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Monitoring the Use of Extra Images on Chest Radiography Examinations

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A B S T R A C T

Background: A large number of chest radiography studies in our department include extra images due to incompletely imaged anatomy (eg, extra frontal view to include a truncated costophrenic angle). Negative impacts include: increased radiologist review time due to disruption of search pattern and the need to review additional films in slightly different obliquities, additional radiation exposure, and increased technologist time expenditure.

Purpose: To determine the chest radiograph repeat rate, collaborate with technologists on a process to decrease the frequency, and incorporate the process into our quality control program.

Methods: Data collection was performed by using coded dictation macros to indicate the type of extra view (frontal, lateral) and whether the extra image was necessary due to patient habitus. Twelve weeks after the macro was instituted, baseline data were collected by querying the macro codes with a search engine (MONTAGE Search and Analytics). Intervention consisted of in-person tutorials of basic radiographic positioning principles with x-ray technologists and posting of checklists in all diagnostic radiology exam rooms. Twelve weeks of postintervention data were collected.

Results: Baseline data included 5645 examinations, of which 335 (5.9%) included extra images. Postintervention, 5943 examinations were performed and 295 (5.0%) included extra images. A significant decrease in the frontal view repeat rate was noted, decreasing from 4.6%-3.3% (P = 0.001). The repeat rate of lateral images did not change significantly (3.1%-3.2%).

Conclusions and Implications: Data monitoring and interprofessional collaboration led to a significant decrease in unnecessary extra radiographs. Ongoing monitoring may lead to sustained improvement and further reductions.

Introduction

In our radiology department, it was noted anecdotally that a large number of chest radiograph studies contained extra images for repeated projections. These extra views were done to compensate for excluded anatomy in the original image, such as a costrophrenic angle or the lung apices. While extra views often are necessary for reasons such as a large body habitus or lack of patient cooperation, more often, no reason for the extra views is apparent to the radiologist. The impact of extra views, while small, is not neglibible. Most importantly, extra views cause a disturbance in the high speed work flow or chest radiograph interpretation due to the extra time spent interpolating the two disconnected views. Acquiring extra views results in increased work and time expenditure for the radiology technologist. In some cases, questionable findings may be noted in one image and not the other. This study was adopted as a quality improvement project to characterize the reasons for the acquisition of extra views in chest radiography and then introduce simple measures within our radiology department to reduce the rate of acquiring extra views.

Methods

The study was conducted in a single institution with a radiology residency program.

Rates of repeat radiographs (“extra views”) were determined by using a standard, one-sentence dictation macro in radiology reports. Resident and attending radiologists were instructed to insert the macro in all chest radiography cases including extra views to indicate the type of projection that was repeated (ie, frontal, lateral) and the perceived reason for the extra view. If the radiologist believed the extra view was due to poor patient positioning by the technologist, the macro stated that the view was performed “to include relevant anatomy in the field of view.” If the view was performed for unavoidable reasons (eg, large patient habitus or stature, severe kyphosis), the macro stated that the view was performed “due to habitus.”

A teaching intervention was performed 13 weeks after implementation of the macro. In collaboration with the lead x-ray technologist, we employed a simple 2-pronged quality improvement strategy of (1) letting technologists know that their repeat rates were being observed, and (2) providing the technologists with refreshers on obtaining frontal and lateral radiographs. The refresher consisted of a brief tutorial and a document showing basic guidelines of patient preparation and positioning, sent by email and posted on the walls of all x-ray examination rooms (Fig 1).

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AP/PA Projection

- All possible foreign bodies removed (jewelry and bra)
- Entire lung field from apices to angles visualized
- Central Ray should enter at the level of T7
- Watch for rotation
  - Evident from sternoclavicular joint symmetry
  - Trachea should be midline
- Use spinous processes as a guide to align the patient
- Collimate whenever possible
- Adequate inspiration and technique settings
  - Lung markings visualized
  - 9-10 ribs visualized
- Patient positioned close to receptor to minimize magnification

Lateral Projection

- All possible foreign bodies removed (jewelry and bra)
- Entire lung field from apices to angles visualized
- Watch for rotation
  - Superimposed posterior ribs
  - Intervertebral spaces should be open on image
- Collimate whenever possible
- No forward or backward leaning
- Arms raised, not overlapping the chest

FIG 1. Refresher given to radiology technologists.

Data were collected for preintervention and postintervention groups using a search engine (Nuance Montage Search and Analytics). Search queries for the specific phrases of the macro were used. In the preintervention phase, the first week of data was excluded to allow for adjustments in using the macro by the faculty and house staff. Similarly, 4 weeks of data were excluded after the intervention to allow for adjustments by the radiology technologists (RT). In total, 12 weeks of preintervention and 12 weeks of postintervention were used for analysis. To compare the 2 data sets, the total number of chest radiograph studies and the distribution of types (ie, single AP portable study or PA and lateral study) were collected from the information technology department to calculate the extra view rates for each type of study. For calculating repeat rates, studies where both frontal and lateral views were repeated in the same study were added to the separate projections. Significance was calculated using the Fisher exact test. While detailed analysis was performed for only the first 12 weeks after intervention, extra views continued to be counted for several months to follow overall trends.

Additional data were collected regarding the radiation doses and the disk space (in megabytes) per study to further describe the impact of each extra image taken. Information was provided by our in-house radiation physicist and information technology department, respectively.

Results

Baseline data included 5645 examinations, of which 335 (5.9%) included extra images. Postintervention, 5943 examinations were performed and 295 (5.0%) included extra images. Pre- and postintervention repeat rates are shown in Table 1. A significant decrease in the frontal view repeat rate occurred in studies that included both PA and lateral views. There was no significant change in the repeat rate for portable AP radiographs. Lateral view repeat rates did not change significantly.

TABLE 1
Total number of extra views and repeat rate of extra views within each laterality. Studies with both frontal and lateral repeats are counted for frontal, frontal PA, and lateral; this is reflected in the reported repeat rate (in parentheses)

Laterality		Preintervention	Postintervention	*P* value
Frontal	All frontal	248/5645 (4.6%)	194/5943 (3.3%)	0.001
	Portables (AP)	33/2499 (1.3%)	40/2495 (1.6%)	0.412
	2-views (PA)	206/3146 (6.9%)	151/3437 (4.4%)	<0.001
Lateral		99/3146 (3.1%)	109/3437 (3.2%)	0.788
Both		12	8	

There was no statistically significant difference in pre- and postintervention rates of unavoidable extra views (eg, large body habitus or stature, severe kyphosis), and proportions of unavoidable extra views were relatively equally distributed among frontal and lateral views (Table 2). For these patients, increased body habitus was slightly more prone to extra lateral views (0.9%-1.0% of extra views in each respective group) compared to frontal views (0.7%). Due to the similar distribution of unavoidable studies between groups, the “avoidable” repeat views grossly paralleled that of the total cases, with statistical significant decreases again seen only in the frontal views, particularly the PA views (Table 3).

A run chart illustrates the total number of extra views over the span of 13 months and demonstrates an overall decrease in frontal

TABLE 2
Extra views (number and repeat rate) that were marked as “unavoidable” due to body habitus. Studies with both frontal and lateral repeats are counted for frontal, frontal PA, and lateral; this is reflected in the reported repeat rate (in parentheses)

Laterality		Preintervention	Postintervention	*P* value
Frontal	All frontal	38/5645 (0.7%)	39/5943 (0.7%)	1.000
	Portables (AP)	3/2499 (0.1%)	4/2495 (0.2%)	0.726
	2-views (PA)	31/3146 (1.0%)	35/3437 (1.0%)	0.812
Lateral		32/3146 (1.0%)	30/3437 (0.9%)	0.390
Both		4	1	

TABLE 3
Extra views (number and repeat rate) that were marked as potentially avoidable. Studies with both frontal and lateral repeats are counted for frontal, frontal PA, and lateral; this is reflected in the reported repeat rate (in parentheses)

Laterality		Preintervention	Postintervention	*P* value
Frontal	All frontal	210/5645 (3.7%)	155/5943 (2.6%)	0.001
	Portables (AP)	30/2499 (1.2%)	36/2495 (1.4%)	0.461
	2-views (PA)	175/3146 (5.6%)	116/3437 (3.4%)	<0.001
Lateral		67/3146 (2.1%)	79/3437 (2.3%)	0.811
Both		8	7	

radiographs since the intervention (Fig 2). Lateral view repeat views again remained relatively constant.

Other metrics acquired during this study involved radiation per image. During a single month span, the mean entrance surface doses for portable AP chest, PA chest, and lateral chest radiographs were 117 μGy, 96.3 μGy, and 625.1 μGy, respectively. These results are comparable with internationally reported mean entrance surface doses.[1,2]

Discussion

The results of data monitoring with a simple teaching intervention led to a significant decrease in unnecessary extra radiographs, almost exclusively from PA frontal radiographs. These results are within the desired outcome, given that acceptable repeat rates have been suggested to be less than 5%.[3] This standard has been adopted by our radiology department. While the total frontal repeat rate was within acceptable limits, the PA frontal repeat rate specifically was above 5% and therefore saw the most room for improvement. Lack of improvement in the portable and lateral radiograph repeat rates was also felt to be acceptable given the low baseline rates, which were already within the 5% threshold.

These results demonstrate how a quality improvement initiative instituting simple interventions of data monitoring and teaching could result in an improvement in patient care and radiologist workflow. Other studies have demonstrated improvements from higher baseline repeat rates with similar strategies, which reinforce the need to adopt an approach tailored to individual practices.[4,5]

Our study had several limitations. Since data collection relied on the use of a macro, accurate data required participation by both faculty and house staff radiologists. Although we did not measure radiologist compliance with macro use, it may have decreased slightly throughout the course of the study, which would have resulted in artificially lower values of repeat views in the tail end of the run chart. However, the overall sample size was large enough that sporadic lapses were likely negligible.

RTs were aware that repeat rates were being monitored, which may have resulted in an increased number of suboptimal studies sent to the picture archiving and communication system (ie, excluded anatomy without repeat views). A separate macro was not created to address this. Anecdotally, while some of these cases were seen, they were exceedingly rare. Of note, we confirmed that repeat images were not rejected before being uploaded into PACS. Digital rejection of images has been reported at other institutions[6,7,8]; therefore, any quality improvement initiative to address repeat views should address this practice.

There was also concern that certain RTs could be disproportionally contributing to the repeat rate. It was not feasible to track each RT, since this data was not accessible on Montage. Furthermore, not only did the work distribution between RTs vary, there were also rotating RT students, which would make any such data on individual RT performance unreliable. In the spirit of embracing a blame-free environment, it was decided that the intervention should be generalized in order to avoid attributing blame to specific individuals.

This study also did not account for time and location of the examinations performed. It is very likely that an incapacitated ICU patient would be more difficult to image properly than an emergency department or an ambulatory patient. Similarly, studies performed in the late-night hours may reflect different practices than those of daytime RTs. However, these patients receive portable studies, and this study demonstrated that this subcategory was not an issue, so further intervention was not necessary. Regardless, these are potential factors that

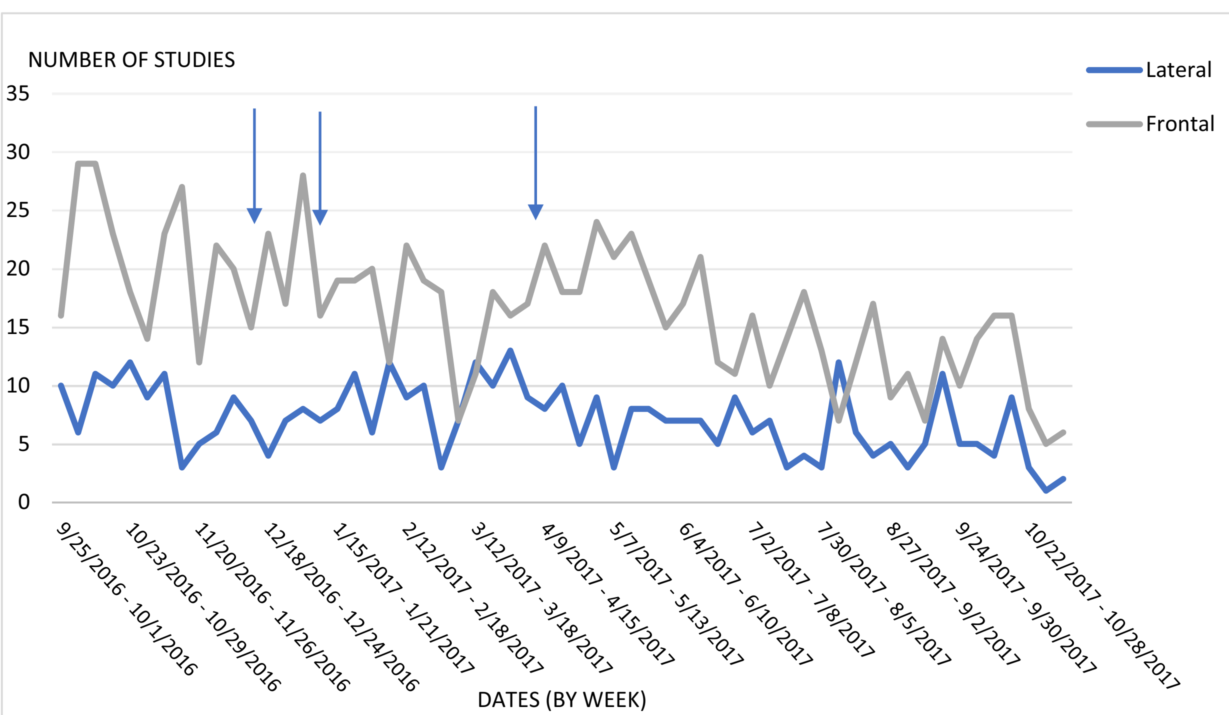

FIG 2. Run chart of number of extra views, with each data point corresponding to total repeats in a single week. Arrows indicate, in order: intervention, beginning of postintervention data collection, and end of postintervention data collection.

should be considered in future quality improvement studies of repeat radiograph rates.

In conclusion, our study demonstrates that it is possible to reduce the rates of unnecessary repeat chest radiographs by implementing a simple strategy of providing refresher tutorials with supporting materials to RTs and by tracking repeat rates through the use of a single-sentence dictation macro. Continued monitoring has the potential to result in sustained improvement in radiologist workflow and patient care.

Conflicts of Interest

Nothing to report.

Supplementary materials

Supplementary data associated with this article can be found in the online version at doi:10.1067/j.cpradiol.2018.07.012.

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