NONHUMAN PRIMATES:
Care and Management

Rudolf P. Bohm Jr., DVM, Dipl. ACLAM
Associate Director for Animal Resources and Chief
Division of Animal Resources Yerkes Regional Primate Research Center
Emory University, Atlanta, GA
PRIMARY AUDIENCE Laboratory animal veterinarians, animal technologists, animal facility managers, research investigators, and veterinary students.

GOAL This tutorial will provide the viewer with an overview of typically used care and management practices in research institutions utilizing nonhuman primates. Topics covered include housing, reproduction, health surveillance, institutional security, nutrition, and biosafety issues.
1. Series  
Laboratory Animal Medicine and Science - Series II

2. Title  
Nonhuman Primates: Care and Management

3. Objectives  
At the conclusion of the program the viewer should be able to:

1. Describe several housing conformations used for nonhuman primates and discuss housing requirements for different species.
2. Discuss the nutritional requirements of nonhuman primates used in research and different methods of providing for these needs.
3. Discuss different housing methodologies for breeding nonhuman primates and the typical methods of monitoring a breeding program.
4. Discuss the proper use of personnel protective equipment for personnel working with nonhuman primates.
5. Discuss routine methods of identification of nonhuman primates.
6. Create a colony and personnel health surveillance plan for institutions utilizing nonhuman primates.

4. Introduction  
Nonhuman primates (NHP) are physiologically, anatomically, and genetically similar to man making them an excellent model for the study of human disease. Primates constitute less than 1% of all laboratory animals used in research today: domestic breeding, use of lower species for preliminary model studies, and more effective use of primates has conserved the number of primates used.

Nonhuman primates used in research environments include a wide range of species. The diversity in body size, nutritional requirements, reproductive requirements, and behavioral requirements of the various species need to be taken into consideration when developing an overall program for housing these animals.

HOUSING

5. Housing  
NHP housing should be chosen based on
- species,
- age,
- research program,
- personnel safety,
- animal safety,
- experience of staff,
- economic considerations,
- regulatory requirements,
- regional climatic conditions,
- and required containment level for proposed studies.

6. Laws and regulations  
The Animal Welfare Act (AWA) describes the minimum requirements for the housing of NHPs. The AWA details cage size, lighting, ventilation, temperature, diet, water quality, and cleaning and sanitation standards. The National Academy of Science Guide for the Care and Use of Laboratory Animals describes optimum standards for the same parameters. Institutions receiving Public Health Service (PHS) funds are required to abide by the Public Health Service Policy on the Humane Care and Use of Laboratory Animals which is consistent with standards set forth in the AWA and the Guide.
7. Separation by species

Many viral infections are nonpathogenic or latent in the host species, but can cause overt clinical disease and death in non-host species. The transmission of several of these viral agents has been controlled by separate housing of different species.

Simian hemorrhagic fever virus (SHF) may infect Patas monkeys (*Erythrocebus patas*) without clinical signs. Infection of macaques with SHF can cause a fatal hemorrhagic disease. Squirrel monkeys (*Saimiri sciureus*) may harbor latent herpes viruses that cause a lymphoproliferative, fatal disease in Owl monkeys (*Aotus trivergatus*), marmosets, and tamarins. While *Cercopithecine herpesvirus 1* (CHV1) is most often latent in macaques, published reports indicate that the infection can be fatal in other species such as Patas monkeys.

Typical separation of species involves separating Old World Monkeys (OWM) from New World Monkeys (NWM). Within the OWM group, separation of African and Asian species is appropriate and within the NWM group, separation of Squirrel monkeys from Owl monkeys, marmosets, and tamarins is appropriate.

8. Species differences in caging requirements

NWM generally live in pairs and require more vertical space and perches because of their longer tails and arboreal nature compared to the other primate groups. Marmosets, tamarins, and Owl monkeys in breeding pairs require nesting boxes.
9. Species differences in caging requirements

OWM are generally larger and require sturdier cages with "squeeze" backs to facilitate manual restraint for the administration of anesthetics and therapeutic agents. The most complex cages are designed for use with apes because of their large size.

10. Indoor caging

Indoor caging can be configured to house animals singly or in social groups. Most single caging is made of stainless steel with welded-bar floors that allow urine, feces, and discarded food to fall to the pan below.

Waste pans below cages should be far enough below the individual cages to prevent animals from reaching into the pans. Pans below the cages may be fixed or movable. Movable pans may be used in circumstances where dry bedding is used or where aerosolization from spray cleaning is not desired. Movable pans should be moved out of the room prior to cleaning to help decrease possible transmission of pathogenic organisms. Movable waste pans increase the labor involved in husbandry practices.

11. Squeeze backs

Squeeze backs should be present in all OWM caging to provide safe, gentle restraint for administration of therapeutic agents, anesthetics, and test articles. A squeeze back is a movable back wall incorporated into the cage structure that allows an operator to pull handles on the front of the cage to restrain the animal to the front of the cage.
12. Perches

Perches are recommended for all caging as they increase the complexity of the environment, allow the animal to posture off of the floor of the cage, and are relatively inexpensive and easy to maintain. Many perching devices have been developed to allow routine use and maintenance of the cage without having to remove the perch.

13. Rolling racks and locking device

To be in compliance with the Guide, the cage should be at least fourteen inches high. The minimum square footage of floor space varies according to the weight of the rabbit housed, as shown here. A mature animal weighing 4 - 5.4 kg requires 4 square feet, and an animal heavier than 5.4 kg requires 5 square feet. The USDA, which enforces the Animal Welfare Act regulations, may require more spacious cages than stated in the Guide, and it is important for all facilities subject to USDA inspection to comply with their standards.

14. Flexible water lines

Flexible water lines run from the main lines to the rack and should be protected from animal access to prevent trauma to the lines. This picture shows a coiled flexible water hose that is protected in a tube. The watering devices should be drained and flushed each time the unit is disconnected from the wall for cleaning. Advantages of the rolling rack system of caging are decreased labor for cage movement between rooms and between cage washers.

15. Wall mounted cages

Wall-mounted cages are hung or mounted on wall brackets. Waste pans are built in place below the cage. Wall mounted cages can be washed in place or removed for cleaning in cage washers. Disadvantages of wall mounted caging include increased labor when cages are moved, and the wall / cage interface may provide a place for collection of uneaten food and vermin.
16. Outdoor caging

Certain NHP species are more tolerant of wide temperature ranges than others. African species are tolerant of warmer temperatures while Asian species are more tolerant of cold temperatures. Long tailed species are susceptible to frost bite of the tail.

Regional climatic conditions are a primary consideration in the determination of appropriateness of outdoor housing. Enough shelter must be provided in the enclosure so that all animals are able to escape the elements simultaneously. Shelter must also be provided so subordinate animals can escape injury from aggressors. Shelters may be provided in the form of concrete or metal culverts.

17. Housing temperatures

The AWA specifies a temperature range for NHP housed in outdoor areas. Animals should be properly acclimated to the prevailing climatic conditions as determined by the attending veterinarian. Providing supplemental heat during the colder months and providing fans and sprinklers during the summer months may be used to control periods of temperature extremes. Care should be taken to schedule animal handling and use in the early morning or late afternoon and evening during the summer months to prevent heat exhaustion and heat stroke in animals housed in outdoor settings.

18. Capture apparatus

Animals housed outside should be trained to run into capture chutes and tunnels for daily observation and for routine health checks and TB testing. Animals can also be removed from an outdoor enclosure for treatment using the capture cage apparatus.

19. Naturalistic

Naturalistic environments are occasionally used to socially house NHP. A moat or other natural barrier is used to contain animals. An island is an example of a naturalistic environment. The principle disadvantage of this housing type is the lack of control over animals and the difficulty in the observation of animals for health monitoring and husbandry practices. The potential for drowning and escape by swimming are other potential disadvantages to this type of housing.
20. Uncovered corral

Corral housing allows containment of large social groups of animals. Corrals are often constructed of chain link and/or galvanized panels. The tops of corrals can be covered or left uncovered. Uncovered corrals require taller inward sloping walls to prevent animal escape. Even with these precautions, occasionally some animals manage to escape.

21. Covered corral

The safest alternative is to cover the corral with chain link or other hardware. A cover increases useful environmental area for the animals by allowing brachiation. The cover can be modified in places to allow the placement of shade cloth or galvanized metal sheets to provide shelter. Perches may be placed under these shelters to increase the use of the sheltered areas. Covered corrals require a greater number of vertical support posts to support the weight of the cover. All chain link constituting the walls of the enclosure should be embedded in cement at the lower edge to prevent escape under the fencing material.

22. Corncrib

Corncribs are usually smaller enclosures than corrals and are constructed of a sheet metal roof with hexagonal cuboidal welded galvanized metal. The floor surface can be cement, gravel, or raised metal gridwork. Corncribs are useful for housing small groups of animals that may not be socially able to interact in a larger group. Corncribs can be used as a solitary unit or can be connected by tunnels to provide a larger more complex housing area.

23. Mini corncrib

Recently, some institutions have used "mini" corncribs to house small family groups or solitary animals. These enclosures can also be modified to allow the use of tunnels to increase space and complexity. Mini corncribs can be surrounded with a secondary enclosure to provide greater security to the animals and personnel.
24. Indoor / Outdoor

Indoor / outdoor enclosures are usually configured as runs adjacent to an enclosed building. The indoor areas are usually air conditioned and heated and must be spacious enough to allow all animals shelter from the elements at the same time. A locking door should be placed between the indoor and outdoor areas so that animals can be confined to one area while staff perform cleaning or maintenance in the other.

25. Bedding / Flooring

Bedding may be used in all housing configurations, both for collection and disposal of animal waste and for environmental enrichment purposes. Certain types of bedding (i.e., hay) may allow animals a place to hide. Bedding should be inert and not promote ingestion of the material. Bedding should be changed regularly to prevent buildup of waste that promotes harborage of disease agents. Small edible items (raisins, cracked corn, and birdseed) can be added to contact bedding to promote foraging activity. Absorbent bedding is used in some facilities in waste pans below caging. This use is beneficial where aerosolization or splashing during cleaning is undesirable, as with some infectious disease studies.

26. Natural flooring

The AWA states that natural flooring such as that used in outdoor enclosures should be raked and cleaned frequently enough to prevent accumulation of feces and organic debris. Frequency is dictated by regional weather conditions. The most commonly used natural surfaces are soil and rock.

Soil surfaces must have adequate slope for proper water runoff. Vegetation should be planted, if possible, to provide hiding places, decrease erosion, and provide environmental enrichment, but should not be allowed to overgrow or harbor vermin.

27. Natural flooring-rocks

Rock surfaces are composed of small pieces of gravel, which must be turned or removed frequently to remove feces, and uneaten food. Some animals may consume gravel, which may become impacted and result in gastrointestinal distress.
28. Concrete / Grid flooring

Finished concrete surfaces are easier to clean and sanitize than rock or soil surfaces. Concrete surfaces should be slightly textured to provide stable footing for personnel and animals. In cold climates concrete slabs can be heated. To increase warmth in winter or to provide enrichment, bedding can be added to concrete floors.

Grid floors, which are not as comfortable for animals as solid flooring, can be used in outdoor enclosures to allow feces and uneaten food to drop through to a substrate below. The substrate should be raked or replaced when necessary.

SECURITY

29. Escape prevention

Padlocks or other cage locks can be placed on enclosures to prevent animal escape or the opening of enclosures by unauthorized personnel. Animal housing areas should have double door entries to help prevent animal escape if the primary enclosure is breached. The AWA requires perimeter fences of at least 6 feet in height around all outdoor enclosures to prevent the entrance of large mammals.

WATER

30. Cage bottle

Water can be supplied to NHP using a variety of methods. Bottles attached to the front of the cage allow administration of water-soluble drugs or electrolyte-rich fluids to encourage drinking by debilitated animals. Bottles also allow evaluation of volume of fluid consumed. Bottles can be more labor intensive to clean and sanitize than automated water delivery systems. This is especially true for large populations of animals.

Bowls may be used with singly-caged animals, but are not recommended because of the possibility of tipping by the animal and because placement and removal of the bowl requires staff to reach into the cage of an unanesthetized animal.
31. Automatic watering devices

Water supplied to group-housed animals in outdoor housing is most appropriately supplied by an automatic watering device. They are also used for indoor singly or group-housed animals. Automatic watering devices have relatively low maintenance requirements and low maintenance costs. They should be checked on a regular basis to insure proper functioning, as system failure may be difficult to determine before animals demonstrate clinical signs of dehydration.

Individual animals have been known to place food or other foreign substances in the watering aperture, obstructing the outflow of water and leading to dehydration. Behavioral signs of lixit failure and dehydration in NHP include licking water from the cage surfaces during cleaning, anorexia, and firm dry stool or the absence of stool.

NUTRITION

32. Diet

NHP in the wild consume a very broad range of diets from strictly vegetarian to those including meat. NHP used in research commonly consume commercial diets. Nutrition has a profound influence on research data derived from NHP used in research. Factors to consider when choosing NHP diets include species, sex, stage of life, and reproduction. As an example, because NWM lack the ability to convert vitamin D2 to D3, NWM food is fortified with vitamin D3.
33. Vitamin C

Vitamin C is added to all primate diets because, like humans, NHP cannot synthesize this nutrient. All NHP food should be fed within 90 days after the date of manufacture, unless specifically labeled as to longer shelf life for Vitamin C, to ensure adequate levels of vitamin C which is heat labile and rapidly leaches from the food. NHP food should be stored in an environment that is less than 70 degrees F (21°C) and less than 60% humidity to decrease degradation of vitamin C. Rotating the stock of primate chow ensures that the oldest food is fed first. Some primate facilities supplement vitamin C-rich foods on a regular basis to further ensure that a deficiency does not occur. Vegetables and fruits may be fed, as can children’s chewable vitamins. Care must be taken not to overfeed supplemental fruits and vegetables to ensure that animals continue to eat the prescribed diet.

34. Feeding

Feed may be provided to cage-housed animals on the floor of the cage, in feeding cups mounted on the cage, on foraging boards outside of the cage, or on top of the cage. Top of the cage and foraging board feeding provides for more complex feeding behavior and are forms of food-related psychological enrichment. Care should be taken to “minimize any risk of contamination by excreta and pests” of food and food receptacles. (AWA).

In outdoor housing areas, a number of water and feeding stations should be present to allow subordinate animals the opportunity for adequate intake. Feed may be placed in feeders or scattered over the floor of the enclosure. Scattering food allows animal-care staff to enter the corral and observe animal activity. If vegetation is present, feeding on the ground can enhance foraging behavior.

Frequency of feeding should be no less than once a day for adult animals and as necessary for neonates and juveniles. Most institutions provide food twice daily because this practice may prevent the gastric dilatation syndrome.

35. Supplementation

Supplementation (if not excessive) can add variation to an animal’s diet. Most NHP should consume the primary diet as the majority of each meal. Small primates may enjoy crickets and mealworms. As many insect species provide minimal calcium, these insects should be supplemented with calcium if they are fed as a regular part of the diet. Plant exudates (gum) can be supplemented to prosimians and callitrichids.

This photo shows a foraging device mounted on the outside of a cage. Many enrichment devices are food oriented because it is known that NHP spend a majority of active hours in the wild foraging for food.
36. Environment

The type of housing and environmental conditions such as light cycle and temperature may affect reproductive parameters in nonhuman primate species. For example, rhesus monkeys housed outdoors are seasonal breeders with births normally occurring between the months of March and June. Other Old World species such as baboons and pigtailed macaques do not have a seasonal breeding cycle and deliver throughout the year. Reduction in stress, excellent nutrition, and housing compatible animals together will increase breeding efficiency.

37. Breeding parameters

Reproductive parameters that should be monitored and recorded in breeding animals include:
- interbirth interval,
- conception rate,
- and birth rate.

Changes in these parameters may indicate subtle health or husbandry problems that impact reproductive efficiency and may not otherwise be apparent. These parameters can also be used as an indicator of success or failure of newly implemented husbandry practices when the data are compared to past breeding seasons.

38. Genetic monitoring

In addition to breeding parameters, genetic monitoring may be undertaken to monitor occurrences of specific traits or to monitor the level of inbreeding present in a colony.

Inbred animals may adversely affect the quality of data obtained in the research environment. As many species of nonhuman primates used in research are now bred domestically, where possible, care should be taken to introduce new genetic material into colonies to reduce inbreeding. This goal can be accomplished by exchange of animals between institutions and import of wild-caught animals when available. Because NHP have complex social structures, introduction of new breeding animals to stable groups is not always possible. Stable social groups can be maintained without offspring by vasectomizing males or by providing contraception to females.
39. Timed mating

Timed mating is used when the specific age of the fetus is important for research studies or to increase breeding efficiency where few males and/or females are available for breeding.

Several methods of timed mating have been used. The most common involves following several menstrual or estrus cycles to determine when ovulation occurs for a particular animal. Once an average time point is calculated, that animal is placed with a male for a few days prior to and a few days after the calculated day of ovulation. The average menstrual cycle length in OWM and apes is 30 days and ovulation occurs between days 12-15. New World monkeys and prosimians have estrus cycles that vary in length between species.

40. Monitoring reproductive cycles

Menstrual cycles are monitored by vaginal smears, behavioral changes, and assays for serum and urinary hormones.

Beta-estradiol and progesterone levels have been used to monitor estrus in the squirrel monkey, marmoset, tamarin, and owl monkey. Timing of ovulation may be determined by detumescence of perineal sex skin in those species that demonstrate those changes, such as the baboon. In baboons, ovulation usually occurs on the third day preceding detumescence. Tumescence is defined as full skin with a smooth, shiny appearance. Detumescence is defined as loss of turgidity with increase in perineal wrinkling.

41. Harem breeding groups

The formation of harem breeding groups has been successful for natural breeding of many NHP species. Care must be taken in transferring pregnant females into new harem groups soon after parturition. Published reports indicate that males of several species, most notably Cercocebus species and Macaca nemestrina (shown), will kill infants that they do not identify as their own.
42. Single pair breeding

Single male/female breeding is also successful and is advantageous when specific parentage is necessary for research or husbandry protocols. When single pair breeding is attempted in cages, the female animal should be brought to the male’s cage. The usual protocol involves introduction of the animals through a window or mesh wall in the center of the cage to assure compatibility prior to placing the animals together.

Many New World monkeys and prosimians breed well when placed in family groups where an adult male, adult female, and one or more offspring reside together. Dominant female marmosets cycle normally while suppressing the cycles of subordinate females. To increase reproductive efficiency, female marmosets should be separated to allow normal cycling in subordinate females.

43. Pregnancy detection - bimanual palpation

The method of pregnancy detection may impact the reliability of calculation of reproductive parameters. Most large breeding colonies diagnose pregnancy by performing palpation once or twice yearly during routine health check and identification roundups. Using bimanual rectal/abdominal palpation can increase the sensitivity of abdominal palpation as a method of pregnancy diagnosis. This procedure is performed by placing the animal in lateral recumbancy and inserting a finger into the rectum. While applying downward pressure to the rectal wall, the other hand of the operator is used to palpate the abdomen. The ventral pressure exerted through the rectum displaces the uterus ventrally and allows more accurate diagnoses of early pregnancies. This method is successful from gestational day (GD) 16 to term.

44. Pregnancy detection - other methods

Other methods of pregnancy detection include ultrasound examination (shown) and measurement of various urinary and serum hormone levels.

Transabdominal ultrasonography is useful to diagnose early pregnancies that may be missed if palpation is used alone. Ultrasonography allows close monitoring of developmental changes and fetal viability. Many interventional procedures have been developed in nonhuman primates such as amniocentesis, chorionic villous sampling, fetal blood sampling and fetal inoculation. Imaging of the fetus and of fetal procedures can be performed during ultrasonography by the use of videotape, video printer, or computer disc.

Several radioimmunoassays (RIA) have been developed to test for chorionic gonadotropin, luteinizing hormone, or both in urine and serum of nonhuman primates for the diagnosis of pregnancy.
HANDLING / RESTRAINT

45. Handling - anesthetized
In most cases, NHP should be anesthetized for handling due to personnel safety concerns. Exceptions may occur when handling animals less than 6 months old, NWM, or severely debilitated animals. Latex gloves should be worn at all times when working with anesthetized animals or animals less than 6 months of age.

Anesthesia for routine husbandry and minor procedures such as blood collection is performed using ketamine HCl given as an intramuscular injection. This dissociative anesthetic is safe and maintains cardiac output and pharyngeal reflexes. Increased salivation occurs as a side effect of the drug and may be overcome using a preanesthetic dose of glycopyrrolate or atropine.

46. Handling - unanesthetized
Handling unanesthetized animals is permitted where proper training has been performed to acclimate animals to various restraint devices such as pole, collar, and chair. The collar can be left on the animal for longer than 12 hours, but the animal may not be "chaired" for longer without scientific justification and the approval of the IACUC. Specially designed leather gauntlets should be worn when handling unanesthetized animals in all other cases.

47. Restraining - unanesthetized
The proper technique for restraining unanesthetized animals consists of grasping the upper arms of the animal above the elbows with one or both hands. The animal's arms are held behind its back with the elbows in close proximity to each other. The two-handed technique (one arm held in each hand as shown here) is the most comfortable for the animal and should be used if large animals are handled. If the two-handed technique is used the animal's hind quarters should be supported by another person or tabletop as shown in this photo. This restraint technique keeps the handler away from the animal's head so that bites are less likely to occur.
48. Transfer cage

The use of transfer cages is a viable and often preferable alternative to anesthetizing animals for routine cage changes and transport. In this photo, the animal is sitting in the transfer cage after having moved from its outdoor cage through the chute into the transfer cage. Transfer cages should have a mechanism that securely attaches them to the animal's home cage to prevent escape. The transferred animals should be trained to run into the transfer cage with minimal effort to decrease potential distress.

IDENTIFICATION

49. Methods of identification Many methods of identification have been used in NHP. The type of identification method should be chosen based on factors such as:

- housing type,
- need to identify animals without restraint,
- and research protocols.

50. Tattooing

Tattooing is the most commonly used method of identification used in NHP colonies. Tattooing is considered a permanent method of identification, although over time the ink may diffuse and become difficult to read. This method requires that the animal be restrained in some manner to adequately read the identifying number.

Tattooing is usually used in combination with other less permanent methods of identification such as dye marking. The site for tattooing is dependent upon institutional practices and has included the chest, abdomen, face, inguinal area, and axillary area. Care should be taken to prevent cross infection with pathogens that may be transferred by the tattoo machine and needle. The use of a sterilized needle for each animal and disinfection of the tattoo machine between animals will decrease the potential transmission of pathogens.
51. Collars and tags

Collars and tags allow observers to identify animals in their cage environment without the need for restraint. Binoculars may be used for viewing the tags on outdoor-housed animals. Disadvantages to this method of identification include loss or damage to the collar and tag or injury as a result of the collar's entanglement. Caution must be exercised when collars are placed on growing animals. Growth should be monitored and the collar size increased accordingly.

52. Dye marking

As with collars and neck chains, dye marking (top of head) is useful for identifying animals that are not restrained for identification such as in outdoor social housing. Cattle dye can be used. Most dyes fade rapidly and must be renewed regularly.

53. Microchip transponders

Microchip transponders as a form of identification have not been widely used in NHP but will probably become more common in the future. The microchips are implanted in a subcutaneous location and are read by a device produced by the manufacturer of the chip.

Implanted microchips used as a form of identification have a few disadvantages: migration of the chip from implant site, required proximity of the reader to the chip, increased cost of equipment when compared to other methods of identification, and lack of standardized coding between different microchip manufacturers. The microchip is probably best used as a supplemental form of identification.
ANESTHESIA / ANALGESIA

54. Anesthetic protocols  Many anesthetic protocols have been developed for use in NHP. These protocols are determined by the needs of research and animal-related factors such as species, concurrent disease, and age. As previously mentioned ketamine HCl is used for restraint and for relatively nonpainful procedures such as venipuncture. Gas anesthetics (halothane, isoflurane) are commonly used in addition to ketamine when a prolonged or potentially painful procedure is anticipated.

Analgesic agents should be administered to NHP whenever a procedure is performed that would typically be considered painful to a human undergoing a similar or identical procedure. The most widely used analgesic agents in NHP are opioids (butorphanol, buprenorphine) and nonsteroidal anti-inflammatory drugs (aspirin, carprofen).

EUTHANASIA

55. AVMA Panel on Euthanasia  The 2000 report of the American Veterinary Medical Association (AVMA) Panel on Euthanasia classifies administration of barbiturates as the only generally acceptable method of euthanasia in NHP. Inhalant anesthetics, carbon monoxide, carbon dioxide, nitrogen, and argon gases are classified as conditionally acceptable agents for euthanasia of NHP. Because of the size of most species of NHP used in research, biosafety considerations for personnel, and the stress associated with physical restraint, an injectable anesthetic such as ketamine is often given prior to administration of an intravenous dose of barbiturate.

VERMIN CONTROL

56. Indoor vermin control  Vermin control is essential in NHP colonies because rodents, birds, large mammals and insects may act as fomites or vectors for parasitic, bacterial, and viral diseases. Rodents may carry and transmit encephalomyocarditis virus (EMCV), *Yersinia* spp. and tularemia. Roaches may act as fomites for several parasites and enteric bacteria. Insects are readily ingested by NHP if given the opportunity. Control measures indoors should be aimed at reducing sites of entry, decreasing availability of foodstuffs by appropriate sanitation practices, and the careful use of toxins where necessary.

57. Outdoor control  Control in outdoor facilities is difficult because of the open arrangement of animal housing and the ready availability of food. Frequent movement of corral furniture to discourage burrowing of rodents and removal of uneaten food are primary control measures. Use of toxins must be performed carefully so research animals are not able to ingest them or come in contact with treated surfaces.
The AWA requires that a perimeter fence no less than 6 feet tall and no less than 3 feet from the primary enclosure be installed to prevent vermin the size of dogs, raccoons and skunks from entering the primary enclosure. Routine microbial monitoring of wild caught vermin can be an important source of information when devising and maintaining a vermin control plan.

**COLONY HEALTH SURVEILLANCE**

58. Routine screening

Health surveillance of NHP colonies by routine screening of breeding colonies and experimental animals should be performed regularly. Longer quarantine periods with more thorough diagnostic workups have become the standard in primate care (partially due to new regulations), resulting in a decrease in the prevalence of infectious and parasitic diseases of nonhuman primates. Better diagnostic capabilities and more progressive treatment strategies have further limited the incidence of disease within primate colonies.

Screening programs provide information to colony managers, veterinarians and health officers that allow them to knowledgeably discuss personnel and animal health related issues. Serological profiles should be based on the specific species present in the colony. Species specific serologic panels have been developed by several private laboratories and reflect the typical viral agents of concern to the species being used. The results of serologic profiles may be used to design vaccination protocols for colonies at risk.

59. Tuberculin skin testing

Tuberculin skin testing is an important component of colony health surveillance. In many cases there are no clinical signs in captive monkeys infected with *Mycobacterium tuberculosis*. Testing is routinely performed using Mammalian Old Tuberculin and delivering at least 1500 units by intradermal injection into the eyelid—generally done while the NHP is anesthetized. Eyelid injection is favored because it permits easy evaluation of the test site, which must be examined at 24, 48 and 72 hours after injection. Swelling and erythema of the tissue around the injection site indicate a positive test.
60. Mammalian Old Tuberculin

Mammalian Old Tuberculin is preferred over Purified Protein Derivative (PPD) because the lower concentration of antigen in PPD may increase the chance of false negative tests. Monkeys inoculated with Freunds complete adjuvant (BCG) are often tuberculin positive.

Several steps can be taken after the development of a positive intradermal tuberculin skin test. Retesting may be performed in the contralateral eyelid and/or abdomen. Abdominal test sites can be biopsied to confirm the presence of a delayed type hypersensitivity reaction by histologic evaluation. In addition, *Mycobacterium avium* tuberculin can be used to assess any possible cross reactivity because primates are susceptible to this bacterium as well. Other diagnostic tests may include culture and cytology of gastric or bronchoalveolar lavage fluid, thoracic radiography, or sacrifice with gross necropsy and histopathology. Unless animals are irreplaceable, treatment is not usually advised because of the risk to the NHP colony and to personnel.

PERSONNEL HEALTH SURVEILLANCE

61. Personnel health surveillance

Because NHP are phylogenetically related to man, many disease agents may be inadvertently transmitted between NHP and humans. Health screening of workers should be performed to prevent animal losses from disease transmitted from man to NHP as well as zoonotic transmission of disease from NHP to workers.

An occupational health and safety program should be developed at each institution utilizing NHP species. Screening may consist of:
- physical examinations,
- clinical blood work,
- serology
- and either intradermal TB testing or chest radiographs.

The health officer at each institution determines the frequency of such testing with input from various individuals representing animal care as well as human health care personnel. TB testing is usually performed 2-4 times yearly in facilities with a large number of primates, but should occur at least annually at all facilities. Specific testing (i.e. serology for SIV infection) may be implemented for persons working with specific hazards. All institutional visitors that will be in contact with NHP should present written proof of a recent TB test and necessary vaccine records prior to being allowed contact with animals.
62. Cercopithecine herpesvirus 1 (CHV1)

Cercopithecine herpesvirus 1 (formerly known as Herpesvirus simiae or Herpes B) is known to have a high prevalence in macaques and may reach 100% in some colonies. Animal to animal transmission can occur by bites and scratches, but is believed to occur venereally in many cases, because the percentage of serologically positive animals increases dramatically as the age of sexual maturity is passed. Latent infections are the most common type with most animals not demonstrating any lesion whatsoever. This photo shows a rhesus macaque with oral ulcers that sometimes can be seen in animals infected with CHV1. Shedding of virus may occur at any time without evidence of lesion development.

Although CHV1 negative breeding colonies are being developed at many institutions, all macaques should be considered to be CHV1 infected and shedding at all times. Some animals have developed positive serological evidence of infection years after being maintained in negative colonies.

63. CHV1

Humans infected with CHV1 have a historical mortality rate of 70%. Although the rate of infection in people seems to be low compared to the reported exposure rate, infection is devastating and can result in permanent neurologic impairment or death. Even in the absence of clinical disease, it can cause persistent serological titers that require lifelong antiviral treatment. An occupational health and safety program designed to decrease exposure risk and to prevent infection with CHV1 should be implemented in any facility using macaques in research. Follow-up should be provided after an exposure has occurred.

PROTECTION

64. Bite and scratch kits

Bite and scratch kits should be available wherever NHP work is performed. These kits should contain
- appropriate supplies and disinfectants for cleansing wound
- viral culture swabs
- sample collection tubes for post-exposure samples collected from NHP and victim
- instructions for cleansing the wound
- instructions for sample collection procedure
- accident report form

The physical examination findings of the animal in question should be noted and sent with the samples and the accident report form. A log should be kept on each injured individual.
65. Protective clothing

Protective clothing is a vital part of an occupational health and safety program at primate facilities. Most animal facilities housing NHP require the wearing of attire that is not worn outside of the animal facility. All laundry should be cleaned on premises.

Protective clothing should be worn when working with NHP:
- scrub suit,
- protective gown or lab coat to cover exposed skin of the arms,
- face mask,
- eye protection,
- gloves,
- and waterproof footwear dedicated to the facility.

Latex gloves must be worn at all times, unless they would interfere with safe use of the leather gloves worn whenever unanesthetized animals are being handled.

ENVIRONMENTAL ENRICHMENT

66. Environmental enrichment

The 1985 amendment to the AWA states that facilities using NHP must provide environmental enrichment adequate to promote the psychological well being of primates. Each institution must develop, document and follow an appropriate environmental enrichment plan. The documentation for the plan must be made available to the Animal Care Section of the USDA Animal and Plant Health Inspection Service (APHIS). Key aspects addressed in the AWA are:
- social grouping
- environmental enrichment
- use of restraint devices
- and special considerations which may warrant additional care.

The AWA should be consulted for more specific information on requirements.

67. Methods of enrichment

Individual facilities use a variety of different methods for instituting an enrichment plan. Several companies now provide caging, toys, and food suited to psychological enrichment schemes. Jungle gyms, perches, food, hiding places, ropes, sticks, balls, plastic barrels, and forage using natural vegetation are other methods to provide enrichment.
68. Social groupings

Since NHP are social animals in nature, social grouping should be used in all cases except where the experimental design may be compromised or the animals are aggressive, debilitated, have contagious disease, or are incompatible with other animals and, as such, are deprived of food and water. The IACUC should review and approve the reasons for not group housing animals because of experimental design.

Social companions may buffer effects of stressful situations, decreasing behavioral abnormalities, increasing exercise, and increasing cognitive stimulation. However, social groupings should be very carefully implemented and monitored as intraspecies aggression can rapidly result in traumatic injuries and distress.

69. Individually housed

Individually housed primates must be able to see and hear NHP of their own or compatible species. For example, this photo shows a wall mirror in a rhesus room that helps the animals see each other.

These requirements may be waived, with IACUC approval, if the principal investigator justifies their exclusion based on the objectives of the study or if the attending veterinarian determines that the enrichment plan has potential adverse effects on the clinical care of NHP under treatment. Both justifications require periodic review to maintain the exemption.

REGULATORY OVERSIGHT

70. Regulatory oversight of NHP use

Several federal agencies are responsible for regulating nonhuman primate use in research:

- The U.S. Fish and Wildlife Service regulates trade and transport of NHP.
- The Centers for Disease Control (CDC) regulates importation of NHP by limiting importation of NHP to those needed for scientific and educational endeavors and exhibition. The CDC is responsible for registration of importers and inspection of quarantine facilities. Guidelines have been set up by the CDC for monitoring signs and reporting of specific illness in NHP during the quarantine period.
- The Food and Drug Administration (FDA) has developed specific criteria for Good Laboratory Practice (GLP) studies and has set standards for human viral vaccine safety and efficacy testing.
The U.S. Department of Agriculture (USDA) is responsible for enforcing the provisions of the AWA through facility inspections and review of the animal care program.

The National Institutes of Health (NIH) has published the Public Health Service Policy on Humane Care and Use of Laboratory Animals which covers animals used in institutions receiving PHS funds for activities involving vertebrate animals. This policy statement is consistent with the AWA and the Guide for the Care and Use of Laboratory Animals.

CRISIS MANAGEMENT

71. Crisis management

An important component of successful crisis management is preparation. A crisis management plan should be written at institutions housing NHP to provide for a swift and coordinated response in such events as natural disaster, fire, and illegal break in or damage to property by demonstrators.

A well-written and tested plan will reduce the response time and the extent of damage that occurs during a crisis. The plan should include provisions for rapid contact of appropriate institutional personnel and local authorities. Local law enforcement and disaster planning officials should be aware of the plan and involved in its creation and implementation. Environmental health personnel and safety personnel should also be included in the planning and implementation process. In addition, veterinarians and animal care staff should be part of the process to assure that animal welfare considerations are addressed. The final plan should be based on the most likely emergency situations that might be encountered while remaining flexible enough for response to unforeseen occurrences.

In the event of an emergency, efforts should be made to quickly assess the extent of damage to property and compile an inventory of escaped animals. A provision to alert local media of potential health concerns should also be addressed. The availability of temporary housing facilities for escaped animals should be assessed during the creation of the plan. Medical personnel should receive specific information on the unique hazards related to individual facilities and their research programs.

72. Summary

This program has presented an overview of the housing and care of NHPs. You should be familiar with some general practices after reviewing this program, and can refer to the bibliography for additional details.
Acknowledgments

Thanks to members of the autotutorial committee: Gary Borkowski, Bernie Doerning, Glen Otto, Cindy Pekow, Tim Lawson, Phil Tillman.

Thanks to Mark Murchison, Tulane Regional Primate Research Center, for some photographs.
Bibliography


