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► An analysis of the images attached to referral messages in an email-based telemedicine system for developing countries

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Summary

Little is known about the quality of the images transmitted in email telemedicine systems. The present study was designed to survey the quality of images transmitted in the Swinfen Charitable Trust email referral system. Telemedicine cases were examined for a 3 month period in 2002 and a 3 month period in 2006. The number of cases with images attached increased from 8 (38%) to 37 (53%). There were four types of images (clinical photographs, microscope pictures, notes and X-ray images) and the proportion of radiology images increased from 27 to 48%. The cases in 2002 came from four different hospitals and were associated with seven different clinical specialties. In 2006, the cases came from 19 different hospitals and 20 different specialties. The 46 cases (from both study periods) had a total of 159 attached images. The quality of the images was assessed by awarding each image a score in four categories: focus, anatomical perspective, composition and lighting. The images were scored on a five-point scale (1 = very poor to 5 = very good) by a qualified medical photographer. In comparing image quality between the two study periods, there was some evidence that the quality had reduced, although the average size of the attached images had increased. The median score for all images in 2002 was 16 (interquartile range 14–19) and the median score in 2006 was 15 (13–16). The difference was significant ($P < 0.001$, Mann-Whitney test).

Introduction

The Swinfen Charitable Trust (SCT) has operated a store-and-forward telemedicine referral system since 1999.¹ The aim is to provide advice to doctors in developing countries. All specialist medical advice is provided free of charge to the referring doctors by a panel of about 250 volunteer consultants. A valuable component of the process is the medical photographs that are attached to referral messages, since they often provide important diagnostic information.

Digital cameras have become a common item of equipment amongst doctors and are readily available in major cities throughout the developing world. Improving the photographic skills of the referring doctors would enable faster completion of cases, as it could save the consultants requesting a 're-shoot' from the referrer. In some instances, consultant doctors have not been able to provide advice due to the poor nature of the images attached to referral messages. This problem was recognized in 2004 when the SCT published a photographic guide to assist the referrers in improving their photographic technique.² Copies of the guide were sent to all referring doctors in the network.

Little is known about the quality of the images transmitted in email telemedicine systems generally, or in that of the SCT specifically. The present study was

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designed to survey the quality of images transmitted in the SCT email referral system.

Methods

Two three-month study periods were chosen. The first period immediately followed the introduction of the automatic message handling system (July–September 2002) and the second was about 18 months after the publication of the SCT photographic guide (February–April 2006). The study periods were three and a half years apart and in that time the referral rate had tripled.

The quality of the images was assessed by awarding each image a score in four categories: focus, anatomical perspective, composition and lighting. The images were assessed by a qualified medical photographer. Each of the four categories was scored on a five-point scale (1 = very poor to 5 = very good). Each image could therefore score a maximum of 20 points. Being awarded a four in each category meant that the photographer had used good technique. Being awarded a five suggested that an exceptional effort had been made. A score of three or less meant that there was room for improvement. Box 1 shows an example.

Box 1 Example: Referrer no 105, Solomon Islands – Dermatology. Date 09/02. Case 6, image 1					
	1	2	3	4	5
Focus					✓
Anatomical perspective			✓		
Composition				✓	
Lighting				✓	
Overall image score = 16					
<i>Key</i>					
Focus: 1 = unrecognisable, 2 = poor, 3 = reasonable, 4 = in focus, 5 = pin sharp and good depth of field					
Anatomical perspective: 1 = orientation unidentifiable, 2 = can only just determine orientation, 3 = reasonable, 4 = correct positioning, 5 = correct with additional views					
Composition: 1 = area of interest is unclear, 2 = messy background and subject not centred, 3 = reasonable, 4 = correct orientation and clear picture, 5 = clean background, good lighting and clear view of area of interest					
Lighting: 1 = unsuitable, 2 = incorrect, 3 = mixed lighting (i.e. flash and back lit, flash and natural), 4 = correct lighting for subject, 5 = correct lighting with good technique					

Images that scored an average of 16 or above were considered excellent; those scoring 13–15 were good. Images that scored 12 or below were considered to be unacceptable. Image size was considered to be acceptable if it fell in the range 150–400 kByte.²

The diagnostic information contained in the photographs was not analysed as this was not considered to be feasible. (It would have required each case to be reviewed by a number of specialists, who might have had differing diagnostic opinions regardless of image quality.)

Table 1 Referral countries

2002 July–September	2006 February–April
Bangladesh	Afghanistan
Nepal	Bangladesh
Pakistan	Iraq
Solomon Islands	Malawi
	Nepal
	Pakistan
	Solomon Islands
	Sri Lanka
	St Helena
	Uzbekistan

Table 2 Numbers and types of attached images in the two study periods

Year	Cases	Image type	No of images	Median score
2002	8	Clinical	16	17
		Microscope	1	16
		Notes	2	12
		X-ray	7	14
		<i>Total images</i>	26	
2006	38	Clinical	45	15
		Microscope	22	16
		Notes	2	15
		X-ray	64	14
		<i>Total images</i>	133	

Results

In the first study period there were 21 cases in total, eight of which had attached images (38%). In the second study period there were 70 cases, of which 38 had attached images (54%).

Referral types

In 2002, the eight cases with images came from four different referral hospitals in four countries (Table 1) and requested advice in seven different clinical specialties. Five of the eight referrals came from Patan Hospital in Nepal and of the clinical specialties, dermatology was the only one that was requested twice.

In 2006, the 37 cases with images came from 19 different referral hospitals in 10 countries (Table 1) and requested advice in 20 different clinical specialties. The most commonly requested specialty was dermatology, with seven referrals.

Image types

There were four types of attached images:

- (1) clinical photographs;
- (2) microscope pictures (taken by mounting the digital camera on a microscope);

- (3) notes (i.e. photographs of pages from the patient's chart, such as test results);
- (4) X-ray images (taken by photographing a film on a light box).

The 46 cases (from both study periods) had a total of 159 attached images. Sixteen of the cases had a median score in the highest bracket (16–20), 22 cases fell in the middle bracket (13–15) and 8 cases had a median score in the lowest bracket (0–12). The numbers and types of attached images are shown in Table 2.

Comparison of the study periods

In 2002, there were 26 images altogether, only seven of which were from radiology films (27%). The average image size was less than 100 kByte, with an average of 3.3 images being attached per case. Only one image contained a measurement scale and no image contained a colour reference.

In 2006, there were 133 images altogether, of which 64 were from radiology films (48%). The average image size was 366 kByte. However, only five cases had images which fell into the acceptable size range of 150–400 kByte. Thirty three of the cases contained JPEG (Joint Photographic Expert Group) files, while two cases had attached bitmaps and another two had copied their images into Word documents. Of the 19 cases that included radiology images, only two had converted the image files to greyscale.

The average image size tripled in the three and a half year period, Table 3.

In comparing image quality between the two study periods, there was some evidence that the quality had reduced. The median score for all images in 2002 was 16 (interquartile range 14–19) and the median score in 2006 was 15 (13–16). The difference was significant ($P < 0.001$, Mann-Whitney test), see Figure 1.

The eight cases in the lowest bracket were all from the 2006 study period. It was also found that while the median score for X-rays remained constant (at 14), the median score for clinical photographs had fallen from 17 to 15 ($P < 0.002$, Mann-Whitney test).

Discussion

Clinical photographs contain a large amount of information, which is potentially important for diagnosis and management, so it is imperative that they are of a high standard. The present study demonstrated that image quality decreased between the first and second survey periods. Image quality was lower for X-ray photographs than for clinical photographs, a perhaps unsurprising finding in view of the difficulty of capturing satisfactory images of X-ray films. Although the proportion of referrals with attached images increased from period 1 to period 2, as did the size of the files, their quality fell significantly. From these results it could be concluded that the SCT

Table 3 Summary of image characteristics

	2002 July–September	2006 February–April
Number of referrals	21	70
Number of referrals with images	8 (38%)	37 (53%)
Average image size (kByte)	99	380
Average number of images per case	3.3	3.5
Average quality rating (0–20)	16.3	14.3

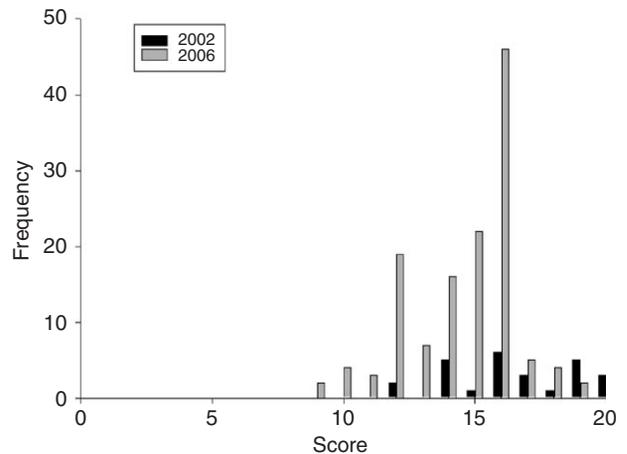


Figure 1 Image quality scores for the two study periods

Digital Camera Guide, published in 2004, had little effect on the standard of the referrers' photography.

Since printed manuals do not appear to be effective, we have recently begun to trial an alternative: online tuition. A set of eight clinical photography tutorials has been developed with the intention of offering them to all referring doctors. The tutorial topics are:

- (1) minimising resolution, maximising information;
- (2) photographing radiology images;
- (3) photographing monitors;
- (4) close-up photography;
- (5) general medical photography;
- (6) dermatological conditions;
- (7) intra-oral photography;
- (8) surgical photography.

If they decline to participate, a simple set of guidelines, tips and examples will be sent to the referrers via email. Examples of photographs taken by the same doctor, before and after participation in the photographic tutorials, are shown in Figure 2. These images demonstrate a substantial improvement in photographic technique.

Conclusion

Clinical photographs are often captured under pressure in the hope that a PhD (Push here, Dummy) digital camera will produce the desired results. It will never be practicable to improve the clinical photography technique of every



Figure 2 Before and after photographs demonstrating the improvement of photographic technique after completing the clinical photography tutorials. (a) *Before*: Close-up of skin lesion; (b) *After*: Well-focused skin lesion; (c) *Before*: Radiology image; (d) *After*: Sharp, correct perspective, greyscale radiology image

person who uses a digital camera. In an email-based telemedicine system it is important that the attached images provide accurate information. To do this, the consultants must be provided with sharp, anatomically correct, well lit images. Our survey of image quality in an email referral network suggests that there is considerable scope for improvement.

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► Real-time videoconferencing: promise for pandemic influenza preparedness

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Summary

In preparing for an influenza pandemic it has been recognised that routine communication modes are inadequate to support transnational responses to public health emergencies. We assessed the Access Grid, a high bandwidth, open source network, as a possible solution. Through the Asia Pacific Economic Cooperation Emerging Infections Network (APEC EINet), we connected various public health sites in the APEC region via the Access Grid. In January 2006, ten APEC members discussed their epidemiological situation and their pandemic planning status in a 210-min videoconference. Few technical difficulties were experienced. Clinical and public health collaborations, surveillance, scenario exercises, vaccine and antiviral use, and business continuity planning were discussed. In a post-conference evaluation by five sites, the videoconference was reported to be both effective and efficient in promoting regional information sharing on preparedness.

Introduction

The avian influenza virus, H5N1, has caused considerable damage to the global economy, having spread from Southeast Asia to the rest of Asia, the Middle East, Europe and to Africa since late 2003. In addition, the H5N1 strain has been increasingly threatening human health and is now considered to be a potential candidate for the next influenza pandemic. Countries in Asia, where avian influenza has hit hardest, are developing pandemic influenza preparedness and response plans. However, there has been little international sharing of the operational planning. Such information may be important for both economic and public health reasons. Furthermore, while the World Health Organization

(WHO) has provided guidelines about pandemic influenza planning, little information is available about how member countries are tailoring this information to their own national situation.

Communication has been repeatedly cited as a key factor in preparedness,^{1,2} but global public health preparedness exercises have shown that routine communication methods are inadequate for global public health emergencies.³ New technologies, such as videoconferencing, may provide a possible solution. While telephone conferencing may be useful, the additional visual cues in a videoconference may be important.

Access Grid videoconferencing offers several advantages over conventional multipoint videoconferencing. The Access Grid provides high quality audio and video, and allows data sharing between multiple institutions.⁴ It operates on telecommunication networks dedicated to research and education. The Access Grid is much less congested than the Internet, and can deliver

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