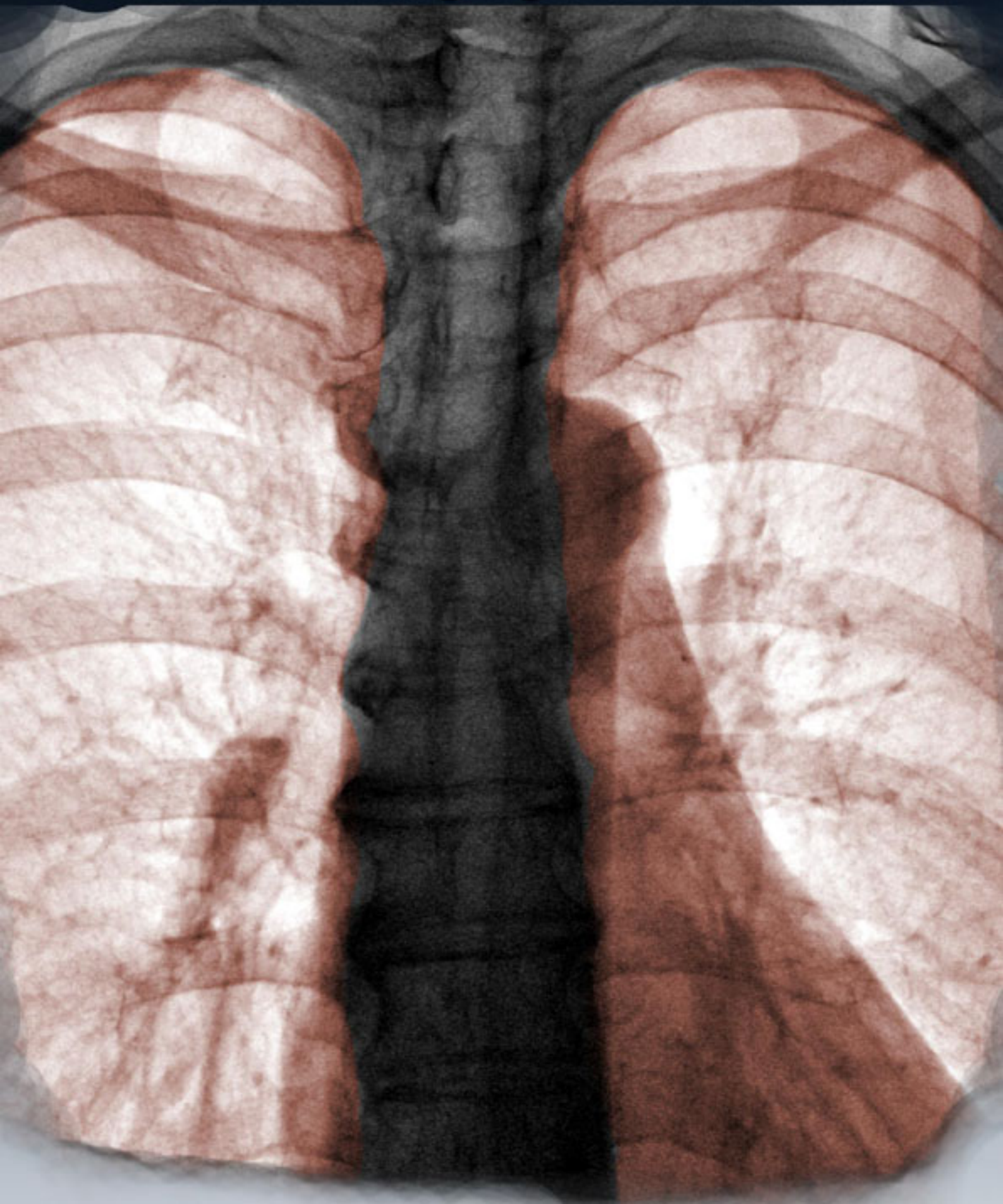
the basics of digital imaging: a guide

healthcare imaging uk



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Introduction to PACS

PACS stands for Picture Archiving and Communication Systems, and is one example of a digital imaging solution. PACS was originally invented by the United Stated department of defence, for use in the battlefield. It allowed radiologists and surgeons away from the front lines to view and advise on images taken in the field of battle injuries. It has since been developed for widespread use in healthcare settings all over the world.

PACS allows a means of acquiring, storing, distributing and viewing images taken from various modalities (XRay, CT, Ultrasound, MRI) across a network, or in remote locations using a web browser. Images are stored electronically, and the system can eliminate lost films and reduce repeat examinations. Images can be annotated and reported on with links to the report available on the same system. As well as offering huge efficiencies in staff time searching for films, there are reduced space requirements for archival, reduced running costs and improved patient safety by reducing unnecessary radiation exposure to a minimum.

The PACS consists of the imaging modalities, the server for locating and distributing images, archival / storage servers for storing all examinations, and an image browser and display for viewing / analysing the images. PACS solutions may be complete systems including all elements, or can be purchased / provided as separate components. You may elect to obtain image acquisition and processing / browsing systems separately from storage servers and displays.

Depending on your organisation's current clinical IT system, you may be able to link the PACS images to the rest of an Electronic Patient Record (EPR).

PACS, DICOM and all that - imaging terminology basics

One of the things that the NHS is famous for is the never ending stream of acronyms that are used by staff both clinical and administrative. Unfortunately, with the advent of digital imaging, the trend continues with a host of acronyms and new terminology becoming commonplace. Sometimes, it can be embarrassing to ask what they all mean, so we have made it easy with a complete beginners guide to imaging terms.

Bandwidth A measure of the amount of data that can be transmitted in a fixed amount of time (usually 1 second). Also known as the transfer rate. Typically expressed as kilobits (1000) per second (Kbps) or megabits (1 million) per second (Mbps). This will affect how quickly large files can be "sent" from one location to another. Bigger is better.

Browser A program that allows you to access the images stored in the PACS. If using a web based PACS, this may be a web browser.

DICOM Digital Imaging and COmmunications in Medicine. The DICOM standard is essentially a set of rules which allows the exchange of medical images. Images created with one DICOM compatible machine can be exchanged / viewed at a different site with different equipment as long as it is also DICOM compliant.

EHR Electronic Health Record. A longitudinal record of a persons health and healthcare from cradle to grave. Can contain information from many separate Electronic Patient Records

	from different care providers. Integration with PACS will increase functionality (but is a long way off).
EPR	Electronic Patient Record. A record of a patient's demographic information and the care received. Typically each institution has a separate EPR for each patient. Can be linked together to form an EHR.
HIS	Hospital Information Systems - A system that stores demographic information about patients, as well as information about previous attendances, appointments and sometimes pathology reports.
Modality	Term used to describe any imaging device including MRI, CT, X Ray, Ultrasound etc. Images produced can be "fed" into the PACS.
PACS	Picture Archiving and Communication Systems - a digital imaging system that allows the acquisition of digital images from various modalities (Systems). These can then be stored (Archiving), transmitted and retrieved (Communication), and viewed on a display (Picture).
RIS	Radiology Information System - systems designed to store, manipulate, and retrieve information and activities associated with the provision and utilisation of radiology services and facilities. Includes appointments / bookings for scans and X Rays. Usually computer assisted. Can be integrated with PACS.
Workstation	A computer terminal where the PACS is accessed. There are many types, depending on the usage, and the specification of computers / displays will vary accordingly. Reporting stations are used by radiologist to view, diagnose and report on images. A fast computer and a very high resolution display is needed. Clinical workstations are used for day to day access

to PACS images on the wards and in clinics. A lower spec computer and display will usually be used.

Displays for Group Meetings (X Ray / Trauma)

Once your organisation moves to a partial or complete digital imaging solution, you may find that large ligthboxes commonly used for group meetings where clinical images are viewed and discussed become redundant. Smaller group meetings such as those held to discuss trauma cases or recent interesting medical or surgical cases become very awkward when upto 10 physicians or surgeons are huddled around a small computer screen vying for a good view of the image.

There are two main ways for dealing with this problem, and we will look at both with the benefits and drawbacks of each. Your department's needs may be met by installing one or both of these options.

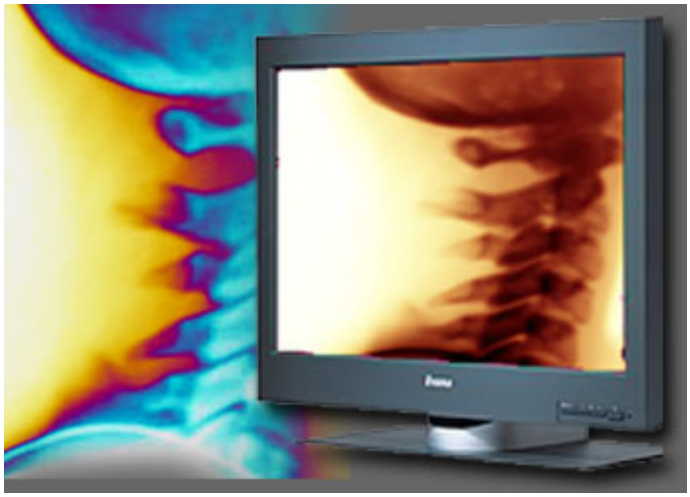
The options for displays for group meetings are:

Large LCD displays

Projectors

We will look at each option and then compare the two.

Large LCD Displays



Over the last few years, LCD display technologies have advanced rapidly, with an increase in quality and a decrease in prices across the board. As the cost of making (and supplying) displays has gone down, it has become more feasible for trusts to buy larger displays, with many trusts moving away from 15 inch screens to 17 inch screens. For group meetings - when 10 or more physicians or surgeons are vying for a view of the screen to discuss a diagnosis or management plan - these screens become inadequate.

To address this situation, you may consider installing a large LCD display - most of the leading manufacturers produce displays that are above 20 inches, with some manufacturers producing 23 inch widescreen displays. Displays vary greatly in their specifications and price, and it is important to choose a display that is fit for the purpose it is being purchased for.

For group meetings with upto 5 people present, we recommend a minimum screen size of 19 inches although 20-21 is better, and a minimum resolution of 1280 x 1024 (1.3 Megapixel). For group meetings of between 5 and 10 people, we recommend a minimum screen size of 22 inches at a minimum resolution of 1600 x 1200 (1.9 Megapixel). Over 11 people, we recommend either a very large display (30 inches and above) or using a projector.

Although there are screens available with much higher resolutions then those quoted, you should only go to the extra expense if it is clinically justified (eg. radiologists using screens for diagnosis / reporting may elect to have a screen with a resolution greater than 5 Megapixels).

Other key specifications to consider are contrast ratio (we recommend at least 500:1), viewing angle (the wider the better for group meetings), brightness, and the warranty package available. Higher end monitors may have DICOM calibration capabilities.

LCD displays are very easy to install and use, take up little space, use little energy and are silent. All the better products can be wall mounted to directly replace your current X Ray viewing boxes. With the correct graphics card, you can set up a multi screen display very easily.

Please look at our reviews section to see displays that we have tested and can recommend for use in the healthcare setting.

Projectors

Projector technology has advanced rapidly over the last decade. There are two main technologies, Liquid Crystal Displays (LCD) and Digital Light Processors (DLP). LCD is the more mature technology, and the only one we will consider here. Projectors display a large image onto any flat surface form a variety of sources. The source can be the computer (to access PACS or other digital images) or video (eg to view arthroscopies or laparoscopic images).

Most modern projectors have a short throw capability, allowing you to produce a large image in a very small room. This allows for everyone in the group to view images without crowding round a screen, or without having to go to a dedicated audiovisual room.

Important features to consider in a projector are the brightness (measured in ANSI Lumens), the resolution and the extra capabilities (better models often have a wireless capability allowing transmission from the computer or laptop without causing a clutter).

We recommend a minimum brightness of 1200 ANSI Lumens to allow viewing in a normal room (without having to turn ALL the lights off). The minimum resolution we recommend to maintain quality is 1024 x 768 (XGA).

Please look at our reviews section to see projectors that we have tested and can recommend for use in the healthcare setting.

Operating Theatre Displays

Operating theatres pose several problems when deciding on a display for your digital imaging solution. The display must be able to withstand the harsh environmental conditions, with organic materials (blood, bone fragments etc.) and chemicals often splattered within the theatre. At the same time the display must be able to show the surgeon clearly the area they are going to operate on. The most common fields needing radiology images in theatre are orthopaedics / trauma, neurosurgery and maxillofacial surgery.

There are two main ways of providing displays in theatre, each with advantages and disadvantages. These are:

Mobile ruggedised displays - LCD displays housed in a rugged protective casing.

Wall mounted LCD displays with a protective glass / perspex shielding.

We will consider both methods.

Operating Theatre Displays - Comparison

Ruggedised mobile displays. This typically involves a standard LCD display with a workstation in a compact form factor. The display can be housed in a toughened glass and metal housing that can withstand the demands of the operating theatre, and can be cleaned easily. They are usually mounted on a wheeled trolley, allowing them to be moved out of the way for cleaning or to give the surgeon a better view. Keyboards are normally rubber and without deep gaps in between (to reduce risk of it becoming an infection hazard).

Advantages Can be moved from one theatre to another

Can be removed for deep cleansing of theatre

Relatively inexpensive / hardwearing

Easy to install / use

Disadvantages Currently only fairly small screens available (max 18 inch)

Hard to visualise two views at once (eg for hip replacement)

Small range of screens available (specialist companies only)

Wall mounted LCD displays. This method allows the use of any large good quality LCD display. By protecting the actual screen with a toughened clear glass or perspex housing, the screen can endure theatre conditions. Images can be changed using a workstation in the theatre (there is often one used for operation logging). Newer systems allow wireless access to the network for clutter free access.

Advantages Offers possibility of life sized images (screensize upto 40 inches)

Can visualise two or more views at once

Less space usage / clutter in the sterile / cutting area

Wider choice of actual display used, wide choice of supplier

Disadvantages Installation by specialist only

Need to install separate screen into each theatre

Can be very expensive (including installation costs)

Please look at our reviews section to see displays that we have tested and can recommend for use in the healthcare setting.

The Future of Digital Imaging

Background

The government recently announced that all acute trusts in England will move to PACS within the next three years. This is a huge undertaking both in terms of costs and especially change management and implementation at a time when people are questioning the benefits of increased IT expenditure in the NHS. So what are the benefits, for patients and clinicians, of moving to a digital imaging system such as PACS? What will be possible once PACS is fully rolled out, and what needs to be done to get there? We will look at a case study to demonstrate the benefits of PACS and then explore emerging trends in digital imaging.

PACS in the real world: A case study

A 25 year old man riding a motorcycle involved in a road traffic accident is admitted to the nearest hospital (a district general hospital), with multiple leg fractures and a head injury. He has X-rays and a CT scan, which reveal that as well as the leg fractures, he has a spinal fracture. Once the scans are reviewed by the orthopaedic surgeons, they request an urgent opinion from the nearest centre with spinal surgeons (50 miles away).

After reviewing the images via a web-based PACS, the spinal surgeons request an MRI scan of the affected area of the spine, and review the images “live” – as they are taken. This confirms the unstable nature of the fracture, and the need for urgent surgery to prevent permanent damage to the spinal cord and possible paraplegia.

The patient is flown by helicopter to the spinal unit, where the operating theatre is already prepared, with the necessary equipment, and all the images available on large wall mounted displays. By accessing the patient's electronic health record, it is established that he has no serious medical history and so can proceed with the surgery. The operation is carried out

within three hours of the ambulance first arriving at the scene, and the man makes a full recovery.

Initially he has follow up appointments at the spinal unit, but has all necessary scans and X-rays at his local hospital (saving him many long, uncomfortable journeys). His continued follow up is managed locally, with the spinal surgeons reviewing his images via the PACS and consulting jointly with the local surgeons via a videoconferencing link, minimising disruption to his life, as he has resumed work at this stage.

Efficient collaboration

This case is a useful way to show some of the benefits of moving to PACS. For the clinician, PACS allows quick access not only to the current images, but also previous X-rays and scans for comparison and follow up. It allows more efficient collaboration with colleagues (radiologists, surgeons, physicians) in other departments or hospitals, making clinicians' working lives easier, and often having a real impact on patient outcomes.

Junior doctors especially will appreciate not having to traipse around wards in the early hours of the morning to collect brown X-ray packets for presentation at the daily trauma or X-ray meetings. For the junior doctor on call, it is often possible to get a quick second opinion from a senior doctor (who may be viewing the images from clinic at a remote site) and make a decision on the most appropriate management more quickly – saving the patient time waiting in the accident and emergency department.

For patients, the benefits can include quicker diagnosis and treatment. PACS can reduce the increased radiation exposure that comes from repeated examinations when X-rays are lost at clinic or on the ward just before an operation. They need never make a long journey to clinic for the result of a scan only to be told that it has been “misplaced” and “can you please come back next week”. Follow up can be managed more locally, causing less disruption for patients and carers.

Emerging trends

PACS is a fairly mature technology, but improvements are being made all the time. Over the next few years we will see more imaging modalities integrated into PACS, not just X-ray, CT, MRI but also echocardiograms, endoscopy, arthroscopy and ultrasound. We will also see integration with electronic patient records and tools to provide enhanced functions for different specialties. Surgeons will be able to template orthopaedic implants prior to surgery, a function already available on many systems.

PACS solutions will increasingly become web-based (or have a web-enabled option) to allow access to colleagues from further afield than within one trust or even one region. Computer aided diagnosis and decision support systems will develop to help junior doctors and, increasingly, nurse practitioners to identify abnormalities by comparing them to other images in the database.

To achieve all the benefits that digital imaging can offer, there are many changes that need to be made apart from simply installing PACS. Working practices will have to alter in most departments, and time will have to be set aside for training. Supporting equipment such as displays, printers and mobile access devices may need to be procured or upgraded for wards, clinics, offices and operating theatres.

X-ray boxes will become redundant, and will be replaced by large screen LCDs or, in some cases projection systems. There are often teething problems when implementing such large changes, and there are some common mistakes that can easily be avoided. We will look at this in more depth in a future article.