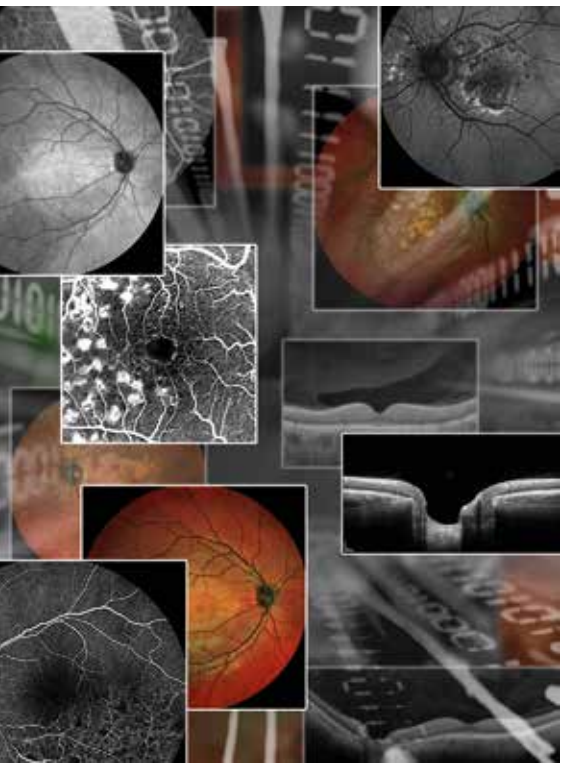

Modernizing
image data management
at ophthalmic practices and hospitals

In recent years, ophthalmic imaging technology has advanced rapidly, revolutionizing diagnostics and treatment monitoring. Optical coherence tomography (OCT), for instance, has considerably increased our knowledge about the pathogenesis and course of numerous eye diseases. Imaging-based examinations have now become an integral part of everyday clinical routine. But with each of these images come large amounts of data that need to be stored and analyzed. How can the growing volume of image data be managed in the future?

OCT imaging has become an indispensable diagnostic tool, particularly for the identification of increasingly widespread diseases such as age-related macular degeneration (AMD) and the ocular complications of diabetes. The treatment management of intravitreal injections (e.g. anti-VEGF therapy) for these diseases also relies on regular OCT examinations. Due to their need for consistent follow-up and monitoring, AMD patients alone may generate several hundred gigabytes in OCT image data per year.

Ophthalmologists already work with a large volume of image data, which must be reliably managed to render it truly useful. With the clinical availability of new technological options (such as OCT angiography and widefield OCT) as well as demographic trends indicating a rise in examinations, the volume of image data in ophthalmic practices is expected to continue to grow considerably.

More time for patients thanks to automated workflows

Organization is half the battle – and this is certainly true when it comes to image data in ophthalmic practices. Rapid and efficient diagnostics require that data are saved securely under the right patient name and can be reliably retrieved for assessment any time in a clearly organized structure. Proper management prevents time wasted searching for and sorting data, leaving more time for direct patient interaction.

However, simply installing a larger hard drive is not enough to manage the increasing amount of data. Efficient diagnostics in ophthalmology now also depend on the treating physician having all the relevant patient data available immediately in a well-structured fashion.

To efficiently utilize image data in routine clinical practice, all steps associated with saving, transferring, and displaying data should also be largely automated and intelligently organized. Doing so allows for standardization of workflows, making them more time-efficient, preventing unnecessary errors, and enabling ophthalmologists to have more time for the patient and for determining proper diagnosis and treatment.

While initially it may seem that this flood of images would be something that only hospitals or larger eye care centers would have to worry about, in the future all ophthalmic practices will need to efficiently archive their image data while meeting data protection requirements. That will ensure that the data can be easily and reliably used, regardless of the device on which they were generated.

Peter Mussinghoff
Managing Director of the Eye Care Center at St. Franziskus Hospital in Münster, Germany

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A quantum leap in ophthalmic image data management

"For us, in order to keep getting the most out of all imaging technology has to offer and to use it in the best interest of our patients, now is the time to set up powerful systems that rise up to these challenges," notes Peter Mussinghoff, Managing Director of the Eye Care Center at St. Franziskus Hospital in Münster, Germany. To manage the center's growing image data, Mussinghoff chose the new HEYEX2.

HEYEX2 is a modern image management and device integration platform that allows users to centrally manage image data from various devices using a single database and to access it simultaneously from various workstations throughout the network environment. In other imaging-based specialties such as radiology and cardiology the image management aspect is already well established. In those specialties, the so-called PACS image management systems (Picture Archiving and Communication Systems, see info box on page 4) have been used successfully for many years and have helped to establish much more efficient and reliable workflows.

HEYEX2 was specifically developed for ophthalmic purposes and is based on the user interface of the proven Heidelberg Eye Explorer (HEYEX). This consistency ensures familiar and intuitive operation for the new platform as well. Since HEYEX2 is also based on a scalable model, it can be tailored to individual customer requirements.

Heidelberg Engineering's pilot project was conducted in collaboration with the Eye Care Center at St. Franziskus Hospital Münster, a German hospital that performs more than 6,000 surgeries annually and more than 10,000 intravitreal injections. It also generates volumes of data to match, so right off the bat a "big solution" was needed. Several SPECTRALIS OCT devices and numerous diagnostic devices from various manufacturers had to be networked quickly and stably through HEYEX2. The data generated by them had to be saved reliably and in a well-organized manner, then archived and made available simultaneously on more than 40 additional viewing stations.

Furthermore, robust communication with the existing medical information system *arkandus* and with *ix.mid*, the existing physician referral network, had to be ensured. "This was a truly Herculean task, which the team mastered with flying colors," raves Mussinghoff.

How exactly does HEYEX 2 work?

The core of HEYEX 2 is the central server. All information, including image data as well as administrative patient data from the various integrated devices in the HEYEX 2 environment, comes together here (Fig. 1). The information is automatically stored in a central location and can be easily accessed by all of the facility's workstations. The new technology used in HEYEX 2 represents a big leap forward because it ensures stable and secure workflows at all times, even with very large data volumes; on top of that, multiple users can access the data at the same time with no loss of reliability.

Not only can various diagnostic imaging devices from different manufacturers be integrated into the HEYEX 2 network environment, but viewing stations can be connected as well. These viewing stations can simultaneously display multiple diagnostic images from different devices by various manufacturers so users can make a comprehensive analysis.

In addition, HEYEX 2 can be connected to existing hospital or medical information systems (HIS/MIS) to make workflows even more efficient. The number of devices to be integrated and the specific design of the HEYEX 2 environment depend on the needs of the specific practice or hospital. Due to its modular design, HEYEX 2 can be tailored to different needs.

Figure 1: Schematic diagram of a "basic" HEYEX 2 installation including only Heidelberg Engineering devices

Standardized communication for smooth data transfer

In order for various devices in the network environment to exchange data seamlessly, HEYEX 2 uses a proven, standardized communication language:

The networked systems communicate with each other in a standardized device language called DICOM (see info box on the right), which minimizes the risk of information loss and ensures high data consistency. The fact that all data entering the server are automatically saved and are immediately available to all participants contributes to this quality.

The communication between the HEYEX 2 server and the hospital or medical information system uses the HL7 standard typically used in medicine (see info box on the right).

Even devices that do not "speak" DICOM can typically be integrated into the HEYEX 2 environment through special interfaces. Their data are "translated" into the DICOM standard to allow them also to be made available on the viewing stations – albeit without some of the analysis options available on the native devices.

In the quest to integrate image data from all devices into image archiving and communications systems as efficiently as possible, the availability of DICOM interfaces on diagnostic devices is playing an increasingly important role.

The question of whether manufacturers support integration into internationally recognized models, such as the World Model of the Unified Eye Care Workflow from the initiative Integrating the Healthcare Enterprise (IHE), is also becoming more relevant for the establishment of efficient workflows.

Key image data management terms at a glance:

PACS

(Picture Archiving and Communication System)

An image archiving and communication system used in medicine. PACS captures digital image data from various modalities (e.g., various diagnostic devices), archives the data, and manages its distribution. For this purpose, the PACS server communicates with the connected imaging modalities and transmits data to viewing and post-editing workstations. In most cases, connection to existing hospital or medical information systems (HIS/MIS) is also established.

The DICOM and HL7 standards were developed in medicine to allow the integration and communication of the various connected imaging systems from different manufacturers and to ensure the integration of the PACS system into existing HIS/MIS.

DICOM

(Digital Imaging and Communications in Medicine)

A standard for the storage and exchange of information in medical image data management. This information may consist of digital images or additional information such as segmentation, surface definitions, or image registration. DICOM standardizes both the storage format and the data transfer protocol, ensuring interoperability between systems of different manufacturers in the clinical environment.

HL7

(Health Level 7)

A communication standard that has been developed specifically for healthcare and is widely used internationally. It serves to transfer patient and service data or diagnoses and covers applications such as patient data management, findings communication, service requests, and communication as well as master data exchange.

Streamlined workflows for practice efficiency

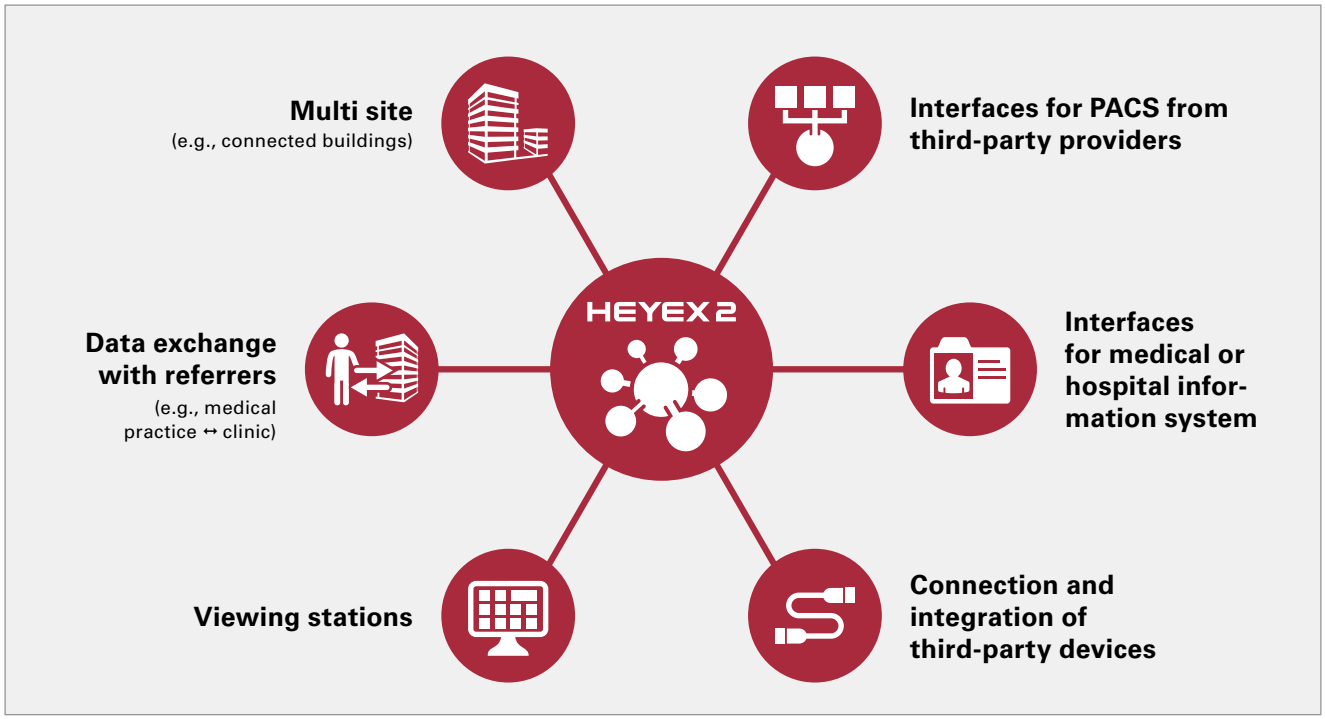
When a new patient comes to a medical practice, the patient's data are initially entered in a medical or hospital information system (MIS/HIS). Simultaneously, a decision is made on the examinations to be performed (Fig. 2). These newly-captured patient data are automatically sent to the central HEYEX 2 server in the form of an imaging "order". From all received orders, HEYEX 2 generates worklists for the corresponding devices. The worklists contain all current orders, that is, the examinations to be performed on a specific device.

This means that a current list of the examinations to be performed is automatically available on all devices. Simply clicking on an order on the device gives the operator access to the HEYEX 2 server, from which all necessary patient data and precise information about the desired examinations are sent. Patient data do not need to be re-entered, and time-consuming queries on the desired examination are eliminated. Once the examination is complete, the generated image data are sent back to the HEYEX 2 server, where they are automatically saved and archived under the corresponding patient's file.

Simultaneously, the HEYEX 2 server informs the MIS/HIS about the examination having been performed and new examination data being available. With this feedback, the MIS/HIS updates the worklist, and the completed order is marked as such. The captured image data can then be viewed instantly and simultaneously from any workstation throughout the practice. Images are clearly organized, allowing doctors to evaluate them more efficiently.

Since access rights to examinations can be specifically defined, compliance with data privacy laws is also ensured in the management of image data.

Figure 2: Complex integration possibilities for a HEYEX 2 installation



Advantages of HEYEX 2 in daily routine

The HEYEX 2 platform allows for digital diagnostics and image management as well as rapid, practice-wide availability of the images, all while meeting data protection requirements. These features offer numerous opportunities for increasing the efficiency of workflows.

A decisive advantage is the clear overview of all of a patient's image data and their simultaneous availability on many workstations. Continuous examinations can be performed on the diagnostic devices, for instance, while the assessment of all of the image data can be performed at the viewing stations, efficiently integrated in the physician's workflow.

Simply clicking on the patient's name instantly provides access to all data from the electronic medical record. Image data can be retrieved, organized, and assessed (Fig. 3). Comprehensive analysis options and functions supporting diagnosis are available for this purpose. For example, OCT images and volume scans from third-party providers can be viewed and volume scans scrolled through if the diagnostic device supplies the corresponding image data via DICOM.

In the future, the ability to implement "hanging protocols" will be available as well, making it possible to create user-defined data viewing.

"A default layout of the image data considerably facilitates diagnostics," states Mussinghoff. "Because when image data are automatically presented in the same layout all the time, the physician does not need to look for or sort through the relevant image data and can better focus on viewing and diagnosis."

Viewing follow-up examinations over extended time periods also will become even easier in the future. This is important particularly for the scientific assessment of treatment success in diseases such as glaucoma, AMD, and diabetic retinopathy.

Furthermore, the integration of HEYEX 2 into the hospital or medical information system (HIS/MIS) has some key advantages, such as considerable time savings when entering patient data, the combined storage of images and findings in a centrally-stored patient file, and high consistency of data. "Particularly these changes, which were originally considered minor, have major effects," notes Mussinghoff.

The fact that patient data are only entered once and are therefore consistent across all systems saves time and eliminates the typical errors of repeated data entry, such as name variants and typos. If errors are found, they only need to be corrected once. "Particularly due to this high data consistency and the rapid accessibility of all data, the system makes billing workflows much easier as well," states Mussinghoff.

Figure 3: Typical view of two monitors: on the left, a navigation window with data management tools and on the right, the viewer with the simultaneous display of multiple images for efficient analysis.

HEYEX2 also simplifies the widespread availability of all image data in the entire practice or hospital environment, as well as the workflows of research, post-editing, and report and presentation generation for continued education and conferences.

Image data can be safely exchanged with external networks via a special interface on the HEYEX2 platform, so follow-up exams can be performed locally by the treating ophthalmologist. Particularly in rural regions, this can save patients from some of the often time-consuming trips to the hospital. This flexibility can contribute to better compliance with the required follow-up examinations in patients with chronic diseases and, hence, to better patient care.

"Right away, HEYEX2 greatly improved our workflows, and our staff was really enthusiastic about it. Our patients noticed it as well: since the system was installed, we have been able to go about our jobs in a much calmer way," states Mussinghoff.

Easy implementation

The experience in Münster demonstrates that switching to HEYEX2 can be achieved with almost no practice down time – even if huge data volumes have to be transferred. At the Eye Care Center at St. Franziskus Hospital, a total of 11.8 terabytes of data was transferred to the new server; this was a smooth process thanks to careful planning by the Heidelberg Engineering project team. Before the scheduled go live weekend, all data had already been transferred from the existing databases to the new HEYEX2 server.

As the last task on Friday afternoon, the necessary software updates were performed on all of the HEYEX2 environment's devices. All devices were connected with each other and thus with the HEYEX2 system. The entire HEYEX2 environment, including all connected devices, was fully functional by Monday morning, which meant that the practice and surgical operations were not affected by the transfer. After only a 30-minute tutorial, normal practice operations were resumed.

"Overall, learning the new system was a piece of cake. Since the user interface is consistent with the HEYEX2 interface we already know, we had a very easy time with it. After a short time, none of us wanted to work without it. We would switch to HEYEX2 again anytime," remarks Mussinghoff, summing up their initial experiences in Münster.

The bottom line:

Switching to HEYEX2 is a worthwhile investment

- The image data volume in ophthalmology practices is already high and will continue to increase rapidly, particularly due to high-resolution OCT imaging. This applies to larger hospital systems and surgical centers in particular, but it is also increasingly true for smaller practices performing diagnostic imaging.
- To efficiently utilize the imaging data generated by various diagnostic devices, quick and reliable access to all of a patient's data must be ensured from multiple workstations, including for follow-up, for many years.
- More efficient workflows are supported by the integration of not just Heidelberg Engineering devices but also third-party devices.
- HEYEX2 offers a modern system architecture and can be tailored based on the requirements of the particular practice or hospital. It also ensures that current data protection and security criteria are met.

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