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Housing and care of laboratory cats: from requirements to practice

C. P. Geret[1], B. Riond[1], V. Cattori[1], M. L. Meli[1], R. Hofmann-Lehmann[1], H. Lutz[1]

[1]Clinical Laboratory, University of Zurich, Switzerland

Abstract

Increased public awareness of the welfare and well-being of laboratory animals in biomedical research and related ethical considerations inspired us to review recent developments and recommendations for the care and housing of laboratory cats. The present review focuses on the practical requirements for maintaining domestic cats as laboratory animals — from the construction of animal shelters to the termination of an experiment. An excellent standard of housing and care will reduce the bias of experimental results due to stress. To provide cats with living conditions that best meet their natural physical requirements and permit natural social behaviour, laboratories should spare no effort to achieve high housing standards. Hence, the present report not only aims to be a practical reference for those who are involved in the care and husbandry of cats, but it also aims to motivate researchers to improve their knowledge in this field and to provide humane conditions for all cats kept for scientific purposes.

Keywords: cats, laboratory, experimental research, specific pathogen-free, welfare

Haltung und Pflege von Laborkatzen: Praktische Umsetzung der Anforderungen

Ein zunehmendes Bewusstsein der Öffentlichkeit für den Tierschutz und das Wohlergehen von Versuchstieren in der biomedizinischen Forschung, und damit verbundene ethische Überlegungen haben uns veranlasst, die jüngsten Entwicklungen und Empfehlungen für die Pflege und Haltung von Laborkatzen in einer Übersichtsarbeit zusammenzufassen. Der vorliegende Beitrag konzentriert sich auf die praktischen Anforderungen für die Haltung von Hauskatzen als Labortiere – von der Einrichtung von Tierräumen bis zum Ende eines Experiments. Hohe Standards bezüglich Haltung und Pflege von Versuchskatzen verringern den Einfluss von Stress auf die Versuchsergebnisse. Die Laboratorien sollten keine Mühen scheuen, um Laborkatzen Lebensbedingungen zu bieten, die ihren physiologischen Bedürfnissen entsprechen und ein möglichst natürliches Sozialverhalten ermöglichen. Der vorliegende Bericht hat daher zum einen das Ziel, praxisnahe Hinweise für Personen zu geben, die an der Pflege und Haltung von Laborkatzen beteiligt sind. Zum anderen soll er Forscher motivieren, ihre Kenntnisse in diesem Bereich zu verbessern, und Laborkatzen unter angemessenen Bedingungen zu halten.

Schlüsselwörter: Katzen, SPF, Tierschutz, biomedizinische Forschung

Introduction

In 1959, William Russell and Rex Burch systematically studied the ethical aspect of the treatment of animals used in research, which led to the widely known «Three R» paradigm of replacement, reduction and refinement (Russell and Burch, 1959). This paradigm is considered a milestone in the development of laboratory animal science that, in addition to ethics, encompasses the biology of laboratory animals, alternatives to their use, their environmental requirements, genetic and microbiological standardisation, prevention and treatment of disease and experimental techniques, such as anaesthesia, analgesia and euthanasia. Nowadays, laboratory animal science is essential in applied and basic research, which has seen increased demand for standardised animal models,

but it must also cope with rising criticism of the way that animals are used for experimental purposes. In Europe, the use of animals in experiments is regulated in the European Convention for the Protection of Vertebrate Animals Used for Experimental and Scientific Purposes from the Council of Europe (CoE) (CoE Convention ETS 123, 1986) and in a similar document from the European Union Council Directive 86/609/ (European Union, 1986). The regulations include the obligation to ensure that all experimental animals are provided with housing, an environment with at least some freedom of movement, food, water and care appropriate to their age, health and well-being.

Domestic cats are more than an essential companion animal. To date, over 200 feline hereditary pathologies have been described, many of them a valuable model for their corresponding human diseases. This holds true for infectious diseases as well: for example feline immunodeficiency virus infection is the only naturally occurring model for the human immunodeficiency virus (Burkhard and Dean, 2003; Menotti-Raymond and O'Brien, 2008).

The quality of husbandry and housing has a major impact on the health and welfare of laboratory cats. Good welfare, or «quality of life» (Duncan and Fraser, 1997), is related to the breadth of the behavioural repertoire individuals are allowed to perform, which requires knowledge of species-specific behaviours and needs (Baumans, 2004). An environment that does not meet the animals' needs can be very stressful, especially to cats. This stress can cause changes in behaviour and physiology if the animal's state is challenged beyond its capacity to adapt to its environment (Terlouw et al., 1997). Stress, in turn, implies poor welfare (Broom and Johnson, 1993). To assess stress levels among laboratory cats, physiological and behavioural parameters can be measured. Physiological parameters include cortisol levels, haematological and immunological parameters and clinical signs, such as loss of appetite or weight, diarrhoea, respiratory and cardiovascular problems and gastric and intestinal ulceration, as well as hypertension. Behavioural abnormalities – sudden fear or aggression, attempts to hide, vocalising, changes in posture or activity or a decrease in grooming frequency – may be assessed, for example, by the «Cat-Stress Score» (Kessler and Turner, 1997). These results may also indicate the environmental design strategies that can be implemented to reduce stress among cats and thus justify efforts to improve housing and handling. Stress will not only compromise the animal's welfare, It may also influence the validity and reproducibility of experimental results (Poole, 1997; Moberg, 2000), for example, by altering susceptibility to infectious diseases (Peterson et al., 1991). Moreover, controlled laboratory settings allow for a better understanding of cause and effect compared to field conditions. Nonetheless, laboratory settings should mimic the natural environment to avoid results that may be irrelevant when applied in practice (Calisi and Bentley, 2009).

The goal of this review is to describe practical implementation of the existing guidelines for the accommodation and care of domestic cats in research. We strongly believe that the work presented here will not only represent a valid reference for scientists who are or will be involved in the care and husbandry of domestic cats, but it will also motivate researchers to improve their techniques so that they can provide humane conditions for cats used for experimental or other scientific purposes.

Housing

Dimensions and internal structuring of the cat enclosure

Space allowances and minimum dimensions of cat enclosures have been clearly defined (CoE Convention ETS 123, 1986). The required minimum dimensions for a 10-cat group is 2 m in height, 8.25 m^2 of floor area and a total of 2.75 m^2 of raised vertical structures (for example, shelves). The space provided should allow the cats to keep sufficient distance from their mates and to express a variety of normal behaviours, such as playing, exploring and hiding. It has been suggested cats be housed in groups of 5 to 10 animals in structured rooms of 15 to 23 m^2 and up to 3.5 m in height. The height is intended to provide the cats with environmental complexity and the opportunity for active behaviours, such as climbing, jumping and chasing as well as for seeking comfort and security; and for rest and retreat (McCune, 1995; Rochlitz, 2000; Overall and Dyer, 2005). Appropriate structuring of the enclosure environment may be more beneficial than providing a large floor area (Baumans, 2005). The rooms should be structured so that they can be fully used by the cats, by means of introducing second-level areas at different heights, for example, by the inclusion of raised walkways, shelves, climbing frames or hammocks (Fig. 1). Cats prefer and use the elevated space more often than the floor area (Rochlitz, 2000). Elevated resting places

Figure 1: Room construction. A cat lying in a hammock, perching and watching activities.

serve as lookout points and thus ease stress by permitting a certain amount of control over their environment while maintaining a distance from other cats (Carlstead et al., 1993). Furthermore, the cats should be offered a variety of partially closed structures (for example, boxes, tubes) and visual barriers (vertical panels, curtains) so that they can avoid interactions and hide from their mates if desired. Finally, a part of the room must be devoted to separate feeding and elimination (litter box) areas.

The age of the cats housed in the rooms is important: kittens have different demands than adults. It is essential to provide kittens with supplementary ladders and shelves to overcome height differences and to provide them with baskets so that they can snuggle up together; the latter behaviour is favoured by cats in the first weeks of life. Young cats should be protected from accidents. Sharp edges, open windows (in non-specific pathogen-free [SPF] facilities), narrow openings, where cats can be trapped, plastic wires, small toys and fabric fibres that could be swallowed should be avoided.

The room should be partitioned by a fence with a door to allow the caregivers to enter without the cats escaping from the room. In addition, the extra space may be used to separate an individual cat from the group (for example, a diseased cat). Furthermore, these anterooms should be equipped with high-pressure cold and hot water for cleaning the room properly. A disinfection splash lance may be located centrally outside of the room so that it can serve several rooms.

The European Convention recommends use of at least one litter box of 300 x 400 mm for every two cats (CoE Convention ETS 123, 1986). We suggest use of a single litter box per room (Fig. 2). The box should be made of acryl glass or a polycarbonate with dimensions of 2 m in length, 0.3 m in height and 0.5 m in width. It should be semi-filled with autoclaved sawdust and hang on the wall about 1 m above the ground. The large litter box allows the cats to hide their urine and faeces in the sawdust, which mimics their natural environment. By mounting the box to the wall, it is clearly separated from other functional areas (for example, the feeding area) and can be easily cleaned. Moreover, this placement avoids behavioural problems, such as defecation outside of the litter box (O'Farrell and Neville, 1994). The boxes are easy to clean and are therefore well accepted by both cats and caregivers.

The surface of the floor should be non-slip when wet and resistant to the abrasive chemicals that are used for cleaning and disinfection. Floor drainage should be facilitated by a slope of 3–5 % towards the water drain-pipe. In addition, proper disinfection must be ensured by coating the ground and walls up to a height of 1.8 m with epoxy paint. Good ventilation is essential. It not only provides sufficient fresh air for the cats and caregivers, it also regulates the temperature and humidity and reduces bad odours, dust and infectious agents. For cats, 15–20 air changes per hour and a temperature of 15–21 °C have been recommended (CoE Convention ETS 123, 1986). Ventilation pipelines should be protected by a grid to avoid damage by the cats. They should include filters that are replaced twice per week to protect the ventilation ducts from clogging. Ideally, light should be electronically regulated on a 12-hour light/dark cycle. Additionally, daylight may be provided by windows. The doors should have windows to permit observation of the cats without entering the rooms and disturbing them.

Figure 2: Litter boxes attached to the wall, rather than lying on the floor.

In SPF facilities, all equipment, including wooden boards, sawdust, bedding and toys, must be autoclaved. Non-autoclavable items should be disinfected by immersion in disinfecting baths or by gas-sterilisation. Strict barrier procedures must be followed to guarantee the SPF and health status of the cats. Undetected infections may influence the outcome of an experiment (Lutz et al., 1995). In this context, the feline parvovirus (FPV) and coronavirus (FCoV) are of particular importance. These two viruses are highly contagious and often lead to disease following infection (Addie et al., 2009; Truyen et al., 2009). Parvoviruses can only be eliminated by sterilising or autoclaving. It is therefore crucial to avoid permanent fixation of items in the rooms that cannot be removed.

Environmental enrichment

The cats should be offered a variety of environmental enrichment. Enrichment items need to be well designed and critically evaluated (Newberry, 1995; Shepherdson et al., 1998). Cats have individual preferences for environmental conditions, level of activity and social interaction with other cats or caregivers. Therefore, a broad selection of toys, such as balls, fishing rods, cardboard boxes, shredded paper, play tunnels, hammocks or swings, and furniture covered with polyester fleece (Hawthorne et al., 1995) should be offered. Moreover, pseudo-predatory behaviour should be encouraged (McCune, 1995; Overall and Dyer, 2005), for example, by using moving toys or puzzle boxes containing dry food, which can be preyed upon by the cats. This technique stimulates the cats to expend time and energy in the retrieval of food (de Monte

and Le Pape, 1997; Hall and Bradshaw, 1998), triggers the hunting instinct and provides mental and physical stimulation while motivating the cats to play.
Olfactory stimulation can be provided by catnip. Laboratory cats have been found to prefer toys containing catnip (Ellis, 2007). The toys described above are somewhat unpredictable and allow the cats to influence their environment, which in turn enhances their capacity to cope with novel and unexpected changes. However, certain toys may also be swallowed and cause fatal intestinal obstruction if not recognised in time. Therefore, toys should be counted and furniture checked regularly, especially when keeping young cats. Scratch posts, cat trees and carpets permit the natural behaviours of claw-sharpening and scent-marking. Windows facing the outside or between rooms, provide daylight, varying temperatures, visual stimulation and entertainment for the cats. According to our observations, cats spend a significant amount of time sitting in front of and watching activities through these windows. Finally, the concept of novelty is important. Toys should be regularly changed to avoid habituation. Creative thinking and continuous efforts are necessary to keep the cats interested in their environment (Benn, 1995).

Care

Health and SPF status check

The SPF status must be evaluated on a regular basis by sensitive diagnostic methods, and access to the SPF facility must be permitted only to persons who have had no contact with other cats or veterinary clinical institutions that day. Before entering the facility, clothes and shoes should be changed and hands and clogs disinfected to minimise the risk of introducing pathogens. Only cats from entrusted SPF catteries should be brought into an SPF facility. In any case, after the arrival of new cats, a detailed clinical examination should be performed and blood samples collected for haematological and biochemical analyses. In addition, blood, faeces and saliva samples should be tested for specific infectious diseases according to the parameters compiled in Table 1.

Table 1: Known health problems concerning SPF status.

Method	Material	Parameters
Serology	Plasma	Feline coronavirus
		Feline immunodeficiency virus
		Feline parvovirus
		Feline herpesvirus
		Feline calicivirus
		Feline leukaemia virus (p27)
RT-/PCR[1]	EDTA blood	Feline leukaemia virus
		Feline herpesvirus
		Feline immunodeficiency virus
		Feline parvovirus
		Feline coronavirus
		Feline calicivirus
		Clamydophila felis
		Bartonella henselae
		Mycoplasma haemofelis
		Candidatus mycoplasma haemominutum
		Candidatus mycoplasma turicensis
	Saliva swab	Feline herpesvirus
		Feline calicivirus
	Conjunctiva swab	Feline herpesvirus
		Feline calicivirus
		Clamydophila felis
	Faeces swab	Feline parvovirus
		Feline coronavirus

[1]reverse transcription PCR

Feeding

Nutrient recommendations have been formulated by the National Research Council (NRC) (Subcommittee on Dog and Cat Nutrition, 2006). The amount of food provided to experimental cats may depend on the goals of the experiments. For infectious disease studies and for maintaining blood donors, kittens are ideally fed ad *libitum* and adults twice per day with commercial dry, semi-moist or canned cat food. To avoid uneven body weight distribution or obesity, smaller animals should be allowed extra food while being separated from the heavier members of the group. The energy requirement for an adult laboratory cat is approximately 239 kJ/kg BW per day (Wichert et al., 2007), which is less than that recommended by the NRC. Therefore, animals should be weighed once per week, and rations should be adjusted accordingly. The introduction of new feeding strategies (for example, puzzle boxes, hiding food) can enrich the daily routine. Self-filling water bowls should be emptied, cleaned and refilled at least once per day to guarantee unlimited fresh water access.

Socialisation

Felids are (with the exception of lions) solitary animals and lack formal dominance hierarchies and post-conflict

reconciliation mechanisms (van den Bos, 1997). However, cats have a strong tendency to learn social behaviours and adapt to living in groups, particularly when the food resources are plentiful (Caro, 1994). Furthermore, evidence of bonding, structured relationships and preference for one partner have been observed among long-term resident cats (Smith et al., 1994; Crowell-Davis et al., 2004). Therefore, living in a community can provide cats with additional environmental enrichment. The ideal group size depends on different factors. If provided with adequate structures to find refuge and privacy, up to 20–25 individuals can be housed together in a laboratory cat enclosure (James, 1995; Hubrecht and Turner, 1998), while the current European guidelines recommend groups of up to 12 cats (CoE Convention ETS 123, 1986). Males should be neutered at the age of six months to reduce the probability of starting to spray and fight later on. The question of which gender is the least affected by in-fights is unclear. Some researchers prefer neutered males over intact females kept in groups (Hurni and Rossbach, 1989; van den Bos and de Cock Buning, 1994a), while others report that it is also possible to peacefully house males or neutered females together with other entire or neutered males (Hart, 1980; Podberscek et al., 1991). Sex differences might affect the outcome of an experiment, as demonstrated for studies of FIV and FeLV (Hofmann-Lehmann et al., 1998; Tejerizo et al., 2005). Regardless of the group composition, cats can be brought to live together as long as they have been well socialised within the first two months of life (Karsh and Turner, 1988) and if, within this time, they had many positive experiences with conspecifics, people and variable life situations. It is absolutely necessary to regularly monitor the compatibility of all individuals in the group. Regrouping or removing cats from the experiment may be necessary if repeated aggression is observed.

Positive social interactions and human-animal-bonds between laboratory staff and the animals play a central role in cat husbandry and have a significant beneficial influence on their well-being (Bayne, 2002). Cats that live in enriched environments demonstrate a clear preference for human contact over toys (de Luca and Kranda, 1992). While some cats prefer to be petted and groomed, others prefer human interaction via playing with toys (Turner, 2000). Consequently, the caregivers develop strong relationships with the cats. Nonetheless, they should be able to cope with difficult, stressful situations, for example, euthanizing animals, which is psychologically demanding (Chang and Hart, 2002). Routine interactions with the cats and the daily presence of the same persons are of central importance for the observation of changes in behaviour or health. Unpredictable caretaking characterised by irregular feeding and cleaning times or caregivers ceasing to pet and play with the cats can result in a stress response in the cats (Carlstead et al., 1993). Therefore, time should be set aside for the caregivers to interact with the cats on a daily basis (Rochlitz, 2000). Careful handling techniques, routine interactions by the caregivers and an early socialisation of the cats to humans will help to decrease the level of stress for the cats and, in turn, make them more tolerable to experimental procedures (Hurni and Rossbach, 1989; Wolfle, 2000; Hoskins, 2002).

Routine training

A minimal adaptation period of five weeks should be observed before starting experimental manipulations (Rochlitz, 2002) so that the cats can adapt to their new environment and establish trust in the people responsible for the experiment. Researchers should spend time petting and playing with the cats. In the beginning of the experiment, this time should span at least one hour per day. A lack of early interaction leads to increased stress and may lead to aggression of the cats toward humans and other conspecifics (Podberscek et al., 1991). Playing a radio can lessen the effects of sudden, loud or unfamiliar sounds and may help to habituate timid cats to human voices (Hurni and Rossbach, 1989). Working with cats requires a demeanour that is calm, gentle and confident. Several animal training techniques, for example, positive-reinforcement training (also known as clicker training), are well accepted (Laule et al., 2003). Training to perform certain actions reduces the stress in both the animals and personnel and enhances the animals' trust and well-being (Reese, 1991). Such training may simplify later handling or experimental procedures, for example, blood collection without anaesthesia. For the latter case, a trusted person can place the cat on his lap and slightly restrain the cat while a second person clips the hair and aseptically cleans the neck area before inserting the needle in the jugular vein. After blood collection, cats should receive a reward in the form of extra attention and a treat, for example, tuna paste, which is particularly liked by cats. All cats are not necessarily fit for this procedure (for example, depending on the degree of early socialisation). Uncooperative cats should receive light anaesthesia to minimise stress and conflicts. Currently, our preferred anaesthesia is the combination of 3 mg/kg BW S-ketamine, 5 µg medetomidine and 0.2 mg/kg BW butorphanol administered intramuscularly into the biceps.

Euthanasia

Laboratory cats may need to be euthanized at the end of an experiment to collect tissue and blood samples for scientific investigations or during an experiment, when levels of pain, distress or suffering are likely to exceed the designated level. It is mandatory to grade the level of discomfort and define events or signs (so-called humane end-points) that dictate the removal of a cat from an experiment or euthanasia. Euthanasia is expected whenever animals demonstrate one of the following conditions: substantial weight loss, extreme anorexia, weakness or inability to take up food or water, uncontrollable infection,

tumour, pain or distress, as well as moribund state, organ dysfunction or failure (UCA-Irvine, 2008). Humane and appropriate methods to euthanize laboratory animals have been published by the European Commission (Close et al., 1996). Healthy and non-infected laboratory cats may be adopted by private households. Alternatively, they may serve as blood donors for patients in veterinary clinics.

Conclusion

Domestic cats are not only exceptionally valued as companion animals. They are used in research as indispensable animal models for many inherited and infectious human diseases and also for species-specific research. Their use is often discussed in more emotional terms than the use of other laboratory animal species, and frequently attracts the critical interest of animal activists. Therefore, providing experimental domestic cats with the best possible husbandry in a friendly environment, regardless of minimum standards or additional cost is an essential condition. The present review describes how to implement essential requirements in practice and is based on our long-term experience with our SPF cat research facility. The review is subjective and not a comprehensive study: it is intended to serve as a starting point for researchers who want to provide their cats with an enriched, complex and challenging environment and to keep them under the best ethological conditions.

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Détention et soins des chats de laboratoires: réalisation pratique des exigences

La prise de conscience croissante du grand public en matière de protection des animaux ainsi que le bien-être des animaux de laboratoire dans la recherche biomédicale et les réflexions éthique qui y sont liées nous ont conduit résumer les développements et recommandations les plus récents concernant les soins et la détention de chats de laboratoire. Le présent article se concentre sur les exigences pratiques concernant la détention de chats en tant qu'animaux de laboratoire, de la conception de l'animalerie jusqu'à la fin d'une expérience. Des standards élevés en matière de détention et de soins diminuent l'influence du stress sur les résultats des expériences. Les laboratoires devraient tout mettre en œuvre pour assurer aux chats de laboratoires des conditions de vie correspondant à leurs besoins physiologiques et permettant un comportement social aussi naturel que possible. Le présent article a donc pour but de donner aux personnes impliquées dans la détention et les soins de chats de laboratoire des informations proches du quotidien. D'autre part, il doit motiver les chercheurs à approfondir leurs connaissances dans ce domaine et à détenir des chats de laboratoires dans des conditions satisfaisantes.

Tenuta e cura dei gatti da laboratorio: le esigenze in pratica

L'aumento della consapevolezza pubblica per la protezione degli animali e per il benessere degli animali da laboratorio nella ricerca biomedica uniti alla riflessione etica ci ha spinto, in questo lavoro, a riassumere in un quadro d'insieme, i più recenti sviluppi e consigli per la cura e la tenuta dei gatti da laboratorio. Il fine del presente articolo è di dare una visione delle esigenze pratiche per la tenuta dei gatti da laboratorio, dall'allestimento degli spazi per gli animali fino al termine dell'esperimento. Alti standard relativi a tenuta e cura dei gatti da laboratorio diminuiscono, sui risultati degli esperimenti, gli influssi provenienti dallo stress. I laboratori non dovrebbero ritenersi dall'offrire ai gatti da laboratorio condizioni di vita che corrispondono ai loro bisogni fisiologici e che rendano possibile il più possibile un comportamento sociale naturale. Questo lavoro ha inoltre lo scopo di impartire suggestioni alle persone orientate alla pratica e che partecipano alla cura e tenuta dei gatti da laboratorio. Inoltre dovrebbe motivare i ricercatori, a migliorare le loro conoscenze in questo campo alfine di tenere i gatti da laboratorio in condizioni adeguate.

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Corresponding author

Prof. Dr. Hans Lutz
Clinical Laboratory
Vetsuisse Faculty
University of Zurich
Winterthurerstrasse 260
CH-8057 Zürich
Tel.: + 41 (0)44 635 83 12
Fax: + 41 (0)44 635 89 06
E-Mail: hlutz@vetclinics.uzh.ch

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