IACUC Considerations for the Use of Livestock in Translational Research

Joseph D. Thulin and Wendy J. Underwood

Joseph D. Thulin, DVM, MS, DACLAM, is Director of the Biomedical Resource Center at the Medical College of Wisconsin in Milwaukee, Wisconsin. Wendy J. Underwood, DVM, MS, DACVIM, is Senior Director Veterinary Resources at Eli Lilly and Company, Indianapolis, Indiana

Address correspondence and reprint requests to Dr. Joseph D. Thulin, Biomedical Resource Center, Medical College of Wisconsin, Milwaukee, WI 53226 or email jthulin@mcw.edu.

Abstract

Through its program oversight function, the institutional animal care and use committee (IACUC) plays a central role in ensuring the humane use and care of animals in research. To be effective in this role, the IACUC requires explicit knowledge of the species for which it bears oversight responsibility. Owing to a variety of species-specific factors, such as their relatively large size and range of acceptable housing environments, livestock present many special considerations for the IACUC. This article reviews many of those considerations in a format intended to aid IACUCs in the review of animal care and use programs involving livestock species used in translational research.

Key words: animal care; animal welfare; livestock; oversight; regulatory

Introduction

Effective management and oversight of an institutional animal care and use program (ACUP) requires consideration of a broad range of general principles as well as the contextual application of those principles. General principles address things like the ACUP organization, programmatic responsibility of the requisite organizational entities (i.e., the institutional official [IO], attending veterinarian [AV], and the institutional animal care and use committee [IACUC]), as well as tenets of humane use and care of experimental animals. Contextual considerations address species- and research-specific needs, as is the case for IACUCs that oversee the care and use of livestock.

While the term livestock can be applied to a rather broad range of domesticated animals, here we limit use of the term to the ungulate species commonly raised or used on farms, including swine, small ruminants, cattle, and horses. Livestock, particularly swine and sheep, are used commonly in research. According to institutional reporting data compiled by the U.S. Department of Agriculture (USDA) for federal fiscal year 2013, pigs, sheep, and other farm animals accounted for 11% of the roughly 880,000 animals used in USDA-regulated research and teaching activities (USDA/APHIS 2014). The number of pigs alone was more than double the number of cats, and the combined number of pigs and sheep was about the same as the number of dogs or nonhuman primates. Given the common use of livestock in research, many IACUCs are accustomed to their attendant issues. However, at many research institutions, the number of livestock used and concomitant program effort are very small compared to those of species like mice. As such, some IACUCs may not have the need to address livestock-specific issues very frequently.

In this article, we review some of the issues and challenges faced by IACUCs in the oversight of livestock in translational research or, more specifically, the care and use of livestock models employed in that block termed “T1” research, in which discoveries made in the laboratory are translated into knowledge that may be applied in human trials (Westfall et al. 2007; Woolf 2008). IACUC’s should recognize, however, that the qualifier of the research category, whether translational, basic, applied, biomedical, agricultural, or other descriptor, does not in itself affect IACUC function or responsibility. Yet livestock models in T1
research might be maintained and housed in either a traditional laboratory animal facility or in a farm/production setting. As such, we provide information on the oversight of animal care and use across these disparate settings. We purposefully follow the general outline of the Guide for the Care and Use of Laboratory Animals (Guide; NRC 2011) in order to facilitate the use of the information herein by IACUCs in the evaluations of their own programs and facilities. It is worth noting also that much of the information in this paper is dealt with in greater detail in the Guide for the Care and Use of Agricultural Animals in Research and Teaching (Ag Guide; FASS 2010).

**Animal Care and Use Program Regulations, Policies, and Principles**

While not necessarily having a direct impact on animal welfare, it is essential for IACUCs to know which laws, regulations, and standards apply to the animal activities for which they bear oversight responsibility. Often, the source of funding will dictate which of these apply. For example, animal research funded by the National Institutes of Health (NIH) will require adherence to the Public Health Service Policy on Humane Care and Use of Laboratory Animals (PHS Policy) and the Guide. Yet, when considering livestock, the legal requirements may not always be readily apparent.

The definition of animal in the Animal Welfare Act Regulations (AWAR 2013) excludes livestock when they are “... used or intended for use for improving animal nutrition, breeding, management, or production efficiency, or for improving the quality of food or fiber” (AWAR §1.1). In the absence of funding that requires adherence to PHS Policy, the IACUC might reasonably assume that T1 research involving animals is to be considered biomedical rather than agricultural in nature, and is thus subject to the provisions of the AWAR. However, this is not necessarily the case. While expressly directed toward improving animal production, agricultural research explores subjects with parallels in human medicine, for example, nutrition and endocrinology. Therefore, IACUCs, particularly at land grant academic institutions, should be open to the possibility that some T1 research involving livestock might be conducted in agricultural production settings and not be subject to the provisions of the AWAR. Regardless of the precise regulatory requirements, IACUCs are encouraged to reference not only the Guide, but also the Ag Guide and relevant literature in determining the most appropriate standards for the care and use of livestock in their local programs.

**Program Management and Oversight**

The species involved does not affect the fundamental roles and responsibilities of the requisite organizational entities (i.e., IO, AV, and IACUC) charged with the management and oversight of the animal care and use program. However, in evaluating this aspect of the program, there are a number of considerations for the IACUC related to the use of livestock.

**Training and Education**

Whether considering the research, operational support, or oversight components, program personnel must have sufficient knowledge and experience with the species used and cared for in order to have an effective ACUP. Appropriately trained and qualified personnel permit and ensure adequate animal care and humane and safe use; and they provide program oversight. This requirement encompasses the research team, veterinary staff, animal care staff, and IACUC membership. Livestock, particularly when maintained in production settings, present unique requirements for housing, husbandry, handling, restraint, biomethodology, and veterinary medical care. The IACUC should have processes in place to assess the preparedness of personnel to work with these species. Personnel training should be documented.

For illustrative purposes, consider an investigator who proposes to conduct a long-term study involving pigs. The intent is to procure mixed-breed pigs weighing approximately 20 kg from a commercial producer. The study design calls for daily subcutaneous injections and weekly blood collection from the pigs over a 6-month period. In this case, the IACUC will want to know that project personnel are aware of the considerable growth to be expected in the animals (100 kg or more per animal) over the course of the study and that the personnel are appropriately trained to safely handle and restrain both small and large animals for injections and blood collections or any other procedures to be performed. The committee will also want to ensure that the animal facility and animal care staff are prepared to house and care for the animals over the full course of the study. Of course, the IACUC will need to be equipped with sufficient knowledge of the species involved, either within its membership or through consultation, in order to know what questions to ask.

**Occupational Health and Safety**

Evaluation and oversight of the occupational health and safety program can be challenging for some IACUCs, in that the organizational entities operationally responsible for the program (e.g., environmental health and safety and the occupational medicine provider) typically are peripheral to the ACUP proper. Nevertheless, this IACUC responsibility is critically important in ensuring a safe working environment for personnel who work with animals in research. The occupational health risks for personnel working with livestock are not categorically different from those working with other species—the risks from all species include physical injuries, zoonoses, and allergy. However, the precise causes and, in some instances, the severity of some livestock-associated risks are worthy of IACUC consideration.

Physical injuries from livestock are common among persons working with these animals in agricultural and veterinary clinical settings (Epp and Waldner 2012; Erkai et al. 2008). It is reasonable to assume that similar risks exist for personnel when working with these large animals in a laboratory setting. Obvious means by which livestock can injure personnel include biting, kicking, butting, going, and trampling. In addition to these, personnel may be subject to musculoskeletal injury (e.g., lower back strain) from lifting or manipulating animals. It is also worth noting that, unlike with small laboratory animals, workers often will be required to enter the primary enclosures of livestock in order to provide husbandry or perform experimental or medical procedures. This creates opportunities for slips, trips, and falls from which personnel injury may result. To minimize the risk of livestock-associated injury, the IACUC should ensure personnel are properly trained and equipped to work safely with the livestock. This would include a basic knowledge of livestock behavior, proper application of handling techniques, use of restraint devices (e.g., stanchions, blocking boards, halters, leads, etc.), and chemical restraint when warranted.

Reportedly, approximately two thirds of the pathogens that cause diseases in humans are zoonoses, and livestock are potential sources for many of these (LeJeune and Kersting 2010). Among the better known are Q fever in sheep, cryptosporidiosis in cattle, and influenza in swine. Livestock can pose a greater risk of harboring zoonoses than many other species used in research.
because the environments from which they originate, as opposed
to those of more common laboratory animals such as commer-
cially raised mice and rats, often are not as controlled and afford
greater chance of exposure to vectors of zoonoses such as wild
rodents. Comprehensive herd/flock health programs are essential
for zoonosis prevention (Weber and Rutala 1999). The IACUC
should evaluate how the occupational health and veterinary
medical programs, whether for laboratory- or farm-housed ani-
mal's, address issues of zoonotic disease. This should include as-
sessing the risk for exposure to specific agents, preventing
procurement of infected animals, screening resident herds/
flocks, and providing pest control. The committee also should en-
sure program personnel are appropriately educated as to the risk
of zoonosis.

Personnel who work with animals are at risk of developing al-
lergy to those animals, and those working with livestock are no ex-
ception (Zabradnik and Rauf 2014). Livestock hair, dander, sal-
iva, and urine are known sources of allergens. Some of the prima-
ry engineering controls used to minimize exposure to small
laboratory animal allergens (e.g., microisolation caging) are not
available for livestock. The nature of livestock husbandry requires
workers to enter the animal environment, which creates more op-
portunity for exposure to allergens as well as a variety of airborne
particulates that may pose potential adverse health consequenc-
es (Pearson and Sharples 1995). The IACUC’s review of the occupa-
tional health program should assess the strategies for prevention
and treatment of animal allergy. This should include assessment of
the need for personal protective equipment such as respirators.

In some studies, human hospital clinical resources (e.g., com-
puted tomography or magnetic resonance imaging) are used for
research animals. This typically involves the transportation of the
animal(s) from the animal holding facility to the clinical loca-
tion and creates the potential for exposure of human patients,
health-care workers, and others to zoonotic pathogens and ani-
mal allergens. For any species involved, the IACUC should be
aware of the policies and procedures designed for human patient
protection, facility decontamination, animal transport through
common corridors or elevators, and other personnel protection
procedures. When livestock are transported through public
areas, characteristics such as their physical size, strength, and
vocalizations create logistical issues that are not of signifi-
cant concern when transporting small laboratory animals. There-
fore, the IACUC should carefully evaluate the adequacy of vehi-
cles, transport caging, and animal restraint (physical and chemical)
for capacity to provide secure transport of the animals and pre-
vention of potential exposure of people.

Another occupational health and safety consideration for the
IACUC is animal experimentation involving the introduction of
hazardous biological, chemical, and physical agents. The larger
size of livestock compared to other laboratory species provides
challenges for bioccontainment. In addition, introduction of bio-
logical agents to livestock may require consideration of not
only mitigation of potential human exposure, but also of the po-
tential risk for release of agricultural pathogens into the environ-
ment (Heckert and Kozlovac 2007). For these reasons, IACUCs
should evaluate institutional policies governing the oversight
processes for the use of hazardous agents and have some famil-
liarity with both the standard animal biosafety levels as well as
the enhancements required for agricultural pathogen biosafety
(CDC/NIH 2009).

Other Program Management and Oversight Considerations

Standard agricultural practices. Production of livestock in agri-
cultural settings often involves the routine performance of
procedures that may induce a degree of pain, discomfort or dis-
tress, but that are intended for the long-term benefit of the ani-
mal or personnel handling them (Ag Guide p 24). Such standard
agricultural practices include castration, dehorning, and tail
docking. Rather than being described in the research animal
care and use protocol, these procedures are often detailed in an-
other document such as a standard operating procedure (SOP).

Some standard agricultural practices might not be necessary or
desirable for livestock destined for use in the biomedical labora-
tory environment. IACUCs with responsibility for oversight of an-
imals in the production research settings are advised to consider
standard agricultural practices as part of protocol and/or pro-
gram reviews.

Prolonged restraint. Head gates or stanchions are commonly
used to temporarily restrain livestock for routine examinations
and procedures; however, devices such as these might be used
for longer, even prolonged periods. For example, cattle may be
housed in stanchions as normal dairy practice, and swine or
sheep might be housed in metabolism crates for experimental
purposes. Thus, IACUCs may find it helpful to define the term pro-
longed restraint and have a process, procedure, or SOP in place for
continual monitoring of these animals.

Suitability of farm settings. Above we discussed circumstanc-
es under the applicability of regulatory standards when livestock
are used in translational research. It is important for IACUCs to
understand that, in cases where the research conducted is catego-
rized as biomedical, housing the animals in a farm/agricultural
setting may not only be acceptable but desirable for animal
well-being or the science (Guide p 32). The professional judgment
of the investigator, veterinarian, and IACUC collectively will
determine the best setting for any particular experiment.

Disaster planning and emergency preparedness. The emer-
gency response plan for livestock, as for other species, will
need to address contingencies for basic animal care, medical
care, relocation, and other issues. Again, the size of livestock spe-
cies presents issues for emergency response that are not issues
for small laboratory species. For example, if in the wake of a dis-
aster, large numbers of livestock require euthanasia, does the fa-
cility have sufficient stores of euthanasia drug or the necessary
equipment and trained personnel to perform appropriate physi-
cal methods of euthanasia? If animals need to be relocated, what
are the means of conveyance? These are but a couple examples of
the considerations for the IACUC in evaluating the animal pro-
gram’s disaster and emergency response plan.

Environment, Housing, and Management

While an important component of the IACUC’s evaluation of an-
imal environment, housing, and management is the review of
documentation (e.g., SOPs and animal use proposals), one
might argue that the committee’s on-site assessment of condi-
tions, as occurs with the semiannual facility inspection, is para-
mount. As such, we emphasize important considerations for the
IACUC during its facility inspections. Although, in keeping with
the outline of the Guide, we provide additional considerations in
the Physical Plant section below, it is understood that the
IACUC evaluates both animal care and the physical facility during
disaster and emergency response plan.

Environment

Because livestock have been domesticated for thousands of
years, most are capable of adapting to a wide variety of environ-
ments including extensive or pasture-like environments as well
as intensive or higher-density, confined environments (Curtis [et
Downloaded from https://academic.oup.com/ilarjournal/article-abstract/56/1/139/660705 by guest on 13 March 2019
Many environmental considerations affect the well-being of livestock, including temperature, humidity, ventilation, illumination, and noise. The recommendations for these environmental parameters are generally more explicit for laboratory housing (Guide pp 43–50) than for agricultural housing (Ag Guide pp 17–20).

When evaluating the environment of livestock housed in laboratory settings, the IACUC will use as benchmarks the Guide recommendations for temperature (61–81°F) and humidity ranges (30%–70%) as well as fresh air changes (10–15 per hour). However, when evaluating farm/production facilities, the IACUC will not have such unambiguous measures against which conditions may be judged. In agricultural facilities, building ventilation is the primary means for controlling temperature and humidity, but normally not as precisely as in laboratory facilities. Agricultural facilities may have mechanical ventilation systems that are strictly automated or rely on natural ventilation. These facilities may be tunnel ventilated, side ventilated, and/or curtain sided. In order to properly evaluate agricultural facilities, IACUCs should have a basic understanding of the theory of negative pressure ventilation and how the ventilation works for any particular building.

In addition to the temperature and humidity conditions in the immediate environment, the committee may need to consider the changing environments animals are exposed to, as when they are moved from pasture to a confinement operation or when there are rapid changes in weather. Rapid, wide temperature swings or exposure to wet, windy weather can be deleterious to livestock health. This is evidenced in commercial livestock settings where outbreaks of respiratory disease tend to cluster in spring and fall. Abrupt exposure to very warm conditions can be particularly difficult for late pregnant and lactating sows and dairy cows.

In intensive environments, illumination and noise levels should be evaluated. Both light and dark cycles should be provided, and lighting should be sufficient to provide for good observation and safe husbandry practices (Ag Guide p 20).

**Housing**

**Primary Enclosures**

Acceptable housing for livestock varies considerably depending upon the species and the nature of the research. As a general rule, animals used in research categorized as biomedical are housed in laboratory settings, and those used in agricultural research are housed in farm/production settings. However, there are many exceptions to this. For example, goats used for cardiac valve replacements likely will be housed in a traditional laboratory animal facility, yet those used for antibody development for biomedical purposes might be housed in a barn. In general, species should be physically separated. When cohousing different species, this practice should be addressed in the IACUC-approved protocol.

The recommendations for primary enclosures articulated in the Guide (pp 50–52) are, for the most part, applicable whether the livestock are kept in laboratory or farm settings. Pens should be strong and without sharp edges. Feeders must be kept clean and devoid of sharp edges. Waterers should be operative. In cold environments, watering devices may need to be heated. Internal water lines should be flushed if not used on a regular basis. Flooring should be of a nonslip nature and not too soiled. Smooth flooring is not ideal; a patterned texture is preferable. While structural materials used for primary enclosures in the laboratory typically will have smooth, impervious surfaces to accommodate cleaning and disinfection, primary enclosures in farm facilities often have porous surfaces, such as unsealed wood, concrete, or dirt. As such, IACUC will need to exercise discretion in evaluating the suitability of primary enclosures.

**Space**

Provision of adequate space is critical for livestock. Animal space requirements depend on many factors, including age, species, size, physiological status (e.g., lactation, gestation, etc.), enclosure space, feeder space, health status, and weather conditions (Ag Guide p 17). As indicated previously, the regulatory category of research (biomedical versus agricultural) may also affect space requirements. The performance measures indicating sufficiency of space described in the Guide (pp 56–57) and the Ag Guide (p 17) are very similar, and both emphasize accommodating normal postural adjustments of the animals; however, the species-specific space recommendations between these two guidance documents differ. IACUCs need to be familiar with these recommendations and know the circumstances that determine which standards apply. Of special consideration for livestock is the use of stanchions, metabolism crates, or stalls, which might be used routinely in a farm setting but might qualify as restraint in a laboratory setting. For example, sows in production settings may routinely be kept in farrowing crates for considerable lengths of time, and the ability of these animals to make normal postural adjustments while crated is critical.

**Environmental Enrichment**

IACUC evaluations of environments should include assessment of the need for environmental enrichment. The goals of environmental enrichment are to increase normal behavior, decrease abnormal behaviors, and increase use of space. For animals kept in extensive environments, specific environmental enrichment may not be needed. For other animals, enrichment may be needed and could include social, occupational (i.e., the animal participates), physical, sensory, or nutritional aspects. In all cases, environmental enrichment should be evaluated.

**Sheltered or Outdoor Housing**

Livestock, particularly when used in agricultural research, may be kept in pasture environments. Shelter from sun, wind, and precipitation should be provided as appropriate to the climate. Each shelter should be inspected for necessary repairs or sanitation. If shelters are not provided, then animals should have respite from weather extremes by some other method (i.e., trees, building shade, etc.). Fences should be well maintained, and pastures should be kept as weed-free as possible. Pasture rotation and renovation may be necessary. Watering areas should be maintained as mud free as possible. Automatic pasture waterers should be regularly checked, and all water containers should be cleaned on a regular basis. In cold climates, animal access to unfrozen drinking water must be assured. For small ruminants housed outdoors, exclusion of or protection from predators should be considered as well.

**Management**

**Behavioral and Social Management**

The Guide indicates that “animals should be added to, removed from, and returned to social groups . . . with appropriate consideration of the effects on the individual animal and the group” (p 55). Because all livestock are social species, behavioral and social management is particularly important. In some species, especially swine, groups should be created early and maintained
Husbandry

In the context of research using livestock, the term husbandry incorporates all routine aspects of animal care, including provision of adequate feed, water, bedding, and sanitation. Each species has its own nutritional requirements, especially pregnant or lactating animals, and whole volumes have been written on this subject. Nevertheless, the IACUC should be aware of the general nutritional requirements per species and life stage and/or have a nutritionist to consult should any question or concern arise. Lactating dairy cows, for example, need high-quality feedstuffs, as do neonatal pigs. Sheep should not be fed horse feed due to tainting dairy cows, for example, need high-quality feedstuffs, as do neonatal pigs. Sheep should not be fed horse feed due to high concentrations of copper. Monensin, often fed to feeder cattle, should be fed with care to ensure that it does not taint dairy milk. For certain livestock species, limit feeding, especially high concentrations of copper, may be a management practice to ensure health. These cases should be justified in the protocol and approved by the IACUC.

Water provision is essential. A municipal water source, as is typically supplied in laboratory facilities, is usually satisfactory for livestock without further processing (e.g., reverse osmosis or chlorination). Water sources other than municipal, as often is the case for farm facilities, should be evaluated or tested on a regular basis for pesticides or organic contaminants that may affect research. Fluid intake requirements have been set (NRC 2007). If water is restricted, then that restriction should be justified in the protocol. The Ag Guide simply indicates that water must be provided in “a consistent manner” and that exceptions “must be justified” (p 21). Minimum water requirements vary depending on age, species, and stage of life, weather, and physical activity. However, general guidelines have been published (OMA-FRA 2014). Water tanks should be on a regular schedule for sanitation.

A variety of bedding materials can be used for livestock—wood shavings, straw, sand, sawdust, or other dried organic material. Resting dairy cows should have bedding or a mattress to avoid hock lesions (Ag Guide p 74). Late gestation sows enjoy bedding or mats as well. Beef cattle can be maintained in cold climates on a bedded pack that is continually layered with new material, which results in heat production. Bedded packs are usually cleaned only three or four times a year. In some cases, bedding may not be necessary. For example, small livestock in laboratory facilities are often housed in enclosures with raised, plastic-coated flooring without bedding.

Proper sanitation is important in all animal housing environments. In laboratory facilities, IACUCs should expect the same level of cleanliness for livestock as for other larger species such as dogs. The IACUC will need to tailor its expectations for farm production facilities; however, the importance of appropriate sanitation is not diminished. Sanitation practices in these environments will minimize accumulations of excreta and dust in primary enclosures, working areas, and other parts of the facility. Appropriate cleaning and sanitation is especially important for milking equipment, as well as that used for standard agricultural practices (castrators, dehorners, etc.). Pest control also is an important component of sanitation, and the IACUC should ensure that an effective program is in place. Managers should be queried about bird, rodent, and fly control. If pesticides are used, investigators should be contacted to determine any real or potential effects. Feed stores should be protected from access by resident carnivors (e.g., cats and dogs), which can transmit diseases such as toxoplasmosis and neosporosis by soil ing the feed. If cats or guard animals are used for pest control, then health care must be provided them. Rodent traps require daily monitoring.

Handling and Restraint

IACUCs should carefully review handling and restraint of livestock not only for safety of personnel (see above) but also for animal well-being. The actual path of movement of animals from pen or crate to head gate or stanchion should be walked. Livestock may balk at uneven lighting, trash or clothing hung on chutes, open chutes, dark entryways, uneven or changing flooring, or hanging chains that make noise. Animals should be acclimated to handling and restraint whenever possible. Restraint devices should be utilized for the minimal time necessary. Animals being manipulated in hobbles, hydraulic head gates, or squeeze chutes should be evaluated for potential leg, neck, or shoulder injury. Appropriate equipment per species should be utilized. Principles to prevent agitation during restraint have been published and include nonslip flooring (especially in squeeze chutes), avoidance of sudden movements, even pressure in chutes, and use of a calm attitude and voice (Ag Guide p 49). Electric prods rarely have a justifiable use in the research animal setting.

Waste Management and Carcass Disposal

Both waste management and carcass disposal should be evaluated in any agricultural animal environment. The goals of proper waste management are to decrease odors, dust/feces/dirt, and pollution while ensuring health and well-being. For farm facilities, the flow of waste management should be followed from animal holding area to land application. Large operations may require a state-level approval and operate under state regulations. Manure pit sanitation requires strict safety procedures. Outdoor mounds of dried materials are often used in dairy facilities to keep animals clean and dry and to avoid foot rot. Carcass disposal must be evaluated. Different types of carcass disposal include burial, rendering, incineration, digestion, and composting. Burial is not recommended for larger operations. State laws and regulations again must be followed. If barbiturates are used for euthanasia, precautions must be taken to avoid release of the agents into the environment and endangering wildlife and other animals.

Animal Identification

Individual animal identification is usually necessary, but, in some cases, group or pen identification is sufficient. Individuals can be permanently identified by ear tag, ear notch, freeze brand, neckband, neck chains, tattoos, and by electronic transponders (Ag Guide p 23). The method of identification should consider animal welfare and, whenever feasible, those causing relatively less pain or distress (e.g., ear tagging) should be selected over those associated with more pain or distress (e.g., branding) (AVMA 2011). However, federal and state regulations may dictate the method of livestock identification. In some cases, states require hot-iron branding. Chapters 6–11 of the Ag Guide provide species-specific identification information. From an
inspection perspective, animals should be identifiable by some consistent means, as livestock may be used on more than one study, especially, for example, nutritional studies.

**Record Keeping**

Good record keeping is essential and is often lacking in research agricultural programs. Good record keeping starts with individual animal identification (source, age, sex, productivity, etc.). Group records can be kept for general agricultural practices (vaccinations, parasite control, castrations, etc.). Health records should be kept on individual animals and include date of onset, treatment, and final resolution or disposition. These records are particularly important for documenting antibiotic and other drug residue avoidance as required.

**Veterinary Medical Care**

IACUC considerations in evaluating veterinary medical care for livestock are essentially the same as they are for other species used in research. The committee should evaluate veterinary medical care during its review of the ACUP, when it may focus primarily on written descriptions, and during its facility inspections, when it may focus primarily on visual assessments of animal health and animal health records. The committee should specifically assess the components of veterinary medical care specified in the Guide (Chapter 4) and Ag Guide (Chapter 2). The IACUC should be aware that, in farm/production settings, animal scientists as investigators or facility managers may play a significant role in the veterinary medical care program.

**Animal Procurement**

The program should include a process for assessing and approving animal vendors. Regular vendors should be thoroughly evaluated prior to procurement for health status and animal welfare. Vendor site visits should be made whenever possible prior to the purchase and transportation of animals. State and federal regulations for procurement (e.g., certifications of veterinary inspections) must be strictly followed. Most importantly, procurement must be coordinated with on-site personnel to ensure timely arrival where facilities, feed, water, and bedding have been prepared. IACUCs should review procurement approval procedures and documentation of health certificates. Regular reevaluation of vendors may be necessary.

**Transportation**

IACUCs should review transportation procedures and vehicles. All animals should be properly prepared (identification, vaccination, proper feed, appropriate health records, etc.) for transport. Flooring in vehicles should be clean and nonslippery. Appropriate transportation will vary depending on density, temperature, ventilation, type of siding, vent openings, and duration. If long duration transportation is necessary, lairage may be necessary and animals should be provided rest and water at minimum. Loading and unloading are especially critical times, so these areas should be inspected carefully. A plan should be in place for accidents or emergencies, including a list of emergency contact information. Hot- and cold-weather transportation indices are available for reference (ILAR 2006). Additionally, subject experts (Grandin 1981) and species-specific organizations (Livestock Network 2014; National Pork Board 2014) have published excellent transportation guidelines that address loading, space, and heat and wind chill indices.

**Quarantine and Stabilization**

All species require stabilization after arrival. This acclimation period allows for the animal to adapt to new environments. Acclimation duration varies depending on species, age, life stage, and purpose of experimentation. Lactating dairy cattle, for example, may need 2 to 4 weeks to acclimate and return to full production. Some experiments may require immediate use, such as when studying infectious disease. General acclimation guidelines should be provided by the AV and made available to the IACUC for review and approval, with exceptions to the guidelines reviewed and approved by the IACUC (Ag Guide p 8).

Quarantine refers to the separation of animals by group or species. In general, groups arriving at different intervals or from different vendors should be housed separately, as should different species. Exceptions may be appropriate but should be approved by the AV. Quarantine procedures become very important when animals are purchased from sale barns or the health history is unknown.

Whether undergoing stabilization or quarantine, all animals should be observed for illness or injury on arrival. Some may need vaccination, identification, or other standard agricultural practices. These efforts should be recorded and documented. In all cases, the AV should have the authority to observe all animals at any time.

**Biosecurity**

In the laboratory setting, the term biosecurity refers to measures to control known or unknown infections in laboratory animals (Guide p 109), while in the agricultural setting it refers to the prevention of infection or transfer of agents from one group to another or one site to another (Ag Guide p 25). Regardless of the precise definition, biosecurity is important for protecting animal and human health as well as the integrity of the research. Good biosecurity requires a combination of properly designed facilities, proper equipment, well-conceived procedures, and trained personnel. Personnel should wear appropriate personal protective equipment and clothing that is not worn home. Many confinement operations require shower in/shower out procedures. Other facilities may simply use strict admittance procedures, footbaths, and foot coverings. Footbaths should be cleaned and changed according to the manufacturer’s recommendations. Traffic flow from clean to dirty or from high-risk to lower-risk areas must be adhered to by all personnel. A plan should be in place to prevent disease transmission and detailing how to respond if an outbreak occurs.

**Health Care, Preventive Medicine, and Disease Control**

Health care and disease control are critical aspects to be evaluated in a veterinary care program. A veterinarian who is knowledgeable and experienced with the species must be made available and must have access to the animals (Ag Guide p 9). The veterinarian should also understand potential study-related impacts to the research animal. Animal care personnel should be trained on how to identify illness, injury, and pain or distress per species (Ag Guide p 10). Individual and/or group records should be evaluated; the Ag Guide describes what should be included in these records, which “should be structured so that information is easily collected, gathered, analyzed, summarized and available” (Ag Guide p 10). The IACUC should be able to follow the record without difficulty. Inspectors should ask to review all available written programs of preventative medicine and should check records to ensure that these programs are appropriately implemented. How information is communicated to key personnel,
including investigators, veterinarians, and the IACUC, should be reviewed.

Surgery, Anesthesia, and Analgesia
The surgical environment will vary depending on the type and purpose of the surgery. In general, it is important to understand the difference in larger animals in regard to anesthetic techniques and any special considerations. Due to their large size, livestock typically require a team effort to properly handle and restrain the animal prior to anesthesia induction and perhaps for proper surgical positioning after induction. If general anesthesia is required, the team must be trained in transportation, intubation, venous access, anatomy, and proper padding to prevent muscle damage. Preamnesthetics are most often required and should include anticholinergics for longer procedures. Ruminants are extremely sensitive to alpha 2 agonists and are more likely to experience regurgitation, aspiration, myopathy, and hypoxemia following general anesthesia.

As with other species, multiple survival surgeries in livestock are discouraged but may be necessary because of an experiment protocol, for nontherapeutic reasons (e.g., castration, dehorning), or for critical health reasons. The IACUC review should consider the rationale for multiple surgeries as well as provisions to minimize pain and distress.

Aseptic technique should always be employed regardless of whether the surgery is conducted in a dedicated surgical suite or in a farm environment. Good practice includes the use of sterile gloves, gown, cap, and mask. Surgical sites should be aseptically prepared.

Appropriate post-surgical care is critical. Post-surgical animals should be separated from others and recovery areas should be clean, warm, and well bedded. Regular observation of animals should be documented, as should the administration of appropriate analgesics—pain management is critical and should be well documented. Animals should be monitored until fully recovered and able to walk. Monitoring of incisions should be documented at least until sutures are removed. Because inadequate post-surgical care—for example, failure to recognize signs of pain—has such potential for direct negative impact on animal well-being, it is especially important for the IACUC to ensure proper training of personnel engaged in this activity.

Euthanasia
Proper euthanasia is an important aspect of appropriate veterinary care and must be evaluated. Inspectors should interview personnel on training, equipment, techniques, and maintenance procedures. Many methods of euthanasia exist, but all methods utilized should follow the guidelines established by the AVMA (2013). Factors to consider include effectiveness, timeliness, reliability, irreversibility, and safety. Each method has advantages and disadvantages, so the AV should be consulted. Equipment used for physical methods of euthanasia (such as captive bolt) should be placed on a regular maintenance schedule. Proper voltage and placement of electrodes are critical when electrical methods of euthanasia are used. Personnel should be trained to recognize signs of death.

In some cases, livestock may be euthanized by humane slaughter. The method of slaughter should be described in a protocol that is reviewed and approved by the IACUC. In these cases, the slaughter facility should be inspected. Slaughter must be conducted in accordance with the Humane Slaughter of Livestock Regulations (HSLR 1979) implemented by the U.S. Food Safety Inspection Service. Research institutions that allow research animals to be sent for slaughter and entry into the human food chain should have a policy explaining cautions and regulations. Veterinary oversight is critical, and all drug withdrawals must adhere to the implementing regulations of the Animal Drug Use Clarification Act of 1994 (AMDUCA 1996).

Physical Plant
Effective IACUC evaluations of the livestock facility help ensure that the physical plant design, construction, and attendant processes for animal care and building/equipment maintenance provide adequately for the needs of the animals, the science, and the safety of personnel. Regardless of the type of facility—laboratory, sheltered/outdoor, or production confinement—the considerations are essentially the same. Each evaluation should provide a comprehensive assessment of the condition and function of the overall facility, animal rooms/secondary enclosures, primary enclosures, procedure/animal working areas, surgical facilities, and support spaces such as feed storage, bedding storage, and loading docks. IACUCs should consult the Guide and Ag Guide for specifications regarding these.

When conducting the facility inspection, it may be best to evaluate the physical plant, including both exterior and interior conditions, before looking at any animal. The housing exterior surfaces should be maintained in good condition, including roofing, siding, gutters, windows, pit covers, fan covers, doors, door seals, and any existing security devices (cameras, locks, etc.). The IACUC should ensure that maintenance plans are in place. For intensive environments, the inspection should start at the ceiling and continue to the floor or pit. Ceiling fans and/or tunnel ventilation must be operable and in good condition. Some confinement structures have evaporative coolers that should be operative and maintained.

Because the scope of this article does not permit a comprehensive review of all the things the IACUC should look for in its facility inspections, we have chosen but a select few issues that, in the authors’ experience, exemplify some of the more common problems encountered in operating livestock facilities.

Livestock can be hard on facilities. Behaviors such as rooting, pawing, chewin, rubbing, leaning, etc., can cause significant damage to walls, flooring, fencing, feed and watering devices, and other structures and objects with which they have contact. The IACUC should be on the lookout for such damage, especially in primary and secondary enclosures.

Objects, including but not limited to nails and wire protruding from walls and fences, can be hazardous to livestock. Wooden flooring in outdoor operations is particularly prone to these. Sharp objects can result in penetrating wounds to animals’ skin, joints, and eyes. Careful inspection of walls, fencing, stanchions, and other surfaces that the animals contact can identify these hazards. Slip-resistant flooring is important for providing secure footing and avoiding slip injuries of hooved animals. Modern facilities designed specifically for livestock typically will have such flooring, but this is not necessarily the case with laboratory facilities that house livestock. In addition, flooring can wear and lose its slip-resistant properties over time. This can be especially evident in swine facilities. IACUCs should carefully examine flooring in primary enclosures as well as in areas through which animals are herded/led to ensure that proper flooring is provided.

Poor drainage in animal enclosures, including pastures, can contribute to a variety of health problems such as infectious foot rot and diarrhea. When significant amounts of standing water/urine are seen in livestock enclosures, the IACUC should evaluate the underlying causes, including improper sloping, inadequately sized drains, or blocked drains.

As mentioned above, it is difficult to completely exclude pests such as rodents and birds from farm livestock facilities. So, while
it may be reasonable to have zero tolerance for pests in laboratory facilities, IACUCs have to exercise judgment in terms of what is achievable in farm facilities. Regardless of the setting, IACUCs should expect a rigorous vermin control program concentrating on prevention of facility entry by vermin and elimination of harbors. Such controls may include netting to prevent entry by birds and flying insects and sealing or screening of building openings to deter entry by rodents. Feeding and food storage areas are particularly attractive to pests, and IACUCs should carefully inspect these areas for signs of infestation.

Intensive agricultural facilities also have other considerations to be evaluated, including feed storage and feed supply. Bagged feed should be kept off the floor with expiration dates or manufacturing dates clearly labeled with a first in/first out procedure of use. Opened bags of feed should be kept in labeled containers with tight-fitting lids. Feeding implements and containers should not be used to handle or transport trash, dirt, or manure. Most agricultural facilities also use feed and grain bins for feed storage. Augers used to supply feed from these bins should be inspected for wear and mold growth. Strict safety controls should be in place for operation and maintenance of this equipment.

**Conclusion**

The principal role of the IACUC is to oversee and perform ongoing evaluations of the ACUP to ensure conformance with applicable regulatory requirements and professional standards. Both the Guide and Ag Guide emphasize the need for professional judgment in applying standards for animal care and use. This in turn requires IACUCs to have expertise not only in the standards but also in how they are best applied to the species involved. Like all species, livestock present the IACUC with unique considerations. The relatively large size and strength of these animals affect housing and handling practices. Disease susceptibilities affect occupational health and veterinary medical care. The housing setting (e.g., laboratory versus farm) affects facility design and construction, husbandry practices, and vermin control. The IACUC that is appropriately informed to consider these species-specific issues within the context of the research being conducted will be better positioned to ensure that regulatory obligations are met and animal welfare maximized, while facilitating the institution’s translational research endeavors.

**References**


