to particular users.

Breeding animals may also become surplus where colony management requires breeding stock to be retired whilst still relatively young, or where animals are removed due to poor or suboptimal reproductive performance. The relocation of such animals for use in scientific procedures is strongly discouraged because of the additional adverse welfare effects associated with the change from a breeding to an experimental environment (Animal Procedures Committee 1999). However, this might be considered acceptable if it can be guaranteed that such an animal can be used in a terminal procedure within a short period of time, and that this could potentially save the breeding of another animal specifically for that purpose. Where proven breeding animals are required for scientific procedures, they should be provided with social companions and a creative socialization programme. In addition, if ex-breeding animals are transferred to an unfamiliar environment for use, try to maximize the degree of visual and olfactory familiarity by retaining pen furniture.

In some breeding establishments, dogs with minor physical defects, clinical or haematological anomalies, or undesirable behavioural characteristics may be categorized as 'sub-standard' and not issued because it is believed (correctly or incorrectly) that users will not accept them. Rejection of such animals should not be accepted without first discussing whether there is a very good reason for them to be considered unusable. Careful thought should be given to the allocation of dogs to studies such that those displaying undesirable behaviour, such as specifically fear-related behavioural responses, can be issued for

short-term terminal studies rather than long-term use.

Production planning: Production planning should be regarded as a critical element of colony management. The intention should be to achieve efficient production, using the optimum sized colony comprising individuals displaying good fecundity, with minimal surplus.

When initially establishing a dog breeding colony a decision should be made on the target inventory and production levels that are to be achieved. The level of production is directly related to the size and fecundity of the colony. Fecundity is normally regarded as optimal fertility: an ability to produce normal healthy puppies frequently and in optimum numbers. Certain assumptions will have to be made regarding the anticipated fecundity in order to achieve the required inventory and production levels. The size of the colony may require subsequent adjustment to compensate for any deviation from this conjectural level of performance.

Target inventory levels will need to reflect the predicted total requirements, i.e. the total number of dogs that are to be produced in a given period of time (normally per annum). This should take account of the number of dogs available for supply at any time during that period, the number of dogs required as replacement breed stock and, normally, a proportion of dogs otherwise available for supply. Inventory targets should be reviewed periodically and revised as necessary with regard to the number of dogs supplied during the preceding period as well as projected requirements for the future.

Production levels should be compared with breeding targets, i.e. the agreed colony size and its average fecundity. Breeding targets should only be changed, as a policy decision, on the authorization of senior management, and if changes in inventory levels are required these should be achieved by adjusting the number of matings in the colony.

The level of production should be regularly recorded in inventory and production reports.

The inventory report should identify, normally by age and weight, both the numbers of animals allocated to orders and the number of dogs otherwise available for sale. These inventory and production reports should then be reviewed periodically, normally monthly, with consideration for the number of dogs likely to be sold and space availability.

Recommendations:

- **All possible measures should be taken to ensure the supply of animals does not exceed demand in order to minimize the creation of surplus animals.**
- **Good communication and coordination between breeders, suppliers and users, and also between and within multidisciplinary research teams, is essential to match supply with demand.**
- **If surpluses occur it is important to review the causes and take appropriate action to try to prevent the situation recurring.**
- **Scientific requirements for a single sex or specific age or weight range of dog should be questioned.**
- **More attention should be paid to the allocation of dogs to studies, with those displaying undesirable behaviour, such as specifically fear-related behavioural responses, being issued for short-term terminal studies rather than long-term use.**
- **The relocation of an ex-breeding animal at the end of a useful breeding life to a designated user establishment for use in scientific procedures is strongly discouraged.**
- **If there is a surplus that cannot be re-directed for use in scientific procedures then the animals should be considered for rehoming as companion animals as early as possible in their lives.**
- **Production planning is a critical element in colony management. Key persons involved in managing breeding colonies should meet regularly to review reproductive performance and target inventory levels.**

Part 5

13 Socialization, habituation and training

In common with other mammals, the social and physical conditions to which a dog is exposed during its early life can have an enormous impact on its developmental process. Attempts have been made to determine the precise ages during which this exposure is important. In fact, it is probably not helpful to place limits, as animals continually interact with their environment and are always capable of learning. Nonetheless, puppies between approximately 3 and 14 weeks of age (the 'primary socialization period') are particularly sensitive to their social and physical environment. During this time they become familiar with the 'members of the pack', learn to communicate satisfactorily and behave appropriately within the group; they also explore and discover the environment in which they are living.

The dog's ability to cope with interactions with unfamiliar conspecifics and humans, and with changes in its environment, is key to its well-being. It is important, therefore, that puppies are exposed to both human and conspecifics during the 'primary socialization period' to ensure that they will interact well with both in later life (e.g. Freedman *et al.* 1961, Scott & Fuller 1965, Wolfle 1987). Moreover, dogs that have been handled by humans as puppies show greater resistance to stress and greater disease tolerance than those which are not handled (Fox 1975). Exercising puppies with adult dogs can help with their socialization to conspecifics but should be well supervised. It is also important that puppies should be exposed to a reasonably complex environment so that they will be confident and not fearful when exposed to new stimuli later (Fox & Stelzner 1966, Fox & Spencer 1969, Wright 1983). As well as changes in responsiveness, dogs exposed to a complex environment show physiological changes such as more rapid brain maturation (Fox & Stelzner 1966).

Lack of necessary experiences during puppyhood results in dogs that, because of fear and distress, cannot react adequately to, or interact satisfactorily with, their conspecifics, humans or their environment, because everything that is unfamiliar is regarded as potentially dangerous. Such dogs will have poor welfare and do not make good research subjects. It has been reported that physiological measurements on such dogs can fall outside normal limits (Vanderlip *et al.* 1985). Furthermore, dogs that have undergone limited socialization show greater variation in behaviour (including during mock procedures) compared with dogs that have experienced intensive socialization (Boxall *et al.* in press). With the right socialization, habituation and training at the breeding establishment, dogs can be better prepared for the challenges of life in a laboratory environment and for the specific procedures that they are used for (Heath *et al.* 2002). Advice on behavioural aspects of rearing should be sought from an appropriately qualified canine behaviour specialist.

Unfortunately, little is known about how much human contact time is needed to adequately socialize a dog with humans. Some studies suggest that socialization with humans can be achieved through relatively small amounts of time: 40 min or less per week spent with a litter (Scott & Fuller 1965), or 5 min per week spent with each puppy (Wolfle 1990). In short-haired breeds, interaction through grooming is often overlooked as it is not considered necessary, but grooming has social significance in a canine context and can be an effective method of accomplishing socialization to humans.

Dogs that have been socialized to humans while puppies will seek human interaction as adults, and it is generally agreed by professionals that human socialization with adult dogs improves their handleability (see Section 16) and provides a form of enrichment (Fox 1986). However, in facilities housing large numbers of dogs the pressures on staff are often such that contact with the dogs becomes very limited (Hubrecht *et al.* 1992), and it is possible that socialization may create a need for social contact that may be

difficult to satisfy later in the dogs' lives (Hubrecht 1995b). Managers should be aware that this could be a serious problem and should establish and implement appropriate formal socialization programmes which continue throughout the dogs' lives. If this is not done, not only is the welfare of the animals likely to be compromised, but also the quality of science.

Habituating and training laboratory dogs to prepare them for experimental use is as important as socializing them to the presence of humans since it teaches them to react calmly, and without fear, in laboratory situations. This has two major benefits:

- (1) A reduction in stress during laboratory procedures is highly desirable in terms of animal welfare; less-stressed animals should also mean less stress for care staff.
- (2) Experimental data resulting from studies carried out on calm, well-adjusted animals, are likely to be more consistent and meaningful.

A basic outline of a socialization, habituation and training programme for laboratory dogs is given in Appendix 3. All of the dog care staff (including veterinarians and study directors) should be trained in order to ensure that all of their actions make a positive and consistent contribution towards the programme. Failure to do so can result in unintentional reinforcement of undesirable behaviour, causing misunderstanding and frustration for both dogs and personnel. All staff, including management, need to appreciate that the provision of consistent socialization, habituation and training routines is as important as all other husbandry activity.

Positive reinforcement training: It is important to reinforce suitable behaviours from an early age. This can be achieved by the provision of positive rewards (e.g. food, verbal praise, stroking, activity) when the dog performs a desired behaviour. At the same time undesirable behaviour should be ignored. The timing of delivery of rewards is crucial and any positive reinforcement must occur while the dog is actually behaving in an appropriate manner. This means that

dogs that are calm during a procedure should be rewarded while the procedure is being carried out rather than when it has been completed. They should learn to sit calmly at the end of the procedure before removal from the examination table, and therefore it is important that the end of the procedure is not rushed. It is important that dogs associate procedural training with the context of a procedure room. Putting dogs on a lead is a good way of differentiating between what is procedure time and what is playtime.

When dealing with very young puppies who do not respond to food rewards it is possible to reward the pups by simply returning them to the pen floor from the examination table at the time when they are behaving calmly. Within a laboratory context, the use of human attention as a reward can be counterproductive by increasing the value of human interaction and leading to a craving for human company and an increased level of appeasement behaviours in the presence of humans. The use of food rewards (e.g. dog biscuits or dried liver) or release from the table as the primary reward are therefore recommended.

Recommendations:

- **Advice on behavioural aspects of rearing should be sought from an appropriately qualified canine behaviour specialist.**
- **All dogs should experience adequate socialization with humans and other dogs during and after the 'primary socialization period'. Positive interactions with humans should be continued throughout the dog's life.**
- **Managers should establish and implement an appropriate formal socialization, habituation and training programme, based on the principles of positive reinforcement. This is beneficial for good welfare and good science.**
- **All of the dog care staff (including veterinarians and study directors) should be trained in order to ensure that all of their actions make a positive and consistent contribution towards the socialization, habituation and training programme.**

- **A signal, such as putting dogs on a lead, should be provided in order to enable dogs to differentiate between procedure time and playtime.**

14 Grouping

Care is needed to establish and maintain dogs in socially harmonious groups because fighting may lead to serious wounding or even death. Care is also needed when regrouping dogs or introducing an unfamiliar dog to an established group. Groups should be checked for social compatibility and stability on an ongoing basis by care-giving staff in order to forestall such potential problems. A video and sound monitoring system can be helpful in monitoring animals remotely, and alarms can be used to alert personnel to particular instances of fighting (see Section 4.4).

Groups of dogs are normally initially established at breeding sites at weaning, as same-sex groups of similar age. The size of such groups is commonly dependent on the facilities available at the particular breeding site and the custom of that site, but such groups may initially be as large as about 25 pups. However, as dogs are unlikely to be kept at user establishments in such large groups, they should be regrouped into smaller groups as the pups grow. As dogs mature the issue of relative rank becomes relevant in determining social interaction within the group and this may bring problems of confrontation. Establishing stable hierarchies within groups can take some time as the dogs test their relationships with each other by repeated confrontation over resources. The outcome of these incidents will be determined by factors such as the resource holding potential of the individuals involved. An understanding of canine communication and social behaviour is essential in order to avoid misinterpretation and premature or inappropriate intervention (see Sections 4.3 and 4.4).

The nature of research will commonly mean the disruption of established groups at the breeding site to meet the requests of users seeking dogs of a particular age or

weight. It is good practice to ensure pups have at least one group mate to travel with (see Section 15.1), and that on arrival at the user premises, such established pairs or groups are retained at this particularly stressful time.

Following receipt of a group of dogs of a requested age or weight range, it is common practice to randomize the animals prior to use. This traditionally takes place after an acclimatization period following arrival in the new environment, but this can mean disruption of groups for a second time. Systems which seek to even out larger or older dogs across different groups may be beneficial as a means of obtaining a wide range of resource holding potentials within the groups and thereby encouraging group stability (see Section 4.4).

Similarly, the introduction of a new dog into an established group can trigger a disruption of the settled hierarchy, especially if the newcomer has a resource holding potential similar to that of existing group members, and the challenges that occur can be quite violent, particularly in the presence of humans. Where possible it is good practice to attempt to randomize the animals in established, compatible pairs or small groups within the confines of the experimental protocol, not just because of animal welfare concerns but also because stress caused by non-compatible groupings could be a confounding variable in experimental studies.

Temperament assessment is important in providing for the immediate needs of animals brought into establishments, because the way that an animal reacts to stress and the way that this is expressed as behaviour will have a direct impact on its welfare in the establishment. A short behavioural assessment (see Section 11.2) should be carried out on arrival and used to guide allocation and development of resources. For example, additional shelter and socialization can be provided for dogs that are identified as anxious.

Recommendations:

- **Groups should be checked for social compatibility on an ongoing basis by care-giving staff in order to forestall**

problems with aggression. A video and sound monitoring system and alarms can be very helpful in monitoring animals remotely.

- **Attempts should be made to randomize animals in established, compatible pairs or groups, within the confines of the experimental protocol.**
- **Behavioural assessment should be carried out when dogs arrive at establishments and be used to guide allocation and development of resources.**

15 Transport

Most laboratory dogs will undergo transportation at some time in their life, normally from breeding premises to a separate facility where scientific procedures are to be conducted. Transport may involve movement within a building from room to room, between buildings or between premises, or even perhaps from one country to another.

15.1 General principles

Directive 91/628/EEC (as amended by Directive 95/29/EEC) (European Community 1991) and Convention ETS 65 (Council of Europe 1968) cover the movement of animals, including dogs, within the EU. The Directive is implemented in the UK by the Department of Environment, Food and Rural Affairs (DEFRA) through the Welfare of Animals (Transport) Order 1997 (UK Government 1997). The Convention has recently been reviewed and codes of conduct addressing the transport of animals by road, rail, air and sea are currently being drawn up by the Council of Europe. In addition, the transport of dogs by air is governed by the Live Animals Regulations of the International Air Transport Association (2001).

The type of journey, the destination, design of the transport container and level of accompaniment will each influence the degree of comfort experienced by the animal. The overriding principle should be to transport dogs in a manner that does not jeopardize their well-being and ensures their safe arrival in good health with minimal

distress. They should receive sympathetic handling at all times during transport (including loading and unloading). Time in transit and waiting times should be kept to a minimum, however the quality of the journey is more important than the duration.

Dogs moved between buildings or premises are best transported in containers that are designed for the purpose (see Laboratory Animal Science Association, in preparation, International Air Transport Association 2001). It is generally recommended that the container should be large enough to permit the animal/s to stand in a natural position, turn around and lie down (Animal Transportation Association 2000). For journeys within buildings, other means may be more appropriate and may include lead-walking, or the use of trolleys or carts that allow the dogs to see out. Whilst loose housing in transport is not recommended, dogs may travel by road, loose in small single-sexed groups, utilizing the cargo area of a suitably equipped vehicle (see Laboratory Animal Science Association, in preparation). Where more than one dog is to be transported in a single container, trolley or cart, they should be of the same sex and be socially compatible. Social groupings should be retained wherever possible.

In all circumstances the aim should be to minimize the negative aspects and maximize the positive aspects of the journey for the dog. Prior to transportation, dogs should be habituated to the container, cart or trolley for short periods of time to minimize levels of fear and apprehension; this can be achieved by placing the container, trolley or cart in the dogs' pen. Short periods of confinement and habituation to motion should also be considered, particularly prior to longer journeys. Such activities can be included in the dogs' general habituation and training programmes (see Section 13 and Appendix 3).

Recommendations:

- **All national and international legislation and guidance on transport should be read and applied.**
- **Dogs should receive sympathetic handling at all times during transport.**

- **Time in transit and waiting times should be kept to a minimum. However, the quality of the journey is more important than the duration.**
- **Transport containers should be of an appropriate size and construction for the journey length.**
- **Where more than one dog is to be transported in a single container, trolley or cart, they should be of the same sex and be socially compatible.**
- **Dogs should be habituated to transport containers, trolleys or carts prior to transport to minimize fear and apprehension.**

15.2 Transport by road, air and sea

Movements between premises may involve a combination of road, rail, air or sea transport and are generally completed within 24 h. For transport by air, dogs are usually held in the below-floor cargo section (belly hold) of passenger carrying airlines. For transport by sea, dogs are usually held in ventilated vehicles on roll-on roll-off passenger ferries.

In all circumstances, the journey should be planned in advance to minimize disruption to the transported animals' welfare. A journey plan should be produced detailing the responsibilities of various individuals involved in the transport (see Laboratory Animal Science Association, in preparation). The journey plan should be agreed with the intended recipient and should give accurate details of events at each stage of the journey. The plan should also provide instructions for contingencies in the event of delays and adverse events, and include contact details for all those involved in the journey.

It is recommended that information on the animals' husbandry and care (e.g. diet, established pairing or groupings) are shared between sender and recipient so that arrangements can be made for animals to become quickly acclimatized on arrival at the new premises. Sufficient time for socialization and acclimatization should be allowed before any procedures begin (see Section 15.4).

15.2.1 Preparations for dispatch

The use of a checklist of tasks that need to be carried out prior to dispatch is

recommended to ensure all aspects are considered in the planning of the journey and preparations for dispatch. Factors to consider include:

- the health and welfare of the dogs;
- the nature and duration of the journey (including changes in ambient conditions and the need for breaks for water and food);
- loading and unloading restrictions;
- the training and experience of personnel involved;
- compliance with national and international regulations.

All dogs should be inspected by a senior animal care person no more than 5 days prior to the intended journey. In the case of longer journeys, and particularly for international transport, the examination should be performed by a veterinarian. Any unsuitable animals should not proceed; for example, those showing signs of ill health. Check that prophylactic treatments are complete and the dogs' records are correct and up-to-date (see Section 10).

All documentation, including movement permits, health certificates, journey plans, transport arrangements, invoices and delivery notes, needs to be prepared well in advance. The sender is usually responsible for arranging the documentation for the whole journey; for transport, rest, food and water to be provided throughout the journey; and, where necessary, for a competent attendant to accompany the animals. The sender should ensure that all those involved in transporting the animals are clear as to who has responsibility for the animals at each stage of the journey.

Immediately prior to loading, the dogs should be subject to a physical examination by a suitably qualified person (e.g. a senior animal caretaker) and loaded as near as possible to the time of departure. In order to prevent problems of sickness during travel, dogs should not be fed and watered within 4 h of dispatch and should be exercised 30 min before being placed in the transport container to try and encourage elimination. The number of animals within any one container must be such that they travel in

comfort with due regard to conditions likely to prevail throughout the journey.

Stress should be minimized by making the animals as comfortable as possible in their containers. Suitable substrate should always be provided (e.g. clean sawdust and shredded paper). The purpose of the substrate is to absorb urine and excreta as well as to provide warmth and comfort. Sufficient material should be provided to fulfil these objectives, and it may be necessary to mix different types of material for the various purposes.

Containers should be labelled, inspected and handled according to national and international guidelines (e.g. Laboratory Animal Science Association, in preparation). All those involved with loading should be trained in the correct ways of handling containers to reduce the risk of personal injury. It may be necessary to arrange proper manual handling assessments in accordance with national regulations providing for the health and safety of employees.

Vehicles used to transport dogs should be equipped with mechanical ventilation and, ideally, will have temperature control that can be operated independently via an external electrical supply when the vehicle is parked or when travelling on ferries. Some means of monitoring conditions in the cargo area should be provided (possibly with alarms). Containers should be loaded in the vehicle such that all dogs can be checked during the journey and that there is sufficient air to circulate around the load. Rubber mats in the vehicle will help secure the load and reduce noise.

Drivers must drive to a high standard such that the dogs can maintain their balance, and should be trained to handle dogs or else should be accompanied by a competent dog handler. Nominated personnel should be notified when the animals are in transit and should be available to manage any problems.

It is recommended for personnel to stop every 2–3 h during the journey and check all dogs. All the dogs are offered water during each check and the journey restarted after the animals have been allowed sufficient time (30 min) to absorb the fluid. Adequate

supplies of food should be carried for use during long journeys (>12 h) and in the event of any unforeseen delay. Thirty minutes should be allowed after feeding before the journey is restarted. It is good practice to carry a spare container containing clean bedding in case of emergencies.

15.2.2 Receipt of animals

The journey terminates on receipt of the animals by the recipient, when responsibilities for the animals' care changes. Recipients have a duty of care to assure the welfare of the dogs by making suitable arrangements for their receipt and acclimatization in the new surroundings. Prior to delivery the recipient should prepare the required number of clean pens and make arrangements for the dogs to be fed, provided with fresh drinking water and supplied with suitable bedding. Try to ensure that the dogs are fed the same diet as at the sender establishment (see Section 7.1). On arrival all dogs should be examined by a suitably trained and competent person against a pre-determined checklist (see Section 9), and subsequently transferred to their new accommodation with the minimum of delay. Where possible, to limit the potential for transfer of infection between groups, dogs should not be mixed with other dogs in the animal unit. The sender should be notified that the animals have arrived in a satisfactory condition and notified of any concerns. Records should be maintained of the journey and location of the animals.

Recommendations:

- **Make a journey plan, with contingency plans in case of delays. The journey plan should specify responsibilities for the animals *en route* and include contact details for all those involved in the journey.**
- **Take care to ensure appropriate physical and environmental conditions during transit.**
- **Dogs should be physically examined by a suitably trained and competent person prior to loading for transport and on arrival.**

- **Suitable substrate should always be provided in transport containers.**
- **Adequate supplies of food and drinking water should be carried for use during long journeys and in the event of any unforeseen delay.**
- **A suitably trained and competent person (sometimes the driver) should accompany the animals.**
- **After transport, sufficient time should be allowed for acclimatization before any procedures begin. Sharing information on the animals' husbandry and care can facilitate this process.**

15.3 On-site transport

Transport on-site between buildings:

Longer journeys or those between buildings may require the use of purpose-built transport containers, and the dogs will normally be transported in ventilated vehicles.

Trolleys and carts may suffice for shorter journeys. Minimize stress during transport by making animals as comfortable as possible in their containers. A clean layer of substrate should be placed in each.

During transit, containers should be firmly secured within the vehicle, even for short journeys, and they should be carried, not dragged, when in use. When stacked, the containers should not occlude any aperture and thereby obstruct or interfere with good ventilation. The use of dividers or spacers within the vehicle may be necessary for this purpose.

Transport within buildings: Trolleys and carts used to transport dogs should be checked periodically; all wheels and hinges should be kept oiled to avoid unnecessary noise and the use of rubber wheels will further reduce noise and vibration. The floor of the trolley should present a non-slip surface for the dog and there should be a lid to prevent dogs jumping out. Care should be taken to give the dogs a slow, gentle journey, taking care not to unnecessarily bump or jolt the trolley. Dogs must not be left unattended in a trolley or cart.

Dogs, particularly those trained to respond to verbal commands, may be walked

between rooms. If leads are used, any training should include a gradual introduction to lead-walking. Once trained, minimal pre-planning is required prior to transport as the dog will be accustomed to such movements. It will only be necessary to agree suitable arrangements for receipt and arrival. Normally, this form of transport will include movement between holding and separate procedure rooms or to another holding room. Invariably the transport will be for short periods requiring a similar return journey. Dogs should be trained in such a way as to ensure that they enjoy such experiences (see Appendix 3). The training of young dogs can be aided by walking them with other experienced dogs. The effect of strangers and other novel situations encountered *en route* may also need to be considered in such training.

Dogs can be carried relatively easily but should be introduced to such a form of handling from an early age so that they remain still and do not struggle. Attention should be paid to the manner in which dogs are lifted from the floor and 'scruffing' should not be used. If dogs are being carried their full body weight must be supported (see Section 16). It is important to remember that male dogs are sensitive to touch near their genitalia (National Research Council 1994). A correct approach is essential (see Section 16). Dogs may be encouraged and trained to jump onto an intermediate surface such as a low shelf. This will reduce the strain to the handler in having to bend over to pick up the dog. Carrying as a means of transporting dogs is only appropriate for very short journeys (e.g. between adjacent rooms on the same floor or to transfer dogs into other containers for onward transport).

Recommendations:

- **Except for very short journeys, dogs should not be carried as a means of on-site transport. Instead they should be walked, lead-walked or transported in trolleys, carts or containers. Dogs should be habituated and trained in such a way as to ensure that they enjoy such experiences.**
- **If dogs are carried, their full body weight must be supported. 'Scruffing' should not**

be used for carrying or for lifting dogs from the floor.

- Dogs in trolleys, carts or containers should be made as comfortable as possible in order to minimize stress. Suitable substrate should always be provided.

15.4 Effects of transport

There are few published data on the effects of transport on dogs (but see Leadon & Mullins 1991). Probably the greatest effect of transport on animals is psychological, in terms of fear and anxiety as a result of novel sensations and situations, and these are difficult to quantify. More information is required in this area.

Transporting animals leads to a temporary disturbance of normal physiology (Knowles & Warriss 2000). Much depends on the type of animal, the degree of adaptation prior to transport, and the circumstances of the journey. Of course, there will also be individual variation in response to transport. A suitable acclimatization period is essential, not only for animals to overcome any stress imposed by transport, but, more importantly, to allow sufficient time and opportunity for them to become accustomed to a new physical and social environment, and to allow a period of adjustment for physiological variables to return to normal before scientific investigations are carried out.

It is recommended that dogs are given an acclimatization period of at least 7 days following transport involving a journey in a vehicle and between sites, and at least 3 days when moved in individual containers between buildings on-site. Data on the effects of transport of dogs or other species moved within a building are scant. However, at least 24 h should be permitted for acclimatization where there is a permanent change of pen location, assuming a similar husbandry and care regime exists. At least 14 days of acclimatization may be needed if dogs are to be trained prior to the start of procedures (see Section 16).

Recommendations:

- Dogs should be given an acclimatization period of at least 7 days following transport involving a journey in a vehicle and

between sites, and at least 3 days when moved in individual containers between buildings on-site.

- At least 24 h should be permitted for acclimatization following a permanent change of pen location, assuming a similar husbandry and care regime exists.
- At least 14 days should be allowed for acclimatization where dogs are to be trained prior to the start of procedures.

16 Handling and restraint

One of the most important ways to minimize stress for dogs in the laboratory is to ensure that they react well to handling. The dog should feel at ease when being approached, picked up, carried and restrained. All dogs should, therefore, experience adequate socialization with humans during the 'primary socialization period', combined with appropriate habituation and training related to their activities during studies (see Section 13). Positive interactions with humans, through regular and appropriate handling, should continue throughout the dogs' lives.

In handling and restraining dogs, it is essential to understand species-typical behaviour patterns and communication systems and to be able to accurately interpret signals and respond appropriately (see Section 4.3). It is important that all members of staff adopt a similar approach to handling and restraint and that interaction with the dogs is as consistent as possible. It is now becoming accepted that there should also be close liaison between breeders and users of dogs to ensure that handling methods are standardized between facilities.

Breeds of dog vary in size, and techniques for handling, therefore, need adaptation. The confidence of the dog should initially be assessed by interacting with him/her in a passive and non-threatening manner. Squatting down to approach from the dog's level can help keep the dog calm and talking to him/her in a quiet but confident manner can also be beneficial. Moments taken to speak to and stroke the dog may be repaid through reduction in the dogs' anxiety and physiological variability (Wolfe 1990).



Fig 14 When carried, dogs should be safely restrained and have their body weight supported

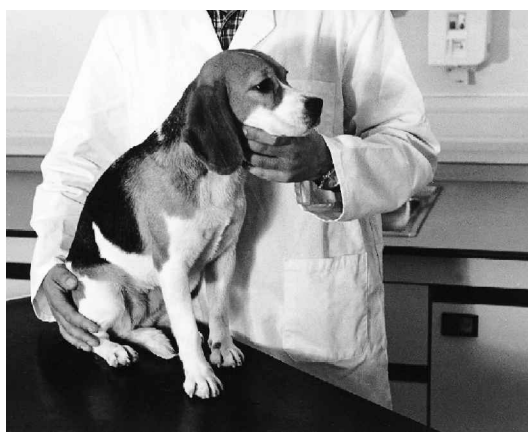


Fig 15 Dogs should be trained to tolerate restraint with positive reinforcement techniques

Direct eye contact and potentially threatening body postures must be avoided. When dogs are carried, they should be safely restrained and their body weight should be supported (Fig 14: Animal Welfare Institute); 'scruffing' should not be used for carrying or for lifting dogs from the floor or tables. In the procedure room, staff demeanour should be calm, confident and quiet. Dogs can be stroked while on the examination table but care should be taken not to unintentionally reinforce fearful responses in this way.

Temporary restraint is known to be potentially stressful to dogs (Knol 1989) but habituation and training can reduce the associated stress. If restraint is necessary to control a dog during a scientific procedure, then the method used should provide the least restraint required to allow the procedure to be performed properly (Fig 15: Animal Welfare Institute). It should protect both dogs and personnel from harm and should avoid causing distress or unnecessary discomfort (National Research Council 1994). The duration of restraint should always be minimized. Minor procedures, such as taking a rectal temperature or administering a subcutaneous injection can usually be accomplished by using minimal restraint. During venepuncture, sufficient restraint and accuracy should be used to avoid repeated needle insertions and to prevent the development of painful haematomas.

Where restraint or confinement is required as part of a scientific programme in the UK, specific justification must be included in the project licence, and details must be provided of the measures to be adopted to maintain high welfare standards, for example details of additional human-animal socialization and training for procedures (Animal Procedures Committee 1999).

It is always preferable to train laboratory animals to cooperate during procedures and husbandry, rather than to automatically physically restrain them, unless there is likelihood that they will injure themselves or staff. Such training helps reduce the stress associated with procedures and is an essential part of everyday husbandry. Dogs should be trained to tolerate restraint, especially if they are to be restrained frequently or for prolonged periods. Positive reinforcement training should be used in the form of attention or praise, providing a favourite toy or morsel of highly palatable food (see Section 13). Positive reinforcement techniques can also be used to train laboratory dogs to accept procedures such as intramuscular injection, intravenous injection and oral dosing.

Acclimatizing animals to the facility before procedures begin is likely to reduce distress and help build a positive relationship with animal care staff. Allow extra time for habituation and training animals to accept procedure rooms, restraint devices

such as slings, metabolism cages (see Section 17.3), and stressful dosing procedures such as inhalation (by habituation to the mask) and oral gavage (by sham dosing for a fixed period).

Slings: Body slings are used to support dogs when it is deemed necessary to restrain them for prolonged periods (e.g. in inhalation studies). Introduction to body slings can be usefully incorporated into the initial habituation process at the breeding establishments, but specific habituation to the sensation of being suspended by these devices should also be provided prior to individual studies. Quiet, calm dogs should be selected for use in procedures using slings. Dogs restrained in slings should be attended to at all times.

Recommendations:

- **All staff with responsibility for handling dogs should be trained and competent in the appropriate handling techniques.**
- **There should be close liaison between breeders and users of dogs to ensure that handling methods are standardized.**
- **If restraint is necessary to control a dog during a scientific procedure, then the method used should provide the least restraint required to allow the procedure to be performed properly.**
- **The duration of restraint should always be minimized.**
- **Positive reinforcement techniques should be used to train dogs to tolerate restraint.**
- **Socializing, habituating and training dogs so that they become used to humans and experimental and clinical procedures should be considered an essential element of everyday routines.**
- **Extra time should be allocated before procedures begin for training animals to accept procedure rooms, metabolism cages, restraint devices and stressful procedures.**
- **Where necessary, all dogs should be habituated and trained to stand quietly in slings. Any animal that does not settle quickly with initial training should not be used.**

- **Dogs restrained in slings should be attended to at all times.**

17 Procedures

Experimental procedures conducted in dogs can be divided into various categories: administration of substances; removal of body fluids; metabolism cages; telemetry; anaesthesia, analgesia and perioperative care; and euthanasia. Detailed reports on most of these issues are available, and so only brief attention is given here.

17.1 Administration of substances

It is a common requirement to administer substances to dogs as part of an experimental procedure, particularly for the purpose of testing the substance to be administered. Advice on best practice and refinement of administration of substances for various species, including dogs, can be found in the fourth report of the BVAAWF/FRAME/RSPCA/UFAW Joint Working Group on Refinement (Morton *et al.* 2001). In addition, a joint European Federation of Pharmaceutical Industries and Associations (EFPIA)/European Centre for the Validation of Alternative Methods (ECVAM) working group has also recently published a paper addressing good practice on administration of substances by various routes for laboratory animal species, including dogs (Diehl *et al.* 2001).

Commonly the route of administration is dictated by the expected clinical route of administration of the substance in question. Where there is an element of choice, the least invasive route with the least potentially adverse effects should be chosen. Such a choice may involve a degree of compromise between the potential for short-term and long-term effects. Therefore the sum of all of the procedures to be performed should be assessed in the development of the least aversive study design.

Recommendation:

- **The administration of substances should be by the least invasive route appropriate,**

and that with the least potential for adverse effects over the whole of the procedure.

- The relevant recommendations in the fourth report of the BVAAWF/FRAME/RSPCA/UFAW Joint Working Group on Refinement should be applied.

17.2 Removal of body fluids

Blood sampling is another very common requirement of experimental procedures in dogs. The EFPIA/ECVAM publication addresses refinement of blood sampling, as does the earlier, first report of the BVAAWF/FRAME/RSPCA/UFAW Joint Working Group on Refinement (Morton *et al.* 1993). A similar decision-making process may be appropriate in assessing the potential for vascular catheterization as a refinement, in preference to repeated sampling by needle and syringe.

Other substances commonly sampled in the experimental situation include urine and faeces. Total collection of such materials will normally require housing in a restricted space with grid flooring to assist the collection of urine (e.g. a metabolism cage) (see Section 17.3). Critical analysis of the need for a total collection is wise, as urinary catheterization may be an appropriate alternative collection method. In experienced hands, this is a procedure which is quick and relatively non-stressful, and removes the need for single housing on grid floors.

Collection of other fluids from dogs will likely require invasive procedures and possibly catheterization. The real need for such collections should be established in all cases, and the least invasive, least restrictive regimes for collection should be used.

Recommendations:

- Always critically assess whether the collection of body fluids other than blood and urine is really necessary. If so, always use the least invasive, least restrictive regime.
- Potential refinements for the removal of body fluids include vascular catheterization as an appropriate refinement for

blood collection, and urinary catheterization for urine collection in preference to single-housing in a metabolism cage.

- For the removal of blood, apply the relevant recommendations in the first report of the BVAAWF/FRAME/RSPCA/UFAW Joint Working Group on Refinement.

17.3 Metabolism cages

Metabolism cages are employed to collect urine, faeces and cage wash from dogs usually dosed with radio-labelled materials. The animals are housed for periods of time (usually 5–7 days) in order to determine the absorption, distribution, metabolism and excretion of such materials. Metabolism cages are also sometimes utilized for shorter periods (up to 24 h) for the collection of small volumes of urine to assess clinical pathology.

Metabolism cages should not be used unless they are absolutely essential. The necessity for metabolism cages should be determined in consultation with the veterinarian, animal care staff and competent person charged with advisory duties in relation to animal welfare. The justification for their use should be included in any cost–benefit analysis by ethics committees of a proposed programme of research.

Specific habituation to this unusual form of housing, albeit temporary, is important. During early procedural training in the breeding units all puppies should be exposed to grid flooring as part of the textural diversity of the habituation programme. Dogs that are intended for use in studies involving metabolism cages should also be introduced to confinement within such devices in a gradual manner as early as possible. In addition, acclimatization to metabolism cages should be carried out prior to the commencement of individual studies.

A small cross-company team within the UK has reviewed the dimensions and general operations of metabolism cages for dogs. The Working Group wishes to endorse their recommendations:

- The cage dimensions should allow the dog to perform the following activities without being restricted by the cage

sides or roof: to stand on all four legs; turn around; lie in a natural, curled-up sleeping position; and stretch out comfortably.

- A floor area of around 1–1.2 m² appears to give a reasonable balance between allowing the dog room to perform the stated activities, and good recovery of compound. However no hard-and-fast minimum size is proposed, as it is felt that the performance criteria stated above are more important than any precise dimensions.
- Food and water containers should not interfere with an animal's ability to stretch out.
- Shelves may be incorporated, but again they should not interfere with an animal's ability to stretch out and move around.
- Flooring materials should not cause damage to the animal's paws.
- Duration of containment should always be minimized. Any limits should be specified in the research protocols and balanced against other potential sources of stress on the animals, the objectives of the studies, and the potential risk of repeating studies that have been terminated prematurely. It is suggested that research protocols should specify a 15-day post-dose holding period as an upper limit for routine use. Dogs should routinely be given, as a minimum, 2 weeks of recovery for every week held in a metabolism cage. There should be scope for the establishments' veterinarian to decrease this recovery period if such a reduction has the potential to improve welfare (e.g. if by doing so, the end date of a study could be brought forward).
- Dogs in metabolism cages should always be able to see at least one other dog. Where only one dog is required for the procedure, consideration should be given to allowing sight of a 'companion' dog.
- Dogs in metabolism cages should be provided with contact from their handlers *in addition* to contact needed to conduct the study. The establishment policy for this should be recorded as part of the overall socialization programme for the dogs.

- Enrichment such as chews should be provided.

Recommendations:

- **Metabolism cages should not be used unless scientifically justified and unless other methods requiring less confinement or not requiring isolation cannot be used. The justification for their use should be included in any cost-benefit analysis performed by ethics committees.**
- **The dimensions, design and construction of metabolism cages should be carefully considered so as to minimize their impact on welfare.**
- **Consideration should be given to habituating animals to metabolism cage housing, including grid flooring, during procedural training.**

17.4 Telemetry

Dogs are frequently used in telemetry studies, especially to fulfil requirements of regulatory bodies. Telemetry is widely viewed as benefiting science and animal welfare (for example, because it can reduce stress caused to animals by the use of restraint), however, the use of telemetry can require invasive procedures such as implantation surgery, single housing and the use of jackets which can cause pain and distress. Advice on refinements in telemetry can be found in the seventh report (Parts A and B) of the BVAAWF/FRAME/RSPCA/UFAW Joint Working Group on Refinement. Part A (Morton *et al.* 2003) details refinements in telemetry procedures and Part B (Hawkins *et al.* 2004) details refinements in husbandry for animals used in telemetry procedures, including the selection of suitable individuals and habituation of dogs to single housing and to the telemetry pen and apparatus.

Jackets and collars: Jackets are often used in telemetry studies (e.g. to hold devices) and in other types of scientific study (e.g. to hold pumps for continuous dosing). Collars may be used to prevent interference with implanted cannulae or dermally-applied materials. Where jackets and collars are

required, dogs should be habituated gradually to their use, and monitored for potential adverse effects such as skin irritation.

Positive reinforcement techniques, such as putting the devices on just before feeding and removing them as soon as feeding is complete, can be employed to encourage the formation of positive associations with the wearing of these devices during the acclimatization process. Foam collars are preferable to Elizabethan collars, which restrict the dog's vision and make movement around the pen more awkward.

Recommendations:

- **Telemetry procedures and husbandry for animals used in telemetry procedures should be refined to reduce any pain and distress. Apply the relevant recommendations in the seventh report (Parts A and B) of the BVAAWF/FRAME/RSPCA/UFAW Joint Working Group on Refinement.**
- **Where jackets and collars are required, gradual habituation and monitoring for adverse effects should be routine. Foam collars should be used in preference to Elizabethan collars.**

17.5 Anaesthesia, analgesia and perioperative care

The use of appropriate anaesthetic and analgesic techniques are an expected part of experimental studies, except where their provision would lead to greater potential pain or distress than were they not provided, or where the scientific objective would not be achieved. The potential for interference with experimental results is another commonly cited reason why analgesics may not be appropriate in particular circumstances, but any failure to provide adequate anaesthesia and analgesia where significant pain is expected requires specific justification when authorizing the work (e.g. by the ethics committee). Where there is concern over the use of a particular class of analgesic (e.g. opiates), alternative classes of drugs can be considered (e.g. NSAIDs).

The use of safe and effective anaesthetic and analgesic regimens can have a major

impact on animal welfare. When planning an experimental protocol, consulting textbooks on anaesthesia, analgesia and pharmacology (e.g. Green 1982, Flecknell 1996, Kohn *et al.* 1997), thorough literature searches, and discussion with experienced colleagues are all crucial for success and represent best practice. Regular handling and habituation to the experimental procedure will provide calm dogs, a prerequisite for smooth and painless anaesthetic induction (see Sections 13 and 16). Dogs recovering from general anaesthesia are frequently hypothermic. In such cases, heat should be supplied to maintain normal body temperature (see Section 6.2.2).

Pre-surgical assessment should be carried out to establish baseline data and to identify any abnormalities which may interfere with the safe use of a dog in an anaesthetic or subsequent surgical or experimental protocol. Pre-anaesthetic evaluation of dogs should comprise at least a physical examination, clinical history assessment, body weight recording and preferably clinical chemistry and haematology. The evaluation should be further customized to the needs of each protocol and animal. Where abnormalities are identified they should be addressed in the light of the particular protocol, and appropriate action should be taken, which may include withdrawal of the affected animal from the protocol. Monitoring of dogs during anaesthesia will form part of the identified anaesthetic protocol.

Dogs should remain closely monitored until they have fully regained consciousness. Monitoring of dogs in this period and for the assessment of post-surgical pain should be undertaken by appropriately trained personnel. For a list of the degree and duration of pain that can be expected after surgery on various parts of a dog's body see National Research Council (1992). Protocols for the alleviation of pain and for the treatment of infection or wound breakdown should be conducted under direct veterinary control and should be initiated in good time. Post-surgical pain can be largely prevented by administering 'pre-emptive analgesia' before surgery begins, in conjunction with postoperative top-ups. If this

protocol is not followed, established pain can only be controlled, which is more difficult to achieve (Dobromylskyj *et al.* 2000).

Suitable post-surgical assessment can be a major factor in assuring the welfare of dogs and should be planned in advance. Potential complicating factors include circulatory and respiratory factors, hypothermia, pain and discomfort, infection and wound breakdown. The extent to which the various factors will interfere with the welfare of the dog depend largely on the type, length and invasiveness of the surgical protocol.

The long-term aim of post-surgical management is to return the dog to the physiological and behavioural state matching its pre-surgical condition. Care will commonly include provision of additional warmth and bedding, regular human contact (stroking should normally reassure the animal and assist in providing a smooth recovery, see Section 4.2.4) and monitoring of surgical incisions, maintenance of dressings as appropriate, suture removal and recording of changes in body weight. It may be appropriate to note a conclusion to a post-surgical monitoring period, or prepare an ongoing plan of observations, to assure continual monitoring. Such actions should be under veterinary supervision.

Retrospective analysis or review of the perioperative care plan should be carried out and any improvements which are identified should be incorporated into subsequent protocols. More specific information can be found in the published literature (e.g. Bennett *et al.* 1994, Flecknell 1996, Kohn *et al.* 1997).

Recommendations:

- **Where animals are expected to experience pain and distress after procedures, appropriate anaesthesia and analgesia should be given unless there are scientific or welfare reasons for not doing so.**
- **Pre-anaesthetic evaluation of dogs should comprise at least a physical examination, clinical history assessment, body weight recording and preferably clinical chemistry and haematology.**
- **Conduct suitable literature searching prior to the selection of appropriate**

anaesthetic and pre-emptive analgesic regimens.

- **Make sure that protocols for dealing with chronic discomfort or pain are in place before projects begin.**
- **Provide pre-emptive analgesia for animals undergoing surgery and conduct retrospective assessment of the degree and duration of any pain and distress.**
- **Review of the perioperative care plan should be carried out and any improvements identified should be incorporated into subsequent protocols.**

17.6 Recognition and monitoring of adverse effects

Dogs are highly intelligent, sentient and social animals with a complex range of physical as well as emotional needs. There can be no question that they have the capacity to experience pain. It is also generally accepted that dogs experience a range of negative emotions (e.g. anxiety, apprehension, fear, phobia, frustration, boredom and mental distress) as well as a range of positive emotions (e.g. interest, pleasure, happiness, excitement).

It is of fundamental importance to be able to recognize when dogs are suffering pain and distress so that one can alleviate or reverse such suffering, or take steps to avoid it in the future. This is important for humanitarian and ethical reasons and for satisfying legal obligations. Moreover, there is a pragmatic reason to minimize pain and distress—unless a stressor (such as pain) is the subject of the experiment, distressed animals might provide erroneous data (e.g. Amyx 1987). Unless the contrary is established, investigators should consider that procedures that cause pain and distress in humans may cause pain or distress in other animals (see Organisation for Economic Co-operation and Development 2001, Soulsby & Morton 2001).

The recognition of animals in pain and distress is important as it is the first basic step in any programme of avoidance or alleviation of such conditions. Care-giving staff are generally familiar with the normal behaviour and temperaments of individual

animals and therefore are the ones most likely to recognize that an animal is 'not right' (Morton & Griffiths 1985). They may interpret this as some form of emotion (e.g. agitation, stress, pain, fear, anxiety, and so on), but it is important to understand and annotate what they are seeing in order to provide the right sort of treatment—it is no good giving analgesics to relieve distress or sedatives to relieve pain. The critical observation of animals leads to some descriptors of what the abnormal behaviour or other sign is which is being seen. Some of these signs may be measurable such as changes in body weight or rapid breathing, whereas others may be equally reliable and objective such as limping, diarrhoea, closed eyelids and so on (Morton 2000). Just because they cannot be quantified does not make them less useful or less likely to be seen by trained observers. When monitoring animals for signs of pain and distress, it is often useful to assess unprovoked behaviour, then to look for further signs when the animal is first disturbed and handled, since animals may show a change in their normal response to being handled or manipulated. Check animals at regular intervals during the course of the experiment, particularly at times when adverse effects are most likely to occur.

A brief summary of signs of pain and distress in dogs is given below. Although pain thresholds are similar between individuals, pain tolerance varies widely. Therefore, each dog should be observed and treated as an individual in determining the need to administer analgesics (see Section 17.5). See Holton *et al.* (2001) for a detailed, validated behaviour-based scale for measuring acute pain in dogs in a hospital setting (also Lascelles *et al.* 1994, Firth & Haldane 1999). Note that a study on subjective and objective measures of pain in dogs in a clinical situation found poor correlation between them, suggesting that clinicians should not rely too heavily on subjective measures when deciding on pain management protocols (Conzemius *et al.* 1997). For more information on current techniques for pain assessment in the UK, including downloadable score sheets that can be adapted to specific procedures, see Hawkins (2002).

Sharing comprehensive information on how pain and distress were recognized, avoided, prevented or alleviated in an experiment can help others use similar techniques, and this promulgates good welfare and science (Morton 1992). When writing up studies for publication in mainstream scientific journals, such information should be included.

Signs of pain: Signs of pain in dogs, including initial and additional responses to acute pain, post-injury pain and chronic pain, are reviewed in detail in Flecknell and Waterman-Pearson (2000). Dogs usually respond to acute pain by vocalizing (e.g. yelping) and by protecting or guarding the area of perceived pain. In circumstances where the animal is able to reach the painful area, it may rub, bite and scratch at it. It may seek out cool areas in which to rest. Other signs include withdrawing, growling without provocation and attempting to bite if touched, and adopting unusual postures (e.g. with abdominal pain, dogs adopt a hunched or 'prayer' posture and may be reluctant to move: Hardie 2000).

Pain can produce restlessness or inactivity according to the site affected, for example, colic as opposed to musculoskeletal pain, respectively. Severe pain, especially if chronic, usually makes dogs appear distressed and lethargic. The decrease in activity can be accompanied by one or more of the following: shivering, panting, howling or whining, and sometimes attention seeking, depending on the temperament of the dog (Wolfensohn & Lloyd 1998). Loss of appetite (a failure to eat all the food, or to eat it at a slower rate than normal), especially in a dog which normally eats well, can be a marker of ongoing pain (see Section 9). As recovery progresses, whimpering is the most frequent type of vocalization and often stops when the animal is comforted. Chronic pain, especially, is insidious in onset, and pain caused by dental disease, can go unnoticed in dogs for years.

Severity limits: The collation of signs of pain and distress together with some idea of frequency will lead to an assessment of the

overall intensity and duration, and in the UK to what can be described as an acceptable or an unacceptable severity. In the UK each scientific protocol has a severity limit and if an animal exceeds that limit or is likely to do so then action must be taken to reverse the situation or to avoid the limit being exceeded. As the limit is the maximum any animal undergoing that protocol may be subjected to, it is often an overestimate. There are no ways in which actual suffering is being recorded in the UK at present, although other countries are starting to look more carefully into this. The Working Group recommends that an assessment of the actual level of suffering should be documented retrospectively and reported to the ethics committee in order that refinements can be introduced into subsequent studies.

All adverse effects, not just those presenting signs, must be taken into consideration when making an assessment of the effect of a procedure and the degree of pain, distress or lasting harm which may be experienced by an animal. Appendix 5 gives an example of a table of clinical signs used to guide caregivers in the assessment of pain severity. The table lists possible clinical signs of toxicity in dogs and classifies the signs as mild, moderate and substantial. Other humane endpoints have been documented in a symposium (see Hendricksen & Morton 1999, Organisation for Economic Co-operation and Development 2001).

Recommendations:

- **Avoid, prevent or alleviate pain and distress in dogs wherever possible.**
- **Before commencing a scientific procedure draw up a list of likely clinical signs that might be seen, when they may occur and what to do in the event that they are seen. Think about and discuss with other caregivers how you might recognize whether a dog is suffering pain or distress.**
- **Ensure appropriate clinical examination of dogs prior to the conduct of surgical procedures, and conduct retrospective analysis of results to identify potential improvements in pre- and post-surgical care.**

- **Staff involved in assessment of dogs before and after surgery should be suitably trained in the potential adverse effects expected, and in the appropriate actions to be taken.**
- **Include comprehensive information on how pain and distress were recognized, avoided, prevented or alleviated when writing up studies for publication in mainstream scientific journals.**

17.7 Euthanasia

Because of their special relationship with humans (Hart 1995), working with dogs is, for many people, a more emotional experience than working with many other species. So too is the killing of these animals, and any human anxiety can be transferred to the animals. It is therefore essential that the staff members chosen to euthanize the animal are willing and mentally prepared to do it, and competent in the method chosen. Both attributes are important, as if something goes wrong it can be remembered for a long time and can affect their future interactions with dogs. Good training, adequate supervision and empathetic yet directive guidance are all essential. The American Veterinary Medical Association (AVMA) (2000) lists the conditions that must be provided for a method to be called humane. Most important are a painless and rapid induction of unconsciousness with the minimum of distress and fear to the animal. The animal has then to be killed efficiently with no room for error. The method should also be aesthetic for some of the reasons stated above.

One of the most common methods for killing dogs is to give them an overdose of an anaesthetic, such as sodium pentobarbitone (at 75 mg/kg or more) intravenously. The strength of the solution used for euthanasia varies and can be from 60 to 400 mg/ml as some establishments make up their own solutions from the solid chemical. However the solution is prepared, it has to be recognized that it is extremely alkaline at high concentrations, having a pH of 12 or more. Consequently, it has to be given into a vein and not subcutaneously

or into the peritoneal cavity because of the irritancy that will be caused to the tissues and organs. It is unacceptable to give mixtures of pentobarbitone with a neuromuscular blocking agent, as the animal may suffer from the effects of neuromuscular blockade before becoming unconscious.

In addition to welfare concerns for the animal, the choice of euthanasia method will be influenced by the scientific study and what is consistent with the scientific objective. This may necessitate other routes and agents and the reader is referred to the standard texts such as Close *et al.* (1996, 1997) and American Veterinary Medical Association (2000).

Method: Dogs should be handled gently but firmly and empathetically when restrained for injection. Talking to the animal can also provide reassurance for it. If something goes wrong this can cause the dog to become stressed; therefore it is better for euthanasia to be conducted in an area separate from other dogs. (Guidance on humane killing under the UK A(SP)A states that, as a general rule, animals to be killed should be removed from the immediate presence of others: Home Office 1997).

The importance of the person holding the animal for the intravenous injection cannot be overestimated as this ensures the dog feels secure and the cephalic vein of a front leg is raised in such a way that the person giving the injection has no difficulty in locating it. Other veins can be used (e.g. jugular, saphenous) but the position in which the dog is restrained is not so natural or comfortable. The holder should restrain the dog firmly (see Fig 16) but not too tightly, and similarly the vein should be raised with sufficient pressure to prevent venous blood return (but not so tightly as to stop the blood from entering the limb). Pulling back slightly on the vein also keeps it in position during injection, and once the needle is clearly in the vein (e.g. blood aspiration) the injector can indicate to the holder that the pressure on the limb be slowly slackened. The person injecting should not start to inject unless they are absolutely sure the needle is in the vein as they are likely to



Fig 16 Correct restraint for euthanasia (Redrawn with permission from the Kauai Humane Society)

'blow' the vein (i.e. place the injectate outside the vein and make it difficult for further injections). For this reason it is important to stop injecting as soon as there is a 'blow'. If the first injection site chosen is lower on the limb, it provides a chance for a second injection further up the leg if something goes wrong. If there is failure injecting the animal during the first time and the dog has become agitated for some reason and cannot be calmed, then it is best to wait for a while (say 30 to 60 min) before trying again. It may also be necessary to sedate the animal or even anaesthetize it before humanely killing it by another method (e.g. cut down onto a vein).

In some animals with poor circulation it may be necessary to use the jugular vein or even to anaesthetize the animal and carry out a cardiac injection or cut down onto a vein. Cardiac injections should not be given to conscious animals, as injecting into the chest can be more painful than through the skin due to the chance of hitting the ribs and injecting into the cardiac musculature.

Death should be confirmed by an absence of respiration, heartbeat (using a stethoscope) and femoral pulse. In order to ensure death after an intravenous injection, a second dose can be given into the heart. The observation that rigor mortis (e.g. stiffening of the back legs) is setting in is also a confirmatory sign.

Recommendations:

- **Euthanasia where required should be conducted using a method ensuring painless and rapid induction of unconsciousness. Intravenous injection of barbiturate is recommended for conscious dogs, with or without prior sedation.**
- **Neuromuscular blocking agents should never be used alone to euthanize animals.**
- **Ensure that all staff chosen to euthanize animals are willing, mentally prepared, empathetic and competent in the method to be used.**
- **Euthanasia of dogs should be conducted in an area separate from other dogs.**

18 Long-term use

The lifespan of dogs, compared with other laboratory animal species, is relatively long. Some dogs may therefore be housed in the laboratory for a number of years either as breeding or experimental animals. These latter include, for example, telemetered or surgically prepared dogs on long-term studies, and animals authorized for re-use. In such circumstances, there are particular ethical, scientific and welfare issues that must be addressed (see Morton *et al.* 2003, Hawkins *et al.* 2004). The age at which dogs are routinely euthanized or rehomed varies between establishments, but the upper limit is generally when they are 7 or 8 years old.

The welfare concerns with respect to maintaining animals for long periods in a laboratory environment relate to potential adverse effects from housing and husbandry and, for experimental animals, their continued use in scientific procedures. These need to be weighed against the welfare cost of

obtaining, and in some cases surgically preparing, a naïve animal. It will therefore be necessary to decide the maximum time it is acceptable to keep and/or use animals before they are euthanized or rehomed (see Section 19). It is not easy to define criteria for such decisions, except where there are clear veterinary grounds for euthanasia.

Decisions will often need to be made case by case on the basis of what is in the best interest of the individual animals concerned, but it is helpful to have some guidance on the factors that need to be taken into account. All the potential welfare costs to each individual, including those associated with housing and husbandry in the laboratory environment throughout the animal's lifetime, should be carefully considered. For example, the longer dogs are kept in kennelling the more likely they are to develop stereotypies (see Section 5); some dogs get more difficult to manage as they get older and may have to be singly-housed as a result; surgical preparation can also limit pair- or group-housing and socialization with other dogs. Given the importance attached to group housing and socialization for dogs, the likely need to singly house animals should be a significant factor in decisions on long-term use, although this will in turn depend on the nature of the individual dog and other opportunities for socialization with care staff.

There are additional ethical and welfare concerns with regard to re-using animals in subsequent experiments. Re-use has the advantage that it could result in a decrease in numbers used overall. However, the actual or potential costs to the individual animals concerned (e.g. single housing, and the effects of subsequent procedures) must be weighed against this. In the UK, re-use is subject to legal constraints (Home Office 1990) and the view is that a reduction in overall numbers does not justify causing a significant increase in costs for the individual animals involved.

In all cases, the health and welfare of all dogs held long-term should be regularly reviewed (e.g. every 3 months) by the attending veterinarian as part of a full clinical examination. Particular attention should

be paid to specific health issues for older dogs (see Section 9) and to behavioural health. Ongoing assessments should be conducted to monitor for abnormal behaviours indicating that animals are unable to cope with their environment, and appropriate action should be taken as necessary (see Section 5). Additional resources (enrichment, exercise, procedural training, habituation and socialization with other dogs and humans) should be targeted at dogs used long-term.

Recommendations:

- **When maintaining dogs for long periods in the laboratory think carefully about the potential adverse effects that long-term housing and husbandry, and/or continued use in procedures, will have on each individual dog from his/her point of view.**
- **Additional consideration should be given to ensuring that the behavioural, social and physiological needs of dogs used on a long-term basis are adequately met, and this may require additional resources.**
- **Think carefully about the criteria that you would consider grounds for euthanasia. Discuss these with the attending veterinarian, scientists or animal care staff concerned as appropriate and make sure that everyone responsible for monitoring animals is familiar with them.**
- **Carefully balance the reduction in numbers of animals achieved by re-using those that return to a normal post-experimental 'baseline' position, against the increased welfare cost for those individuals of long-term confinement in the laboratory and use in further procedures.**

19 Rehoming

The possibility of rehoming as an alternative to euthanasia for surplus dogs and/or ex-breeding and ex-experimental animals should always be explored. This concept is not new, and is being successfully developed in several countries, notably the UK, Germany and the USA. Clearly, animals should only be rehomed if they are not

suffering or likely to suffer any adverse effects from their experiences in a laboratory environment. In the UK their fitness for rehoming must be assessed and certified by a veterinary surgeon (see Laboratory Animal Veterinary Association 2001 for guidance on discharge of animals from the UK A(SP)A).

There are a number of other factors that must also be considered if rehoming is to be truly in the best interests of the individual animal. These factors were addressed in detail at a Laboratory Animal Science Association (LASA) meeting in the UK in 2001. It was generally agreed that laboratory beagles could be successfully integrated into home environments, provided that the rehoming process was carried out carefully, with due regard to all the issues regarding animal welfare, the prospective owner, participating organizations and the establishment from which the animals came. LASA has produced useful guidance on rehoming laboratory beagles safely and humanely (Laboratory Animal Science Association, in preparation), and therefore only a brief summary is presented here.

An essential pre-requisite is a comprehensive and effective socialization, habituation and training programme (see Section 13). In addition, as with any rehoming programme, proper matching of the retired dog with the new owner is a basic condition for success. Rehoming laboratory dogs results in a change of canine company, human contacts and physical environment, all of which may have behavioural consequences for the animals. These must be addressed if rehoming is to be a positive experience.

It is important to consider whether each individual animal can learn to cope with a change in what is 'normal' in their environment. The 'normal' physical environment for a laboratory dog is constant, relatively barren, and often exclusively indoor. It generally offers constant canine company, but minimal human interaction. In contrast, a companion dog's environment is likely to be complex and varied, with outdoor and indoor elements, a variety of experiences, varied human interaction and, in some cases, very limited canine interaction. It is therefore vital to have a preparatory phase

in any rehoming scheme. Although this could take place immediately prior to release, once rehoming is accepted as a potential option, there is much that can be done within the routine management of both breeding and experimental animals to give a baseline of preparation for potential future rehoming. This will benefit both science and animal welfare since programmes of socialization, habituation and training not only make the animals more suitable for rehoming, but they will also lower their stress levels when faced with novel situations in the laboratory, such as visitors or experimental procedures.

The suitability of the new home and the prospective owner are also important elements of the process. For example, laboratory dogs should probably not be rehomed into homes without other dogs. Owners need to know what to expect from an ex-laboratory dog and to understand and be able to manage potential problems. The LASA report and guidance both provide additional details in this respect.

It should be noted that rehoming of significant numbers of laboratory dogs is

unlikely to be possible without the participation of animal welfare organizations that already rehome animals. There is a precedent for this in the German programme (described in the LASA report) and in a trial programme being developed with the RSPCA in the UK.

Recommendations:

- **The possibility of rehoming as an alternative to euthanasia for surplus dogs, ex-breeding and ex-experimental animals should always be explored.**
- **The rehoming process should be carried out carefully with due regard to all the issues relating to animal welfare, the prospective owner, participating organizations and the establishment from which the animals came.**
- **A pre-requisite for rehoming laboratory dogs safely and humanely is a comprehensive and effective socialization, habituation and training programme. The UK Laboratory Animal Science Association has detailed information and guidance on rehoming and this should be used.**

Part 6

20 Staff training

The actions, or lack of actions, on the part of laboratory staff working with dogs, can play a large and important part in the quality of day-to-day life of each individual dog in their care. Laboratory staff should have a good relationship with the dogs, be competent, empathetic and motivated to carry out their work, and be well versed in the latest developments in their field. Those who use dogs in experiments and those responsible for their husbandry and care must therefore receive adequate and appropriate training; in many countries this is required by law (e.g. European Community 1986).

Training needs to encompass all aspects of dog husbandry, care and health, including environmental and nutritional requirements, environmental enrichment, handling and recognition of ill health, pain and distress (see Federation of European Laboratory Animal Science Associations 1995, 2000). Training in dog behaviour is also important and handlers should become familiar with the patterns of behaviour associated with, for example, greeting, sexual behaviour, nervousness, submission and aggression (see Section 4.3). Appropriately qualified canine behaviour specialists can assist in this regard. Expert advice can also be sought from organizations such as the UK Institute of Animal Technology (IAT) which runs a 'Dog Management and Welfare' course for animal care staff and facility managers.

Training and competence in carrying out the relevant experimental techniques is also essential. Artificial training aids should be used wherever possible before progressing to scientific procedures on animals, and there are several available for simulating the dog (e.g. dog leg cephalic simulator, dog neck venous access cut down simulator: Bell Isolation Systems Ltd, www.bell-isolation-systems.com). Audio-visual training aids (e.g. videos and CDs) covering many aspects of working with laboratory dogs are commercially available. These are best watched

or worked through with an appropriately experienced person. The Working Group hopes that the present report will also prove useful as a training aid.

Facilities breeding or using dogs should develop a comprehensive training programme for new staff and establish an adequately-funded continuing professional development programme to encourage staff and ensure they can keep up to date with novel developments or improved practices in dog welfare. Training programmes should include some form of ongoing assessment to ensure that suitable standards and competence are attained and maintained, and there should be written training records.

Staff training and assessment of competence should be regularly reviewed as an integral part of the ethical review process (e.g. by the local ERP in the UK, ethics committee in Sweden, or IACUC in the USA). This will help ensure that any improvements in training processes can be recognized and implemented without delay.

Recommendations:

- **All those who use dogs in experiments and those responsible for their husbandry and care must receive adequate and appropriate training which should include an understanding of the physical, physiological, behavioural and social needs of the dog. Such training should be followed by an assessment of competence.**
- **Every research or dog breeding facility should develop appropriate training programmes for their staff and ensure that everyone who will be caring for or using dogs is adequately trained and competent before projects begin. There should be some form of ongoing assessment to ensure that suitable standards and competence are attained and maintained.**
- **The process of staff training and assessment should be regularly reviewed as an integral part of the ethical review process.**

21 Towards an ideal system: future research areas

Refinement of dog husbandry and care would be greatly facilitated if more knowledge and techniques were available. Possible areas for future research include:

- The relationship between welfare and the physical and social environment (to determine a better understanding of what constitutes optimal dog housing).
- Economical and practical ways of enriching the pen environment, which take into account dogs' needs and sensory modalities.
- The relationship between pen size, number of individuals and behaviour, preferably under carefully controlled experimental conditions.
- Ways to ameliorate the negative effects of single housing.
- Ways to prevent and manage aggression.
- The percentage of time to which dogs are exposed to various sound levels throughout the day and evening (for assessing the potential effects of such sound levels on dogs, and in attempting to set realistic limits for noise levels in kennels that take into account the frequency sensitivity curve of dog hearing).
- The demand for different toys and chews. (No such studies have been attempted in canids.)
- Comparing different methods of presentation of toys and chews, and determining how effective various types of enrichment are in single housing or in larger groups.
- The influence of early experience on behaviour, including vocalization, in laboratory beagles.
- The psychological and physiological effects of transport.
- The design of metabolism cages to reduce their impact on dog welfare.

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Glossary

Acclimatization: Adaptation to a new climate or environment.

Acidosis: A reduction in the pH of the blood, commonly due to an increase in blood carbon dioxide level.

Aetiology: The part of medical science dealing with the causes of disease.

Agonistic behaviour: Any form of behaviour associated with conflict, including threat, attack, appeasement or flight.

Allelomimetic behaviour: Behavioural activities that have strong components of social facilitation, imitation, and group coordination.

Anorexia: Loss of appetite.

Ataxia: Loss of coordination, though the power necessary to make the movements is still present.

Auscultation: The diagnostic technique in medicine of listening to the various internal sounds made by the body, usually with the aid of a stethoscope.

Capnography: Continuous analysis and recording of carbon dioxide concentrations in respiratory gases.

Circling: Repetitive circling around the pen.

Conditioning: Development of a specific response to a specific stimulus.

Conspecific: Another member of the same species.

Cost-benefit analysis: The process by which the potential beneficial effects of a programme of research is weighed against the likely adverse effects on the animals concerned. It is normal to take into account the lifetime experience of the animals.

Debarking: Surgical removal of the vocal cords.

Dichromatic: Possessing two types of cone photoreceptors.

Dystocia: Abnormal or difficult labour.

Electrocardiography: Measurement of the variations in electric potential which occur in the heart as it contracts and relaxes.

Gastric fistula: The direct communication, via a tube-like passage, between the stomach and the skin over the abdomen.

Gingivitis: Inflammation of the gums.

Habituation: The waning of a response as a result of repeated stimulation, but not fatigue. This kind of learning is of importance in familiarizing an animal with aspects of the environment to which it is not expected to react. It is of value in the training of dogs to ignore non-threatening stimuli.

Homeothermic: Ability to maintain a constant core body temperature.

Hydrocephalus: A condition in which there is abnormal accumulation of cerebrospinal fluid within the skull.

Hypercapnia: Elevated level of carbon dioxide in the blood.

Hyperkeratotic: An increase in thickness of the horny layer of the skin; characterized by excessive growth and accumulation of the cells of the stratum corneum, the barrier layer of the skin.

Hypoxia: Depressed level of oxygen in the blood.

Iatrogenic: Caused by a doctor or veterinarian; caused by medication.

Idiopathic: Arising spontaneously from an unknown cause.

Inguinal region: The groin; the area of the body where the lower part of the abdomen meets the upper thigh.

Jumping: Repetitive jumping so that hind legs leave the ground.

Multiparous: Having given birth two or more times.

Neophyllic: Demonstrating a preference for novelty.

NSAIDs: Non-steroidal anti-inflammatory drugs.

Osmatic: Having or characterized by a well-developed sense of smell; relying on smell for orientation.

Osteopaenia: Reduced bone mass.

Oximetry: The measurement by an oximeter of the proportion of oxygenated haemoglobin (q.v.) in the blood.

Pacing: Repetitive pacing, usually along a wall.

Palpebral: Relating to the eyelid.

Polydipsia: Excessive water drinking.

Polyphagia: Excessive eating.

Positive reinforcement: The process whereby the presentation of a pleasant (rewarding) stimulus increases the probability of

a behaviour recurring in similar circumstances in the future.

Pound: A facility in which stray, abandoned and lost animals are held, or 'impounded' for a period of time. The purpose of impoundment is to allow time for owners to claim lost pets or to find new homes for the animals. Animals neither claimed nor adopted at the end of this period are killed humanely.

Primiparous: Belonging to a first birth; bearing young for the first time.

Prognathism: Abnormal protrusion of the lower jaw or sometimes of both jaws.

Prophylactic: Something that prevents against disease.

Purpose bred: Bred specifically for research and testing.

Repetitive grooming: A stress-relieving behaviour, which may become compulsive in nature if stressors are chronic or unavoidable.

Resource holding potential: An index of competitive ability (the ability of an individual to gain and retain resources). It is based on physical attributes such as size and weight together with outcome of previous encounters. Mutual assessment allows the prediction of the outcome of interactions between competitors and reduces the risk of aggression.

Rhinarium: The moist naked area surrounding the nostrils in most mammals.

Snellen fraction: A ratio measuring the acuity of a person's eyesight compared to a standard observer with good normal acuity. 20/20 means he/she can resolve two target features at 20 feet.

Socialization: The process by which an animal learns how to successfully interact with members of its own species and with other species with which it cohabits.

Stereotypies: The performance of unusual motor acts, repeatedly and often invariably, which serve no apparent purpose;

often indicative of an inadequate or inappropriate environment.

Swimmers: Puppies born with a broad, flattened chest, which seem unable to get up on to their feet when their litter mates can. A swimmer keeps its forelegs at right angles to its flanks, and the hind legs are usually extended behind the pup. Typically, an affected puppy moves around the whelping box in a swimming motion. The condition is thought to be due to weakness of the muscles or a deformity of the bones.

Tapetum: A reflecting layer, containing crystals of guanine, in the choroid area of the eye that greatly enhances vision in dim light by reflecting light back through the retina a second time.

Trichromatic: Possessing three types of cone photoreceptors.

Turbinates: Bony ridges located in the nasal passages covered with mucous membrane containing scenting cells. They serve to slow the movement of incoming air, warm it, moisten it and spread it out over the scent reception area of the nasal chamber.

Uterine inertia: Failure of the uterus to have the strength to expel a puppy.

Vomeronasal (Jacobson's) organ: A second and independent olfactory system located within the roof of the mouth and with its own nerve and accessory bulb in the brain. The role of the vomeronasal organ in dogs has not been well studied; it may be important in the detection of oestrus by male dogs or in some other aspect of sexual behaviour.

Visual acuity: Ability to see the details of an object separately and clearly.

Wall bouncing: Repetitive jumping at a wall, and rebounding off it.

Whirling: Tail chasing.

Withers: The highest point on a dog behind the neck, typically the point of the shoulder blades.

Appendix 1 Legislation on the husbandry and care of dogs

Legislation and codes of practice which deal with the husbandry and care of dogs in the UK include:

- Animals (Scientific) Procedures Act 1986 (UK Government 1986)
- Home Office Code of Practice for the Housing and Care of Animals Used in Scientific Procedures (Home Office 1989)
- Home Office Code of Practice for the Housing and Care of Animals in Designated Breeding and Supplying Establishments (Home Office 1995)
- Home Office Supplementary Guidance—Results of the Survey of Dog Accommodation and Care (Animal Procedures Committee 1999)
- Animal Boarding Establishment Act 1963 (UK Government 1963)
- Model Licence Conditions and Guidance for Dog Boarding Establishments—Chartered Institute of Environmental Health Working Party Report (Chartered Institute of Environmental Health 1995)
- Breeding of Dogs Act 1973 (UK Government 1973)
- Breeding of Dogs Act 1991 (UK Government 1991)
- Breeding and Sale of Dogs (Welfare) Act 1999 (UK Government 1999)
- Department for Environment, Food and Rural Affairs Voluntary Code of Practice for the Welfare of Dogs and Cats in Quarantine Premises (Department for Environment, Food and Rural Affairs 2002)
- Pet Animals Act 1951 (Amendment) Act 1983 (UK Government 1983)

In Europe, for animals used for scientific procedures there are two main pieces of legislation:

- Council of Europe Convention ETS 123 for the protection of vertebrate animals used for experimental and other scientific purposes (Council of Europe 1986). Appendix A which accompanies the Convention provides guidance on accommodation and care.

- European Community Directive 86/609/EEC regarding the protection of animals used for experimental and other scientific purposes (European Community 1986). Annex II which is attached to the Directive provides guidance on accommodation and care.

The Canadian Council on Animal Care has produced guidelines on accommodation and care for laboratory animals (Canadian Council on Animal Care 1993). In the USA, guidance on standards of accommodation and care for laboratory animals is incorporated into regulations for the Animal Welfare Act (see Title 9, Code of Federal Regulations, Chapter 1, Subchapter A—Animal Welfare Part 3: United States Department of Agriculture 2001).

Australia has a code of practice for the care and use of animals for scientific purposes (National Health and Medical Research Council 1997), and New Zealand has animal welfare codes of practice and minimum standards for animals used for scientific purposes and for dogs not used for research purposes (Animal Welfare Advisory Committee 1994, 1998). In some countries, but not in all, there are legal controls over the breeding and acquisition of dogs for use in scientific procedures (see Section 2.4).

Appendix 2 Factors to consider for good dog housing

The following list pre-supposes that the housing meets the dogs' physical and physiological needs and allows easy husbandry. Other factors will need to be considered also, but the most important in terms of animal welfare are emphasized here.

Good dog housing will:

- provide pens of sufficient space to permit housing in socially compatible groups, allow separate areas for defaecation, activity and resting/sleeping, and allow essential enrichment such that the dogs can perform a wide range of normal behaviour;
- provide pens of sufficient depth to allow retreat;

- allow good visibility of the room outside the pen whilst still allowing a semi-enclosed area for privacy and control over social interactions;
- provide bitches with a secluded area for whelping out of sight of other dogs and free from disturbance;
- offer interest and choice (e.g. of location, height and social contact)—in some circumstances choice can be provided through the management practices of the entire facility; in many cases it will be necessary to provide choice within the pen environment;
- contain objects to chew, presented so that the dog can hold them in a species-typical fashion;
- contain toys for the expression of species-typical postures and activities;
- provide a choice of microenvironment within the pen (e.g. light, temperature, noise);
- provide a warm, dry, draught-free area for resting/sleeping within the pen;
- allow flexibility in running pens together;
- be designed and constructed so as to facilitate refurbishment and remodelling as knowledge develops and improves understanding of the housing needs of dogs;
- control noise through facility design and construction (e.g. by incorporating noise absorbent ceilings, upper walls and/or baffles), pen furniture and enrichment, and the use of good management practices;
- limit the number of dogs in a room to around 20 to reduce allelomimetic barking.

Appendix 3 Example of a socialization, habituation and training programme

A basic outline of a suggested socialization, habituation and training programme for laboratory dogs is summarized below. This programme was developed by Heath (in preparation, b) in conjunction with staff at GlaxoSmithKline and Astra Zeneca in the UK and has been used and demonstrated to lead to benefits to puppies and staff.

Birth–3 weeks: Each pup should be handled in a calm manner, within the home pen, on a daily basis. This accustoms the pups to the presence, touch and smell of human contact. At this stage the handling can be associated with a daily health check, provided that no aversive experience is encountered. If aversive human interaction is necessary for some reason, then additional handling for the purposes of socialization with humans will be necessary.

Age approximately 3–6 weeks: At least three times per week, each pup should be placed on an examination table so that it sits calmly on the surface. The use of a portable table that is fitted over the door of the home pen is beneficial since these young puppies can remain in their safe home environment when being introduced to this form of handling. The aim here is to establish an association between the presence of humans and *calm* behaviour in the context of an examination table. Puppies on the table should be discouraged from climbing over or jumping up at care-giving staff by interacting with them with hands held low and avoiding eye contact.

It is beneficial for the surface on the examination table to be varied so that puppies have the opportunity to come into contact with the surfaces that they are likely to encounter during study, such as metabolism cage flooring and rubber examination table surfaces. At this age, puppies should also be exposed to variety through the provision of toys, visits from several people other than their primary carers, and sound stimulation. Audio systems and cassettes or CDs (available from Behavioural Solutions Ltd) can be used to replay a range of noises to puppies for the purpose of habituation to auditory complexity. This provision of environmental complexity should continue throughout the primary socialization period (3–14 weeks), and where possible through the first year of life or to the point of release for study. By having a variety of people participate in the socialization of each dog and by reinforcing their socialization as adults, the problem of over-attachment to an individual person can be avoided.

Age approximately 6–9 weeks: This is the phase where the pups should be introduced to procedural training and it should be carried out as often as possible and at least three times per week. The duration of each training session will vary according to the response of the individual puppy but each session must finish on a positive note with the puppy behaving in a calm and relaxed manner. When each pup is sitting calmly on the table they should gradually be introduced to the following procedures:

- touching the head and neck area and mock raising the jugular vein;
- handling forelegs as if raising the cephalic vein;
- opening the mouth;
- examining the ears;
- pressure on abdomen;
- other interactions that mimic procedures that the dogs could be issued for in the future.

9 weeks onwards: At this stage it is important to associate procedural training with the context of a procedure room. This training should be carried out as often as possible and at least twice a week with the aim that the pups view calm handling on the examination table as a 'normal', positive part of their lives. Lead training should be gradually introduced at this time; putting dogs on a lead is a good way of differentiating what is procedure time and what is playtime for dogs. They should be taken to the procedure room on a lead in small groups in a calm manner.

Training should cover all of the areas mentioned for 6–9-week-old puppies and may also be expanded to include more specific procedures such as exposure to the sound and feel of electronic clippers, and to transport containers, carts or trolleys. Training for metabolism cages, slings, inhalation equipment, or jackets and collars will need to be incorporated for those animals allocated to studies in which these devices are to be used.

The first few weeks are crucial in shaping the dog's response to novelty and challenge later in life but the process is an ongoing

one and it is important that dogs continue to receive socialization, habituation and training throughout their lives. Positive interactions with humans in a social context are of particular importance in order to balance the potentially aversive interactions associated with studies.

Appendix 4 Role of a canine behaviour specialist

An appropriately qualified canine behaviour specialist can advise on the following:

- kennel design to take into account species-specific behavioural needs;
- environmental enrichment;
- natural/normal behaviour (e.g. ethogram, behavioural time budgets, communication signals, social interactions within the kennel environment);
- abnormal behaviour and behaviour indicative of poor welfare;
- behavioural monitoring techniques;
- controlling aggression;
- socialization, habituation and training techniques;
- staff–dog interactions;
- canine welfare publications;
- behaviour–physiology interactions;
- staff training.

Appendix 5 Clinical signs

The signs in Table 5 have been collated over several years of experience in assessing the effects of scientific procedures on dogs and are adapted from the work of Buckwell (1992) and Jones *et al.* (2001). The signs presented are non-specific signs of toxicity and many other adverse clinical signs are possible. Observation of *any* of the listed deviations from normality within the allowed severity band should result in careful subsequent observation to check for any deterioration in the animals' condition. Observation of a sign asterisked should normally result in immediate action (such as lowering or ceasing of dosing, euthanasia, amelioration of the signs by treatment, or, at minimum, seeking of veterinary advice). Observation

Table 5 Clinical signs in the dog

	Mild	Moderate	Substantial
Body weight	Weight loss up to 10% body weight*	Weight loss up to 20% body weight or absence of weight gain in growing animals*	Weight loss greater than 20% body weight*
	Food consumption less than 75% of normal for up to 72 h*	Food consumption less than 40% of normal for up to 72 h*	Anorexia for greater than 48 h
Clinical signs	Restless or slightly reduced activity	Subdued but still responds to attention	Markedly reduced responsiveness
	Transient diarrhoea or vomiting	Mild dehydration (loss of skin tone)	Dehydration—dry gums, skin tenting, sunken eyes, cold extremities
		Transient convulsions or ataxia	Repeated or prolonged convulsions or ataxia
		Repeated vomiting or diarrhoea	Persistent vomiting or diarrhoea
		Occasional vocalization (e.g. yelp, whimper)	Repeated vocalization Changes in respiratory rate and character

of a sign from the next severity band should also result in immediate action, as the severity limit may well have been exceeded,

or else result in some of the other actions outlined above if agreed with the veterinary surgeon.