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A Multi-observer Study of the Effects of Including Point-of-care Patient Photographs with Portable Radiography: A Means to Detect Wrong-Patient Errors

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Abstract

Objectives—To evaluate whether the presence of facial photographs obtained at the point-of-care of portable radiography leads to increased detection of wrong-patient errors.

Materials and Methods—In this IRB-approved study, 166 radiograph-photograph combinations were obtained from 30 patients. Consecutive radiographs from the same patients resulted in 83 unique pairs (i.e., a new radiograph and prior, comparison radiograph) for interpretation. To simulate wrong-patient errors, mismatched pairs were generated by pairing radiographs from different patients chosen randomly from the sample. Ninety radiologists each interpreted a unique randomly chosen set of 10 radiographic pairs, containing up to 10% mismatches (i.e., error pairs). Radiologists were randomly assigned to interpret radiographs with or without photographs. The number of mismatches identified and interpretation times were recorded.

Results—Ninety radiologists with 21 ± 10 (mean $\pm$ SD) years of experience were recruited to participate in this observer study. With the introduction of photographs, the proportion of errors detected increased from 31% (9/29) to 77% (23/30) ($P = 0.006$). The odds ratio for detection of error with photographs to detection without photographs was 7.3 (95% CI: 2.29, 23.18). Observer

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qualifications, training or practice in cardiothoracic radiology did not influence sensitivity for error detection. There is no significant difference in interpretation time for studies without photographs and those with photographs (60 ± 22 seconds vs 61 ± 25 seconds; $P=0.77$).

Conclusion—In this observer study, facial photographs obtained simultaneously with portable chest radiographs increased the identification of any wrong-patient errors, without substantial increase in interpretation time. This technique offers a potential means to increase patient safety through correct patient identification.

Keywords

Patient identification; medical errors; digital photography; DICOM; PACS

INTRODUCTION

The Institute of Medicine's Quality Report estimates that nearly 98,000 deaths annually may be attributed to medical errors [1]. Within radiology, an important source of error is the *wrong-patient error*, wherein one patient's imaging study may be placed in another patient's folder in a Picture Archiving and Communication System (PACS). Such errors can create problems for both of the involved patients. In fact, the National Quality Forum recognizes that wrong-patient errors can affect radiologic practice, and that agency, along with the Agency for Healthcare Research and Quality, specifically endorses implementation of a “standardized protocol to prevent mislabeling of radiographs” [2].

Based on a statewide adverse event reporting system, the Pennsylvania Patient Safety Authority published [3] that, in 2009, it received 652 reports on radiology events: 196 (30.1%) of these reported events were related to wrong-patient events. Of these 196 wrong-patient events, 93 (47%) occurred in the imaging modality of radiography. The report concluded that such errors “occur more frequently than healthcare providers and patients may realize” despite various quality improvement measures [3].

In an attempt to prevent wrong-patient errors, the Joint Commission's first specific requirement in its National Patient Safety Goals (NPSG) is that at least two patient identifiers are required while delivering healthcare [4]. The two identifiers can be any combination of name, date of birth, social security number, hospital-assigned number, or telephone number. However, these identifiers can be difficult to obtain particularly in the Emergency Department in a number of circumstances, e.g., in patients who are unconscious, intoxicated, or otherwise nonresponsive. This requires that extrinsic temporary identifiers—a name, such as “John Doe”, and a medical record number, which may be based on the date of patient presentation, be assigned to such patients. These can then be reconciled with the true patient identifiers when they become available. In other situations, particularly in intensive care units, where imaging is done in the early hours, technologists may find it difficult to obtain such information from sleeping patients, and may misread armbands containing identifying information under suboptimal lighting. We propose the use of an intrinsic but externally visible identifier—the face, as an identifier that can be used with imaging examinations, by acquiring facial photographs at the point-of-care of medical imaging. We suggest use of this identifier as an adjunct to, rather than a replacement for, the

extrinsic identifiers required by the Joint Commission. Note that our scheme will not prevent wrong-patient errors at the image acquisition level; rather it is expected to lead to increased detection of such errors at the interpretation stage thus resulting in decreased wrong-patient radiology reports. The error detection is possible if radiologists can see point-of-care photographs along with the radiographs from the new and prior studies.

In prior work [5], we developed a system that automatically obtains patient photographs simultaneously with portable chest radiographs. The system is designed to require no additional input from the technologists and thus does not impact the workflow at the time of radiograph acquisition. In addition, by using an innovative combination of timestamps and radiographic *Plate_IDs*, the technology ensures that the photograph and radiograph are tightly coupled, i.e., one patient's photograph cannot be coupled with another patient's radiograph [6].

The purpose of the current pre-clinical study was to assess whether the use of patient photographs improves the error detection capabilities of a large, diverse group of academic radiologists from various subspecialties and institutions and possessing a range of experience levels.

MATERIALS AND METHODS

Study Population

Our university's Institutional Review Board approved this study. Full, written, informed consent was obtained from either the patients recruited into the study or from one of their family members authorized to provide such consent. The study was compliant with the Health Insurance Portability and Accountability Act.

The data were gathered from two cardiothoracic intensive care units (ICUs) using a convenience sampling method between August 5th, 2011 and November 8th, 2011. The techniques used for gathering the dataset were described in detail in [7]. However, we summarize them here briefly.

For each patient recruited into the study, radiograph-photograph combinations were obtained when a portable radiograph was ordered. A total of 41 patients were recruited into the study. However 11 of these patients had only one radiograph-photograph combination, and because our study required both a new radiograph (and photograph) and a prior radiograph (and photograph) for comparison, these 11 patients could not be included in the final study. Thus the final study cohort consisted of 30 patients. These patients each provided a variable number of radiograph-photograph combinations, from which we generated image pairs as discussed below.

Data Acquisition and Case Selection

Details on the data acquisition process are also described in [7] and summarized here. Photographs were obtained with a 5-megapixel camera on an Apple iPhone 4 (Apple Inc., Cupertino, CA), and were converted from JPEG into the Digital Imaging and Communication in Medicine (DICOM) format. This color photograph, with a height and

width at approximately $\frac{1}{4}$ the height and width of the radiograph, respectively, was then integrated with the radiograph as shown in Figure 1.

A total of 166 chest radiographs along with photographs were obtained. Thus we were able to create 83 pairs of radiographs, with both the new and comparison examinations belonging to the same patient. Anonymized study pairs for each patient were generated by combining two sequential radiographs from the same patient; a *current* radiograph and the most recent *previous* radiograph were presented as a pair of images to the observer for interpretation. When more than two radiographs existed for the same patient, every two consecutive images were paired. We ensured that no radiograph appeared in two different pairs so that some degree of independence between pairs was maintained.

We generated error pairs by randomly pairing radiographs from two different patients. For generation of an error pair, we first randomly selected one patient and then one radiograph from that patient to represent the *current* radiograph. Then, we randomly selected a second patient from the remaining 29 and a randomly selected radiograph from this second patient served as the *comparison* or previous radiograph. We ensured that the comparison radiograph was temporally earlier than the current radiograph.

Display Workstation Environment

We used ClearCanvas Workstation Community Edition (ClearCanvas Inc., Toronto, Ontario, Canada)—a Free and Open-Source Software DICOM viewer as the display environment for the study. ClearCanvas workstation software was loaded on two individual workstations running Microsoft Windows 7, with dual 21" LCD displays. This program provided capabilities for image manipulations, such as zoom, pan, and invert. The open source nature of the software allowed us to develop custom modules that were necessary for the study, which included:

1. The *ObserverDemographics* component, which allowed an observer to enter his or her demographic information, such as name, age, and specialization, and also automatically loaded images from a predetermined worklist.
2. A *Next Study* button, which brought up the *ReviewStudyComponent*. The latter presented the observer with a pop-up window containing a questionnaire at the end of each pair reviewed (Figure 2). The *ReviewStudyComponent* also included a timer, which recorded the interpretation time per image pair including the time to answer this questionnaire. Once an observer completed the evaluation for the current image pair, the responses were saved to a database and the next image in the worklist was automatically presented.
3. After the final (i.e., the 10th) study was presented, the *Next Study* button brought the *PostStudyQuestionnaire* component (Figure 3). Depending on whether the images presented to the observer had associated photographs, the *PostStudyQuestionnaire* component generated questions accordingly.

Observer Study Design

The observer study was performed with approval from our university's Institutional Review Board and with permission from the American Board of Radiology (ABR). The study was performed at the ABR Oral Examination setting in May 2012. Oral board examiners were recruited to participate in the observer study over a four-day period. They reviewed sets of images during a 20-minute break between oral examination sessions. Written sheets of information regarding the study were provided to the observers, and observers' informed consent was obtained to participate in the study. As an incentive, participating observers' names were entered into a drawing for a tablet computer; oral board examiners who did not participate were not penalized in any way.

These examiners, who were all board-certified and represented all radiologic subspecialties, were from regions widely distributed throughout the United States and included one international examiner. Observers were informed before their participation that the study was designed to evaluate their performance in interpreting portable chest radiographs. Observers were neither specifically informed that they may read radiographs with photographs nor were they informed that simulated wrong-patient errors could be introduced into the sets of cases.

Observers were randomly assigned to interpret a set of 10 pairs of cases either with or without concomitantly obtained photographs. To avoid any observer learning or memory effects, the 10 pairs were each chosen randomly starting with the pool of 83 pairs without replacement for each set to avoid repetition of a pair in the set. To simulate a wrong-patient error, randomly selected pairs from two different patients were introduced into a set of 10 pairs. Each observer, whether interpreting radiographs with or without photographs, saw at most one error in their set (i.e., readers saw no errors or one wrong-patient error). The error was randomly located within the set of 10 pairs. Importantly, observers were not presented with more than one error in a set; this ensured that the error detection rate was not artificially increased because of the heightened level of surveillance that might be introduced after detection of the first error pair.

Demographic information was collected at the start of the process from all observers, using the custom-built *ObserverDemographics* program. Observers were all given identical instructions. Although this is a synthetic environment, each observer was asked to treat the session like a true clinical setting, interpret pairs of chest radiographs and provide only the information that would normally be provided in a real-world set of portable cases (Figure 2). A study team member was always present with the observer to answer questions. A study team member demonstrated the software controls for window level, reset, inversion, next study, etc. For each case, the observer had to interpret the *current* portable radiograph in comparison with a temporally *prior* radiograph and was asked to answer the four questions in Figure 2, which were provided by the *ReviewStudyComponent* in the form of a pop-up window. For the first three questions, the software solely allowed observers to click on radio buttons for the possible choices. Because observers were not informed about the possibility of errors, we introduced a free-text response as a last question in an attempt to capture possible observation of a wrong-patient error without leading the observers. This last

question allowed observers to enter any additional information they thought might be clinically relevant or interesting. Most observers who identified mismatches made a note of the mismatch in the response to this free-format question. Some observers who identified a mismatched image pair notified a team member, possibly because they viewed the error pair as indicating a software error. These observers were then asked to make a notation on the questionnaire's "Other Comments" section and to proceed with the rest of the study.

Once an observer answered the questions, the next case was automatically shown. The time spent on each case pair in the set was recorded; however, the time spent on the first case was not used for statistical analysis because most observers used the first case to get accustomed to the workstation controls and reading process.

At the end of their set of 10 cases, the *PostStudyQuestionnaire* component of our software asked observers who interpreted studies with photographs to complete a survey with additional questions (Figure 3). As with the questions at the end of each case, three of the four questions solely allowed them to select between choices, while one (Question 3) allowed a free-text response. Observers who interpreted studies without photographs were asked to choose "yes" or "no" for the question: "Did you notice any mismatch errors in your list?"

At the end of each observer's session, the purpose of the study was revealed and the observer was requested not to disclose it to other potential observers so that study integrity would be maintained.

Statistical Analysis

A two-tailed χ^2 test was used to compare error detection rates without and with photographs. Logistic regression was used to test if error detection was influenced by observer attributes such as fellowship in cardiothoracic radiology, current specialty in cardiothoracic radiology, and experience level (binary variable: experience > 10 years vs. experience ≤ 10 years). An additional categorical variable was created to differentiate between radiologists who are considered to maintain current expertise in interpreting portable chest radiographs (those practicing abdominal, cardiothoracic, general, musculoskeletal, and interventional radiology) versus those who are not considered to maintain current expertise in interpreting portable adult chest radiographs (breast, nuclear medicine, and pediatric radiologists). The odds ratio for detection of wrong-patient errors with photographs to detection of errors without photographs was calculated for the entire group and for various characteristics of radiologists.

A Student *t*-test was performed to compare the average times taken by observers who interpreted radiographs without photographs and those with photographs. A *P*-value of 0.05 was considered to indicate a significant difference. All statistical analyses were performed using JMP Pro 10.0 software (SAS Institute Inc., Cary, NC, USA).

RESULTS

Observer Characteristics

A total of 90 observers were recruited into the study, representing both genders, a wide range of subspecialty training and subspecialty experience, and years of experience (Table 1).

Qualitative Results Examples

Figures 1 and 4 show example simulated wrong-patient errors used in the observer study without and with photographs, respectively.

Quantitative Results

Table 2 summarizes the proportion of errors detected by observers for whom photographs were available and proportion of errors detected by observers for whom photographs were not available. A total of 29 errors were shown to observers who interpreted without photographs, and 9 (9/29 = 31%) of these errors were correctly identified as wrong-patient errors. A total of 30 errors were shown to observers who interpreted with photographs, and 23 (23/30 = 77%) of these were correctly identified as wrong-patient errors. No false-positives were noted by any of the observers who interpreted with or without photographs. The Odds Ratio of identifying the error with photographs to identifying the error in the absence of photographs was 7.3 (95% confidence interval [2.29, 23.18]). The two-tailed χ^2 test P -value = 0.006. Table 3 summarizes the proportion of errors detected by observers for whom photographs were available and proportion of errors detected by observers for whom photographs were not available, according to demographic and subspecialty training features. All subgroups of observers performed better when provided photographs, although statistical significance was achieved only for some subgroups where there were larger numbers of observers (Table 3). We attribute the lack of statistical significance for other observer characteristics to the small number of observations.

The average (standard deviation) interpretation time per radiograph pair without and with the presence of photographs was 60 (22) and 61 (25) seconds; Student t -test P -value = 0.77.

Post-study Questionnaire

The post-study questionnaire of the 40 observers who interpreted the studies with photographs yielded the following results (Table 4).

1. 80% of observers indicated that photographs were not a distraction. The average interpretation time per radiograph by observers who thought photographs were distracting vs those who did not find the photographs distracting was 57 and 62 seconds, respectively (two-tailed Student t -test P -value = 0.63).
2. The subjective impression of 42% of observers was that photographs increased their interpretation time. The average interpretation time per radiograph by observers who thought photographs delayed them vs those who did not feel photographs delayed them was 67 and 54 seconds, respectively (two-tailed Student t -test P -value = 0.16).

3. Subjectively, 44% of the observers reported that they found the photographs aided interpretation. Six of these observers specifically mentioned that the photographs helped with evaluating intravenous lines and tubes. Three observers specifically mentioned that photographs aided in their discovery of a wrong-patient error. Fourteen observers stated that the photograph gave a subjective sense of the patient's well-being and alertness, although almost all of them cautioned that radiographic indicators could lag behind external appearances of patients.
4. 96% of observers who noticed a discrepancy between the current and prior photographs reported that this discovery prompted them to reexamine the radiographs for discrepancies.

DISCUSSION

We assessed the impact of including point-of-care photographs with portable chest radiographs in a large multi-reader study involving a diverse group of radiologists including many subspecialties and varying levels of experience. We found a significant improvement in their ability to detect wrong-patient chest radiographs when photographs were introduced, irrespective of whether they specialized in chest radiology or whether they had current expertise in interpreting adult portable chest radiographs. There was no significant difference in interpretation time between the observer group that interpreted with photographs and the group that interpreted without.

In addition to the Pennsylvania Patient Safety Authority's [3] published data about wrong-patient errors in Radiology resulting in serious harm, two other studies raise the alarm about wrong-patient error rates in medical imaging. Morishita et al. [8] found that the rate of misfiled radiographs at Osaka Hospital between March 2000 and March 2002 was 0.075% in general radiography and 0.429% for radiography in the emergency room. More recently, in the US, Schultz et al. [9] describe an internet-based, radiology-specific patient safety reporting system at their institution, which had an average annual volume of 930,000 examinations. That system [9] indicated that 19% (313 events) of reported events over a two-year period were related to errors in patient identification. Of note, that system and protocol underwent a change one-year into the two-year observation period, which required that reporting individuals be identified; this may have discouraged some users from reporting adverse events. Patient misidentification was reported in 0.017% of all imaging examinations. While this percentage may seem small, in absolute terms this may be a large number. To place this number (313 patient misidentification events over a two-year period) in clinical terms, on average such events must have occurred more than once every three days in the data from Schultz [9].

Because wrong-patient error rates in radiology nationwide are now likely substantially less than 1%, an argument could be made that techniques such as photography to detect these errors may not be cost-effective. At our academic institution, we have a reported error rate of approximately 0.01%, which may be a lower bound on the true error rate. However, given that we perform more than 1 million examinations annually at our institution and affiliated hospitals, the absolute number of errors is still too high, likely on the order of several dozen

errors annually. Against the benefit of detecting wrong-patient errors, one must weigh the financial costs. In a previous study [5], we have shown that the cost of adding a photograph to a radiograph may be as low as a few cents per examination over the life of the hardware. Furthermore, in the study reported here, there was no significant increase in interpretation time with the introduction of photographs. Thus, we submit that such a system may be beneficial in preventing patient harm while remaining cost-effective.

It should be noted that the scheme of comparing photographs between current and prior studies works best if prior studies with photographs are available. It is not inconceivable that if such a photography system is implemented, that interpreting radiologists will be able to compare the photograph obtained simultaneously with the radiograph with a previously obtained photograph in the electronic medical record (EMR). Indeed, several institutions are obtaining patient photographs for inclusion in the EMR.

There are other extrinsic identification techniques, such as bar-codes and radiofrequency identification (RFID) technologies, that could potentially also reduce misidentification errors. Alternatively, systems employing intrinsic identifiers such as palm vein mapping [10], fingerprinting [11] and iris scans [12] have also been pursued [13]. However, facial photographs are the only intrinsic, externally-visible identifiers.

Relationship to Prior Studies

Other methods to detect wrong-patient errors in chest radiography have been pursued. Morishita et al. [14] and Kao et al. [15] developed automated patient recognition methods by image analysis and image matching of chest radiographs. These automated methods are able to detect wrong-patient errors with a fairly high rate and without radiologist intervention. However, these methods are limited to chest radiography and cannot be easily translated to other areas of medical imaging. Even within chest radiography, these methods are limited in that they are optimized only for upright posteroanterior views of the chest and may not be effective with portable radiography

The idea of including photographs with medical imaging examinations was explored earlier by Turner and Hadas-Halpern [16], where they showed that the addition of photographs to CT scans increased both the word-length of radiologists' interpretation and the number of incidental findings that were reported. Unlike our study, their study did not assess the added value of photographs as an aid in detection of wrong-patient errors.

Weiss and Safdar [17] conducted a single-institution survey of 21 radiologists to assess their view on including photographs with medical imaging studies. That study consisted of a survey of radiologists' attitudes toward a hypothetical instance in which photographs would be included with radiographs. Thus, it differed fundamentally from our study in which the effects of real photographs were measured. In the survey by Weiss and Safdar, only 24% of the respondents indicated that photographs would help inform medical decisions [17]. However, in our current study in which radiologists were actually provided photographs, approximately 44% responded affirmatively that the photographs helped with the interpretation. While we did not define for the observers what "helped with the interpretation" meant, such a response suggests that attitudes towards acceptance of

photographs could potentially increase if photographs became part of routine practice. Furthermore, 96% of radiologists who noted mismatches reported increasing their level of attention to the radiographs; only 20% of them thought photographs were distracting. Thus, the results of this study suggest that inclusion of photographs may not only increase the likelihood of error detection but also appears to increase the level of attention to radiographs, at very little cost in terms of additional time for interpretation.

In a prior study [7], we demonstrated a significant increase in the error-detection capabilities of 10 recently-trained radiologists from a single institution, none of whom were trained or served as subspecialty cardiothoracic radiologists. That study design was slightly different from the one in the present study in that the same radiologists interpreted sets of radiograph pairs both with and without photographs. We conducted the current study to evaluate if these results could be generalized to a larger set of radiologists with more varying levels of experience and subspecialty training that included cardiothoracic imaging. Indeed, we did find that experience may matter in that a sizable minority of the observers in the present study (9/29) was able to detect errors even without the presence of photographs. However, we found that significant improvement in error detection capability was still obtained for all observer types with the introduction of photographs.

Study Limitations

A number of study limitations are evident. The first limitation is the use of an error-rate of up to 10% in this controlled study, i.e., each observer could see zero or one error in their set of 10 cases. The actual error rate was 6.4% and 6.7% for the groups who interpreted with photographs and without photographs, respectively. This error rate is higher than that reported in the medical literature (i.e., far <1%) [8], [9], and some may consider our error rate not reflective of true clinical conditions. Our rationale for use of this larger error rate is that a <1% error rate would have required each observer to interpret more than 100 pairs in order to encounter a single error, which would have made the study impractical. Our goal was to allow observers to encounter a single error pair while interpreting the number of radiographs that could reasonably be evaluated during the time allowed for the interpretation sessions (i.e., 20 minutes). However, we ensured that no observer was presented with more than one error to avoid a heightened sense of surveillance that might be introduced after detection of the first error.

It is possible that the interpretation times seen in this controlled observer study environment are not reflective of what may happen in the real world if such a photography system is incorporated, since the novelty of seeing photographs may have persisted to the 10th study in the set. It is also possible that if radiologists become accustomed to photographs in true clinical practice that they may spend less time on the photographs. Radiologists have to constantly alter their practice pattern and search pattern—witness the changes that they have incorporated into their practice with the advent of PACS, voice recognition, and Radiology Information Systems. Thus, the time that they will spend on photographs associated with medical imaging studies, if it were to become a standard, may diminish even further in the future as they build efficiency through practice. A rigorous clinical trial is required to answer this question.

The average 60 second interpretation time per radiograph noted in our study is consistent with another study that measured time for interpreting chest radiographs [18]. We acknowledge that this may not be reflective of real-world settings depending on the practice pattern and type of PACS, Radiology Information System, and dictation system employed. Nonetheless, an important result to note from our study is that the interpretation was not significantly altered by the presence of patient photographs.

While the majority of the observers in this study who interpreted with photographs reported that subjectively they did not find the photographs to be distracting, 20% of the observers did find the photographs distracting. This study, however, was not designed to determine if the quality of interpretations was negatively impacted by the presence of photographs.

We used color photographs in this study, which we believe are more helpful in distinguishing facial features than gray-scale photographs. Color photographs may not be practical in many radiology departments where only grayscale monitors are employed for reading stations, and these departments may not see the same benefits in detecting wrong-patients errors as demonstrated in our observer study. However, because many departments are beginning to use color monitors (e.g. for depicting color Doppler and power Doppler images from ultrasound studies), this problem may diminish with time.

Most of the observers who participated in this study were academic radiologists and engaged in subspecialty practice. It could be argued that the effect of photographs on performance of private practice general radiologists may be different. Again, this may not be a significant limitation, because we included both cardiothoracic radiologists and noncardiothoracic radiologists, and the observers had a wide range of experience levels. Many of the recruited observers had training in a different subspecialty but did read portable chest radiographs while they were on call: this could approximate the competence level of a private practice generalist with respect to interpreting portable chest radiographs. In any case, our results show that radiologists who were shown wrong-patient errors with photographs were more likely to detect the errors than radiologists who were not shown such photographs, irrespective of whether or not these radiologists' routine practice included interpretation of portable chest radiography.

CONCLUSION

In summary, our study demonstrated that radiologists who interpreted portable chest radiographs detected significantly more simulated wrong-patient errors with the inclusion of point-of-care facial photographs than those who interpreted without the aid of such photographs. The inclusion of such photographs could have a substantial impact on patient care and safety in medical imaging, and a clinical trial is warranted to study the effects of photographs in clinical practice, with portable chest radiographs and with other imaging studies.

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Figure 1.

Hanging protocol displaying a study as seen by some of the observers.

(A) The radiograph-photograph combination on the left refers to the *current* study, and shows a 64 year-old white woman with history of aortic stenosis and aortic valve replacement;

(B) The radiograph-photograph combination on the right refers to the *prior* study, which shows a radiograph obtained two months earlier, of a 73 year-old man also with a history of aortic stenosis and aortic valve replacement.

The radiographic differences are subtle and mainly related to body habitus. The presence of the photographs show more obvious differences in hair color and body habitus, and the observer asked to interpret this case correctly identified the wrong-patient error.

The image shows a software window titled "Please Review this StudyABR0100100 - ABR0100100". It contains the following elements:

- Subject Name:** A text box containing "ABR0100100 - ABR0100100".
- Image Quality:** A group box with two radio buttons: "OK" and "Not OK".
- Lines and Tubes:** A group box with two radio buttons: "OK" and "Not OK".
- Patient Status:** A group box with three radio buttons: "Worse", "No Change", and "Improved".
- Other Comments:** A large, empty text area for free-form responses.
- Buttons:** "Save" and "Cancel" buttons at the bottom.

Figure 2.
ReviewStudyComponent—image of pop-up window used by the observers to evaluate the image pairs. The *Other Comments* field was used to obtain free-format responses from observers.

The image shows a software window titled "Post Study Questionnaire" with a close button (X) in the top right corner. The window contains the following elements:

- A text field labeled "Reviewer" containing the text "Reviewer #1001".
- A question in red text: "Were the photos a distraction?" followed by two radio button options: "Yes" and "No".
- A question in red text: "Did you feel you spent more time because of the photos?" followed by two radio button options: "Yes" and "No".
- A question in red text: "Did the photographs help with the interpretation?" followed by two radio button options: "Yes" and "No".
- A text label "If yes, How?" above a large, empty white rectangular text area.
- A question in red text: "If you saw photographs of two different persons did you go back to check if the radiographs appear to belong to two different individuals?" followed by two radio button options: "Yes" and "No".
- A "Save" button at the bottom center of the window.

Figure 3.
PostStudyQuestionnaire—image of pop-up window with questionnaire for observers who interpreted studies with photographs. This questionnaire was completed at the end of the interpretation session

Figure 4.

Representative wrong-patient error without photographs.

(A) An 89 year-old white man with a history of aortic stenosis, status post surgical aortic valve replacement; median sternotomy wires are seen with proper window-level settings.

(B) Radiograph obtained three weeks earlier, used to serve as a comparison for A in a wrong-patient error scheme, shows a 63 year-old woman also with a history of aortic stenosis, status post percutaneous aortic valve replacement.

Differences in the prosthetic valves, sternotomy wires, and vascular and nodal calcifications in both patients are evident. It is unlikely that a person who has undergone surgical aortic valve replacement (the patient in B) would subsequently undergo percutaneous aortic valve replacement and have the medical sternotomy wires removed in the same three-week period (the patient in A). Even more illogical is the development of advanced calcified atherosclerotic disease and calcified mediastinal lymph nodes within three weeks. Despite these obvious differences, the observer who was shown this combination did not identify the wrong-patient error.

Table 1

Observer Characteristics

Characteristic	Value <i>without</i> photos (n = 45)	Value <i>with</i> photos (n = 45)	Total (n = 90)
Age [*] (years)	53 ± 10 (35, 83)	53 ± 9 (37, 82)	53 ± 10 (35, 83)
Gender ^{**}			
Male	27	29	56 (62)
Female	18	16	34 (38)
Years post-residency training [*]	22 ± 10 (4, 52)	20 ± 10 (6, 50)	21 ± 10 (4, 52)
Fellowship training ^{**}			
Yes	38	38	76 (84)
No	7	7	14 (16)
Fellowship subspecialty ^{**}			
Abdominal	11	5	16 (18)
Breast	2	4	6 (7)
Cardiothoracic	7	9	16 (18)
Interventional	5	5	10 (11)
Musculoskeletal	2	5	7 (8)
Neuroradiology	2	2	4 (4)
Nuclear medicine	2	3	5 (6)
Pediatric	4	5	9 (10)
Other	3	1	4 (4)
Not applicable	7	6	13 (14)
Current subspecialty practice ^{**}			
Abdominal	11	6	17 (19)
Breast	8	7	15 (17)
Cardiothoracic	9	9	18 (20)
Interventional	4	5	9 (10)
Musculoskeletal	3	7	10 (11)
Neuroradiology	2	2	4 (4)
Nuclear Medicine	2	2	4 (4)
Pediatric	3	6	9 (10)
General radiology	3	1	4 (4)

^{*} Data presented as mean ± standard deviation (range in parentheses)

^{**} Data presented as number (percent in parentheses)

Table 2

Likelihood of Detecting A Wrong-Patient Error: All Radiologists

	<i>Without photos</i>	<i>With photos</i>
Radiologists <i>unexposed</i> to wrong-patient error (n = 31)	0 / 16 [*] (0 ^{**})	0 / 15 [*] (0)
Radiologists <i>exposed</i> to wrong-patient error (n = 59)	9 / 29 [*] (31)	23 / 30 [*] (77)

^{*} Ratio of (errors detected) / (number of observers in each category)

^{**} Data presented as % in parentheses

Table 3**Likelihood of Detecting Wrong-Patient Error By Radiologist Characteristics**

Characteristics	Without photos errors detected [*]	With photos errors detected	OR ^{**}	P-value ^{***}
Total readers (n = 59)	9/29 (31)	23/30 (77)	7.30 [2.29, 23.18]	0.006
Current subspecialty				
Cardiothoracic (n = 12)	1/5 (20)	6/7 (86)	24 [1.14, 505.19]	0.072
Non-cardiothoracic (n = 47)	8/24 (33)	17/23 (74)	5.67 [1.61, 19.99]	0.008
Portable chest radiograph interpretation				
Specialties with current expertise in chest radiography [#] (n = 36)	6/18 (33)	14/18 (78)	7 [1.5, 30.80]	0.017
Specialties without current expertise in chest radiography ^{##} (n = 23)	3/11 (27)	9/12 (75)	8 [1.24, 51.50]	0.039
Experience level				
> 10 yr post residency (n = 50)	8/25 (32)	20/25 (80)	8.5 [2.34, 30.98]	0.014
10 yr post residency (n = 9)	1/4 (25)	3/5 (60)	4.5 [0.25, 80.56]	0.524
Fellowship subspecialty				
Cardiothoracic (n = 10)	1/3 (33)	7/10 (86)	12 [0.49, 294.55]	0.183
Non-cardio. (n = 49)	8/26 (31)	17/23 (74)	6.38 [1.83, 22.23]	0.004
Fellowship trained				
Yes (n=51)	8/25 (32)	21/26 (81)	8.93 [2.46, 32.33]	0.006
No (n = 8)	1/4 (25)	2/4 (50)	3 [0.15, 59.89]	1.000

* Data presented as number ratio and % in parentheses.

** OR = Odds Ratio, 95% confidence intervals in brackets.

*** P-value for hypothesis that likelihood of detection is not affected by inclusion of photographs, two-tailed Fisher's Exact Test.

[#] radiologists currently practicing abdominal, cardiothoracic, general, musculoskeletal, and interventional radiology.

^{##} radiologists currently practicing breast, nuclear medicine, and pediatric radiology.

Table 4

Results of Questionnaire that Observers Who Interpreted Studies with Photographs Completed at the End of Their Interpretation Session *

Question	Response	
	Yes	No
1) Were the photographs a distraction?	8 (20)	31 (80)
2) Did you feel you spent more time because of the photographs?	18 (42)	25 (58)
3) Did the photographs help with the interpretation?	19(44)	24 (56)
4) If you noted mismatched photographs, did you go back and check the radiographs ** ?	22 (96)	1 (4)

* Data presented as number and % in parentheses

** Only readers presented with errors were asked this question.