The mPlexus® Relevant Prior Engine

Bringing automated, intellient image retrieval to hospitals and other medical facilities

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mPlexus LLC, an Indiana company specializing in the development of reliable DICOM software, has been developing tools to manage the flow of medical images within and between medical facilities since late 2005. The first mPlexus product, DICOM eXtender, a DICOM router or image transfer engine, has been on the market since early 2006 and has been established as a fast, flexible and reliable tool for many institutions.

The mPlexus DICOM Relevant Prior Engine (RPE) has been introduced more recently and is currently in clinical use by a large radiology group in North Carolina. See the attached case study white paper for details of that implementation.

Why Share Medical Images?

As much as 30 million dollars per year is wasted due to unnecessary medical imaging. Much of this imaging is done because recent imaging studies and their relevant comparison films are not quickly available for referrals and transfers. Studies have shown that repeat imaging is much more prevalent when recent images are not available. Thus, cost and unnecessary radiation exposure are reduced by sharing images and by making prior images readily available. Also, it is both intuitive and proven in peer reviewed research that the availability of relevant comparison images improves the quality of radiology interpretations. In fact, referring to comparison images is a requirement in the mammography standards set by the FDA.

The Stage 2 meaningful use criteria that sprang out of the 2009 American Recovery and Reinvestment Act (ARRA) included image sharing as one of the criteria until public comment forced removal. The prevailing opinion was that image sharing should not be used as a criterion at Stage 2 implementation because the technologies that might facilitate automated sharing did not exist at that time. It is rumored, however, that the Stage 3 meaningful use criteria will likely include image sharing. Therefore, facilities that begin to share images sooner rather than later will place themselves in a situation to receive greater Medicare reimbursement in years to come

Current State of Medical Image Sharing.

Currently, the most prevalent method of image sharing is by CD, which is both inconvenient and nearly impossible to do in a timely manner and on a large scale. Recently, a trauma center has encouraged pushing CD imaging data to the trauma center via secure internet connections (Flanagan, Relyea-Chew, Gross, & Gunn, 2012). This would seem a workable solution at those facilities, but one that is not automated and therefore still requires valuable time, and one that is not widely reproducible without significant ingenuity at other trauma centers nationwide. Consequently, image sharing in the United States has not occurred routinely or automatically on a large scale between institutions.

Sharing Between Facilities in Large Health Care Delivery Networks.

A recent trend has been for large hospital institutions to acquire smaller hospitals and for large radiology groups to acquire contracts at multiple outlying institutions. In these cases, often image sharing has been accomplished to a certain extent within the institutions or large organizations. Even within some very large geographically dispersed institutions, central image storage and availability of comparison images to connected institutions has been accomplished.

However, in many of these hospital organizations or large groups, a centralized architecture has been accomplished at great expense to the individual institutions since it has essentially entailed deploying a traditional Local Area Network (LAN) architecture (a Picture Archiving and Communication System—PACS) from a single vendor over a Wide Area Network (WAN). This type of application often requires large bandwidth expenditures.

As well, when a larger institution acquires a smaller, the transition often entails the replacement of the existing PACS at the acquired hospital by the larger institution's enterprise offering. This results in a significant homogenization of workflow between the newly aligned institutions such as the use of a common worklist and a common central archive, but at a very high cost. Significant waste is apparent in replacing a perfectly functional PACS at the smaller institution, in addition to the expense and frustration of migrating from one proprietary image archive to another.

Finally, once this grandiose intra-institutional imaging network is accomplished the institution is still not able to share images with the other hospitals or imaging centers that it does not own but which may be just across the street. That is a big problem when it is those facilities that the patient is most likely to frequent when not attending the larger hospital.

Other PACS Considerations: The VNA Trend and Imaging in the Cloud

PACS implementations also have traditionally had another major potential cost; an upgrade or replacement decision will likely be forced five years or so after the system is first implemented. This decision has been discussed extensively in recent academic and trade literature as "PACS jail," a situation in which the facility must essentially repurchase their PACS system or purchase a competing solution. If the facility does not, then it will be unable to retrieve its own archived images without significant effort or massive unnecessary cost.

To avoid the problem of "PACS jail," vendor neutral archives (VNA) have been championed. This theoretically would allow the facility to change their PACS vendor but not have to migrate their image archive to the new vendor. Recently, vendors and service providers have suggested that this same model could extend to the cloud archival of a facility's images or even the images for a whole state or country (Cadet, 2012; Keen, 2012).The desirable, yet difficult to reach goal in medical image archiving is to establish redundant image archives in the cloud so that on site archives need not grow any further or need not be present at all. However, the latency issue over wide area networks significantly slows transfer times even with very significant bandwidth from the institution through the internet to the archive. The critical factor for any image transfer system is the question "How long is the radiologist willing to wait for comparison films before moving on and reading the case without the relevant prior films?" The answer is: no more than two seconds. Thus, the prior studies must be available on the workstation at the moment that the current study is to be read or they will not be referenced.

In another common scenario, digital image transfers are the backbone of any teleradiology system. Oftentimes, teleradiology providers will not provide final interpretations unless they can ensure that a reasonable effort has occurred to obtain relevant prior images. However, in the middle of the night, the selection of comparison studies is inconsistent at best because it requires the diligence of the nighttime skeleton crew that is under pressure to attend to the patients and not spend time searching the image archive. Consequently, the higher order service, the final interpretation (also a better reimbursed service), often cannot be performed by the teleradiologist if quality is a high priority.

How Can These Problems Be Solved?

mPlexus has solved these problems with the mPlexus DICOM Relevant Prior Engine (RPE). The only fully automatic system of its type, the patent-pending RPE is relatively sophisticated. It automatically identifies that an imaging study has been done and then retrieves all relevant prior imaging studies from any archive to which access has been granted. Unlike other vendors that have simple automated retrieval solutions based on the type of study done or when it was done, mPlexus has developed a sophisticated algorithm to intelligently retrieve (or "pre-fetch") only the relevant prior studies. Prior to placing the imaging studies into the destination archive, the medical record or other

predetermined DICOM header information on the images is automatically changed (generally best done by referring automatically to a Master Patient Index to assure fidelity in patient information) to match that patient's information within the destination system. The RPE saves time for radiologists and referring physicians alike, and results in higher quality interpretations and overall patient care.

The mPlexus RPE can provide relevant prior imaging studies automatically to any institution from any other site owned by that institution as well as any nearby hospital or imaging center that it does not own or control. Each site may simply use its current local PACS for workflow control of interpretations or the workflow can be driven by some other shared RIS application. This can be accomplished at a fraction of the cost of a replacement PACS. It is worth reiterating that the RPE can add significant value by making cases from other institutions available and not just from other facilities or sites that are also controlled by the Health Care Group in question. These cases would never have been available under any circumstances or at any expense in the case of the replacement PACS described above.

The RPE proactively fetches the relevant prior studies based on a triggering event. The most useful and common triggering event is the HL7 message sent from the Radiology Information System (RIS) at the time of scheduling or patient check in. If the search for relevant prior studies is left to the radiologist when he sits down to read the case, then the latency will make it impossible for the comparison films to arrive in time to be read (two seconds or less). The RPE overcomes the internet latency issue and makes relevant comparison studies available at the right place and at the right time since, in most cases, the studies are fetched before the current study is even performed. This technology makes the VNA strategy described above more tenable and would allow cloud-based image archives to actually be used as active real-time archives and not just backup or redundant archives.

How does the RPE work?

The Relevance Engine – Patent Pending

First, intellectual property resides in the ability of the software to automatically parse and understand the nomenclature used in each archive to describe the individual studies. Although constituted of a finite number of possibilities, the universe of imaging nomenclature is not standardized in the industry and is dauntingly large. Currently, mPlexus software can understand the nomenclature at introduction to a new site with approximately 50% accuracy -- straight out of the box and without human intervention. mPlexus expects that accuracy rate to increase to over 90% as more sites are integrated. This technology allows mPlexus to index imaging archives in a matter of days, allowing customers to integrate many disparate sites rapidly.

Secondly, the Relevance Engine determines relevance by the correlation of every possible study with every other possible study. This is followed by specialty-specific post-processing rules and time frame considerations. For instance, in a patient with multiple recent Head CT exams after a traumatic incident, the relevance engine would not only select comparison Head CT exams, but would prioritize an MRI of the brain done yesterday over a more remote CT of the head. The entire solution incorporates a radiologist's intuition and is relatively elaborate, but entirely automatic.

Conclusion

The mPlexus RPE is the right product at the right time to meet the specific needs of any institution that desires to effect image sharing automatically. The RPE will allow teleradiology providers to always have relevant prior images on every case, enabling the providers to perform final interpretations. It will fully enable the VNA model and likely enable true cloud real-time off-site archive use.

Ultimately, with the mPlexus RPE the power of controlling image flow could be returned to the patient. The patient has the greatest vested interest in the efficient flow of his or her medical images between institutions, and a solution such as the mPlexus RPE could allow the patient to control the movement of his own images. Such a solution may

help reestablish the patient as the customer in the US Healthcare system, and in turn help drive healthcare quality reform in the United States.

References

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