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Medical students' perceptions regarding the use of patient photographs integrated with medical imaging studies

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Introduction

Each year, an estimated 98,000 to 400,000 Americans die in hospitals due to medical errors, which makes them the third leading cause of death in the United States after heart disease and cancer.[1-3] In radiology, a potential source of error is the *wrong-patient error*, where one patient's radiograph is incorrectly filed under a different patient's folder in the Picture Archiving and Communication System. Alarmingly, of the 652 reported errors which caused serious harm in radiology services reported to the Pennsylvania Patient Safety Authority in 1 year (2009), patient misidentification accounted for 30% (196).[4]

In order to avoid wrong-patient errors, the Joint Commission in its National Patient Safety Goals has a specific requirement that at least two patient identifiers be used whenever care, treatment or other service is provided.[5] These identifiers may include the individual's name, an assigned medical record number, telephone number, or other person-specific identifier, such as date of birth or social security number.[5] Despite these efforts, wrong-patient errors continue to occur. According to prior analyses of misidentification events at single medical institutions, there are between 6.5 and 16.8 wrong-patient errors per 100,000 imaging studies performed.[6,7] Furthermore, we believe the incidence of these events are under-reported.[8]

The face has been proposed as a supplement to current patient identifiers to aid in reducing such wrong-patient errors while radiologists are interpreting radiographs.[9] We have previously described a device that simultaneously and automatically acquires photographs at the time of radiograph acquisition.[9] During imaging interpretation, the patient photograph and radiograph are displayed together (Fig). In two observer studies, one with 10 recently board-certified radiologists[10] and another with 90 radiologists with varying years of experience and specialties,[11] photographs paired with radiographs significantly increased the detection rate of wrong-patient errors, without a substantial increase in interpretation time. In another observer study with 10 board-certified radiologists, the presence of the photograph reduced the number of fixations and total dwell on the chest radiograph but overall viewing time did not increase.[12]

Currently there is no widespread use of photographs integrated with imaging, such as radiography, computed tomography, ultrasound, and magnetic resonance imaging. Stakeholders' perceptions of this technology will impact its overall future acceptance. Several recent studies have surveyed a variety of stakeholders regarding their perception of the use of integrated photographs with medical imaging. In one observer study of ten recently board-certified radiologists, a post-study questionnaire revealed that 20% of the participants indicated that photographs paired with radiographs were a distraction and 70% believed that photographs increased their interpretation time, despite study findings of no significant increase in objective time per case.[10] A larger observer study of 90 board-certified radiologists with varying experience levels and subspecialty focus found that 80% of participants did not find the photographs to be a distraction.[11] A recent survey of 498 parents and guardians of pediatric patients, 78 radiologists, and 50 radiology technologists and nurses found that in general these stakeholders have favorable attitude toward the use of patient photographs with imaging studies.[13] According to the survey results, more than half of radiology faculty and residents believed that the use of photographs would improve accuracy and reduce wrong-patient errors. Additionally, the majority of radiology technologists and nurses were supportive of the technology if it improved interpretation and decreased mislabeled patient errors. Furthermore, 96% of parents and guardians supported the use of their child's photograph in imaging studies to improve safety, and only 38% worried about the impact on their child's privacy.

To expand our knowledge of various stakeholders' impressions of this technology, the purpose of this study was to further explore medical students' qualitative viewpoints on the inclusion of photographs during image interpretation. To date, no similar study has been conducted of medical students who are future consumers and potential advocates of this proposed technology.

Material and Methods

This survey study received an exemption from full review from our institutional review board.

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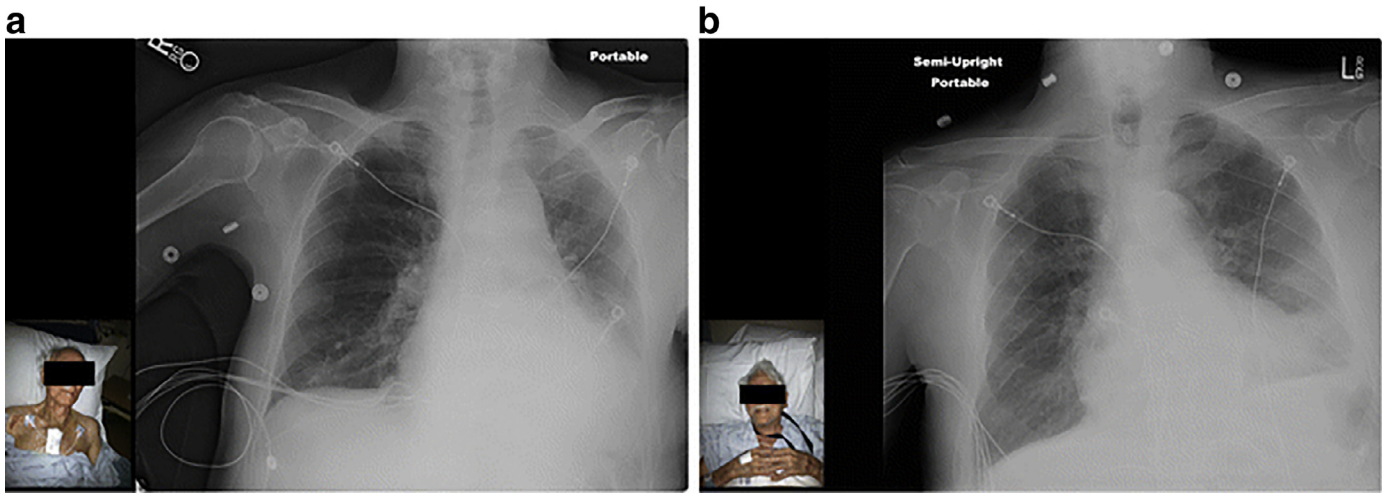

FIG. Example Photograph–Radiograph

Example photograph–radiograph combinations displayed to students taking the survey. The image was preceded by a brief description of the photo identification technology, including assurances that the addition of the photograph would not change the workflow for the technician and that the photograph could only be seen by healthcare providers who are expected to see radiograph as part of the patient's routine medical care. Permission was obtained from the *American Journal of Roentgenology* to reprint the image.

Study Population

Over a 3-week period in October and November 2015, 607 current medical students, including dual-degree students, received an email asking them to complete a voluntary online survey. Two hundred and twenty-three students (91 males, 130 females, and 2 with no gender specified) completed the survey. Average age was 25 years (standard deviation = 2.2, range 21-33). The majority (58.7%) of students were first- or second-year medical students and most had not completed a radiology elective (91.4%). A small number of students (7.6%) had witnessed a wrong-patient error.

Survey

The survey from the previous studies[12,13] was modified for use in this study (Appendix) to collect basic demographic information as well as questions about medical students' impressions of the use of photographs. An anonymous survey was created and distributed through the online survey tool SurveyMonkey Inc (Palo Alto, CA, www.surveymonkey.com). Students were entered into a raffle for a small monetary award if they completed the survey. In accordance with Georgia state law, eligibility for the raffle was not limited to the participants who completed the survey. At the beginning of the survey, there was a brief description of the proposed technology and context, along with two examples of the proposed photograph–radiograph combination (Fig). The survey asked students to indicate their level of support for various statements using a five-point Likert-like scale ("significantly less," "slightly less," "no difference," "slightly more," and "significantly more") or true/false. The statements were constructed to evaluate their viewpoints of the technology and its effect on the accuracy of image interpretation, interpretation of lines and tubes, detection of mislabeled patients, and evaluation of patient health status, on the time spent on image interpretation, and on the number of misidentification errors. Overall support for the adoption of the proposed technology was also assessed. Students were able to submit any typed comments about the technology. Two authors (DTS and AKD) independently categorized students' comments as positive, negative, or neutral. Positive comments indicated only support for the technology, negative comments demonstrated reservations about the use of patient photographs in imaging, and neutral comments expressed both support and concern. At the end of the survey, information about the student's age, gender, level of training, type of degree program, any prior experience of a wrong-patient error, and completion of radiology elective were collected.

Data Analysis

The survey responses were analyzed using MATLAB (MathWorks, Natick, MA). The association between students' gender, age, level of training, degree program, participation in a radiology elective, personal experience with wrong-patient errors, and their perceptions of the technology were studied via multilinear regression. Predictors for medical students' anticipated perceptions or concerns about technology were reported as coefficient and 95% confidence intervals. *P* values are calculated from the T-statistic of the linear regression model for each output. Statistical significance was set at $P < 0.05$. For the purposes of analysis, "slightly more" and "significantly more" were collapsed into the same category of "more," and "significantly less" and "slightly less" were similarly grouped into "less." Student age was analyzed by two groups: less than 25 years and greater than 25 years, inclusive of age 25. Experiences of respondents were similarly categorized as either 1 to 2 years of time in their current degree program, or more than 2 years. The degree program of each student was categorized as either MD only or MD plus any additional degree program.

Results

The data for the responses to the survey questions are presented in Tables 1 and 2. Forty-six percent of respondents predicted more accurate interpretation of images. A majority (65%) thought that the addition of patient photographs would result in more accurate interpretation of lines and tubes. Eighty-eight percent hypothesized that

TABLE 1
Acceptance of integrating patient photographs with imaging studies among medical students

	Overall agreement
The use of patient photographs could result in:	
More accurate *interpretation of images*	104/223 (46%)
More accurate *interpretation of lines and tubes*	142/223 (65%)
More accurate *detection of mislabeled patients*	195/223 (88%)
More accurate *evaluation of patient health status*	111/223 (51%)
No difference in *image interpretation time*	137/223 (62%)
Fewer *misidentification errors*	178/223 (81%)

TABLE 2
Percent who believe photos should be adopted if number of misidentification errors reduced

	No. of respondents (%)	Overall agreement (%)	*P* value*
Student age			
Under 25	100 (44.8%)	97.8%	<0.42
25 and over	118 (52.9%)	95.4%	
None specified	5 (2.2%)	100.0%	
Gender			
Male	91 (40.8%)	97.0%	<0.09
Female	130 (58.2%)	95.8%	
None specified	2 (0.9%)	100.0%	
Years in program			
1-2 years	131 (58.7%)	98%	<**0.01**
More than 2 years	91 (40.8%)	95%	
None specified	1 (<1%)	100%	
Completed radiology elective			
No	204 (91.4%)	97.5%	<**0.03**†
Yes	18 (8.1%)	83.3%	
No response	1 (<1%)	100.0%	
Respondent witnessed wrong patient error			
No	205 (91.9%)	96.1%	<0.60
Yes	17 (7.6%)	100.0%	
No response	1 (<1%)	100.0%	
Respondent provided comment(s)			
No	181 (9.9%)	98.3%	<**0.001**‡
Yes	42 (18.8%)	88.1%	
Positive	*9 (21%)*§		
Neutral	*16 (38%)*		
Negative	*17 (40%)*		

*P values calculated from multilinear regression. Significant values in bold.
†Students who had not completed radiology elective were more likely to support the technology if it reduced errors.
‡Respondents who did not leave a comment were more likely to support use of photos if they reduced errors.
§Percent of comments provided.

more accurate detection of misidentification errors would result. Approximately half of the respondents (51%) believed that photographs would allow for accurate evaluation of patient health status. A majority (62%) predicted no difference in image interpretation time. Eighty-one percent of respondents indicated that the use of patient photographs would result in fewer identification errors (Table 1).

With respect to the statement "If the use of the Photo ID technology improves misidentification errors, I believe it should be adopted by Emory Healthcare," nearly all of the students surveyed (96%) agreed with this statement. Students who had completed a radiology elective were less likely to support the technology if it reduced errors ($P = 0.0302$, $r = -0.1047$). As students advanced in their degree program, while they still viewed patient photographs positively in terms of improving interpretation of lines and tubes, impact on interpretation time, and number of misidentification errors, they were not as favorable toward the technology as were students earlier in their training ($P = 0.0093$, $r = -0.0789$). There were no significant differences in response as a function of gender ($P = 0.0887$, $r = 0.0223$), age ($P = 0.4236$, $r = 0.0056$), or years of experience ($P = 0.0916$, $r = -0.0221$). The degree program of the student did not predict their response ($P = 0.7286$, $r = -0.0111$). There was no significant difference in responses whether or not subjects had witnessed a wrong-patient error ($P = 0.5979$, $r = 0.0244$; Table 2).

With respect to the question "On a scale of 0 to 10 how much would you prefer to have a patient's photograph available at the time of interpretation"?, the mean response was 6.6 (standard deviation = 2.03, median = 7.00, Interquartile Range = 2.00, range = 0-10). As students advanced in their degree program, they were more likely to indicate a lower preference for photos at time of image interpretation (mean preference 6.24 vs 6.92, $P = 0.0002$, $r = -0.5243$). Students not enrolled in a dual degree program were more likely to indicate a lower preference (mean preference 6.51 vs 7.25, $P = 0.0017$, $r = -1.0577$). There was no significant correlation between preference rating and gender ($P = 0.6909$, $r = 0.0541$), age ($P = 0.1273$, $r = 0.1121$), completion of a radiology elective ($P = 0.8872$, $r = -0.0711$), or experience with a wrong-patient error ($P = 0.8284$, $r = -0.1047$).

TABLE 3
Types of respondent comments with representative comments

Type of comment	Number	Representative comments
Positive	9	• "This also humanizes an interpretation. It is no longer the patient with so and so scan results. You can see how the patient feels and their outward appearance, not just internal results." • "I think this will help with patients, especially those with similar names." • "Any image that provides more clarity will be helpful. Perhaps if you could have an image that links the radiograph to a photograph of the area that was imaged. For example, leg x-ray also includes patient face and leg image."
Neutral	16	• "On one hand, I could see it creating more bias and on the other hand I could see it providing more information and improving readings." • "I can foresee a situation in which the patient must consent to have their photograph attached to their radiology images, which could add time and hassle to the process. However, even if this was the case, I would still support the option of adding a photograph to a radiology file." • "Could their image cause assumptions in the patient's care based on their age, race, and gender? Or would these factors help because they may be risk factors"? • "I would be concerned about patient confidentiality. Doesn't mean it's not possible to overcome these concerns, but for me, the picture would have to automatically be removed from the x-ray any time you try to print or copy the image."
Negative	17	• "I don't understand the additional costs required, and I think it's unnecessary. Why can't we just be better at getting the name right"? • "I feel like it may introduce bias where there is currently less. I am also not sure how this will change misidentified patient as the radiologists do not know what the patients look like."

Forty-two students submitted typed comments about the use of photographs in medical imaging. Nine comments were considered positive, 17 were negative, and 16 were neutral. Perceived benefits of the technology include humanization of image interpretation and improved interpretation due to additional clinical context. Students were concerned that the technology could introduce bias due to patient appearance, and complicate issues of confidentiality and patient consent. Examples of students' comments are included in Table 3.

Seventeen students reported witnessing wrong-patient errors, of which 3 students commented that the errors were related to radiology. Students who reported witnessing a wrong-patient error were more likely to comment positively on the technology ($P = 0.0144$, $r = 1.1597$).

Discussion

The survey results from 223 medical students demonstrate that the majority of medical students (96%) support the use of patient photographs in medical imaging if it increases detection of misidentification errors. Their comments suggest that patient photographs may humanize and improve image interpretation, but express concern about bias and patient confidentiality. Students who had not completed a radiology elective or who had fewer years in training were more positive.

We hypothesize that students who completed a radiology elective were slightly less positive in their support of patient photographs because they had spent more time learning from practicing radiologists and had begun to perceive the benefits and limitations of the

technology similarly. Students who had completed radiology elective gave an average rating of 6.1 on a scale of 1 to 10 on how much they preferred to have photographs at the time of image interpretation. This rating is the same average rating that 10 practicing radiologists gave when asked the same question.[12] In other user observer studies, radiologists subjectively perceived that the addition of patient photographs would increase their interpretation time.[10] Medical students who had undergone a radiology elective may perceive similar drawbacks of the technology, making them less favorable in their support.

Our results also indicate that students with more experience in their degree program were less likely to consider the patient photographs to be of benefit. We hypothesize that medical students with more clinical experience are more likely to consider potential benefits and drawbacks to the technology in the context of their experiences in clinical practice. Additionally, students with more clinical experience may become more conservative in their support of new technology, which is in accordance with the opinions of practicing radiologists surveyed in previous studies.[10-12] Students with experience limited to the preclinical curriculum were more likely to support the technology because they did not yet have clinical context to consider the potential pitfalls.

Of the 42 comments left by students, 9 were positive and 16 were neutral. Students who chose to leave a comment were less likely to support the use of photographs if they reduced errors ($P = 0.0008$, $r = -0.1109$). Although the number of negative and neutral comments compared to positive comments appears to be incongruent with the fact that 96% of students supported the technology, we hypothesize that students who took the time to type a comment were more likely to have strong, less favorable opinions regarding the technology.

Students who left neutral or negative comments expressed concern that the technology could introduce bias due to patient appearance and could complicate patient confidentiality and consent. It has been reported that patient photographs added to computed tomography scans resulted in radiologists feeling more empathy and finding pertinent medical information in the photographs such as physical signs of disease.[14] In contrast, another survey found that only 10% thought that a picture would increase empathy and 14% thought that images might introduce negative bias.[15] However, we have limited data on how patient photographs may bias provider interpretation of radiological studies. A 1999 study published in the *New England Journal of Medicine* suggested that the race and sex of a patient influence how physicians manage chest pain.[16] It is possible that including photographs with radiological studies may increase the likelihood that patient demographic factors influence the final report. As far as the issue of confidentiality and consent, we recommend that any future implementation of this technology include an update to the informed consent process and ensure that patient photographs are stored securely within the medical record. Bias, patient confidentiality, and informed consent are important issues to consider in possible future implementation of this technology and merit further study.

In addition to the Pennsylvania Safety Authority's reported data[4] about harmful wrong-patient errors in radiology, near-miss identification errors are also of growing interest given their potential to highlight system vulnerabilities and identify opportunities to improve patient safety.[8] Near-miss wrong-patient errors are ones that are detected and corrected before they affect patient care and are likely under-reported.[17] At Emory University, it was estimated from an analysis of over 1.7 million examination that a lower-bound on the near-miss error rate was about 4 per 100,000 examinations.[8] The radiology department at Memorial Sloan Kettering Cancer Center reviewed 62 near-miss events between 2007 and 2009 and found that the third largest source of their near-miss errors (16%) was related to incorrect patient identification.[17] Over approximately the same period, Mayo Clinic reviewed their near-miss events and found that the second most common group of errors (19%) was due to issues with patient identification.[7] In our survey, the 17 students who reported having witnessed a wrong-patient error were more likely to comment positively on the technology. However, these students were no more likely to have a higher preference rating for the use of photos and not more likely to support its adoption at Emory Healthcare. We believe that students with experience of medical error and who took the time to write a comment were more likely to reflect positively on the technology. These positive written reflections may have been too nuanced to influence preference ratings and support of adoption. Medical students' perception of proposed new safety technology is shaped by their prior clinical experiences with medical error. Medical students as future consumers and advocates for the use of patient safety technology in clinical practice are important stakeholders to consider, given the significant time needed to develop and disseminate new technologies in clinical medicine.

A significant minority (46%) of surveyed students believed that the addition of patient photographs would result in more accurate interpretation of images. These results are in line with a prior survey of 90 board-certified radiologists where 44% believed that photographs improved their interpretation of the radiograph.[11] In contrast, a survey of 21 radiology residents, fellows, and faculty found that only 24% believed that a picture would inform their radiologic decisions.[15] Although a sizeable minority of respondents find value in photographs improving image interpretation, the primary value in this proposed technology lies in its potential to reduce misidentification errors.

Our results are in line with prior stakeholder surveys that suggest support for this technology if it reduces errors.[13] However, it is important to consider the potential pitfalls of a technology intended to reduce patient misidentification errors. A reduction in patient identification errors may be offset by more misperception errors. One study suggested that patient photographs may increase the inclusion of incidental findings in the final report.[14] The addition of incidental findings may have a number of unintended consequences, including increasing report length and possible triggering of unnecessary workup.

These survey results should be interpreted within the context of the methodological limitations. The survey was provided to students who have never experienced the technology. The survey consisted of hypothetical questions based on the "minimum viable product" which was displayed in the form of Figure. Their answers could be different once they experience the technology first hand. Additionally, only one medical school student body was surveyed. The response rate was 38% and, therefore, do not necessarily reflect the opinions of the majority of medical students at this school. Survey results from medical students may be impacted by response bias created by participants with particularly strong opinions on the survey topic. Additionally, over half (59%) of survey respondents were in preclinical training and may have more limited context regarding the use of medical imaging. Furthermore, only 8% of survey respondents had completed radiology elective.

Conclusions

In summary, the majority of medical students (96%) support the use of patient photographs in medical imaging in order to improve safety. Their comments suggest that patient photograms may humanize image interpretation, but express concern about introduction of bias in image interpretation and patient confidentiality. Medical students are important stakeholders to consider in the acceptance of new patient safety technology. Future directions include outcome studies that examine the impact of incorporating patient photographs in medical imaging on patient identification errors.

Conflicts of Interest

The authors declare no conflicts of interest.

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Supplementary materials

Supplementary material associated with this article can be found, in the online version, at doi:10.1067/j.cpradiol.2018.05.003.

Appendix: Medical Student Survey

Please mark the best option:	Significantly less	Slightly less	No difference	Slightly more	Significantly more
The addition of patient photographs could result in:					
1. _____accurate interpretation of images.					
2. _____accurate interpretation of lines and tubes.					
3. _____accurate identification of mislabeled patients.					
4. _____accurate evaluation of patient health status.					
5. Spending _____time on the interpretation of imaging test.					
6. From what I understand at this time, the use of the patient's photograph could result in _____ misidentification errors.					
7. If the use of the Photo ID technology improves misidentification errors, I believe it should be adopted by Emory Healthcare	True / False				
8. Free text comments:					

On a scale from 0 to 10, how much would you prefer to have a patient's photograph available at the time of imaging interpretation?
(0 = not prefer; 10 = most preferable)

|_____|_____|_____|_____|_____|_____|____|____|_____|_____|
0 1 2 3 4 5 6 7 8 9 10

Your age:	Your gender (check one): Male / Female / Prefer not to say / Other (please specify)	_____
SOM Degree program: a) MD b) MD/PhD c) MD/MPH d) MD/MSCR e) MD/MBA f) Other (please specify)	Years spent in current degree program (measure in school years: July 1-June 30): a) <1 (i.e. M1) b) 1 - 2 (i.e. M2) c) 2 - 3 (i.e. M3) d) 3 - 4 e) 4 - 5 f) >5	
Have you completed a Radiology Elective? Yes / No	Have you witnessed a wrong-patient error? Yes / No Please share your experience(s) with us:	

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