

## Picture archiving and communication systems: the users' view

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**Abstract.** A study was undertaken to assess the acceptability to users of a Picture Archiving and Communication System (PACS). A questionnaire was issued to 208 users. Some questions required a graduated score in response and others a free text response. 101 responses were received from a cross section of hospital staff. The majority of users judged PACS to be a major advance for the hospital, with high quality images, less frustration than using film and an improvement in their working lives. They judged that it had made a positive change in their working practices and had met their expectations. They welcomed the access it gave them to Radiology reports. There was more ambivalence about the impact it had made to the efficiency of clinic consultations and the conduct of ward rounds. Free text responses were made concerning the benefits and disadvantages of PACS. Analysis of these demonstrated many more benefits than disadvantages. The Radiology department has been enabled to address the concerns of staff raised through the questionnaire, and has been encouraged by the positive responses. PACS has been accepted well by a wide cross section of hospital staff. It has improved their working lives and made a major contribution to the working of the hospital as a whole.

Picture Archiving and Communication Systems (PACS) are becoming recognised as the most appropriate means of acquiring, archiving and communicating all forms of radiology imaging because of the benefits listed in Table 1. It is an expensive technology but is becoming increasingly affordable. The first installation in the UK was at the Hammersmith Hospital in 1995. The benefits which it brought to the hospital, compared with film based imaging, have been documented [1]. It is being seen as an indispensable part of the drive towards a full Electronic Patient Record.

The Norfolk and Norwich University Hospital is a new 989 bed acute hospital serving a population of approximately 550 000. As part of the new hospital build a fully filmless PACS was installed. As part of the PACS project all CT and MRI scans and 97% of plain radiographs were archived on to PACS starting in March 2001. This ensured that a substantial image archive existed prior to moving to the new hospital. The move to the new hospital took place over 6 weeks during November and December 2001. Prior to the move discussions had taken place with, and a questionnaire had been circulated to, all Clinical Directors seeking their requirements for the availability of previous radiographs in wards and clinics and also to determine their needs for film digitization. No films were digitized prior to the move. Clinic staff were permitted to request previous radiographs from the film file after they had established that relevant examinations existed. These films were viewed on portable light boxes which had been moved from the old hospital. It was recognised that there would be a continuing need for light boxes for the indefinite future in order to view images submitted from outside hospitals as part of tertiary referrals. Clinicians were encouraged to select relevant prior examinations, at the time of consultation, from the film packet and submit them for digitization and inclusion in the PACS archive

for future reference. After 12 months the number of these requests had diminished considerably.

Within the new PACS environment it became possible to copy Radiology reports to the PACS. Reports are generated in two ways, either directly by voice recognition (VR) or by direct transcription on to the Radiology Information System (RIS). In the case of VR the report is authorized immediately after it has been dictated, and then it is immediately sent from the RIS and appears on the PACS within 10 s. Following transcription the report is authorized in the usual way and is sent to PACS only after authorization. Any delays in transcription or authorization lead to delays in the report being available on PACS.

Staff were trained in the use of the PACS before moving to a fully filmless operation in the new hospital. Within the confines of the new hospital film is not generated. For screening mammography, which takes place at a dedicated Breast Screening Unit on a Community Hospital site, film is still generated. Symptomatic mammography is undertaken on the new hospital site and is filmless. Film is generated only for operating theatres and for referral to other centres. Experimentation with image access in operating

**Table 1.** Potential benefits of picture archiving and communication systems

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No lost images
No film packets to handle, file, transport
Reduction in repeat radiographs
Reduced radiation dose with computed radiography and direct radiography
Images available in many places simultaneously
Improved radiographer efficiency
Faster reporting by radiologists
Instant image availability
Previous image availability and comparison
Improved medical staff efficiency because time not spent looking for films
Reports available with images
Image manipulation

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Received 11 October 2002 and in revised form 4 April 2003, accepted 29 April 2003.

theatres is currently taking place, using a combination of diagnostic and web based PACS workstations, however the utility and convenience of hard copy is hard to match in this particular environment.

It was recognised that many different staff need to access images and radiology reports as part of their duties and training was offered to all staff who thought they needed radiology image or report access. Over 2000 users were given passwords for the system and this included doctors, nurses, clinic staff, ward receptionists, secretaries and paramedical staff as well as the staff in radiology.

As part of the PACS installation a web server was installed to permit access to images from PCs anywhere in the hospital over the ordinary hospital network, as part of the hospitals intranet. To ensure that image quality was optimum on PCs in the most critical areas 460 new PCs with 17 inch flat screen LCDs were installed. These were designated as "Image Review Workstations".

New technology will only be accepted by users if they can see that it makes their working lives easier. The initial acceptability of the PACS was good, with numerous compliments and very few complaints. After 6 months of operation the current study was undertaken to document the acceptability of PACS amongst users outside Radiology and to determine whether there were any areas of concern which required addressing.

A limited user survey [2] was undertaken at the Hammersmith Hospital, prior to the development of the web browser technology, with many fewer users having access to the system. Their survey concentrated on medical staff and on the availability of images and reports before and after the PACS installation.

There have been several studies which have attempted to demonstrate the benefits of PACS to users, but many of these have concentrated on particular groups of users such as radiology trainees [3], users in a particular department [4] or have been more focused in their approach [5].

This study concentrates on the impact that PACS has made to the working of the hospital as a whole and on the working lives of individual staff in many different disciplines.

A number of clinicians had communicated the fact that PACS had made an impact both on their ward rounds and clinic sessions. In particular a paediatric surgeon had altered his ward round practice so that he reviewed all images and notes in the office with his team before starting his round. He found that the ensuing round was quicker and that the parents of his patients appreciated the speedier consultation at the bedside.

These communications provoked the inclusion of questions 4 and 5.

## Method

A questionnaire was devised with the assistance of the hospital Quality Department. It used a combination of responses to statements and questions, graduated from 1 to 6, and some opportunities for free text opinion. Respondents were invited to allocate a score from 1, if they thought they could not agree with the question or statement at all, to 6 if they were in complete agreement with the statement or question. The statements/questions are documented in Table 2, with an indication of the values of a score of 1 and 6 in relation to each question.

The questionnaire was sent out to a total of 208 users, of which just over 50% were doctors and the remainder nurses, secretaries, reception, clerical and other staff.

The replies were collated by the Quality Department. The responses were tabulated.

The free text comments were analysed and grouped appropriately. Several respondents made more than one point in the free text sections and each point was recorded separately. Some respondents did not complete the free text sections.

## Results

### Respondents

The numbers of respondents and their job titles are listed in Table 3.

### Tabulated responses

The full results are listed in Table 2.

## Discussion

### Question 1: PACS is a useful advance for the Trust

The results were very encouraging with 97% agreeing strongly or very strongly that PACS had been a useful advance for the hospital. This was taken as an endorsement of the success of the project as a whole. It was gratifying that such a large project, allied to the largest hospital move in the history of the NHS, could have been such a resounding success.

### Question 2: How do you rate the quality of the images on the Image Review Workstations?

The choice of hardware for the Image Review Workstations was vindicated by the assessment of users that the image quality was good, all the responses scored between 4 and 6. Users had been consulted about their requirements for viewing images and their choice of 17 inch flat screen LCDs proved to be very good.

### Question 3: How useful is it to have access to radiology reports on PACS?

The availability of radiology reports alongside the images was considered useful by the majority with 93% scoring 5 or 6 for this response. For many staff the existence of a report is as important as the images themselves and the possibility to view both items simultaneously is a great strength of PACS.

### Question 4: Has PACS improved your patient consultation?

- (a) by helping to show patients their radiology images.
- (b) by reducing the time spent finding images for review.
- (c) by reducing the time spent finding radiology reports.
- (d) by making consultations more time efficient.

**Table 2.** Picture archiving and communication systems (PACS) questionnaire results

Questions	Number of respondents/percentages							Sample size
	1	2	3	4	5	6	N/A	
1 PACS is a useful advance for the Trust (Disagree strongly – Agree strongly)	0 0	1 1	1 1	1 1	26 26	72 71	0 0	101
2 How do you rate the quality of the images on the Image Review Workstation? (Very poor – Very good)	0 0	0 0	0 0	21 21	36 36	38 38	6 6	101
3 How useful is it to have radiology reports on PACS? (Not useful – Very useful)	0 0	2 2	1 1	3 3	20 20	74 73	2 2	102
4 Has PACS improved your consultation?								
a) By helping to show patients their radiology images? (Not improved – Great improvement)	5 5	6 6	9 9	15 15	20 20	25 25	22 22	102
b) By reducing the time spent finding images for review? (Not improved – Great improvement)	0 0	3 3	6 6	14 14	25 25	38 38	15 15	101
c) By reducing the time spent finding radiology reports? (Not improved – Great improvement)	2 2	3 3	5 5	14 14	24 25	41 40	13 13	102
d) By making consultations more time efficient? (Less efficient – More efficient)	1 1	3 3	10 10	25 25	23 23	20 20	18 18	100
5 What change has PACS made to the conduct of ward rounds?								
a) By changing the way ward rounds are conducted? (No change – Major change)	6 6	3 3	13 13	16 16	17 17	4 4	40 40	99
b) By making it more difficult to review images during a ward round? (More difficult – Less difficult)	0 0	8 8	17 17	12 12	9 9	13 13	40 40	98
c) By forcing a change in the way ward rounds are conducted PACS has had an impact. (For the worse – For the better)	0 0	4 4	15 15	20 20	10 10	6 6	41 42	96
d) By making changes in the way images are reviewed at the beginning of a ward round, the ward round itself is conducted more efficiently. (Disagree strongly – Agree strongly)	2 2	8 9	18 19	17 18	5 5	3 3	40 43	93
6 Has PACS caused you more or less frustrations than using film? (More frustration – Less frustration)	0 0	3 3	3 3	16 16	31 31	43 43	5 5	101
7 Has PACS improved your professional life? (Made is worse – Improved it greatly)	0 0	2 2	2 2	29 29	36 36	28 28	4 4	101
8 To what extent has PACS changed your working practices? (Not at all – Greatly)	1 1	3 3	11 11	37 38	28 29	16 16	2 2	98
Please describe any significant changes to your working practices as a result of PACS.								
9 To what extent has the introduction of PACS met your expectations? (Not at all – Greatly)	0 0	1 1	8 8	14 14	44 46	29 30	0 0	96
10 Please list below the three main work related benefits/disadvantages you have encountered since the introduction of PACS								

For clinicians in outpatient clinics PACS had improved their consultations with the majority scoring 4 to 6 on all four sections of question 4. The ability to easily demonstrate images to patients, the improved efficiency in finding images and reports, and the overall improved efficiency of the consultation all showed a favourable response. The unavailability of film packets in outpatients has been a frustration of film based systems. For clinicians whose

practice is heavily dependent on radiology images, such as orthopaedic surgeons and respiratory physicians, the advent of PACS has made a substantial difference to the conduct of their clinics.

The relatively large number of responses in the N/A line reflects the wide range of staff groups responding to the survey, some of whom could not express an opinion on this question nor on the following question.

**Table 3.** Respondents

Staff group:		
Administrative & clerical	9	9%
Allied Health Professional	7	7%
Consultant	49	49%
Management	1	1%
Nursing	20	20%
Prof & technical	1	1%
Research co-ordinator	1	1%
SHO	2	2%
SpR	4	4%
Staff grade	6	6%
Theatre staff	1	1%
Sample	101	

*Question 5: What change has PACS made on the conduct of ward rounds?*

- (a) by changing the way ward rounds are conducted.
- (b) by making it more difficult to review images during a ward round.
- (c) by forcing a change in the way ward rounds are conducted PACS has had an impact.
- (d) by making changes in the way images are reviewed at the beginning of a ward round.

Question 5 was worded to explore how much PACS had impacted the conduct of ward rounds. It can be seen that this impact was widespread and that most clinicians had altered the conduct of their ward rounds. Some found image review more difficult but a few found it easier with the majority of respondents finding little impact. Similarly the impact of PACS forcing a change in the conduct of ward rounds met with a fairly widespread response. There was no clear view that viewing images at the commencement had enabled a more efficient ward round. This was because, for some clinicians, their patients are spread out over many different wards and image viewing was the least of their problems so far as efficiency was concerned.

*Question 6: Has PACS caused you more or less frustrations than using film?*

Overall clinicians preferred PACS to film and found it much less frustrating. One of the declared benefits of PACS is the reduction in frustration afforded by the instant availability of images and the need no longer to handle films and film packets physically. It would have been surprising if this question had been answered any less positively.

*Question 7: Has PACS improved your professional life?*

The response to this question was very surprising. The fact that 93% of respondents scored 4 to 6 on this question shows the impact of PACS on improving the working life of many different staff groups. Radiographs are an integral part of the working lives of many different healthcare professionals, but to find such a positive response from such a wide variety of staff groups indicates the substantial impact that PACS has made on the

perception of the quality of working life experienced by staff.

*Question 8: To what extent has PACS changed your working practices?*

For the majority of staff groups PACS has resulted in a significant change in working practice with 81% scoring 4 to 6 for question 8. When asked to amplify the reasons for this change the most common factors were improved access to images, the ability to discuss images over the telephone, because the images were available in many places simultaneously, the improved time management that PACS enabled and the absence of lost images. A full breakdown of comments can be found in Table 4.

*Question 9: To what extent has the introduction of PACS met your expectations?*

This question investigated the degree to which clinicians expectations had been met. 30 "PACS Roadshows" were held for staff before the move to introduce them to the impact of PACS on the working practices of the new hospital. 90% of respondents scored between 4 and 6 in favour of PACS meeting their expectations. A lot of effort went into the PACS Roadshows and the response from staff at the time was fairly muted. Clearly the message had been communicated well and staff found their expectations were met.

*Question 10: Please list below the three main work related benefits/disadvantages you have encountered since the introduction of PACS?*

The final question allowed respondents to express three benefits and three disadvantages of PACS.

An analysis of results showed that some respondents had not offered an opinion and that others had offered up to three comments in both categories. These were grouped together under headings as shown in Tables 5 and 6.

*Benefits of PACS (Table 5)*

The perceived benefits of PACS match well the proclaimed benefits which have been trumpeted by PACS

**Table 4.** Improvements in working life

Comment	No. of comments
1 Improved access to images	13
2 Ability to discuss images with colleagues over phone	5
3 Better time management	3
4 No lost images	3
5 Improved efficiency, can view images anywhere on PC	2
6 Best aspect of new hospital	2
7 Less delay getting GP letters written	2
8 Improved consultation with patient	2
9 Teaching impact	2
10 No confusion over images	1
11 Computer based	1
12 Frustrating when PACS "down"	1
13 Films were more mobile PCs fixed	1

**Table 5.** Benefits of picture archiving and communications systems

Comment	No. of comments
1 Immediate access to and availability of images	44
2 No film packet handling/no lost images	22
3 Immediate access to radiology reports	15
4 More efficient clinics and ward rounds	9
5 Savings in staff time	9
6 Better image quality	8
7 Showing images to patients/patients better informed	6
8 Allows remote consultation	6
9 Permits image manipulation	5
10 Good for teaching	5
11 Excellent/good	5
12 Easy image comparison	5
13 No film packet storage problems	2
14 Can digitize images from other hospitals	1

**Table 6.** Disadvantages of picture archiving and communications systems

Comment	No. of comments
1 Availability of old (film) images/comparison of images	14
2 Log on problems/moving between systems	9
3 None	8
4 Not all images are reported	8
5 Insufficient PCs in out patient department and wards	6
6 Variable image quality	4
7 Training issues	4
8 System failures/can't log on	4
9 Digitization of old images	3
10 Limited image comparison	3
11 Not able to view images at bedside	3
12 Not available at BUPA or James Paget Hospital (neighbour hospital)	3
13 Image access in theatres	2
14 Hard copy suboptimal (hard copy used for private patients)	2
15 No video images on line	2
16 Images not always immediately on line	2
17 Limited image manipulation on web browser	1
18 Not all staff have access	1
19 Insufficient space for diagnostic workstations	1
20 Can't tilt the film to look for gas bubble	1

suppliers and PACS enthusiasts alike (Table 1). Many of the free text comments reflect the responses to the questions, some are very general ("Excellent") and some highlight advantages neither in the questionnaire nor a recognised benefit, such as "good for teaching".

#### *Disadvantages of PACS (Table 6)*

It should be noted overall that there were fewer comments in this section than in the benefits section (Table 5). Eight respondents made a single entry saying that there were "no disadvantages".

The most obvious disadvantage hinges around the problems of old images being available and the ease of comparison of new PACS images with old film images. Despite substantial efforts to excite the interest of clinicians in this problem before the move, it was only after the move that the need for digitization of previous examinations became a practical reality. Several technical problems needed to be solved and the digitization programme was slow in getting started and met with several delays. The criticisms were fully justified, but at the 6 month stage the system was working much more smoothly though not perfectly.

It would be ideal to have a universal log on to all computer systems and that is the declared aim of the IT department. Technical hurdles still need to be overcome before a single log on becomes a reality. It is frustrating to have to log on to several different systems during one clinical session, and when those systems have time dependent automatic log offs the scope for frustration increases.

The lack of radiological reports has nothing to do with PACS itself but is a radiology management function.

The inadequate provision of PCs in some wards and departments also has nothing to do with PACS itself. Each department was given the responsibility for ensuring that they had adequate provision of PCs. Some were more successful in foreseeing their needs than others.

Some of the comments revealed weaknesses of the implementation of PACS, such as inadequate training being offered, but a small number of comments were completely ill founded, the system has been 100% reliable with no unplanned downtime and yet comments were received about images being unavailable. One respondent was believed to have thought that the questionnaire was about the PAS (Patient Administration System) because of rather unusual responses to the questions.

The responses have given the Radiology department the opportunity to address some of the grievances, but also to enjoy the comments of appreciation.

Many of the advantages (Table 1) which have been used in the promotion of PACS have been endorsed by this survey. In the surveys quoted from other institutions [2-5] PACS has met with an enthusiastic response from users, yet there is still much caution being exercised about the introduction of PACS in the UK. Much of this emanates from a concern about the financial cost of PACS, which is not inconsiderable. It is regrettable that financial restrictions should be hampering the introduction of a system which would bring substantial benefits to a wide range of health service employees.

## **Conclusion**

The response of the users to the implementation of a whole hospital PACS indicated that it had been a useful advance for the hospital, with images of good quality available alongside reports. It had enabled some improvement in the way in which outpatient clinics and ward rounds were conducted. For most respondents the system had lessened frustration, improved their working lives and met their expectations. The perceived benefits of PACS outnumbered the disadvantages and reflected the widely documented benefits of PACS in the literature.

## **Acknowledgments**

The author thanks the Quality Department at the Norfolk and Norwich University Hospital, and in particular Lyn Taylor, for help in compiling and distributing the questionnaires and in compiling the results. Also Maxine Bullock, the PACS System Administrator, for her help in analysing the free text comments.

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