Animal Research Review Panel

Guideline 21

Revised November 2023

Guidelines for the Housing of Guinea Pigs in Scientific Institutions

Contents

Definitions

Guideline

Background	Science-based background information and evidence for animal housing and care.
Code	Code for the Care and Use of Animals for Scientific Purposes (2013) 8th Edition.
Recommendation	Practices that are recommended in addition to '*Standard*' practices to meet best practices.
Standard	Practices that meet minimum Code requirements and/or standard good industry practices.
Best Practice	A practice, procedure, method, or process that has been proven to be most effective in supporting and safeguarding animal wellbeing and that: • Takes into consideration the relevant aspects of species-specific biology, physiology, and behaviour; • Is based on the best available scientific evidence (or in the absence of scientific evidence, accepted good practice) which includes the potential adverse impact of conditions and procedures on thew wellbeing of the animals; • Includes strategies to minimise adverse impacts.
Good Practice	A practice, procedure, method, or process that is effective in supporting and safeguarding animal wellbeing and should be used unless there is strong justification for deviation.
Must	Use to indicate an obligatory part of the Code.
Required	Used to indicate a requirement for animal care, management, and welfare.
Scientific Purposes	All activities conducted with the aim of acquiring, developing, or demonstrating knowledge or techniques in all areas of science, including teaching, field trails, environmental studies, research (including the creation and breeding of a new animal line), diagnosis, product testing, and the production of biological products.
Should	Used to indicate a strongly recommended component of the Code. In some instances, a recommended component of the Code is an example of how it is anticipated that a person will meet the obligatory requirements of the Code.

Housing

Pen	Housing for guinea pigs that allows for freedom of movement by guinea pigs and allows for the provision of a variety of environmental enrichment strategies.
Cage	Fully enclosed container for housing guinea pigs which, because of its size, restricts freedom of movement by guinea pigs and limits the provision of environmental enrichment strategies. Cages are usually constructed from metal or plastic, with solid or mesh sides.

1 General

1.1 Introduction

- These ARRP guidelines are intended for use by people involved in the housing and care of guinea pigs in scientific institutions. The guidelines are not intended to be a complete manual on guinea pigs care and management but rather to provide some key guiding principles on standards, good practices and best practices in guinea pigs care and management.
- The NHMRC 2013 (8th edition) *Australian Code for the Care and Use of Animals for Scientific Purposes*[1] (the Code) governing principles (section 1.1 ii & iii) clearly outlines that respect for animals must underpin all decisions and actions by supporting animal wellbeing and minimising harm, pain, and distress.
- The NHMRC 2018 *Best Practice Methodology in the Use of Animals for Scientific Purposes* describes the requirements for best practices in research and teaching with animals, to prevent unnecessary negative impacts or use of animals, enable robust research outcomes, and maintain social license for working with animals[2].
- Scientific evidence strongly supports the ability for vertebrate animals to experience positive, neutral, and negative states of welfare (affective states)[3]. The literature also continues to demonstrate that inadequate care and negative states of welfare in animals can negatively impact research results and reduce reproducibility[4]. Best practices in animal welfare are therefore paramount and foundational for regulatory requirements, ethical obligations, social license to operate, and high-quality research. The Code supports these principles (1.8-1.10)
- The guidelines will be revised from time to time to take account of advances in the understanding of guinea pig physiology, animal behaviour, technological advances, and changes in community attitudes and expectations about the welfare of animals. As per the NHRMC 2018 *Best Practice Methodology in the Use of Animals for Scientific Purposes,* best practices should be used to maximise outcomes for animal welfare and scientific purposes. Strong justification and consideration are required to deviate from these practices.
- The guidelines are based on best and good practices regarding the care and management of guinea pigs taken from NHRMC codes, scientific literature, and veterinary experts.
- Recommended (best) and standard (good or Code) practices are outlined within this guideline where applicable.
- Where there is minimal literature, guidelines have been extrapolated based on behaviour of guinea pigs in the wild or similar species maintained in captivity. The information included is current at the time of writing. Those involved in the care and use of animals for scientific purposes are expected to maintain current best animal care and management practices.
- It is expected institutional animal care and management plans are reviewed at least annually. As standards improve and new literature arises, this information should be incorporated and implemented into animal care and management plans.
- The information in this document addresses some of the key housing requirements of the Code (3.2.13-3.2.16). The requirements of the Code include that animals held for scientific purposes should have their species-specific behavioural and physical needs

met, whilst at the same time ensuring that the animals can adequately be monitored, protected from disease, and considering the requirements of animals in all scientific purposes.

- To further support the requirements of the Code, a program of veterinary care (2.1.5iv & 2.5.14), training and competency (1.29), adverse event management (2.1.5, 3.1.1 & 3.1.24), an emergency animal care plan (2.1.5), standard operating procedures or similar (2.2.33-36), complaints process (5.4-5.12), and animal welfare policies (2.1.2, & 2.1.5iv), should be developed in conjunction with appropriately trained veterinary and similarly qualified animal welfare experts (2.5.14). The AEC should be consulted and must approve standard operating procedures (2.2.5v & 2.2.33-36).
- All monitoring, recording and care activities should be undertaken in a manner that demonstrates and ensures compliance with approved animal ethics committee projects and regulatory requirements. Monitoring records with animal or room checklists and relevant emergency contacts should be easily accessible to ensure continuity of animal care to animal carers, researchers, AEC members or auditors.
- Prompt detection and management of any animal welfare, care, management, or similarly related issues are required.
- While these guidelines focus on the welfare of guinea pigs, the provision of good practices in housing, husbandry, conditions, and care that provide for the environmental, physiological, physical, behavioural, and mental animal welfare requirements of animals is foundational to robust quality scientific outcomes[4].

1.2 Responsibilities

- As per the Code, respect for animals must underpin all decisions and actions involving the care and use of animals for scientific purposes (1.1).
- Institutions, researchers, teachers, animal care staff and facility managers must ensure all involved in the care and use of animals understand their responsibilities and Code requirements as well as have the necessary skills, competency, knowledge and access to education and resources for best practices. This should include biosecurity, housing, husbandry, care, monitoring, managing adverse impacts on animal welfare, managing adverse events with necropsies and minimising harm, pain, and distress (2.1 – 2.5.17iii).
- Veterinarian care and advice must be available with oversight provided by a qualified competent veterinarian for the program of veterinary care (health, husbandry general care, preventative care, emergency care and biosecurity), quality management and project design (2.1.5iv & 2.5.14).
- Further information can be found in sections for institutions (2.1 & 2.2), animal ethics committees (2.3), investigators (teachers and researchers 2.4), and animal carers as well as animal facility managers (2.5).

1.3 General Care of Animals in Holding, Production, Facilities, and Housing

- Under sections 3.1 and 3.2, animal accommodation should be designed and managed to meet species-specific conditions and requirements, suitable for the species, and achieve high standards of animal care. Variations to these requirements must receive prior AEC approval. Animals should also have additional appropriate monitoring and veterinary oversight during these periods of time.

- Animals must be checked daily with clean, fresh drinking water available at all times.
- Pens, cages, enclosures, and containers must be constructed and maintained to a high standard to ensure animal wellbeing and comfort. The following factors should be considered:
  - Species-specific behavioural requirements, including the availability and design of space to enable free movement and activity, sleeping, privacy, contact with others of the same species, and environmental enrichment;
  - provision of single housing for animals when appropriate for the species and if necessary for the purpose of the project (for example, during recovery from surgery or collection of samples);
  - species-specific environmental requirements, such as lighting, temperature, air quality, appropriate day/night cycles and protection from excessive noise and vibrations;
  - the need to provide ready access to food and water;
  - the need to maintain cleanliness;
  - protection from pests, predation and disease;
  - requirements of the project;
  - the need to observe the animals readily; and
  - facilities must be appropriately staffed, designed, equipped, constructed, managed, and maintained to achieve high standards of animal care and suitable for the animals and activities undertaken.
- Facilities, pens, enclosures, cages, and containers must:
  - be constructed of safe, durable materials;
  - be kept clean, tidy and free of noxious;
  - be maintained in good repair;
  - be secure and escape-proof;
  - protect animals from adverse environmental conditions and other mitigable adverse risks;
  - not cause injury to animals;
  - be large enough for the species and the number of animals held; and
  - be compatible with good animal welfare requirements or any other special requirements of the species.
- The population density of animals within cages, pens, enclosures or containers and the placement of these in rooms must be such that acceptable social and environmental conditions for the species can be maintained.
- Where it is necessary to individually house animals of a species normally kept in a social group or environmental conditions, the conditions must be managed to minimise the impact of social isolation or any environmental deviations. Animals must be housed in these circumstances for the minimum time necessary.
- Bedding and litter are required to be provided if appropriate to the species and should be comfortable, absorbent, safe, non-toxic, sterilisable if needed, and suitable for

scientific or educational aims. Pregnant animals that nest must be provided with appropriate nesting materials and any other species-specific housing requirements.

- The Animal Ethics Committee, relevant investigators or teachers and an appropriately qualified veterinarian are to be informed in advance of planned changes to these conditions since these may affect the welfare of animals and the results of the scientific and teaching activities.
- Any project or activity that precludes or deviates from good animal care, management and housing conditions must have special ethical consideration by the AEC, be specifically AEC approved (3.1.6 & 3.2.13) and is required to be reviewed by an appropriately qualified veterinarian. This includes single housing for social animals (3.1.12). Additional mitigation and monitoring strategies should be applied. Animals that demonstrate signs of welfare compromise should be removed from study and/or housing (3.1.19ii & 3.2.12).

1.4 Aspects of Guinea Pigs Behaviour Relevant to Housing

- Wild guinea pigs are a thigmotaxic prey species that typically inhabit burrows that have been abandoned by other animals, living in family groups of up to 10 individuals centred on an alpha male. There is a high incidence of polyandry amongst litters and little involvement of the males in caring for offspring[5]. Sexually mature males may fight, particularly when females in oestrus are present.
- Domesticated guinea pigs (Cavia porcellus) are social animals that exhibit positive behaviours such as social grooming, nuzzling, and nudging[6]. They can live in multi-male, multi-female groups to be established with minimal stress and aggression. Fighting does not usually occur between males (either sibling or unrelated) that have been raised together without females, or within groups of non-breeding females[7], but the introduction of unfamiliar guinea pigs (especially males) into breeding groups, must be done with careful observation to assess any adverse effects on individuals and the established social structure.
- Guinea pigs have highly developed senses of smell and hearing and seek bodily contact during periods of rest. Guinea pigs can readily distinguish the scents of known versus unknown individuals and determine those from dominant or subordinate cohorts[8]. Scent marking, with urine indicates the animals' social status relative to others in the group.
- The provision of hay ad libitum in the diet has been shown to substantially reduce negative behaviours and health issues in guinea pigs[9,10].
- Guinea pigs produce a range of vocalisations in relation to feeding, social encounters, mating, and mothering. Vocalisations plays an important part in communication with up to 11 distinct calls recognized[11].
- Normal behaviours of guinea pigs include walking, running, tunnelling through and under hay or straw, lying fully stretched out, retreating to shelter to rest, foraging and gnawing/chewing. Juveniles will engage in popcorning (jumping upwards), running, and chasing during play[12] and will climb onto or jump over low obstacles in their enclosure.
- Guinea pigs practice coprophagy to maintain gastrointestinal and general health. Soft, nitrogen rich faeces derived from the caecum are re-ingested almost immediately after being passed, usually at night[7].

Standard

1.4.1 To meet Code and animal welfare requirements (i.e., to provide accommodation that meets the species-specific needs of guinea pigs), housing should be provided which allows guinea pigs the opportunity for social interaction, the opportunity to carry out normal behaviours such as tunnelling and playing (freedom of movement) and the opportunity to rest and withdraw from each other.

1.4.2 The Code recognises there may be circumstances where the requirements of experimental procedures may preclude meeting some species-specific needs under special AEC consideration and approval. Housing in these situations should still meet the physiological and psychological needs of guinea pigs as closely as possible.

1.4.3 The provision of ad lib hay is widely recognised as required to maintain and prevent health issues in guinea pigs[9,10].

2 Housing

Background

- Group housing in floor pens is preferred as they facilitate the use of a deep litter type bedding system with a greater floor space which is often more suitable and recommended for animal welfare requirements.
- When guinea pigs are housed in cages or small enclosures, they should have regular frequent access to floor playpens to mitigate some of the issues associated with housing animals in small cages or small enclosures[13]. When scientific work precludes the keeping of guinea pigs in floor pens or utilising playpens the impacts on animal welfare must be considered and appropriately mitigated[14,15].
- Advantages of housing guinea pigs in groups in pens include:
- Housing in pens provides increased space which allows guinea pigs freedom of movement to carry out normal activities such as playing, stretching out, sitting up, and tunnelling. Physical and psychological well-being is assisted by the opportunity to exercise and explore a complex environment[16].
- Guinea pigs are social animals that benefit from the company of others. Housing guinea pigs in groups in pens allows for social interaction and behaviours such as grooming penmates, lying together and playing[16–18]. The behavioural repertoire of group housed animals are more varied compared to that of singly housed animals[19,20].
- Pens provide a greater opportunity than cages for the environment to be enriched and made more behaviourally stimulating (for example by the addition of tunnels and areas for retreat)[18,21].
- Costs of setting up pens and maintaining guinea pigs in pens may be less than for buying cages and maintaining guinea pigs in cages. Cost savings may be made in the areas of bedding, cleaning agents, maintenance, energy, and labour[22].
- Health advantages include that sore feet (pododermatitis) and gastrointestinal hair balls (trichobezoars) are rare in penned animals[23]. The incidence of respiratory diseases such as Pasteurellosis (“snuffles”) may also be reduced, possibly because of better ventilation than solid walled cages.

2.1 Disadvantages of housing guinea pigs in groups in pens include:

- As with any group housing, fighting, and bullying may occur, with negative impacts especially in mature entire males[10,24,25]. The grouping of guinea pigs may become unstable and there may be difficulties in reintroducing a guinea pig that has been removed for even a short time. Fighting and aggressive behaviours may result in severe injuries and stress responses in subordinate animals.
- Guinea pigs may be more difficult to catch in pens, however this can be mitigated with adaptation of procedures, appropriate use of the enclosure and training.
- The volume of bedding disposal may be increased.
- Vertical space may be reduced.
- Some types of experimental work may require cages.

Standard

2.1.1 Good biosecurity, quarantine and animal care principles are required for the housing of animals. Facilities should have areas for quarantine, management of treatment of sick animals and provision of additional enclosures for emergency purposes and/or during cleaning[26].

2.1.2 Regular sanitation using water and aqueous cleaning agents and disinfectants should be used and will be required for all types of housing arrangements.

2.1.3 Housing arrangements should use of floor pens. Other options under special circumstances can include the use of floor pens or metal, or plastic cages mounted on shelves or in fixed or mobile racks.

2.1.4 Guinea pigs require housing in stable group floor pens and should be housed accordingly.

2.1.5 Pens should be run on an all-in and all-out basis with full decontamination between groups.

2.1.6 Where this is not possible, incoming animals should be quarantined, introduced in pairs along with additional enrichment and monitored closely to ensure prompt management of any issues.

2.1.7 Guinea pigs that cannot be housed in groups (e.g., intact males or for experimental reasons) should be housed in pens with olfactory, visual and, if possible, physical contact with adjacent guinea pigs.

2.1.8 Guinea pigs should only be housed in cages with strong justification, special approval and ethical consideration from the Animal Ethics Committee based on compelling evidence. In such cases, cages should be enriched by methods as described in this document (such as pair housing in double cages and availability of playpens). Lack of space or facilities for pens must not be considered sufficient justification for the use of such cages.

2.1.9 Guinea pigs should not be housed singly in conventional (unenriched) cages except in exceptional circumstances and with strong justification, special approval and ethical consideration from the Animal Ethics Committee based on compelling evidence. Lack of space or facilities for pens should not be considered sufficient justification for the use of conventional cages.

2.1.10 A high level of stockpersonship in caring for and monitoring guinea pigs is required. Animal carers, investigators and teachers should be proficient in recognising all aspects of guinea pig behaviour to ensure welfare, health and social interaction can effectively be monitored.

1. Security barriers and appropriate alarms must be in place to prevent unauthorised entry and or escape of animals.
2. Appropriate firefighting and fit for purpose fire alarm systems and out of hour alerts must be in place.
3. Appropriate fit for purpose alarm systems and out of hours alerts must be in place for heating, cooling, and ventilation.

Recommendation

i. Slower introductions are recommended when introducing or re-introducing guinea pigs into their groups or pairs.

3 Pen Design and Environment

3.1 Materials for Pens

Background

– A variety of materials may be used, depending on the design of the pen. For example, the pen may occupy a whole room or be adapted from plastic bins made for other purposes or from pens for larger animals[27]. Materials for pen walls may be solid (for example plastic) or be open weave (for example wire mesh) and opaque or transparent/translucent. Opaque solid walls between pens have the advantage of providing additional areas for shelter/privacy, but the disadvantages, as with all solid walls, of restricting air flow and of restricting vision of surroundings.

Standard

3.1.1 Enclosures should accommodate the animals' animal welfare requirements including requirements for shelter and retreat from view, particularly in breeding colonies[18].

3.1.2 The front of any enclosure should allow a view of other guinea pigs in adjacent pens and people approaching to reduce fear responses.

3.1.3 A solid floor with a suitable high quality bedding substrate should be used.

3.1.4 The floor space for guinea pigs should incorporate open spaces interspersed with shelter to allow animals to retreat and hide. Temporary covers such as piles of hay, straw, or wood wool as well as permanent shelters such as plastic or timbers and sections of PVC or similar pipe can be used. Hay and other natural products may require additional treatment or precautions where animals must maintain a specific pathogen free status or are immune compromised.

3.1.5 The materials from which an enclosure is constructed should incorporate sufficient floor space for the number of animals, should be able to be cleaned and serviced safely and efficiently. Materials for the construction of enclosures are to be strong and water-resistant.

3.1.6 Materials used in the housing of animals must be non-toxic, easy to clean or dispose of, and where used, made from non-aromatic wood (e.g., aspen not pine). Sawdust should not be used.

3.1.7 Stainless steel can be used but galvanized steel and other metals should be avoided.

3.2.8 Guinea pigs should only be housed in rooms containing other herbivores. However, avoid housing with guinea pigs to prevent the spread of Bordetella bronchiseptica and bullying by guinea pigs[10].

3.1.9 It is inappropriate for guinea pigs to be housed within sight, scent, or audible range of predators. If predators are housed within the same facility, personnel must ensure that clothing & footwear are changed, and hands thoroughly cleansed, before moving between predator and prey species, to avoid undue stress.

Recommendations

ii. Workflows should be arranged so that prey species are managed before predator species.

iii. Guinea pigs should only be housed in single species rooms.

3.2 Enclosure floor area and height

Background

- The provision of sufficient floor space is essential to the well-being of the animals.
- The minimum space provided should allow each guinea pigs to carry out its normal behaviour, including a wide range of locomotory behaviours, such as tunnelling, playing, exploring, and stretching out.
- Overcrowding guinea pigs can cause stress, physiological[28] and immunological changes, decrease reproduction and increase abnormal behaviours[29] such as hair chewing or overgrooming[9].
- Inappropriate housing can impact animal welfare and experimental outcomes[30–36].

Standard

3.2.1 The minimum height should be 40cm. The minimum floor areas should be as listed below:

3.2.2 Breeding pair with unweaned litter – 1.5m2 per pair

3.2.3 Each additional breeding female with unweaned litter - +0.5m2 to a maximum of 1:4 ratio (M:F)

3.2.4 Non-breeding guinea pig 1m2 per animal

3.2.5 In addition to meeting minimum space requirements for movement, space should be provided to allow the provision of structural complexity and environmental enrichment in pens. For example, additional space should be provided to accommodate objects such as boxes and pipes, which provide guinea pigs with plenty of retreat/hiding areas.

Recommendation

iv. Enclosure shapes should maximise effective use of floor space.

3.3 Enclosure Bedding and Flooring

Background

- Bedding ensures a clean, dry, comfortable lying area. In addition, it is desirable for it to be cheap, readily available, and easy to use and dispose of.
- Guinea pigs can be litter box trained. Several and sufficient litter boxes will be required to ensure they are used by all guinea pigs and to prevent resource guarding. Litter boxes can be filled with various substrates such as paper-based pellets or similar guinea pig safe materials.
- Wire mesh flooring is inappropriate and can cause injuries such as pressure neuropathy, increased risk of hair loss, foot pad ulcers and dermatitis, decreased breeding activity and slower weight gain.
- Animals used in experiments involving the disruption of innervation to the distal limb require special care[37,38]. These animals can struggle with their mobility and are at a high risk of developing injuries to the lower limbs and feet.

Standard

3.3.1 Bedding should be dust free, free of microbial or parasitic contamination, non-toxic, ammonia binding, non-traumatic and moisture absorbent[39]. Bedding should be treated, when possible, to remove entrants of disease (e.g., autoclaved).

3.3.2 Suitable substrate for bedding in guinea pig enclosures includes hay, straw, shredded paper, pelleted paper, and non-aromatic wood shavings (e.g., no pine)[10,19].

3.3.3 A depth of at least 5cm should be used for straw and hay and is ideal for all bedding. A depth of at least 3 cm is to be used for shredded paper with a base of paper or newspaper at the bottom. Other substrates are also to have a minimum depth of 3cm.

3.3.4 Hay and straw should be of high quality to avoid grass awns and other undesirable elements.

3.3.5 Sawdust should not be used as a primary bedding.

3.3.6 Where appropriate a layer of higher absorbency of bedding of 3cm can be overlaid with a top layer of straw and hay. This can offer good absorbency and the ability for animals to nibble and manipulate substrate.

3.3.7 Floors in guinea pig enclosures should be solid to assist normal toenail wear and obviate the need to trim toenails. There is evidence indicating that guinea pigs prefer a dark-coloured floor with a textured surface over a light coloured one with a smooth surface.

3.3.8 Enclosures with wire mesh floors should not be used for the housing of guinea pigs.

3.3.9 Where the use of mesh flooring is specifically approved by an AEC based on compelling scientific evidence, the mesh used must provide adequate footing for the animals. Perforated plastic or perforated stainless steel floors should be used. All types of mesh or perforated floors must have a solid area for resting that can accommodate all animals in the enclosure.

3.3.10 Additional support in the enclosures housing animals with distal limb issues or mobility issues should be used. Items such as rubber matting with deep litter can be used. Additional monitoring should be required for these animals.

Recommendation

v. Hay and straw should be used as they have the added benefit of being a substrate animals can safely ingest and nibble.

3.4 Nesting Material

Background

– All animals should be offered additional substrate for nesting materials to offer enrichment for animals.

– Guinea pigs produce precocial young that are fully furred, have their eyes open and are capable of coordinated locomotion almost immediately after birth[27]. Female guinea pigs may not always fully construct a nest, but they do require comfortable substrate and a secure shelter or retreat where they can give birth.

– Additional substrate also offers enrichment and opportunities for natural behaviours.

Standard

3.4.1 All animals should be offered additional substrate and nesting materials to offer opportunities for enrichment and expressions of natural behaviours.

3.4.2 Female breeding guinea pigs must have a comfortable substrate and a secure shelter or retreat where they can give birth to encourage natural reproductive behaviours.

3.5 Cleaning of Enclosures

Background

– Guinea pigs in pens will typically have a toilet area. They will urinate and defaecate in one corner or area, although faecal pellets may be scattered with the movement of guinea pigs in the pen.

– To avoid the need to remove the guinea pigs from their pen and thus reduce the disturbance to the animals, floor pens may be temporarily divided at cleaning time, with the animals herded into one side, behind a removable partition, while the other side is cleaned.

– A balance needs is required between human perception of the need for cleanliness and the level of disturbance to guinea pigs. Smell is very important to guinea pig social interactions related to sex, age, reproductive status, individual identity, hierarchy, and mother/young relationships.

Standard

3.5.1 Daily spot cleaning and of the toilet area and/or litter tray should be done in between complete weekly bedding changes. Full bedding changes must be done every two weeks unless an AEC and veterinary exemption is in place due to extenuating circumstances.

3.5.2 In the rare circumstances where cage trays are utilised for slatted, mesh or perforated floors, they must be cleaned and emptied daily.

3.5.3 Enclosures should be washed and disinfected with an odourless disinfectant at least every month.

3.5.4 Enclosures must be fully cleaned with an odourless disinfectant every time a room is cleared, and new stock is brought in. All substrates and objects should be removed, cleaned with a bacterial/virucidal disinfectant e.g., quaternary ammonium compound (F10, Virkon) allowed to soak before wiping clean, then thoroughly dried prior to replacing bedding and any objects.

3.5.5 More frequent cleaning may be required as needed to ensure appropriate cleanliness.

3.5.6 Humans typically smell ammonia at 8-10ppm which indicates levels of ammonia are too high for animals.

3.5.7 Concentrations of ammonia must not exceed 10ppm.

Recommendation

vi. Concentrations of ammonia should be less than 1-2ppm.

3.6 Enclosure shelters

Background

– The degree guinea pigs will utilise the space provided to them depends on the provision of shelters and retreats to which they can retire to rest or when a threat is perceived. Extensive open space in an enclosure will generally be avoided by the animals if there is no shelter close-by. In the absence of shelter, the animals tend to utilise the space on the periphery of the enclosure, resting and sleeping close together next to the walls[40]. When adequate shelter is provided, use of the space develops over time until it is fully utilised[41,42].

– Permanent shelters can be made from a variety of materials. Shelters can be made from:

- Pieces of straight, angled, Y section or T section of sufficient diameter PVC or similar water pipe with smooth edges. Plastic pipe has the advantage that it can be readily cleaned and disinfected[7].
- Pieces of larger diameter pipe cut lengthways yield two semicircular sections that can be inverted to create tunnel shelters.
- Clean, recycled plastic drums cut down if necessary and with a suitable hole cut in the side.
- Clean, recycled cardboard with at least 2 suitable holes cut in the sides.
- Purpose built boxes made of plastic, exterior grade plywood or timber.
- Some establishments use boxes fitted with a floor, a top opening lid and two sliding doors across the access hole in the side, which allows the staff to capture animals quickly and easily when necessary and facilitates the handling of individuals for examination or treatment[12].

– Temporary shelter can also be provided with biscuits of hay heaped in the enclosure. Guinea pigs will play and tunnel through the hay and gradually eat the leafy material and trampling the stalks.

– The continuous provision of hay also prevents behaviour problems such as hair damage due to barbering and assists normal hypsodont tooth wear[9,10].

Standard

3.6.1 All pens and cages should have shelters and hiding places for guinea pigs. Lack of space or facilities must not be considered sufficient justification for the absence of shelters.

3.6.2 Permanent shelters must have at least 2 holes for exit/entry and where appropriate multiple holes drilled along the top to promote ventilation and prevent smothering.

3.6.3 Shelters must be replaced and/or cleaned as they become soiled or damaged and when enclosures are cleaned and disinfected between groups of guinea pigs.

3.6.4 Wood must not be treated with an insecticide or fungicide and have an impervious, non-toxic finish that can be cleaned effectively.

3.6.5 Hay should be regularly replenished to maintain its value as a feed supplement and shelter. Mouldy or dirty hay must not be used[6].

3.6.6 Animals should be regularly monitored for ocular discharge, blepharospasm and other ocular abnormalities that may indicate a hay or straw poke injury to the eye.

3.6.7 Sufficient shelter should be provided to avoid resource guarding or other similar issues.

4 Guinea pig care and management

4.1 Management of Guinea Pigs in Groups

Background

- The success of group housing rests largely on the skill and enthusiasm of the animal carers.
- Vocalisation is an important feature of the social interactions and communication between guinea pigs and is also directed towards their human carers. There are approximately 11-16 different sounds regularly used by guinea pigs. (see resources for links to sounds).
- It is very important to keep the composition of a group stable. Guinea pigs require considerable socialisation to acquire the skills necessary to establish stable social structures[43].
- The incidence of fighting may increase when established social structures are changed and new groups are formed. There is evidence to indicate that social support between partners significantly reduces endocrine responses to stressful situations[44].
- Although guinea pigs are social animals that form small groups, some individuals are more aggressive than others. The occurrence of aggression, and the severity and outcome of such encounters, can be difficult to predict.
- It is best to establish single sex groups of guinea pigs when they are young (around the time of weaning), and at least before they reach puberty (which may begin as early as 2 months of age).
- Ideally littermates should be used, although separate litters of similar age can be grouped. Large weight or age differences can result in aggression.
- Mature entire sexed male guinea pigs fight which can result in severe injuries[45]. After about 3 – 4 months of age it is unsafe for entire sexed male guinea pigs to be housed together as the outbreak of severe aggressive encounters is difficult to predict and may occur without warning[10,46].
- If animals are desexed they can be carefully housed together but it is still advised to keep siblings together if possible. Injectable chemical (e.g., suprelorin) and surgical desexing are both available options for guinea pigs.
- Males that are reared with one single female do not learn how to deal with agonistic behaviour in a colony situation and if exposed to other males in the presence of females, high levels of aggressive behaviour are often displayed[47]. Females raised in isolation may have impacts on maternal behaviour into adulthood[48].
- Some individuals may be highly aggressive. In such cases it may be necessary to remove the dominant or subordinate guinea pig temporarily or permanently and re-house with another compatible guinea pig[10,47].
- It is important that all guinea pigs are provided with sufficient space and objects to assist them to escape and hide from aggressors. Objects such as boxes, pipes, ledges, and vertical barriers provide means for hiding and escape.
- To ensure that individuals can be adequately monitored for signs of ill health or bullying, group sizes should not exceed 8 guinea pigs with the exception of

pups/juveniles with sows/dam. Limiting group numbers also avoids high stocking densities and overcrowding.

Standard

4.1.1 Carers must be able to monitor and assess guinea pig behaviour and implement management strategies accordingly.

4.1.2 Males can be housed in groups until they reach 3 months of age.

4.1.3 Entire mature sexed animals should not be mixed (apart from breeding groups).

4.1.4 If desexing is to be performed, it should be performed as early as possible and ideally before 10 weeks of age.

4.1.5 No more than 8 guinea pigs should be housed together as numbers larger can create difficulties in developing and maintaining a stable hierarchical system. Groups should be between 4-6 guinea pigs.

4.1.6 Pregnant females are to remain in stable social groups as physiological changes during pregnancy can permanently affect offspring.

4.1.7 Males should be raised with multiple pen mates to decrease incidence of aggression and aggressive encounters.

4.1.8 Guinea pigs should be provided with sufficient space and objects to assist them to escape and hide from aggressors. Objects such as boxes, pipes, ledges, and vertical barriers provide means for hiding and escape. Sufficient objects should be provided to eliminate competition for any items or resourced within enclosures.

4.2 Regrouping/Establishing Groups

Background

– Bonds existing between guinea pigs provide security and health-promoting effects. The severing of these bonds by the isolation of individuals has measurable physiological effects, with potentially deleterious outcomes for the welfare of the guinea pigs including weight loss and reduced water intake[49].

– The maintenance of a familiar environment and provision of visual, olfactory, and auditory contact with familiar cohorts reduces the stress and side effects associated with individual housing and reintroduction to the group[47,50]. These effects may also confound experimental outcomes if not considered during the experimental planning.

– In situations where a guinea pig must be removed from its social group for individual treatment, the housing of a familiar companion animal with the treated animal will help reduce the effects of stress caused by separation[21]. Techniques like placing scented bedding or objects from pen mates into enclosures can also be useful.

– It is possible to regroup guinea pigs, but this requires particular care and intensive monitoring. It is important that guinea pigs are placed in a fresh neutral area to avoid home territory for any animals. Additional measures include:

  - Providing hiding places and breaking up clear areas so that guinea pigs can escape from each other;
  - Placing wire partitions between pens to allow familiarisation between guinea pigs before they are mixed which may take a prolonged period over several days to weeks;

- Scattering faecal pellets and urine-soaked litter from each guinea pig in the new pen;
- Scattering food in the new pen to encourage foraging;
- Having the usual carer handle guinea pigs together in small groups in a different pen before mixing;
- Consider "faux transporting" the guinea pigs together for short period of time in a transport container before transferring to a new pen. This can sometimes help facilitate bonding.

Standard

- If a protocol is approved by the AEC requires individual housing, provision must be made for visual, auditory, and olfactory contact with other guinea pigs.
- Where individual guinea pigs need to temporarily be separated from a group, they should be housed so that visual contact between the individual and the group can be maintained. This helps to ensure that they will be readily recognised and accepted as familiar members of the group when returned.
- Carers must be vigilant and should increase monitoring to identify signs of fighting or incompatibility. Groups may become unstable and may require the removal of individuals.
- Guinea pigs should not be raised or housed in isolation. If required under special ethical consideration and approval with strong justification and compelling scientific evidence then additional monitoring, care, and independent veterinary oversight must be required.

Recommendation

vii. If a single animal will remain for a period of time after cohorts have been removed from a treatment group, then wherever possible a compatible companion should be provided. This could be an already desexed adult male or female guinea pig. Chemical desexing is an option for companions which are excess to colony requirements is also a potential option. Surgical desexing of animals for the purposes of companionship should not be undertaken.

viii. Animals should be removed in pairs and returned in pairs to the larger group whenever possible.

4.3 Catching / Handling of Guinea Pigs in Pens and Cages

Background

– Guinea pigs are highly sensitive to human activity and sounds in the animal room. It is very important to approach the animals and perform husbandry tasks with due empathy to avoid startling them.

– Guinea pigs may either freeze or stampede in response to an unexpected or sudden stimulus. Animals may freeze for periods of up to 30 minutes if startled by a sudden and unexpected noise. Alternatively, they may stampede if startled by an unexpected noise or movement and cause injuries, particularly to young animals and pregnant females, if trampled[27].

- A quiet approach should be taken. Guinea pigs will usually retreat to a darkened hiding place from where they may be picked up. The careful and appropriate use of purpose-built shelters to catch guinea pigs can be utilised.
- Guinea pigs can show a reduction in fearfulness to handlers after repeated positive approach and handling. The use of handling and approach programs may help reduce general emotional reactivity (not just fear of humans) and strengthen the human-animal bond. Positive reinforcement, training and treats are important components of these programs.
- Guinea pigs can seek the attention of their human carers[14] and very quickly learn the sounds associated with caretaking of the colony, such as refilling of water bottles, opening of food containers, rustling of hay and other associated sounds[11].
- Pens may provide room to escape and catching guinea pigs in pens may be difficult when the appropriate strategies have not been implemented. Anticipation of catching and procedures can play a major role in a guinea pig behaviour.

Standard

4.3.1 Guinea pigs should be handled regularly from a young age to facilitate training and acclimatisation.

4.3.2 Guinea pigs should be given training and acclimatisation (operant conditioning) to facilitate ease of animal care and experimental procedures.

4.3.3 Animal carers should also spend time with the guinea pigs, and employ training techniques, treats and other methods which will facilitate catching. Guinea pigs should be positively and routinely handled from a young age to facilitate catching and handling.

4.3.4 Steps should be taken to reduce the stress of procedures and to catch and handle guinea pigs without conducting other procedures[19].

4.3.5 Handlers should be experienced and confident approaching and lifting guinea pigs and hold them in the species-specific way to reduce stress-related injuries. Guinea pigs must be handled with care with their bodies supported. Pregnant females require additional care and support during handling.

Recommendation

ix. Guinea pigs, like other small animals, can be trained to accept procedures (e.g., oral administration of an antibiotic solution) with minimal or no restraint when given positive reinforcement (e.g., drug delivered in a sugar-coated syringe after a period of training by administering a sugar solution)[51].

4.4 Special Housing - Metabolism cages

Standard

4.4.1 Where the use of metabolism cages is approved under strong, compelling scientific justification and special ethical consideration by an AEC, the stress associated with separating guinea pigs from their social group into individual cages should be minimised to negative impacts on animal welfare and experimental outcomes under the experimental protocol by using strategies such housing them in a room that permits visual, olfactory, and auditory contact with familiar cohorts[38].

4.4.2 Alternatives to single housing are frequently available and must be considered and used where possible for sample collections to avoid the use of metabolism cages.

4.4.3 There is scientific evidence animals do not fully habituate to metabolic housing and therefore in some cases experimental aims may be compromised[52,53]. Therefore, animals must be housed for the shortest period of time possible. Animals should ideally not be held for more than 5 days[52].

4.4.4 Acclimatisation periods should not exceed 3 days and can be accomplished in as little as 24-48 hours[52].

4.4.5 Punched metal or plastic flooring should be used. Guinea pigs maintained on a mesh floor must be provided with an area of solid floor large enough for all animals in the enclosure to rest at the same time[52]. An appropriately designed refuge/shelter that does not interfere with urine or faecal collection should be provided.

4.4.6 Where possible additional care and enrichment must be provided.

4.4.7 Increased monitoring and independent veterinary oversight must be provided.

4.5 Enrichment

Background

– The aims of environmental enrichment are not simply to prevent distress or negative experiences, but to offer the potential for positive experiences and to achieve optimum outcomes of experimental work through the application of accepted good animal welfare practices in animal husbandry and care[54].

– The implementation of strategies to provide environmental enrichment for guinea pigs should be regarded as a fundamental requirement for guinea pig care and management.

– Environmental enrichment strategies will extend over all facets of guinea pig housing from pen design to food provision, opportunities for social contact and the provision of objects for manipulation. There is a wealth of information on enrichment for animals available through various lab animal networks, literature, and websites which should be utilised. The recommendations listed below are only a small list in addition to other recommendations throughout the document which contribute to enrichment of a guinea pig's environment.

– Enrichment gives animals a creative outlet for physical activity and mental exercise, as well as choice and control over how they spend their time. Enrichment should stimulate all 5 senses and have motor, sensory, cognitive, and social stimulation components.

– Guinea pigs have four important groups of natural behaviours that should be allowed expression:

  - social interaction;
  - chewing/gnawing;
  - locomotion (including tunnelling, exploring, and playing); and
  - rest/hiding.

– The recommendations listed below are only a small list in addition to other recommendations throughout the document which contribute to enrichment of a guinea pig's environment:

- Social interaction: Housing guinea pigs in compatible social groups
- Chewing / gnawing: small blocks of softwood, seagrass mats, palm tree woven ball, apple/pear branches, hay, and straw[16]. Guinea pigs that are routinely provided with softwood sticks usually do not attempt to gnaw fittings such as food hoppers in their enclosure[41].
- Locomotion (including tunnelling, exploring, and playing): Hay biscuits or a hay rack positioned just above the floor which permits tunnelling; open space interspersed with shelters that encourage the guinea pigs to use the available floor space.

– Resting / hiding: Shelters in the form of PVC or similar pipes, timber, plastic or metal boxes, clean plastic drums or cardboard boxes with holes cut in the sides, and bedding material[54]

– Providing guinea pigs with enrichment via penmates or proximity to penmates, and items to manipulate triggers species-typical behaviours, reduces stereotypical behaviours, results in increased activity, and improves animal welfare and experimental outcomes.

– It is important for guinea pigs to be able to hide and to get away from each other.

– Guinea pigs like to play, manipulate, and chew hay, straw, and various objects.

– Safety and risk assessments are important components of housing and environmental enrichment[54].

Standard

4.5.1 In accordance with the requirement of the Code, accommodation (housing), physical and social environmental conditions to meet should species-specific requirements (3.2.13).

4.5.2 All animals are to be provided with enrichment as a standard requirement for animal welfare and care. AEC specific approval with veterinary oversight for any exemption of any enrichment should be under careful consideration and strongly scientifically justified (3.2.13). Exemptions may also be needed when animals are unwell and under veterinary advice and care.

4.5.3 The suitability of items for enrichment must be critically assessed to ensure that the strategies improve and are not detrimental to animal welfare.

4.5.4 Guinea pigs should be provided with non-toxic guinea pig-safe objects to manipulate and gnaw such as wooden sticks, cardboard boxes, seagrass or hay-based matting, non-toxic branches (e.g., fruit trees like apple, pear, plum) with leaves and small cardboard boxes.

4.5.5 If kept in cages, guinea pigs like other animals, should be taken out of cages on a regular basis for handling/petting and exercise in a play pen[55]. Lack of space or facilities for playpens should not be considered sufficient justification.

4.5.6 Some materials, such as some plastics, treated wood, galvanized, or painted materials, may be dangerous because of their toxicity when chewed and must not be used.

Recommendation

x. A rotating enrichment program and plan should be implemented, regularly updated, and reviewed annually.

xi. A variety of food should be provided. Food may be spread out in the bedding to encourage foraging behaviour.

xii. To reduce negative impacts to physical and physiological health including the relief of boredom[56], all guinea pigs should have access to larger, complex floor pens to assist in providing the opportunity for exercise, enrichment, and better health.

4.6 Identification

Background

– Identification and recording of animals are required for good regulatory, management and experimental practices. Methods of identification vary and can include but are not limited to:

– Coat colour and pattern with photos are useful for the identification of individuals in some breeds of guinea pigs.'

– Dyes including non-toxic animal safe permanent wool dyes, agricultural sheep sprays/crayons may be used. These need to be reapplied at intervals, as the dye fades or the guinea pig moults.

– Xylene free permanent markers may be used on ears and fur. Generally, these need to be refreshed every 3 weeks.37 The use of these markers on the inside of the ears is effective and different colours can be used for coding.

– Fur clipping may be used but needs to be carried out frequently.

– Microchips and ear tattoos may be used for permanent identification.56 Note there is transitory pain associated with applying these forms of identification. Microchips can be inserted from 6 weeks of age.

Standard

4.6.1 Guinea pigs should be individually identifiable and be the least invasive method of identification should be used that is compatible with the project (2.4.18iv).

4.6.2 Methods of identification should be non-invasive, cause the least amount of harm, distress, and pain to animals (3.3.6) and not likely to catch or tear out.

4.6.3 Anaesthesia (local or general) and/or sedation along with analgesia must be used in applying tattoos and microchips and only by specially trained staff.

4.6.4 Numbered ear tags should not be used as they can tear the pinna, causing pain, infection, inflammation, and keloid/scar formation. Collars should not be used due to the risks of catching on enclosures.

4.6.5 Ear notching and toe clipping must not be used.

4.6.6 A permanent record of the individual tag numbers must be kept and available either in the enclosures or in the same location as the animals for ease of identification, compliance, and auditing purposes.

4.7 Food and Water

Background

- Appropriate nutrition and water are critical for regulatory, animal welfare and experimental outcomes.
- Periodic detailed analysis of the diet by a competent laboratory may avoid long-term deficiencies that can affect research results along with consultation with a guinea pig veterinary specialist and/or nutritionist.
- A nutritionally adequate diet is required for good guinea pig welfare and is primarily composed of long-stem hay and grasses appropriate for the life stage[10,57].
- High fibre feed such as hay helps prevent myriad of disease including but not limited to dentition, dental cavity, behaviour, gastrointestinal tract, obesity and trichobezoars (hairballs).
- A diet with around 18 – 25% crude fibre is required[10].
- There are two main types of hay: grass hay and legume hay. Typically grass hays (e.g., meadow, Timothy, oaten) have lower energy, protein and calcium content and are suitable for all guinea pigs. Legume hays like lucerne have higher protein and calcium content and can be fed to growing animals and breeding females for short periods. Prolonged feeding of legume hays will predispose to the development of urinary calculi and should not be fed to non-breeding adults.
- Dried pelleted diets can be standardised with little variation. However, these diets are also monotonous and compromise the dental, nutritional and behavioural welfare of guinea pigs if fed in excess to the below recommendations.
- Guinea pigs have a daily maintenance requirement of 10mg of vitamin C per kg-1 of body weight which increases to 30mgkg-1 for pregnant females[7]. Dampness, heat, light and inappropriate or prolonged storage can reduce the vitamin C content of stored foods. Storage of feed at a temperature above 22˚C may oxidize half of the vitamin C present in the ration[7]. Autoclaving the ration destroys vitamin C but can be corrected by fortification.
- Fresh vegetables such as sweet peppers, spinach, tomatoes, kale, and asparagus are good sources of vitamin C.
- Vitamin C supplemented to the water supply may not be effective. Losses occur at a higher rate in hard water, metal containers or if the water is heated.
- Vitamin C deficiency causes the condition known as scurvy which is characterised in guinea pigs by clinical signs including weight loss, unkempt coat with alopecia, diarrhoea, joint swelling reproductive or growth abnormalities, pain, occasionally pinpoint haemorrhages (petechiae) in the mucous membranes, dental disease (tooth loosening), and blood in the urine (haematuria). Clinical signs may begin to appear in guinea pigs after 2 weeks on diets that lack the vitamin[7].
- Zinc (Zn) plays a key role in central and peripheral nervous system function in guinea pigs. Zinc deficiency may cause abnormal posture and locomotion, tactile hypersensitivity or hyperalgesia and reduced motor conduction in the sciatic nerve[58].
- Guinea pigs differ from other species of rodents in their metabolism of dietary selenium (Se). The activity of the selenium dependent antioxidant enzyme glutathione peroxidase is normally lower in guinea pigs than in other species. Selenium deficiency in guinea

pigs significantly reduces the activity of this enzyme, reduces the steady state level of thyroxine, and significantly reduces the growth rate compared with animals receiving a normal concentration of dietary selenium[59].

Standard

4.7.1 Animals must receive and access to a nutritionally complete, appropriate, uncontaminated, quantity, and composition of diet that maintains normal growth, normal weights, and meets the requirements of pregnancy, lactation, or other conditions (3.2.24)

4.7.2 Clean, fresh drinking water must be available at all times in a way suitable for the species and checked daily (3.3.25).

4.7.3 Long-stem forage (e.g., hay) should form the primary component of the diet and should be available daily.

4.7.4 Special AEC consideration and approval is required to feed diets deficient in daily long-stem forage.

4.7.5 If a restricted diet is required to be fed, it must be only by specific exemption and approvals from the AEC with veterinary oversight. Investigators and AECs should be aware this will compromise physical and psychological welfare as well as increase the risk of disease which can negatively impact experimental results. Feed should be provided in the late afternoon as this has been shown to reduce the frequency of abnormal behaviours in some caged animals[60].

4.7.6 Storage and any other conditions must be taken into account (e.g., autoclaving) when preparing and delivering diets for animals.

4.7.7 More than one source of food and water should be provided to reduce the possibility of aggressive competition.

4.7.8 The selenium concentration should be 0.5mgkg-1 of diet (equivalent to 1.2mg of sodium selenate kg-1 of diet)[59].

4.7.9 An adequate zinc level is 100mgkg-1 of diet if fed ad libitum[58].

4.7.10 The ration should normally contain 500mg of vitamin Ckg-1 of diet[61].

4.7.11 There should be multiple sources of vitamin C in the diet to avoid vitamin C deficiency.

4.7.12 Supplementing vitamin C in the water as a primary source should be avoided.

Recommendation

xiii. Separation of water supplies from food hoppers is recommended as there is tendency for guinea pigs to dribble water into the food which causes caking and wastage of pelleted rations and other feed.

Water

xiv. Systems to supply water may be used. If automatic watering systems or water bottles are used, care should be taken to avoid leakage and overflows. Open water systems (such as chicken water hoppers) should be raised up to prevent water being contaminated with bedding and faeces.

xv. Water supplies require daily checking, should be replenished daily and must be easily accessible. Water dishes tend to become soiled with food and faeces and through guinea pigs resting in them. Water bottles sipper tubes can become clogged with masticated food if they are placed too close to food bowls. Sipper tubes should be

situated sufficiently far above the level of the substrate to ensure that wicking and loss of water into the substrate does not occur[6].

xvi. Stainless steel tubes are less prone to damage by chewing than brass tubes[27]. Sippers and water bottles may be preferred over open bowls of water. If an automatic watering system is used the animals should be able to access the drinker by sticking their muzzle out of the enclosure. The incorporation of a drip channel to convey spilled water away from the enclosure is essential to avoid problems of wet substrate caused when valves leak, or guinea pigs play with them.

Food

xvii. Sudden changes to the diet can affect normal gut flora and should be avoided.

xviii. Scattering food reduces boredom by encouraging guinea pigs to forage[21]. This can reduce the amount of time available for fighting and helps to prevent obesity.

xix. Hay should always be provided as something to manipulate, play with, eat, and should be provided in excess of feed requirements.

xx. Periodic nutritional analysis of the diet should be undertaken to ensure quality as composition varies between types and batches of hay and/or forage.

xxi. Hay should be supplemented with items such as fruit (e.g., apple, pear, strawberry tops) and low calcium vegetables (e.g., leafy green herbs (basil, coriander, mint)), Asian greens (e.g. pak choy, bok choy, choy sum), cos or butter lettuce. Limited amounts of higher calcium leafy greens (e.g. kale, spinach, silverbeet) can also be given.

xxii. Fruit and vegetables should be washed and/or sanitised to reduce the risk of introduction of disease.

xxiii. Fresh food should mostly be composed of low calcium vegetables.

xxiv. Fruit should be given sparingly.

xxv. Excessive feeding of any single fresh item should be avoided, as diarrhoea and other gastrointestinal upsets can occur.

xxvi. Pelleted diets should not be fed at more than the amount of 10g/kg/day and only as an adjunct to hay and vegetables. Pellets must be fed within the prescribed use-by date and stored correctly to avoid the decomposition of vitamins and/or minerals. More than one formulation may be fed to reduce boredom.

4.8 Monitoring and Health of Guinea Pigs

Background

– Good biosecurity, animal health monitoring and animal assessment management plans are paramount to good animal welfare and robust research outcomes[62]. A high standard of animal care is crucial for the success of housing guinea pigs. Observations and familiarity by the animal care staff are required and the foremost important part of a health monitoring program.

– The infectious disease spread in guinea pigs housed in groups in pens does not appear to be greater than for animals housed singly in cages, provided high standards of care and monitoring are maintained. Possible routes for disease spread include direct contact and shared food and water containers[27]. Unless people exercise extreme care going between singly caged guinea pigs with the ventilation carefully controlled and

directed, the spread of infection can occur equally in single housed or group penned systems.

– Guinea pigs are prey species and may hide signs of illness. Therefore, any cause for any concern requires a health check and if abnormalities are found a veterinary assessment. Animals may need to be removed from a group. In cages normal behaviours may be difficult to assess (because it is difficult or impossible for guinea pigs to carry out these behaviours) and changes in grooming, food and water intake may be the only early indicator of illness.

Standard

4.8.1 Facilities must have appropriate animal management plans, a program of veterinary care, relevant SOPs and training plans developed with oversight and/or in conjunction with an appropriately qualified veterinarian.

4.8.2 Animal carers must be aware of the normal behaviour of guinea pigs and of the individuals within a group and observe for deviations from normal.

4.8.3 Familiarity of the animal carer with the normal appearance and behaviour of healthy guinea pigs is essential and any deviation should be investigated promptly.

4.8.4 Guinea pigs must be monitored both for health and social interactions within the group.

Guinea pigs must be monitored by observation at least daily for any signs of abnormality, illness, pain, or distress and to ensure adequacy of environmental conditions, food, and water supplies.

4.8.5 Weekly health checks of growing guinea pigs must be performed until guinea pigs reach maturity in addition to daily observation. Adults should be health checked every 2 weeks but must be checked at a minimum every month.

4.8.6 In addition to regular health checks, facilities should include a weekly review of health and husbandry records, routine husbandry, diagnoses, treatments and fertility, fecundity, morbidity and mortality in breeding, experimental and other animal colonies.

4.8.7 Any signs of abnormalities should be reported with increased monitoring and referral for health checks and/or veterinary care.

4.8.8 Animals that die unexpectedly should be submitted for post-mortem examination and diagnosis.

4.8.9 Guinea pigs introduced into group housing should be quarantined, and free of Pasteurella multocida, ear mites, fungal infections and coccidia.

4.8.10 Routine surveillance and specific-pathogen free testing should be regularly undertaken with a laboratory animal specific pathology laboratory utilised.

4.8.11 Health monitoring data and results of surveillance testing for specific diseases should routinely be made available to the researchers responsible for the guinea pigs and to the AEC.

Recommendation

xxvii. Guinea pig behaviour can be more difficult to interpret, and subjective judgements may not always be reliable. A combination of objective and subjective indicators of health and welfare should be regularly monitored.

xxviii. Health checks for individuals should include body condition score and weight; observation of any lumps or bumps or discharges or drooling; review of the eyes, ears, skin, teeth/malocclusion, jaw, perianal region, genitals, and feet; assessment of

demeanour, behaviour, activity, respiratory rate, and locomotion; review of eating, drinking, urination, faeces, and caecotrophs; and observation of general appearance and shape.

xxix. Health checks for entire and breeding guinea pigs should include specific observations of the mammary glands, external reproductive organs, and genitals.

xxx. Extra care and observation should be undertaken for subordinate guinea pigs to check for signs of bullying (which may result in fight wounds or denial of access to food or water).

xxxi. All sick guinea pigs should be examined and diagnosed by a veterinarian.

4.9 Breeding of Guinea Pigs

Background

– Domesticated guinea pigs do not have a seasonal breeding cycle and can produce multiple litters throughout the year. Litter sizes range from 1 to 4. Sexual maturity is from 2-3 months of age.

– The pelvis of female guinea pigs starts to fuse from 6-8 months of age. If guinea pigs do not have their first litter prior to this age, they are at increased risk of dystocia.

– Males will mate with females immediately after they have given birth.

– Problems that occur in breeding systems which house guinea pigs in cages can include very limited freedom of movement, stereotypies, restlessness, disturbed sexual behaviour, disturbed nursing, and cannibalism. The use of appropriately designed floor pens and managed breeding colonies can reduce the incidence of these problems.

– Inappropriate care and housing can affect the survival of young, especially in the first two weeks of life. Guinea pigs require shelters and soft materials to encourage and perform natural reproductive behaviours.

– The handling of young animals can help to reduce fearfulness towards humans and general emotional reactivity, as well as increasing “open field” activity and exploratory behaviour[14,63,64]. Handling in the first week of life and at a time associated with nursing may be especially effective in reducing fearfulness towards humans. The effect of this handling appears to be long-lasting.

Standard

4.9.1 Breeding animals should have their genitals and reproductive exam prior to breeding and entering a colony.

4.9.2 Genitals and the mammary glands of breeding guinea pigs should be monitored regularly in addition to routine health checks.

4.9.3 Guinea pig females should be bred at approximately 3 months of age to produce their first litter before reaching 6 months of age to avoid future issues of dystocia.

4.9.4 Females should be bred a maximum of 3 litters a year.

4.9.5 Females should be provided with shelter/nesting box, straw, or other suitable nesting materials such as hay or shredded paper.

4.9.6 Females should be able to withdraw from their young by retreating to a separate compartment or area.

4.9.7 Breeding groups should consist of between 2-5 females and one male. Dams and unweaned pups can remain with the breeding group if sufficient space is available and there are no other behavioural issues in group pens.

4.9.8 Females and males should be rested for at least one reproductive cycle between litters.

Recommendation

xxxii. Females should be bred a maximum number of 2 times a year.

xxxiii. Handling of pups should be for short periods of time (<5 min) to reduce risk of rejection of kits by the sow/dam. Care must be taken to ensure minimal scent transfer from staff, the surrounding area, or other animals.

4.10 Special Housing - Single and Double Housing of Guinea Pigs in Cages

Background

– When scientific work precludes the keeping of animals in appropriate environments, such as using floor pens and playpens, or permitting single housing of animals, both the researcher and AEC should be aware of the negative impacts on animal welfare and experimental outcomes[13,15,35].

– The advantages of housing animals singly in cages include:
  - Food and water intake can be controlled and monitored[23].
  - Faeces and urine excretion can be quantified and monitored[23].

– The disadvantages of housing animals singly in cages include:
  - Potential space restrictions in cages mean that guinea pigs cannot carry out normal activities such as playing, lying stretched out, tunnelling, and exploring.
  - The behavioural repertoire of singly caged animals is severely restricted, largely as a result of enrichment, spatial and social deprivation[27].

– Singly housed animals in cages carry out a variety of stereotypic behaviours such as bar gnawing, excessive grooming, fur eating, playing with the water nipple, pawing in the corners, head swaying and vertical sliding of the nose between the bars. Additional behaviours that have been observed include sitting in a hunched position for long periods and sitting with the head lowered in a corner. Animals also exhibit “restlessness” in cages – a high frequency of changing from one activity to another. It is likely that such behaviours are the result of frustration, anxiety, and boredom related to a barren, confined environment[14,50,51]. These behaviours are rarely if ever seen in animals housed in groups in pens.

– Singly caged guinea pigs may overreact to relatively small changes in the environment. Such changes are likely to be a source of stress to the guinea pigs and may become nervous, fearful, or aggressive[35,47,65]. Such behaviour may relate to a chronic lack of stimulation and/or to the fact that they have no way of escaping and hiding. Health problems can be more common in caged guinea pigs and rare or unseen in floor penned guinea pigs include trichobezoars (hairballs), gastrointestinal issues, pododermatitis (sore feet), obesity, and depression.

– Cages are expensive to buy and costly and time consuming to clean.

– Singly housed guinea pigs in cages may be psychologically, physically, behaviourally, and physiologically abnormal[35,44,47,65]. The use of such animals in research will have an influence on experimental results.

Standard

4.10.1 The impacts on animal welfare and experimental outcomes of single housing of social animals must receive special ethical consideration by the AEC and requires special approval (3.2.13).

4.10.2 Where the use of single or double housing cages is approved by an AEC, the stress associated with separating guinea pigs from their social group into individual cages and/or removal from floor pens should be minimised under the experimental protocol by housing them in a room that permits visual, olfactory, and auditory contact with familiar cohorts (3.2.23).

4.10.3 Mitigation strategies should be in place to manage the negative animal welfare and experimental impacts.

Recommendation

xxxiv. Enclosure shapes should maximise effective use of floor space and consider additional levels to provide more space and enrichment.

xxxv. All single, double, cage, or restricted housing should have oversight by an appropriately qualified independent veterinarian.

4.11 Floor Area of Single and Double Housing of Guinea Pigs in Cages

Background

– Caged guinea pigs should be given daily playpen/exercise pen or at least a minimum of 3 times a week unless specially approved by the AEC.

– Caged guinea pigs should be group housed or housed in compatible pairs.

– Cages should be:

- A minimum of 23cm in height
- A minimum of 2500cm2 in size per guinea pig
- A minimum of 4000cm2 in size per breeding pair with litters and +2500 per additional breeding female to a maximum of a ratio of 1:5 (M:F)

Recommendation

xxxvi. Additional space is recommended and should be used to allow for the provision of the expression of natural behaviours and for additional environmental enrichment.

xxxvii. For pair or groups housing of guinea pigs, this will may require the use of double cages. Cages may, for example, be joined by a PVC pipe which also acts as a hiding/resting area.

5 Environmental Variables

5.1 General

Background

– A variety of environmental factors, including light, temperature, humidity, air quality and sound may impact on the behavioural responses and health of guinea pigs. The design, construction and management of guinea pig pens and cages will largely determine how these factors will impact on the animals[20,66,67].

5.2 Light

Background

– Guinea pigs in a consistent environment are observed to be active most of the time with a predilection for crepuscular behaviour, exhibiting some periods of continuous activity interspersed with periods of intermittent activity throughout both light and dark period.

Standard

5.2.1 When working with albino guinea pigs, maintain a lower light level except when bright light is required for working in the room[27].

5.2.2 All animals must have a minimum of 8 hours of dark.

Recommendation

xxxviii. It is recommended to create an artificial dawn and dusk period where possible.5

xxxix. Although individual animals may respond differently, the provision of a 12:12 light-dark cycle is recommended for housed guinea pigs.

xl. A light level of a maximum of 60 lux is recommended for albino animals.

5.3 Temperature

Background

– Air temperature in the pen or cage is influenced not only by the design of the enclosure but also by air distribution, ventilation rate, the position of the enclosure within the air flow pattern and its proximity to other enclosures[66].

– Guinea pigs are better adapted to deal with cold than heat and draughts[66]. Temperatures of above 25C° can cause heat stress which may result in infertility and mortality. Higher humidity exacerbates the effects of heat.

Standard

5.3.1 The temperature range for housing guinea pigs should be between 20°C to 22°C[27].

5.3.2 Pregnant, neonates, sick and geriatric guinea pigs will be more sensitive to temperature changes and/or other adjustment should be reviewed and considered.

5.4 Humidity

Standard

5.4.1 A maximum relative humidity for guinea pig housing is 70% and a minimum of 35%.

Recommendation

xli. A relative humidity for guinea pig housing of between 45 – 65% is recommended.

5.5 Air quality and ventilation

Background

- The effective ventilation of guinea pig enclosures is a critical consideration in the management of environmental factors. The adequacy of air exchange in the guinea pig' immediate environment of the pen or cage will affect temperature, humidity, and air quality. The placement of air inlets and outlets in a room and the rate of air exchange will affect the pattern and efficiency of air distribution[66].
- The number of air changes per hour that are needed will in part be determined by the cleaning routine and stocking density of animals[27]. Air changes and an efficient air flow are required to keep ammonia levels within the guinea pig' immediate environment of the pen or cage at an acceptable level.
- Odours in the environment may influence the health and behaviour of guinea pigs.

Standard

5.5.1 Air exchange rates should be between 10 to 20 changes per hour and is dependent on the stocking density and ambient temperature.

5.5.2 Concentrations of ammonia must not exceed 10ppm. Humans begin to smell ammonia at 8-10ppm which means if an ammonia smell can be detected by staff it is too high.

Recommendation

xlii. Concentrations of ammonia should ideally be lower than 1-2ppm.

5.6 Sound and Vibrations

Background

- Guinea pigs are sensitive to high sound frequencies (ultrasound) and vibrations which cannot be detected by humans.
- Guinea pigs communicate using sound frequencies extending into the ultrasonic range16 and are sensitive to high sound frequencies which cannot be detected by humans (ultrasound).
- The effects of vibration and noise on animal welfare and experimental outcomes can be profound and may not be easy to detect by human sense[68–71].
- Excessive sounds of vibrations can cause reproductive disorders, increase rates of cannibalism in pups, induce physiological and behavioural changes, and can result in death.

– Ultrasound and vibrations can be produced by common laboratory equipment such as temperature regulating devices, electronic equipment such as computer monitors, video recording equipment and telephones, cage cleaning equipment and vacuum hoses as well as by running water and squeaky door hinges, chairs or trolley wheels or distant construction. Such sources should be eliminated by routine maintenance wherever possible and offending equipment should be shielded or its use should be avoided in the animal house[66]. The use of vibration mats may reduce vibrations.

– Artificial background noise such as a radio, piped music, a white noise generator, or white noise arising coincidentally from the operation of an air conditioning system, may be of some use in masking sudden noises that occur in an animal house. Classical and similar sounds of radio music and white noise sources may be of benefit because they do not normally include the very high frequencies that are within the auditory range of laboratory animal species.

Standard

5.6.1 Human conversation is normally around 65db. Noise should be kept to under 70db. Vibrations should be kept to less than 0.25g (gravity).

5.6.2 If there are concerns regarding sounds and vibrations in the facility, then meters should be sourced to determine sound and vibrations levels with appropriate steps to mitigate any potential issues.

5.6.3 Sounds or vibrations in excess to normal volumes or frequencies should be mitigated.

Recommendation

xliii. A background sound level of 50db has been suggested to avoid disturbance to animals or personnel.

5.7 Monitoring of environmental variables

Background

– At the pen or cage level, temperature, humidity, and air quality are all affected by the system controlling the supply to each room.

– Environmental variables of the guinea pigs' living area require regular monitoring.

Standard

5.7.1 Air exchange, temperature, humidity, light, and noise should be maintained within limits compatible with guinea pig wellbeing and good health, monitored and recorded.

5.7.2 Temperature and humidity should be checked daily.

5.7.3 Animal rooms should have temperature and humidity read-outs in a position where staff can easily see them.

5.7.4 Sensors must be fitted to monitor and report malfunctions in ventilation, temperature, and humidity control on a 24-hour basis, with automatic alarm activation and alerting of appropriate staff.

5.7.5 Regardless if a centralised computer system is regulating general environmental conditions, it is still essential to check these variables daily in the room.

5.7.6 Automatic monitoring and control systems should be regularly calibrated and validated at room level.

Recommendation

xliv. Diurnal variations should be checked where appropriate.

xlv. Sensors for reporting and monitoring light:dark cycles should be fitted with automatic alarm activation and alerting of appropriate staff.

6 Records

6.1 Pen / Cage Labels

Background

– Identification and appropriately sufficient record-keeping and labelling of pens, enclosures and animals is required for good regulatory, animal welfare, and experimental outcomes.

Standard

6.1.1 Animals must be identifiable either individually or in groups (2.4.16iv).

6.1.2 Health records for each guinea pig should be kept (2.4.18vii & 2.4.32) detailing dates of monitoring, procedures, and any adverse events such as injuries, fighting.

6.1.3 Pens and cages should have labels attached that provide the following information (2.4.32):

- Guinea pig identification
- Name, location and contact numbers of the principle/chief investigator and (if applicable) other investigators using the guinea pigs
- Name, location and contact numbers of staff associated with the housing and care of the guinea pigs
- Name and approval number of AEC approved protocol
- Age (date of birth) of guinea pigs
- Date of entry of guinea pigs into the pen or cage
- Any other relevant or important information (e.g., treatments)

6.2 Breeding, Health, and Other Records

Background

– Appropriately sufficient record-keeping of breeding records of animals is required for good regulatory, animal welfare, and experimental outcomes.

– Good record keeping is an essential adjunct to good observation. Accurately recorded production data can indicate early changes in the health status of an animal colony that might otherwise pass undetected.

– Standard operating procedures, animal management and emergency/contingency plans are essential for quality control, clarity, training, consistency, safety, and demonstrating appropriate compliance with AEC approved applications and other relevant regulatory requirements.

– All together these documents form the basis for good animal welfare, care, research, and compliance outcomes.

Standard

6.2.1 To assist in monitoring the management of animal breeding colonies, regular reports must be provided to the Animal Ethics Committee, for review, on the fertility, fecundity, morbidity, and mortality of all animal breeding colonies (2.5.12). The frequency of such

reports should be at least 6 monthly and more often if deemed necessary by the Animal Ethics Committee. (See ARRP Guideline: Supervision of Animal Supply by Animal Ethics Committees).

6.2.2 Adequate records to allow effective management of the breeding stock and management of colonies including the detection of the origin and spread of disease (2.5.11, 2.5.13 & 2.5.15x). Records should include:

- the source, care, allocation, movement between locations, use and fate of all animals;
- details of any diseases;
- the fertility, fecundity, morbidity, and mortality in breeding colonies; and
- the health status, genetic constitution, and physical environment of the animals

6.2.3 These reports should be reviewed and analysed in consultation with an appropriately qualified veterinarian. Any issues identified should be promptly investigated, diagnosed, and addressed, with reporting back to the AEC.

Recommendation

xlvi. Breeding and health records should be regularly reviewed, ideally at least quarterly, in consultation with veterinary, animal care staff, and researchers input.

xlvii. Based on this review strategic analysis and planning should be undertaken and implemented with information regularly relayed to the AEC.

xlviii. All records and documentation (e.g., training, management plans, SOPs) should be refreshed at least every 3 years.

xlix. Facilities should consider the use of digital records to facilitate trend analysis and review.

Recommendation Summary

i. Slower introductions are recommended when introducing or re-introducing guinea pigs into their groups or pairs.

ii. Workflows should be arranged so that prey species are managed before predator species.

iii. Guinea pigs should only be housed in single species rooms.

iv. Enclosure shapes should maximise effective use of floor space.

v. Hay and straw should be used as they have the added benefit of being a substrate animals can safely ingest and nibble.

vi. Concentrations of ammonia should be less than 1-2ppm.

vii. If a single animal will remain for a period of time after cohorts have been removed from a treatment group, then wherever possible a compatible companion should be provided. This could be an already desexed adult male or female guinea pig. Chemical desexing is an option for companions which are excess to colony requirements is also a potential option. Surgical desexing of animals for the purposes of companionship should not be undertaken.

viii. Animals should be removed in pairs and returned in pairs to the larger group whenever possible.

ix. Guinea pigs, like other small animals, can be trained to accept procedures (e.g., oral administration of an antibiotic solution) with minimal or no restraint when given positive reinforcement (e.g., drug delivered in a sugar-coated syringe after a period of training by administering a sugar solution)[51].

x. A rotating enrichment program and plan should be implemented, regularly updated, and reviewed annually.

xi. A variety of food should be provided. Food may be spread out in the bedding to encourage foraging behaviour.

xii. To reduce negative impacts to physical and physiological health including the relief of boredom[56], all guinea pigs should have access to larger, complex floor pens to assist in providing the opportunity for exercise, enrichment, and better health.

xiii. Separation of water supplies from food hoppers is recommended as there is tendency for guinea pigs to dribble water into the food which causes caking and wastage of pelleted rations and other feed.

xiv. Systems to supply water may be used. If automatic watering systems or water bottles are used, care should be taken to avoid leakage and overflows. Open water systems (such as chicken water hoppers) should be raised up to prevent water being contaminated with bedding and faeces.

xv. Water supplies require daily checking, should be replenished daily and must be easily accessible. Water dishes tend to become soiled with food and faeces and through guinea pigs resting in them. Water bottles sipper tubes can become clogged with masticated food if they are placed too close to food bowls. Sipper tubes should be situated sufficiently far above the level of the substrate to ensure that wicking and loss of water into the substrate does not occur[6].

xvi. Stainless steel tubes are less prone to damage by chewing than brass tubes[27]. Sippers and water bottles may be preferred over open bowls of water. If an automatic watering

system is used the animals should be able to access the drinker by sticking their muzzle out of the enclosure. The incorporation of a drip channel to convey spilled water away from the enclosure is essential to avoid problems of wet substrate caused when valves leak, or guinea pigs play with them.

xvii. Sudden changes to the diet can affect normal gut flora and should be avoided.

xviii. Scattering food reduces boredom by encouraging guinea pigs to forage[21]. This can reduce the amount of time available for fighting and helps to prevent obesity.

xix. Hay should always be provided as something to manipulate, play with, eat, and should be provided in excess of feed requirements.

xx. Periodic nutritional analysis of the diet should be undertaken to ensure quality as composition varies between types and batches of hay and/or forage.

xxi. Hay should be supplemented with items such as fruit (e.g., apple, pear, strawberry tops) and low calcium vegetables (e.g., leafy green herbs (basil, coriander, mint)), Asian greens (e.g. pak choy, bok choy, choy sum), cos or butter lettuce. Limited amounts of higher calcium leafy greens (e.g. kale, spinach, silverbeet) can also be given.

xxii. Fruit and vegetables should be washed and/or sanitised to reduce the risk of introduction of disease.

xxiii. Fresh food should mostly be composed of low calcium vegetables.

xxiv. Fruit should be given sparingly.

xxv. Excessive feeding of any single fresh item should be avoided, as diarrhoea and other gastrointestinal upsets can occur.

xxvi. Pelleted diets should not be fed at more than the amount of 10g/kg/day and only as an adjunct to hay and vegetables. Pellets must be fed within the prescribed use-by date and stored correctly to avoid the decomposition of vitamins and/or minerals. More than one formulation may be fed to reduce boredom.

xxvii. Guinea pig behaviour can be more difficult to interpret, and subjective judgements may not always be reliable. A combination of objective and subjective indicators of health and welfare should be regularly monitored.

xxviii. Health checks for individuals should include body condition score and weight; observation of any lumps or bumps or discharges or drooling; review of the eyes, ears, skin, teeth/malocclusion, jaw, perianal region, genitals, and feet; assessment of demeanour, behaviour, activity, respiratory rate, and locomotion; review of eating, drinking, urination, faeces, and caecotrophs; and observation of general appearance and shape.

xxix. Health checks for entire and breeding guinea pigs should include specific observations of the mammary glands, external reproductive organs, and genitals.

xxx. Extra care and observation should be undertaken for subordinate guinea pigs to check for signs of bullying (which may result in fight wounds or denial of access to food or water).

xxxi. All sick guinea pigs should be examined and diagnosed by a veterinarian.

xxxii. Females should be bred a maximum number of 2 times a year.

xxxiii. Handling of pups should be for short periods of time (<5 min) to reduce risk of rejection of kits by the sow/dam. Care must be taken to ensure minimal scent transfer from staff, the surrounding area, or other animals.

xxxiv. Enclosure shapes should maximise effective use of floor space and consider additional levels to provide more space and enrichment.

xxxv. All single, double, cage, or restricted housing should have oversight by an appropriately qualified independent veterinarian.

xxxvi. Additional space is recommended and should be used to allow for the provision of the expression of natural behaviours and for additional environmental enrichment.

xxxvii. For pair or groups housing of guinea pigs, this will may require the use of double cages. Cages may, for example, be joined by a PVC pipe which also acts as a hiding/resting area.

xxxviii. It is recommended to create an artificial dawn and dusk period where possible.5

xxxix. Although individual animals may respond differently, the provision of a 12:12 light-dark cycle is recommended for housed guinea pigs.

xl. A light level of a maximum of 60 lux is recommended for albino animals.

xli. A relative humidity for guinea pig housing of between 45 – 65% is recommended.

xlii. Concentrations of ammonia should ideally be lower than 1-2ppm.

xliii. A background sound level of 50db has been suggested to avoid disturbance to animals or personnel.

xliv. Diurnal variations should be checked where appropriate.

xlv. Sensors for reporting and monitoring light:dark cycles should be fitted with automatic alarm activation and alerting of appropriate staff.

xlvi. Breeding and health records should be regularly reviewed, ideally at least quarterly, in consultation with veterinary, animal care staff, and researchers input.

xlvii. Based on this review strategic analysis and planning should be undertaken and implemented with information regularly relayed to the AEC.

xlviii. All records and documentation (e.g., training, management plans, SOPs) should be refreshed at least every 3 years.

xlix. Facilities should consider the use of digital records to facilitate trend analysis and review.

Recommended Reading and Resources

Anderson L (1987) Guinea pig husbandry and medicine. Veterinary Clinics of North America: Small Animal Practice 17(5), 1045-1060.

Clough G (1999) The animal house: Design, equipment, and environmental control. In: The UFAW Handbook on the Care and Management of Laboratory Animals, Ed. Poole (T) 7th Edition. Blackwell Science Ltd, Oxford UK, pp 97- 134.

Donnelly T and Brown C (2004) Guinea pig and chinchilla care and husbandry. Vet Clin Exotic Anim, 7, 351-373.

Department of Primary Industries New South Wales. "Animal Ethics Committee Supervision of Obtaining, Breeding, Keeping and Supplying Animals for Use in Research." DPI NSW, June 2021. https://www.dpi.nsw.gov.au/__data/assets/pdf_file/0003/1320267/ARRP-Gl-16-AEC-supervision-of-obtaining,_ding,-keeping-and-supplying-animals-updated-Sept-2022-AR-Reg-2021-refs-only.pdf.

Guinea Pigs Manual, "Guinea Pigs Sounds." https://www.guineapigmanual.com/guinea-pig-sounds/

Liss, Cathy, Kenneth Litwak, Viktor Reinhardt, and Dave Tilford. *Comfortable Quarters for Laboratory Animals*. Animal Welfare Institute Washington, DC, 2015. https://awionline.org/sites/default/files/publication/digital_download/AWI-ComfortableQuarters-2015.pdf

Meredith, Anna, and Sharon Redrobe. *BSAVA Manual of Exotic Pets.* British Small Animal Veterinary Association, 2002.

NA3RSC, "Guinea Pig Housing and Handling." https://www.na3rsc.org/guinea-pigs/

NC3Rs, "Housing and Husbandry: Guinea Pig." https://nc3rs.org.uk/3rs-resources/housing-and-husbandry-guinea-pig

Oxbow, "Guinea Pig Sounds and Their Meaning." https://oxbowanimalhealth.com/blog/guinea-pig-sounds and-their-meanings/

RSPCA (2005) The guinea pig: Good practice for housing and care. RSPCA Southwater UK www.rspca.org.uk/laymembers Supplementary Resources.

Stevens et al., "Report of the 2020 RSPCA/UFAW Rodent and Rabbit Welfare Meeting." https://science.rspca.org.uk/documents/1494935/9042554/2020+RSPCAUFAW+Rodent+and+Rabbit+Welfare+Group+meeting.pdf/b6fbe9ee-3f49-7f46-ea2e-6087c7767ecc?t=1621942480160

Underwood, Wendy, and Raymond Anthony. "AVMA Guidelines for the Euthanasia of Animals: 2020 Edition." Retrieved on March 2013, no. 30 (2020): 2020–21. https://www.avma.org/sites/default/files/2020-02/Guidelines-on-Euthanasia-2020.pdf

University of Michigan, "Approved Enrichment Devices - Guinea Pigs." https://az.research.umich.edu/sites/default/files/media/embedded/Approved%20Enrichment%20Items%20-%20Guinea%20Pig.pdf

References

1. National Health and Medical Research Council. Australian code for the care and use of animals for scientific purposes, 8th Edition. Published online 2013.

2. National Health and Medical Research Council. Best practice methodology in the use of animals for scientific purposes. Published online Updated 2018.

3. Mellor DJ, Beausoleil NJ, Littlewood KE, et al. The 2020 Five Domains Model: Including Human–Animal Interactions in Assessments of Animal Welfare. *Animals*. 2020;10(10). doi:10.3390/ani10101870

4. Mellor DJ. Affective States and the Assessment of Laboratory-Induced Animal Welfare Impacts. In: ; 2012. https://api.semanticscholar.org/CorpusID:38800174

5. Adrian O, Brockmann I, Hohoff C, Sachser N. Paternal behaviour in wild guinea pigs: a comparative study in three closely related species with different social and mating systems. *Journal of Zoology*. 2005;265(1):97-105. doi:10.1017/S0952836904006090

6. Anderson LC. Guinea pig husbandry and medicine. *Veterinary Clinics of North America: Small Animal Practice*. 1987;17(5):1045-1060.

7. Donnelly TM, Brown CJ. Guinea pig and chinchilla care and husbandry. *Veterinary Clinics: Exotic Animal Practice*. 2004;7(2):351-373.

8. Martin IG, Beauchamp GK. Olfactory recognition of individuals by male cavies (Cavia aperea). *Journal of Chemical Ecology*. 1982;8:1241-1249.

9. Gerold S, Huisinga E, Iglauer F, Kurzawa A, Morankic A, Reimers S. Influence of feeding hay on the alopecia of breeding guinea pigs. *Journal of Veterinary Medicine Series A*. 1997;44(1-10):341-348.

10. Meredith A, Redrobe S. *BSAVA Manual of Exotic Pets.* British Small Animal Veterinary Association; 2002.

11. Berryman JC. Guinea-pig vocalizations: their structure, causation and function. *Zeitschrift für Tierpsychologie*. 1976;41(1):80-106.

12. Reinhardt V, Reinhardt A. Comfortable quarters for laboratory animals. *(No Title)*. Published online 2002.

13. Cait J, Cait A, Scott RW, Winder CB, Mason GJ. Conventional laboratory housing increases morbidity and mortality in research rodents: results of a meta-analysis. *BMC Biology*. 2022;20(1):15. doi:10.1186/s12915-021-01184-0

14. Mancinelli, E. Guinea pig husbandry – housing, diet and handling. Published online December 12, 2016. Accessed January 7, 2023. https://www.vettimes.co.uk/app/uploads/wp-post-to-pdf-enhanced-cache/1/guinea-pig-husbandry-housing-diet-and-handling.pdf

15. NC3Rs. Housing of Guinea Pigs. Published online 2022. Accessed January 7, 2023. https://nc3rs.org.uk/3rs-resources/housing-and-husbandry-guinea-pig#:~:text=Guinea%20pig%20enclosures%20should%20contain,create%20burrows%20in%20the%20wild.

16. Morton D. Enrichment techniques for rodents and rabbits. Published online 1994.

17. Animal Resources Centre. Husbandry Guinea pigs. Published online 2005.

18. Liss C, Litwak K, Reinhardt V, Tilford D. *Comfortable Quarters for Laboratory Animals*. Animal Welfare Institute Washington, DC; 2015.

19. Clemons DJ, Seeman JL. *The Laboratory Guinea Pig*. Taylor & Francis; 2018.

20. Rose M. Laboratory animal behaviour management. In: ; 1996.

21. Sachser N, Künzl C, Kaiser S. The welfare of laboratory guinea pigs. *The welfare of laboratory animals*. Published online 2007:181-209.

22. Morton DB, Jennings M, Batchelor G, et al. Refinements in rabbit husbandry: Second report of the BVAAWF/FRAME/RSPCA/UFAW joint working group on refinement. *Laboratory Animals*. 1993;27(4):301-329.

23. Morton DB, Jennings M, Batchelor G, et al. Refinements in rabbit husbandry: Second report of the BVAAWF/FRAME/RSPCA/UFAW joint working group on refinement. *Laboratory Animals*. 1993;27(4):301-329.

24. Berryman JC. Social behaviour in a colony of domestic guinea pigs: aggression and dominance. *Zeitschrift für Tierpsychologie*. 1978;46(2):200-214.

25. Sachser N. Short-term responses of plasma norepinephrine, epinephrine, glucocorticoid and testosterone titers to social and non-social stressors in male guinea pigs of different social status. *Physiology & behavior*. 1987;39(1):11-20.

26. Hubrecht RC, Kirkwood J. *The UFAW Handbook on the Care and Management of Laboratory and Other Research Animals*. John Wiley & Sons; 2010.

27. Hubrecht RC, Kirkwood J. *The UFAW Handbook on the Care and Management of Laboratory and Other Research Animals*. John Wiley & Sons; 2010.

28. Machatschke IH, Wallner B, Schams D, Dittami J. Social environment affects peripheral oxytocin and cortisol during stress responses in guinea-pigs. *Ethology*. 2004;110(3):161-176.

29. Sachser N, Kaiser S. Prenatal social stress masculinizes the females' behaviour in guinea pigs. *Physiology & behavior*. 1996;60(2):589-594.

30. Loss CM, Melleu FF, Domingues K, Lino-de-Oliveira C, Viola GG. Combining animal welfare with experimental rigor to improve reproducibility in behavioral neuroscience. *Frontiers in Behavioral Neuroscience*. 2021;15:763428.

31. Kleven GA. Behavioral biology of guinea pigs. In: *Behavioral Biology of Laboratory Animals*. CRC Press; 2021:131-146.

32. Kaiser S, Sachser N. The social environment during pregnancy and lactation affects the female offsprings' endocrine status and behaviour in guinea pigs. *Physiology & behavior*. 1998;63(3):361-366.

33. Hennessy MB, Ritchey RL. Hormonal and behavioral attachment responses in infant guinea pigs. *Developmental Psychobiology: The Journal of the International Society for Developmental Psychobiology*. 1987;20(6):613-625.

34. Hennessy MB, McInturf SM, Mazzei SJ. Evidence that endogenous corticotropin-releasing factor suppresses behavioral responses of guinea pig pups to brief isolation in novel surroundings. *Developmental Psychobiology: The Journal of the International Society for Developmental Psychobiology*. 1997;31(1):39-47.

35. Hennessy MB, Deak T, Schiml-Webb PA, Wilson SE, Greenlee TM, McCall E. Responses of guinea pig pups during isolation in a novel environment may represent stress-induced sickness behaviors. *Physiology & behavior*. 2004;81(1):5-13.

36. Hennessy MB. Both prevention of physical contact and removal of distal cues mediate cortisol and vocalization responses of guinea pig pups to maternal separation in a novel environment. *Physiology & behavior*. 1988;43(6):729-733.

37. Fullerton PM, Gilliatt R. Pressure neuropathy in the hind foot of the guinea-pig. *Journal of Neurology, Neurosurgery, and Psychiatry*. 1967;30(1):18.

38. Shimpo T, Gilliatt RW, Kennett R, Allen P. Susceptibility to pressure neuropathy distal to a constricting ligature in the guinea-pig. *Journal of Neurology, Neurosurgery & Psychiatry*. 1987;50(12):1625-1632.

39. Potgieter F, Wilke P. Laboratory animal bedding and nesting materials for rodents and lagomorphs: the South African situation. *Journal of the South African Veterinary Association*. 1993;64(4):144-148.

40. White WJ, Balk MW, Lang CM. Use of cage space by guineapigs. *Laboratory Animals*. 1989;23(3):208-214.

41. Scharmann W. Improved housing of mice, rats and guinea-pigs: a contribution to the refinement of animal experiments. *Alternatives to Laboratory Animals*. 1991;19(1):108-114.

42. King JA. Social relations of the domestic guinea pig living under semi-natural conditions. *Ecology*. 1956;37(2):221-228.

43. Sachser N. Of domestic and wild guinea pigs: studies in sociophysiology, domestication, and social evolution. *Naturwissenschaften*. 1998;85:307-317.

44. Hennessy MB. Social influences on endocrine activity in guinea pigs, with comparisons to findings in nonhuman primates. *Neuroscience & Biobehavioral Reviews*. 1999;23(5):687-698.

45. Valenstein ES, Goy RW. Further studies of the organization and display of sexual behavior in male guinea pigs. *Journal of Comparative and Physiological Psychology*. 1957;50(2):115.

46. Valenstein ES, Goy RW. Further studies of the organization and display of sexual behavior in male guinea pigs. *Journal of Comparative and Physiological Psychology*. 1957;50(2):115.

47. Sachser N. The effects of long-term isolation on physiology and behavior in male guinea pigs. *Physiology & behavior*. 1986;38(1):31-39.

48. Stern JJ, Hoffman BM. Effects of social isolation until adulthood on maternal behavior in guinea pigs. *Psychonomic Science*. 1970;21(1):15-16.

49. Fenske M. Body weight and water intake of guinea pigs: influence of single caging and an unfamiliar new room. *Journal of experimental animal science*. 1992;35(2):71-79.

50. National Research Council. Environment, housing, and management. In: *Guide for the Care and Use of Laboratory Animals. 8th Edition*. National Academies Press (US); 2011.

51. JM M. A non-stressful alternative to gastric gavage for oral administration of antibiotics in rabbits. *Lab animal*. 1993;22(2):47-49.

52. Seveljevic-Jaran, D. Review of welfare effects of metabolic cage housing. Published online 2021. Accessed January 7, 2023. http://www.crolasa.com/wp-content/uploads/2021/05/Review-of-literature-on-welfare-effects-of-metabolic-cage-housing.pdf

53. Kalliokoski O, Jacobsen KR, Darusman HS, et al. Mice Do Not Habituate to Metabolism Cage Housing–A Three Week Study of Male BALB/c Mice. *PLOS ONE*. 2013;8(3):e58460. doi:10.1371/journal.pone.0058460

54. Banjanin S. Environmental enrichment for guinea pigs: a discussion by the laboratory animal refinement & enrichment forum. *Animal Technology and Welfare*. 2004;3:161-163.

55. Knutsson M. Exercise pens as an environmental enrichment for laboratory rabbits. Published online 2011.

56. Wemelsfelder F. Animal boredom: a model of chronic suffering in captive animals and its consequences for environmental enrichment. *Humane innovations and alternatives (USA)*. Published online 1994.

57. Keeble E. Guinea pig nutrition: what do we know? *In Practice*. 2023;45(4):200-210. doi:10.1002/inpr.309

58. Browning JD, O'Dell BL. Low zinc status in guinea pigs impairs calcium uptake by brain synaptosomes. *The Journal of nutrition*. 1994;124(3):436-443.

59. Cammack PM, Zwahlen BA, Christensen MJ. Selenium deficiency alters thyroid hormone metabolism in guinea pigs. *The Journal of nutrition*. 1995;125(2):303-309.

60. Krohn T, Ritskes-Hoitinga J, Svendsen P. The effects of feeding and housing on the behaviour of the laboratory rabbit. *Laboratory animals*. 1999;33(2):101-107.

61. Kipp DE, Grey CE, McElvain ME, Kimmel DB, Robinson RG, Lukert BP. Long-term low ascorbic acid intake reduces bone mass in guinea pigs. *The Journal of nutrition*. 1996;126(8):2044-2049.

62. FELASA Working Group on Revision of Guidelines for Health Monitoring of Rodents and Rabbits, Mähler M, Berard M, et al. FELASA recommendations for the health monitoring of mouse, rat, hamster, guinea pig and rabbit colonies in breeding and experimental units. *Laboratory animals*. 2014;48(3):178-192.

63. Kersten A, Meijsser F, Metz J. Effects of early handling on later open-field behaviour in rabbits. *Applied Animal Behaviour Science*. 1989;24(2):157-167.

64. *Code of Practice for the Care and Handling of Pigs*. National Farm Animal Care Council; 2014. https://www.nfacc.ca/pdfs/codes/pig_code_of_practice.pdf

65. Hull EM, Rosselli L, Langan CJ. Effects of isolation and grouping on guinea pigs. *Behavioral Biology*. 1973;9(4):493-497.

66. Clough G. The animal house: design, equipment and environmental control. *The UFAW handbook on the care and management of laboratory animals*. Published online 1987.

67. Hall LES, Robinson S, Finch J, Buchanan-Smith HM. The influence of facility and home pen design on the welfare of the laboratory-housed dog. *Journal of pharmacological and toxicological methods*. 2017;83:21-29.

68. Anthony A, Harclerode JE. Noise stress in laboratory rodents. II. Effects of chronic noise exposures on sexual performance and reproductive function of guinea pigs. *The Journal of the Acoustical Society of America*. 1959;31(11):1437-1440.

69. Anthony A, Ackerman E, Lloyd JA. Noise stress in laboratory rodents. I. Behavioral and endocrine response of mice, rats, and guinea pigs. *The Journal of the Acoustical Society of America*. 1959;31(11):1430-1437.

70. Bailey K, Stephens D, Delaney C. Observations on the effects of vibration and noise on plasma ACTH and zinc levels, pregnancy and respiration rate in the guineapig. *Laboratory animals*. 1986;20(2):101-108.

71. Turner JG. Noise and vibration in the vivarium: recommendations for developing a measurement plan. *Journal of the American Association for Laboratory Animal Science*. 2020;59(6):665-672.

The current draft of this document was researched and prepared by:

Dr. Shari Cohen, Veterinary Animal Welfare Consultant and Fellow of Animal Welfare, Ethics and Law on behalf of the New South Wales Department of Primary Industries PO Box 100 BEECROFT NSW 2119
email: sharicohen.vet@gmail.com

Acknowledgments

We acknowledge the original assistance and support in the initial version of this document of Dr. Peter Johnson (Animal Welfare NSW DPI, Australia), Assoc Prof Margaret Rose, Chairman, NSW Animal Research Review Panel, in providing key references, editing, and reviewing the text was invaluable to the development of these guidelines. The critical comments and suggestions offered by Dr Bill White (Charles River Laboratories, USA), Prof David Morton (University of Birmingham, UK), Dr Penny Hawkins and Dr Maggy Jennings (RSPCA, UK), Dr Robert Hubrecht (Universities Federation for Animal Welfare - UFAW, UK) Dr Wolfgang Scharmann (University of Berlin, Germany), Dr Gilly Griffin (Canadian Council on Animal Care - CCAC, Canada), Dr Jon Richmond (Home Office, UK), Prof Elspeth McLachlan (Prince of Wales Medical Research Institute, Australia), and University of NSW Animal Ethics Committee (Australia), Dr Lynette Chave, Senior Veterinary Officer, Animal Welfare Branch NSWDPI and members of the NSW Animal Research Review Panel (Australia), have contributed significantly to the guidelines and are gratefully acknowledged.

We acknowledge the additional assistance and support for the current version of this document of Dr. Michelle Sutherland (Avian and Exotic Pet Specialist, Australia), Dr Lynette Chave (Leader Animal Research, NSW DPI Australia), Compliance and Licensing Unit NSW DPI, Animal Welfare Unit NSW DPI, and members of the NSW Animal Research Review Panel (Australia), have contributed significantly to the guidelines and are gratefully acknowledged. This document was prepared by staff of the Animal Welfare Unit, NSW Agriculture on behalf of the NSW Animal Research Review Panel.

Disclaimer

Printed copies of the document are regarded as uncontrolled. Please check ARRP policies, guidelines & factsheets | Department of Primary Industries (nsw.gov.au) to ensure use of the latest version.