Introduction

Animal welfare considerations are important to the conduct of good research. A generally accepted tenet is that animals which are maintained in a non-stressful environment will be more physiologically stable and therefore provide more reliable data in an experiment. In order to provide such an environment personnel must be familiar with the normal behavior and normal physiologic requirements for the species. Some protocols may require adjustment from the recommendations in this manuscript for both practical and experimental reasons.

Normal Behavior in the Wild

Laboratory swine, whether minipigs or domestic breeds, are the same genus and species as wild pigs and continue to exhibit the same types of behaviors when housed in the research setting. In the wild pigs live in herds known as sounders. They are highly social and prefer to be in contact with other members of their species. The population of a sounder tends to be predominately females and their offspring. At some point during their maturation males leave the group and form bachelor sounders and prior to breeding age they tend to become solitary boars. Females become solitary during parturition and for a few days afterwards; after which they rejoin the sounder. Obviously some of the behaviors will be modified by their microenvironment in a controlled laboratory setting where they are typically housed in pens, have controlled light cycles, stable environmental temperatures, and are fed a regular diet.

Pigs establish a dominance order in the first days postpartum. The piglets struggle with each other for teats on the sow which produce the most milk. Generally these are the most cranial teats. Once the dominance pattern, known as the teat order, is established it remains stable unless individuals are introduced or eliminated from the litter. This dominance remains stable throughout the weaning period. Within sounders dominance orders are established by fighting. The pattern is changed only when individuals are introduced or eliminated from the group.

Swine are most active in the nocturnal period especially at dawn and dusk. They have a keen sense of smell and a wide range of vocalizations ranging up to 5000 Hz. Their visual field is wide but long range vision is probably limited. Pigs are true omnivores and spend most of their waking time searching for food. They engage in a rooting behavior with their snouts and can readily dig up food sources with the dorsal tip.

Pigs are relatively hairless and are sensitive to extreme changes in environmental temperature. In order to protect themselves from sunburn and excessive heat they will coat themselves with mud and seek shade. In cold temperatures they will huddle together to preserve body heat.

In general pigs in the wild indulge themselves in complex social behaviors. Generally it would be considered beneficial to provide swine in the research setting with the opportunity to engage in as many of these normal behaviors as possible. There are obvious restrictions associated with research protocols and housing.

Behavioral Considerations in the Research Setting

For the most part in the research setting breeding is not part of the protocol. Consequently many of the social aspects of sounders in the wild are not applicable for consideration in research facilities. Swine remain social animals and prefer to be in the company of other members of
their species, but they will also bond with the humans with whom they interact. They continue to exhibit the rooting behavior and maintain their feeding preferences as well as their social interactions with other pigs. Pigs in pens are relatively sedentary, spending approximately 80% of their time at rest. The other 20% of time is split between feeding and exploring.

In order to avoid stress and potential disease transmission in the laboratory setting, they should not be mixed with other species. Pigs from different sources should also be housed in separate rooms in case there are differences in the health status of the various suppliers. They can be housed in socialized groups, however, dominance fighting will occur when the pigs are first housed together. Dominant animals will bite the tails and ears of submissive animals, especially at feeding time. This can be minimized by housing problem animals separately and by providing longer or separate feeding troughs. They tend to be cannibalistic if a sick or injured animal is housed with them. For this reason, it is best for animals that have had surgery to be housed singly. Even if they are not on surgical protocols the dominance fighting may lead to chronic injury and scarring which can interfere with other protocols such as those which involve dermatologic studies or wound healing.

Swine develop a dunging pattern and will defecate at the opposite end of the cage from where they are fed. The cage should, therefore, be designed to have their food and water separate from the area where they are supposed to defecate; although frequently the defecation area will be developed near the watering area.

Swine will seldom exercise on their own. Generally, they will only move when aroused by activity such as feeding or the introduction of personnel or new swine. They tend to move around the perimeter of their area of confinement rather than in the center. The rooting behavior may be satisfied by housing them in pens with bedding such as wood shavings or straw. However, when they are fasted they will eat their bedding. This is problematic when they are being anesthetized or being provided with oral test substances. For example, either of those beddings can cause intestinal obstruction and bloat. Also, softwood bedding contains substances which can affect hepatic microenzymes. In artificial environments, such as those that are likely to be found in research institutions, it is best to provide them with toys. Large Teflon balls or cones can be used to provide an object that can be rooted and thrown, and they are easily sanitized (Figures 1, 2). Swine also like to pull on objects such as chains hung from the ceiling or roof of the cage. If enrichment items are not provided then swine may exhibit stereotypic or destructive behavior on the cage or their cagemates. However, these objects for psychological well-being must be carefully selected to minimize damage to the cage or animal.

**Figure 3.** Yucatan minipigs being auscultated while given a food treat.

**Figure 4.** Pig being herded with a “hog panel”.

**Design of Housing Space**

Housing standards are detailed by various regulatory guidelines. These standards provide details on the square footage requirements, temperature ranges, humidity ranges, ventilation rates and sanitization requirements. These standards vary according to size, age and research usage. For example, there are different standards for pigs used in agricultural research versus biomedical research. In particular, temperature ranges vary for newborns and animals in postoperative recovery. Housing should be provided in pens rather than cages. It is beyond the scope of this manuscript to provide the complete details of the regulatory standards, many of which have been recently revised. However, recommendations based upon extensive experience with housing pigs in the research setting are provided in this section.

In the authors’ institution, the pens are stainless steel with raised fiberglass slatted flooring (Figures 1, 2).
The flooring has medium grit which keeps the pigs hooves trimmed. Other types of flooring can be used but many of them have disadvantages. Vinyl coated raised flooring is another commonly used type. It does not provide a gritty surface thus it does not allow for normal hoof wear. Also if the vinyl becomes damaged the pigs will sometimes eat the torn vinyl and the metal tends to rust with time if the vinyl surface is breached. Pigs should never be housed directly on slick surfaces like those provided by seamless epoxy or tile. Pigs will become stressed on these types of flooring especially when it is wet from the cleaning process. If pigs do not have secure footing they can develop stress related gastric ulceration which can lead to fatal hemorrhage. If solid surface flooring is provided it must have grooves in order to provide secure footing. Vertical bars on the pens allow for snout contact and visualization of other pigs. If a pig is housed alone in a room a mirror outside the cage can be provided for the pig to visualize itself. In our institution the use of a mirror in this setting seems to relieve the anxiety of lack of contact with other members of the species.1

Autowatering systems are preferred over water bowls (Figures 1, 2). If a water bowl is not firmly attached to the side of the pen the pig will overturn it and also tend to foul it with feces and debris. Even if the water bowl is attached to the cage it will become dirty very quickly from the pigs snout access of the container. Food bowls should be firmly attached to the side of the pen separate from the water source. In the research setting food should be restricted to provide adequate nutrition for normal growth but not excess calories which lead to obesity. The pens used in our facility have proved to be very versatile. They have been interchangeable for housing many other species without injury or stressful situations. Species that have been housed in these pens include small ruminants, dogs, cats, rabbits and ducks.

Handling and Socialization in the Research Setting1-7
Swine should be acclimated to the facility and the personnel prior to being introduced into a chronic research protocol. Swine will lose weight and become dehydrated during shipping. Acclimation to the animal facility for seven days prior to placing the pig on study will allow for environmental and physiological stabilization. It is during this time period that the pig should be socialized with the animal care personnel and the research staff who will be working with the pig. This socialization can be accomplished by positive interactions and the use of food treats. Pigs are startled by loud noises and quick movements so it is important to speak softly and approach a pig close to the pig level. Pigs respond positively to scratching behind the ears and on the abdomen. Providing them with food treats during physical examination is another method to ensure non stressful cooperation (Figure 3).

Even small pigs can overpower animal handlers so it is important to use persuasion rather than force to handle a pig. Pigs are not highly mobile and cannot readily bend their bodies. They tend to back away from a perceived threat. They can be herded by using panels to guide them in the direction you wish for them to move (Figure 4). They can also be persuaded to move to a location or weigh themselves by temptation with food treats (Figure 5). Pigs can also be trained to restraint in slings (Figure 6). They are highly intelligent and will learn tasks in a relatively short period of time. Clicker training techniques can be used to train them to stand for examination or other non-painful research techniques.
Conclusions

Knowledge of the normal behavior of pigs is important to ensure animal welfare in the research setting. Design of the housing area, training of personnel, socialization of pigs with the staff and humane handling techniques are all important aspects of ensuring that the pig normal physiologic and behavioral needs are being met. Reduction of stress should provide better data for the research protocol.

Selected References

8. AAALAC International Regulatory Guide Links:
   http://www.aaalac.org/resources/theguide.cfm
   http://aaalac.org/about/Ag_Guide_3rd_ed.pdf
   http://aaalac.org/about/AppA-ETS123.pdf