Asteris Solutions:  Beyond Digital Image Archiving
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Storage requirements, disaster recovery plans, and cross-system integration processes are some of the many unexpected issues veterinary practitioners are being forced to address soon after purchasing digital imaging systems. Asteris, Inc. has developed solutions that address these dilemmas as well as the myriad of industry shortcomings, particularly those involving patient management and workflow. Authors’ address:  P.O. Box 245, Sedalia, CO  80135; 877.727.8374 x701; jeff@asteris.biz

1. Introduction

While medical-grade digital imaging systems have allowed veterinarians and specialists to employ improved and more efficient methods of diagnosis, the associated elements involved in integrating and maintaining these systems in standard veterinary practices has left many practitioners with a mass of technical issues to contend with. At the forefront of the list are questions regarding archiving the digital image data, including:

- What are the Veterinary Practice Act liabilities for data retention enforced by my state?
- Why are images being deleted from my system without my knowledge?
- Why are some archiving solutions significantly more expensive than others?

As with many other aspects of digital imaging, the costs and headaches associated with archiving medical data are ironically seeded by efforts to standardize the practice as a whole.

The “standard” digital imaging system, typically referred to as a modality, utilizes the National Electrical Manufacturers Association (NEMA)-regulated DICOM (Digital Imaging and Communications in Medicine) Standards for image format and storage. From the initial glance, DICOM standards seem the natural choice for veterinary imaging systems, as the comprising elements have been in use within the human health industry for several years. Methodologies and compliance are rigidly enforced, therefore all DICOM-compliant systems communicate seamlessly with other compliant devices, creating a streamlined architecture for acquiring, transferring, and storing images and supplementary medical documents.

To address the lack of veterinary-specific elements within the DICOM Standard, a new DICOM Standards Committee was formed; Workgroup 25 (Veterinary Medicine) is diligently striving to address said shortcomings. However, since the veterinary standardization is, at the time of this writing, still in its infancy, most of the digital imaging system vendors are either offering hardware or software products that are direct carryovers from the human health industry, or have implemented their own proprietary standards, rendering them incompatible with other systems. To complicate these matters, a large cloud of debate has arisen regarding whether or not the veterinary industry need even employ the DICOM standard, given the non-necessity to comply with Health Insurance Portability and Accountability Act (HIPAA) standards, which enforces the use of the DICOM Standard within the human health industry.

The quagmire of differing opinions and incompatible systems presents a veterinarian with an immeasurable number of questions, causing them to dedicate increasing amounts of time and energy searching for answers – time better spent practicing medicine.
2. Background:  
Digital Imaging Elements Commonly Employed for Veterinary Use

DICOM Image Files:  
While a traditional digital image file contains primarily the data required to render the image, the DICOM format also includes various depths of informational data, including client and patient information and exposure/image capture specifications. With this, a single image separated from its associated set of images (typically referred to as a study) contains enough information to provide association to a medical record as an individual entity.

DICOM standards ensure that while images can be manipulated for viewing and diagnostic purposes, the true image integrity remains unaltered for medical record purposes. Unfortunately, maintaining a high image quality requires a significant amount of image data to be retained within the file itself, resulting in relatively large file sizes. Many of the current DICOM modalities deployed for veterinary use are generating average file sizes between nine megabytes (MB, 1 MB = 1,024,000 bytes) and twelve MB.

Given that typical veterinary digital imaging study sets are comprised of four to nine images, it is immediately evident that disk space becomes a premium for storage within a busy veterinary clinic. For example, a clinic averaging seven 9.5MB images per study that generates 2,500 studies per year for a single modality will require 166 gigabyte (GB, 1GB = 1,000MB) of storage space. Given that hard drive manufacturers define 1MB as 1,000,000 bytes, this translates to a requirement of 170GB of hard disk space per year for that single modality.

PACS Servers:  
DICOM Picture Archiving and Communications Systems (PACS) servers are the most common solutions recommended for storage and centralization of DICOM images. As DICOM-compliant devices, they are theoretically simplistic “drop-in” solutions dedicated to the storage, retrieval, distribution, and presentation of medical images/studies. Most systems are implemented within the veterinary practice as a quick answer to in-house archiving issues. Some vendors also offer PACS servers as a means of offsite storage, utilizing DICOM protocols to transfer the images across the internet for archiving and remote access.

While effective in their primitive functionality, there are four significant negative aspects to employing PACS servers for a veterinary practice:

i. Initial cost: Since most of the PACS systems being offered by veterinary-field vendors are direct carryovers from the human medical fields, the prices of these systems are far above what a veterinary practice can typically afford. They are often priced 500% over the cost of the actual hardware.

ii. Ongoing costs:
   a. High-powered servers require IT professionals to properly maintain them.
   b. RAID servers require significantly more electrical power than a standard PC.
c. Non-renewable; industry standards suggest that the server should be replaced in full after three years of service. According to Stanford Research, by 2007, life expectancy will be down to two years.

iii. **Lacking in network performance:** Although DICOM compliance allows for tight-knit integrations with DICOM-compliant modalities, transferring an image across the internet via DICOM protocols is significantly slower than many other standardized methods. This translates to saturated internet connections from the clinic to the server while uploading the images and poor performance for web-based retrieval. As a further complication, a network administrator must be involved in setting up remote access between the server and remote clients. Among several other factors, this typically involves opening firewall ports on both ends.

iv. **Poor disaster recovery methods:**
   a. PACS servers employed within a veterinary clinic do not serve well as disaster recovery solutions, given that they will fail and can be destroyed by natural disaster.
   b. A remote PACS server is often implemented as an offsite storage device. While this is a viable option for backup, the time and effort required to rebuild a clinic’s image database from a remote PACS server is enormous. Not only will the transfer take an unacceptable amount of time (approximately 6.3 days for 100GB over a dedicated T1 line), but PACS servers offer limited means of automatically repopulating the image database once the images are downloaded.

**Non-DICOM Systems:**
While the movement towards full DICOM compatibility within the human health industry is admirable, if not impressive, the costs associated with the corresponding hardware and software is generally not always feasible for the veterinary practitioner. Rather than exclude themselves from these markets altogether, veterinarians have oftentimes chosen to acquire diagnostic equipment that is not DICOM-compliant. While referred to as “sub-standard” by DICOM-oriented vendors, this equipment is typically more than sufficient to fill a need within a veterinary practice, and should by no means be dismissed.

3. **Solutions**

Considering the advantages of digital technology in veterinary medicine, even the most conservative estimates would suggest that the installed base of digital equipment will continue to increase. Evidence of this market growth is seen in a recent announcement that the American College of Veterinary Radiology (http://www.acvr.org) has formed a digital imaging standards committee to focus on standardization and best practices for image management and archiving.

Asteris firmly believes the industry is in desperate need of a single all-encompassing solution, and has spent the past two years researching and developing products to achieve that goal. Governed by a Veterinary Advisory Committee consisting of respected veterinary practitioners, surgeons, radiologists, and office managers, Asteris has designed a system tailored specifically for veterinary practices, addressing all shortcomings and frustrations involving patient data management and workflow.
Digital Image Archive and Management:
Asteris systems are designed to communicate with all veterinary modality and image acquisition systems, DICOM-compliant or otherwise (see Figure 3.1). DICOM protocols are used to query and retrieve images from DICOM-compliant modalities, transferring them to a centralized data store. For other devices, Asteris has created relationships with numerous companies to develop vendor-specific modules that monitor the device for new images and automatically transfer them to the data store.

Images are stored within the Asteris data store in a patent-pending proprietary format. The intent of this methodology was neither to introduce yet another obstruction in the existing digital imaging debacle, nor to isolate potential competition. Rather, it affords the veterinary practice two key elements Asteris deems missing from current solutions:

i. **Security:** Even with rigorous standardization, DICOM security leaves much to be desired, and can be broken with standard network compromising technologies. Asteris packages files using encryption routines approved and utilized by the United States government. Since no encryption routine is completely unbreakable, Asteris employs a secondary algorithm to enforce authentication and disallow modification. If a user cannot be approved for access to a particular image, or if a single byte of the image has been altered since being acquired, access will be denied, and a system administrator alerted.
ii. **Performance:** Once packaged, a medical document can be transferred across a network or the internet in a manner that is up to 2.5 times faster than standard DICOM transfer protocols, with no degradation of data or image quality. With regards to archiving or retrieving images over the internet, transfer speed is of paramount importance, and this performance distinguishes Asteris from all other current digital image archive solutions.

Images can also be stored and exported in their native format (including DICOM) if a clinic desires.

The primary archiving process is executed by the Archiving and Synchronization Module (see **Figure 3.2**). Archiving can be a manual or automatic process, depending on clinic needs. Medical documents are transferred to the Asteris Archive Servers, at which point they can be searched and retrieved by any software that implements the Asteris security and transfer protocols. The archiving module also serves as a database replication broker, ensuring that the database is regularly synchronized with the archive database for integrity and offsite access.
Each month, the veterinary clinic is provided with a set of DVD’s containing a password-protected, searchable, viewable collection of the medical documents archived within the past month. With these, the clinic is granted three items not offered by standard archiving solutions:

i. **Full possession of their intellectual property:** Asteris retains no rights to any of the medical data or associated records archived by the clinic.

ii. **Redundancy:** Although redundant backup methods are implemented on the Asteris servers, two copies of the DVD library are shipped to the clinic each month. One copy is for onsite and offsite (shows, etcetera) use, while the other is to be kept at a secure location such as a safe deposit box, thereby indemnifying the practice’s legal liabilities to retain diagnosable data.

iii. **Disaster recovery:** Upon the event of computer failure or natural disaster, the clinic’s medical document database is quickly rebuilt using import utilities on the DVD.

To avoid confusion regarding disk usage or per-image billing practices that can lead to missing costs, Asteris has structured archiving fees on a per-study basis. With this, the costs for archiving a study are directly realized, and can thereby be passed directly to the client without image count or disk space analysis. This “one-time” archive fee is all encompassing – archiving, web access, unlimited transfers to specialists, DVD library inclusion, and technical support is included.

**Practice Management Software (PMS) Integration:**

In the human health industry, DICOM standards are in place for associating patient data with medical documents and reports. Hospital Information Systems (HIS) are developed to be tightly coupled to modalities, allowing for automatic data population and modality scheduling, thereby streamlining workflow. By further employing a Radiology Information System (RIS) and providing an integrated interface for viewing and managing images and reports, all facets of patient management are addressed, from check-in to diagnosis to treatment to checkout and billing.

With regards to the veterinary clinic, there are five primary disadvantages to implementing standard HIS and RIS systems:

i. **Designed for human health care industry:** In their official capacity, most tried and tested HIS and RIS systems in the current market are designed for the human market. Some vendors have implemented minor customizations with these systems for veterinary practices, and several companies have veterinary-specific systems in development.

ii. **Initial cost:** As with the PACS servers, said HIS and RIS systems carry the human field price tags.

iii. **Ongoing costs:** Large-scale HIS and RIS systems typically need to be installed on enterprise-level servers. These require DICOM-knowledgeable system administrators, and have large electrical power requirements.

iv. **DICOM only:** For a complete integration, most HIS and RIS systems currently being deployed in the veterinary market require full DICOM compliance from all hardware and software within the veterinary practice. The few systems that are capable of handling
non-DICOM data typically require a mediating system that “wraps” the data into a DICOM format before transferring it to the HIS or PACS server.

v. Poor Means for Remote Access:
As with the PACS server, a network administrator is required to create and continually maintain the elements required to allow remote access to the clinic servers. Deploying a system within the clinic also significantly increases the bandwidth requirements for the clinic, since the clinic’s internet service provides the source of connection.

To accommodate these issues, Asteris has designed their systems around an Application Programming Interface (API), with the intent of creating a veterinary-specific HIS/RIS integration with veterinary PMS vendors. Offered to the public for complete, robust integrations, the API offers such functionality as patient record associations, image retrieval, modality work list scheduling, DICOM printing, and image search and retrieval. To further enhance the system as a whole, Asteris has developed a veterinary-tailored image viewer and is offering the application to PMS vendors for viewing images within their software. The viewer offers all the functionality and manipulation tools required for thorough diagnosis, allows for notations and measurements, and is capable of implementing the security and performance attributes of the Asteris packaged file format.

Minimal Hardware Requirements:
The human health industry model of installing large servers within the clinic for PACS, HIS, or RIS systems is not a practical application for the common veterinary clinic. These systems are extremely expensive to purchase, and their ongoing configuration and maintenance must be performed by a skilled professional, either contracted or permanently employed. Further, most systems include a mandatory service contract.

Since the Asteris systems are designed specifically for veterinarians, they are compiled to run on a moderate workstation within the clinic. Typical systems will include enough hard drive space to maintain a clinic’s data in-house for three years. Services run in the background that monitor disk space, removing old data as necessary. Records of deleted medical data remain available along with the active records. Should a clinic need to access deleted data, the system automatically retrieves and imports it from the Asteris archive servers, transparent to the user.

With this model, the cost requirements are drastically reduced with respect to implementing enterprise-level servers. These savings are compounded when factoring in the replacement of the hardware after a standard of three to four years.

Flexible Offsite Data Access Options:
As mentioned, Asteris only charges the veterinary practice for archiving a study. Once archived, the associated images can be used by the practice in any manner necessary to obtain diagnoses and enhance workflow.

Often, a practitioner may want to send study data to a fellow practitioner or specialist for consultation or interpretation. Asteris has chosen not to employ a standard telemedicine model and charge for this process, but instead provides a simple application that allows the practitioner
to request that images be sent to the recipient of their choice. The images can then be viewed or imported by the receiving party, free of charge. The sending party is immediately notified via email when the recipient downloads the study. By eliminating the need to burn the data to CD and mail it to the specialist, Asteris is saving veterinary practices up to $800 per month on shipping charges alone.

To further enhance the diagnosis workflow, Asteris will soon offer standardized screens for the specialist to notate points of issue and create diagnosis reports. Once submitted, these elements will be permanently saved with the patient’s record at the originating clinic. Features will also be offered to allow the specialist to catalog and invoice studies referred through the Asteris software.

Asteris Workstation software is “network-smart” and can determine whether it is operating in or out of the clinic. When offsite, the software connects directly to the Asteris archive servers and thus the appropriate synchronized clinic data store, without requiring modification of the user’s network connection of firewall. Changes made to patient data while in “offsite mode” are reflected back from the Asteris archive servers directly to the data store at the clinic, creating a seamless large-scale imaging network.

4. Summary

Veterinary digital imaging systems have recently shifted from being niceties to necessities. The incompatibilities and the unavoidable archiving issues however, have forced many practitioners to spend undue time researching and weighing the technical aspects of integration options. While many of the pertinent hardware and software vendors have been designing proprietary systems that further complicate these issues, Asteris has concentrated on developing systems that expound the potentials of offsite archiving and data sharing with a focus on the benefits for veterinarians and the manner in which they practice.

Asteris was initially founded in 2004 as a digital image archiving solutions provider for veterinary practices. Since then, they have dedicated their resources to designing a complete veterinary practice software solution that incorporates all aspects of patient management, diagnosis, and treatment, whereby the archiving services are a supplementary (albeit necessary) component. Through their willingness to establish relationships with other veterinary product companies and maintain an “open architecture”, they have created an expandable system that seamlessly operates with most hardware and software installed within any practice.

By developing systems under the guidance of seasoned veterinary professionals, Asteris is providing the means necessary for practices to realize profits for digital imaging services that were previously labeled sources of loss. Coupled with practice management software integration, practical offsite data access, and elimination of the standard telemedicine business model, the Asteris solution provides the veterinary practice the ability to operate in an equivalent, if not higher capacity than most human medical systems at a fraction of the initial and ongoing costs.