The Royal College of Radiologists

Board of the Faculty of Clinical Radiology

Picture archiving and communication systems (PACS) and quality assurance

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This guidance forms part of a series on the developments in information technology in radiology. This is a fast-moving field and developments are occurring rapidly. Consequently, this guidance will be updated regularly and readers should check regularly that they are using the most up-to-date guidance available.

This document gives radiologists essential guidance on the areas of quality assurance which need to be monitored throughout the life of picture archiving and communication systems (PACS). It includes the need to ensure consistency in image appearance, the testing of image display devices, and the issue of rejecting and analysing inadequate digital images.

1. Overview

1.1 PACS quality assurance (QA) is an overarching topic that covers all aspects of system design and implementation, embracing everything from information governance to network performance. PACS QA is a core component of PACS acceptance testing, and quality of service should be maintained thereafter through regular performance monitoring.

1.2 From a clinical perspective, image quality is the major consideration for anyone using PACS for primary (diagnostic) image interpretation. PACS should support image QA through system design, and PACS training should ensure staff can acquire and manipulate images to optimise image display. Medical physicists have an important role in the acceptance testing and monitoring of acquisition modalities and medical display devices.

2. Consistent presentation of images

2.1 QA of PACS image display relies on consistent presentation of images across the enterprise, irrespective of whether images are viewed on a soft copy display device or on printed hard copy.

2.2 PACS and acquisition modality workstations can optimise image presentation by enabling users to adjust the contrast and brightness of images, and to apply spatial and graphical operations, such as user annotations, shutters, flip/rotate, display area selection, and zoom. These changes can be saved with the images in the form of a Digital Imaging and Communications in Medicine (DICOM) Greyscale Softcopy Presentation State (GSPS). To ensure safe and consistent presentation of images, all PACS display devices must display these images with their saved presentation state applied. Where more than one presentation state is saved with an image, the system should ensure that one of these is the ‘default’ QA presentation state for image display.

2.3 For the consistency of the perceived pixel intensity, a standard contrast curve has been defined as the DICOM Greyscale Standard Display Function (GSDF). This provides a standard against which different types of display and hard copy output devices can be calibrated. The Integrating

the Healthcare Enterprise (IHE) consistent presentation of images profile requires support of both the DICOM GSPS and the DICOM GSDF.

3. QA of image display devices

3.1 All PACS display devices used for primary diagnostic image viewing should undergo formal QA acceptance testing and regular performance monitoring. In the UK, guidance on these procedures is provided by Institute of Physics and Engineering in Medicine (IPEM),[1] referencing guidance from the Medicines and Healthcare products Regulatory Agency, the American Association of Physicists in Medicine and the International Electrotechnical Commission. A summary of the 2005 IPEM guidance is given in Table 1.

3.2 In addition to the 2005 IPEM guidance,[1] it is recommended that all primary diagnostic displays meet acceptance criteria matching the minimum specification guidelines for display devices used for clinical image interpretation summarised in Table 2.

3.3 If a primary display workstation does not meet all the recommendations outlined above, then a local risk assessment should be undertaken as to whether the workstation can be used for primary diagnostic clinical interpretation. PACS workstations not suitable for diagnostic use should be clearly labeled and the rationale for imposing restrictions on clinical use should be covered in PACS training.

Table 1. Summary of image display monitor guidance from IPEM 2005[1]

Physical parameter	Frequency	Remedial level
Image display monitor condition	Daily to weekly	Image display monitors should be clean, and the perceived contrast of the test pattern should be consistent between monitors connected to the same workstation. Ensure that the 5% and 95% details superimposed on the 0% and 100% squares respectively are visible.
Greyscale contrast ratio	3 monthly	Ratio white to black <250
Distance and angle calibration	3 monthly	± 5mm ± 3°
Resolution	3 monthly	Grade AAPM TG18-QC resolution patterns according to the reference score (CX >4)
Greyscale drift	6 to 12 monthly	Black baseline ±25% White baseline ±20%
DICOM greyscale calibration	6 to 12 monthly	GSDF ±10%
Uniformity	6 to 12 monthly	U% >30%
Variation between monitors	6 to 12 monthly	Black baseline >30% White baseline >30%
Room illumination	6 to 12 monthly	>15 lux

Table 2

Summary of the PACS and Teleradiology special interest group minimum and recommended specification for primary diagnostic display devices used for clinical image interpretation. This guidance applies to all workstations where CR, DR, fluoroscopy, ultrasound, CT, MR, nuclear medicine and PET images are viewed (excluding mammography).

	Minimum[a]	**Recommended**
Screen resolution[b] (Native pixel array)	≥1280 x 1024 (~1.3 megapixels)	≥1500 x 2000[c] (~3 megapixels)
Screen size (viewable diagonal)	≥42 cm (~17")	≥50 cm (~ 20")
Maximum luminance	170 cd/m2[d]	≥500 cd/m2
Luminance ratio (maximum/minimum)	≥250:1[e]	≥500:1
Greyscale calibration	Within 10% GSDF	Calibrated to GSDF
Greyscale bit depth	8-bit greyscale (24-bit colour)	≥10-bit greyscale
Video display interface	Digital-analogue	Digital video interface (DVI)

Notes

a: The minimum specification for diagnostic display devices is only appropriate if clinical image viewing is performed according to image viewing guidelines, making use of the application software zoom, pan, magnification, and windowing tools.

b: LCD devices should be run at their native resolution to ensure there is a 1:1 match between screen pixels and screen resolution, and therefore no loss of image quality due to screen interpolation. CRT displays can be run at a variety of resolutions with no loss of display quality; however, care should be taken that the correct aspect ratio is maintained to avoid distortion of the image.

c: High fidelity displays (≥3 megapixels) are recommended in radiology and other areas where large numbers of images are reported to reduce image interpretation and reporting times, and thereby assist department workflow.

d: AAPM TG18 recommendation

e: AAPM TG18 & IPEM recommendation

4. Image rejects and reject analysis

4.1 PACS must be able to hide images that are not considered adequate for clinical image viewing. These images should not be deleted from the system, but retained so that they can be accessed by authorised personnel for reject analysis. It is helpful if PACS enables these images to be categorised at the time of rejection, and can collate them in a PACS reject folder to facilitate audit analysis.

4.2 PACS can support QA workflow by optionally hiding images received from modalities from general clinical viewing until the images have been quality assured on a PACS workstation. By combining PACS support for QA workflow with PACS reject analysis functionality, it should be possible to store all images acquired on PACS, without the need for a separate image archive and reject analysis package.

Approved by the Board of the Faculty of Clinical Radiology 29 February 2008

Reference

1. Institute of Physics and Engineering in Medicine. *Report 91. Recommended Standards for the Routine Performance Testing of Diagnostic X-Ray Imaging Systems*. London: IPEM, 2005.

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Citation details:

The Royal College of Radiologists. *Picture archiving and communication systems (PACS) and quality assurance.* London: The Royal College of Radiologists, 2008.

Ref No. BFCR(08)8 © The Royal College of Radiologists, April 2008