Image transfer has been a challenge in radiology since the first x-ray was performed. When x-rays were single studies, individual films were guarded jealously in case they were lost and could not be viewed. In the digital era, when studies can be reproduced ad infinitum, they are still kept under lock and key perversely to prevent too many people looking at them. Despite the ability to transfer images, we have developed an aversion to doing so with impunity. This article will consider the familiar, yet unresolved, issue of image transfer with the studied experiences of its implementation at a regional and national level.

One of the greatest advances in information technology has been the change to digital format for data encoding. This is the basis of all modern information storage and transfer systems. The DICOM (digital imaging and communications in medicine) format was finally introduced in 1993, as the result of a move to standardise computer-generated images, specifically CT and MRI, so that the images that were digitally encoded could be read in a unified way. The DICOM standard was then gradually applied to all radiological images, with the inevitable move to a single storage facility for a single institution’s images – the PACS (picture archiving and communication system).

Digital storage systems in medical imaging have been gradually rolled out to complete national coverage during the last ten years in the UK. Remote access to images has, therefore, been a routine matter since PACS was introduced and indeed is perhaps the primary reason for PACS implementation, to allow staff throughout an organisation to review images in different locations, in the clinic, office, MDT meeting rooms or at the bedside. The transfer of images between hospitals has been in practice since medical imaging was invented. The reasons behind image transfer have not changed for decades and remain – for images to accompany a patient when that patient moves between centres, or for images to be transferred separately for a second or more specialist opinion.

Before digital media formats, x-ray films would be developed as a single film per examination. These studies would therefore be safeguarded according to local policy either in the radiology department or at the bedside. Individual institutions would have their own protocols for tracking studies or film packets and the transfer of images off-site was a serious matter. Despite the importance quite rightly attached to these studies, anyone who worked in the NHS before 2005 will either remember themselves or colleagues looking for film packets for hours, expecting up to one in 10 examinations not to be in the recorded location.

Modern medicine has seen a greater reliance on imaging studies and their specialist interpretation. The subjective evaluation of advanced radiological investigations means that their remote review has become not just desirable, but vital to day-to-day patient management. This has been particularly important in many specialities not represented in every hospital and the challenges of image transfer are rapidly apparent.

It is truly fortunate that advanced imaging (CT and MRI particularly) are in digital format as this allows electronic image transfer, without the need to use a courier physically to move the pictures or data storage units from one institution to another. Those specialities that have for many years been represented at a regional, or tertiary level are neuroscience and oncology. Other specialities, principally transplant surgery, are represented at a supra-regional level. Unfortunately, oncology and neuroscience – especially neurosurgery, which has been influenced and revolutionised by cross-sectional imaging – have, since the 1970s and the widespread introduction of CT, routinely had to provide remote opinions on patients based on clinical details and imaging.

Neurosurgery was the first area of medicine to have to deal with issues surrounding remote image transfer, which began to arise with the widespread introduction of CT scanners in non-neuroscience units. The first image transfer system, the Imtran, was introduced in 1986. It was the basis of systems that have only been phased out recently; a remote terminal, located at the neurosurgery unit to which studies could be sent from a referring hospital or hospitals. The Imtran was generically reproduced as a dedicated remote viewing terminal, commonly known as an “image link.” This continued to be the standard modality for remote viewing of neuroradiological scans for more than two decades.

In recent years there have, however, been other pressures driving the need for image transfer. These have been the development of regional cancer networks and more recently the identification of major trauma centres and their networks. During this period, radiology has been revolutionised by the use of PACS. The near-complete phasing out of the use of x-ray film has offered greater opportunities to link hospitals electronically. Unfortunately the opportunities offered here have been missed as frequently as they have been realised. Our national study of image transfer into neuroscience units found a variety of systems being employed between 2005 and 2009, from direct access to PACS and Imtran-style image links to routine use of couriers and taxis to transport CDs and films between hospitals (figure 1).

This disorganisation resulted in great variation in the quality of image transfer facilities between referring hospitals and neuroscience units (figure 2).

There is no question that there has been the technological capability to provide adequate teleradiology for many years. The principle barriers that have stood in the way of this provision have been organisational and, we would argue, bureaucratic. Patient confidentiality is a central tenet of modern healthcare, but in the modern governance era it has begun to impinge on safe care.

Clinical and nonclinical staff will be familiar with the following scenario. A local hospital refers a patient with a suspected brain tumour to the regional unit. The clinical details are discussed and the conversation ends with “we will review the images and call you back.” Two hours later the call back is made; the images are not available. A further series of calls are made locally to send the images to...
the regional unit. Another call is made to advise the regional unit that it is done. Another few hours pass before the outcome of the review is communicated back to the local hospital. This timeframe changes to one of days or even weeks depending on the clinical problem and the patient’s disposition.

PACS provides the ability to view images from any computer linked to the server as soon as the study is completed. The accessing terminal is typically, but does not have to be, within the trust of the hospital performing the study. PACS eliminates the crucial added step of requiring a study, once completed to the satisfaction and review of the local unit, to then be sent to another destination (via a “push” to an image link or similar). The ability to access PACS remotely via a secure connection between trusts must, therefore, be considered the “gold standard” of image transfer as there is no additional transfer step. Why transfer an image when it does not need to be transferred?

With remote access to PACS servers, additional studies not realised to be immediately clinically relevant may be viewed at the same time. How many oncological opinions are informed further by imaging from the previous three years or more? How many trauma studies benefit from x-rays of the same area done two months earlier showing a non-united fracture that may then be considered definitively not new?

Our department studied the rapidity of image transfer according to modality; direct remote access to PACS, image link (studies “pushed” to the regional unit after completion and loading onto PACS locally) and use of a courier to physically transport a CD or films of the images from one unit to another (figure 3). Unsurprisingly we found that remote access to PACS was typically fast (median delay in viewing studies zero minutes) but also highly reliable (mean delay six minutes). Use of an image link was typically fast as well (median delay zero minutes), but not reliable with mean delay 84 minutes. This shows that image links are usually good, when they fail for organisational reasons (ie scans not being “pushed” as expected) the delays incurred are severe.

The NHS programme for Information Technology has recognised this issue and, as many readers will be aware, in 2010 began to roll out the Image Exchange Portal (IEP), a network to connect all trusts in the UK to allow image transfer from any one unit to any other. The centralised and coordinated attempt to solve the problems of image transfer must be welcomed. Will it prove adequate?

Undoubtedly a pan-UK system is needed and the IEP was the most reliable method of reviewing studies in remote access to PACS. According to our study this was the most reliable method of reviewing studies remotely.

FIGURE 1
Image transfer modalities. The myriad ways images have been transferred into neuroscience units during the last 10 years. The fewest steps are involved in remote access to PACS. According to our study this was the most reliable method of reviewing studies remotely.

FIGURE 2
Neuroscience network connectivity in 2009. Of the 317 hospitals we identified in the UK routinely referring patients to neurosurgery units in 2009, 160 were connected using remote PACS access, 97 using an image link, 20 using an image link with partial functionality, eg CT only but not MRI, and 40 were not electronically connected at all and routinely used couriers (data from 3).
References


