Introduction

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This issue of *ILAR Journal* focuses on the topic of noninvasive imaging. Contributors to the issue are scientists who routinely use the four technologies described herein. They were invited to provide a brief review of their respective technology, discuss how it works, and describe its advantages and disadvantages in relation to other technologies.

Chatham and Blackband (2001) review nuclear magnetic resonance (NMR[1]) spectroscopy and imaging, often referred to as magnetic resonance imaging (MRI[1]). This technique has been a useful tool in clinical medicine for more than 20 years, and it is being used more and more frequently in animal research.

Krishna and colleagues (2001) review electron paramagnetic resonance (EPR[1]) imaging in small animals. EPR is based on principles that are similar to NMR, and it detects paramagnetic species. The information from EPR images may be used to overlay functional information onto anatomical maps. Application of EPR thus complements other techniques such as positron emission tomography (PET[1]).

Cherry and Gambhir (2001) describe PET, which images the distribution of compounds labeled with positron-emitting radionuclides. Although PET technology has been used both clinically and experimentally, it has often been limited to larger species such as primates. The development of high-resolution dedicated animal PET scanners has been critical in the application of this technology to rodent-based research.

Probably the best known of the four technologies described is ultrasound. Ultrasonography, specifically echocardiography, has been a mainstay of both human and veterinary cardiology for more than two decades. Coatney (2001) discusses the use of ultrasound imaging in rodent research. Again, evolving technology has resulted in the transferred use of a clinical tool in the research setting, where it can capture better and clearer images in rodents.

In the early 1980s, Gordon and Ruddle (1981) reported manipulating eukaryotic cells of mice. Since that time, mice created by transgenic manipulation have become the mainstay of many research projects. Although other species are discussed herein, transgenic mice are emphasized because their use exerts a tremendous impact on biomedical and laboratory animal science. Traditionally, it has been necessary to pool the data from these small animals for sample size due to the limitations of existing technology. The imaging technologies described in this issue play a dual role in being noninvasive and in allowing for longitudinal studies in small animals. For example, techniques such as NMR (MRI[1]) imaging enable a scientist to follow each mouse in an experimental group for changes in heart morphology rather than having to resort to euthanasia for tissue harvesting.

For larger animals, the primary advantage of noninvasive imaging technology is the replacement of techniques that may have required necropsy as an endpoint. In drug research, all of these technologies in a preclinical setting may provide insight into techniques or surrogate markers important in clinical trials.

The last article, in which Balaban and Hampshire (2001) review the challenges and opportunities of imaging in small animals, provides insight into the specific use of existing technology. The authors introduce the idea of postmortem imaging and describe its potential role in research. In addition, they outline problems investigators may face when using the technology and equipment in mice that often have been designed for humans.

Finally, in a world of 15-sec sound bites where the present thrust is for "high-throughput" biology, authors identify the time required to capture images as the main barrier for these technologies. Of the four, ultrasound lends itself best to "high throughput." However, it does have the limitations described by Coatney (2001). NMR (MRI), EPR, and PET involve extended image acquisition time and have the added burdens of expense and equipment operating skill that exceeds the level normally found in a research facility. The authors have outlined strategies to minimize these issues; however, they conclude that none of the technologies will be used as a primary tool in a high-throughput biology setting in the near future.

The overall intent of this issue was twofold: (1) to bring to our readership in-depth reviews and discussions of techniques by those who are the leading users of these methods in animal research; and (2) to provide descriptions of techniques and tools that can refine the endpoints in animal studies, allow for the replacement of higher mammals with rodents and, in some cases, reduce the number of animals needed. The editors believe this purpose has been achieved, and we hope our readers find this information useful.

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[1]Abbreviations used in this article: EPR, electron paramagnetic resonance; MRI, magnetic resonance imaging; NMR, nuclear magnetic resonance; PET, positron emission tomography.

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