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Reduction of need for repeat chest x-rays caused by insufficient inspiration through enhanced patient communication

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KEYWORDS
Repeat/reject analysis; Chest x-ray examination; Inadequate/ insufficient inspiration; Geriatric patients; Patient communication.

ABSTRACT
This two-phased study first (phase 1) explored the effect of patient age and gender on the repeat rate of chest x-ray examinations due to inadequate inspiration. In phase 2, we sought to reduce this rate using an instructive video to improve patient understanding of the chest examination. In phase 1, the analysis included a total of 12,905 radiographic images from all types of examinations from a 3-month period collected retrospectively. These included 1,484 repeated images which gave a total repeat rate of 11.2%. The highest proportion of repeated images were chest examinations (29.7%). Of the chest examinations, with a repeat rate of 10.0%, inadequate inspiration was the major reason (76.3%) for repeating the exam. Our analysis of these repeated examinations showed that there was a positive association between increased repeat procedures caused by inadequate inspiration and patient age (more than 40 years). In phase 2, we designed and provided an instructive video about chest x-ray examinations. We found that its use was associated with a significant reduction in the repeat rate due to inadequate inspiration among patients aged 41-60 years. Effective communication is an important role of healthcare providers and can improve the quality of medical services.

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Introduction

Repeat or reject analysis is one of the important parts of a quality assurance program for general diagnostic radiography. Parameters monitored in the repeat analysis can include image and imaging procedure quality, skills of radiological technologists, patient radiation dose and performance of equipment[1]. Discovery of the causes or factors affecting rejection of images, allows radiology departments to make changes which improve service quality and patient dosage[2-6].

Anderson et al.[3] collected and analyzed data on rejected images in order to define the causes of repeat studies in routine work. Their total rejection rate was 12%, with the highest (in decreasing order) being examinations of the knee, then shoulder, and wrist. Though having a lower rejection rate, chest examinations made up the largest percentage (27.9%) of rejected images. Using a questionnaire, they polled 15 radiographers as to the reasons for rejection in different situations. Ten of the 15 radiographers defined poor inspiration in chest x-rays as a cause of repeat studies among elderly hearing-impaired patients. These images usually showed poor inspiration and/or non-projection of the left coronary sinus[3].

Even after the transition to digital radiography, quality control analysis of rejected images remains crucial for maintaining image quality[7]. Consequently, factors affecting the need for repeat images have been analyzed, and solutions as well as guidelines have been proposed for improving service quality[2,4,6,8]. Multiple variables, including sex, age, type of examination and projection, on the need for image retakes were analyzed. As a result, guidelines were proposed in 2016 for reducing the frequency of repeat imaging[8].

In our medical center in Thailand, repeated chest examinations made up the highest proportion (one-third) of all repeated images of any x-ray type. The main indication for retake of chest examinations was inadequate inspiration during exposure. The radiological technologists suspected that such inadequate inspiration was most common in older patients. Therefore, this study was designed to explore possible associations of patient age and gender with repeated chest examination caused by inadequate inspiration (phase 1). Since effective patient communication is important in optimizing radiological and medical care[9,10], the study also sought to reduce the need for repeat chest examinations by creating and using an instructive video (phase 2).

Materials and methods

The study was approved by the Institutional Review Board for Research Ethics on Human Subjects, Multicenter Research, Mahidol University; the date of approval was December 28, 2018.

Data collection and analysis

Data acquired by the digital imaging system in the Division of Radiological Technology, Golden Jubilee Medical Center, Salaya, Nakhon Pathom, Thailand, were retrospectively collected for 3 months in 2018 (phase 1). There were 12,905 images from all radiologic examinations. Repeated images totaled 1,484; the overall repeat rate was 11.2%. The type of examination with the highest proportion of repeated images was chest examination (29.7%). The repeated images of chest x-rays were so frequent which they made up one-third of all repeat examinations. Causes of repeating chest examinations were classified into: inadequate inspiration, positioning error, patient artifact, improper exposure, user error, or miscellaneous. Criterion for full inspiration was visibility of more than 9 posterior ribs above the diaphragm. The department's radiological technologists were responsible for accepting or rejecting images. All of them had been trained in using the same criterion and had adequate experience.

Only patients 18 years of age and older were included in the analysis of association between age and gender, and repeat imaging due to inadequate inspiration to ensure cooperation during instructional video and chest examination. The analysis used simple logistic regression to determine if there was a significant association between these variables and inadequate inspiration.

The statistical analysis was performed using PASW Statistics 18 software (version 18.0.0). The significance level was defined as *p*-value < 0.05.

Design and implementation of instructive video

After analyzing the repeat rates, a video was designed to increase patient understanding with the hope that this would reduce the need for repeat chest examinations. The instructional video consisted of patient preparation, examination procedures, and patient positioning. The importance of removing metal and radiopaque materials, and of full inspiration during radiographic exposure, were emphasized. Patients were informed that these steps would enhance image quality and diagnostic accuracy. The instructive video was displayed in the waiting room and the participants 18-years-old and older were advised (but not forced) to watch it. After launching the video, chest image data were collected for another 2 months (phase 2). The repeat rates caused by inadequate inspiration were calculated and compared to rates from data collected during the two months before launching the video.

Results

During the pre-intervention period of the study (phase 1), there were a total of 12,905 radiographs performed, among which were 4,309 chest x-rays (33.4%). Overall, 430 (10%) chest x-rays needed to be repeated (Table 1). Of the 430 repeated chest x-ray examinations, the most common cause for repeat was inadequate inspiration which accounted for 76.3% of these cases, followed by positioning error causing 19.8% of cases. For evaluating the association of age and gender with the repeat rate caused by inadequate inspiration, the patients younger than 18 years (n = 205) were excluded. The frequencies of repeated chest examinations due to inadequate inspiration stratified by age and gender are shown in Table 2. Compared with the youngest age group (18 - 40 years), the odds ratios of repeat studies among the patients aged 41-60, 61-80, and more than 80 years old were 2.31, 2.27, and 2.17 (all *p*-value < 0.001), respectively. Females and males did not differ significantly in repeat rates.

Table 1 Causes of repeat chest examinations over 3 months (phase 1)

	Number of cases	Percentage of total cases	Percentage of repeated cases
Total cases	4,309	100.0	
Repeated cases	430	10.0	100.0
Inadequate inspiration	328	7.6	76.3
Positioning error	85	2.0	19.8
User error	1	0.0	0.2
Patient artifact	5	0.1	1.2
Exposure error	2	0.0	0.5
Miscellaneous	9	0.2	2.1

Table 2 Association of patient age and gender with repeated examination due to inadequate inspiration (phase1)

Patient characteristics	Number of total images	Number of repeated images (%)	Odds ratio (95% CI)	*p*-value
Age group (years)				
18 - 40	1,231	56 (4.5)	1.00	
41 - 60	902	89 (9.9)	2.31 (1.64, 3.22)	< 0.001
61 - 80	1,451	141 (9.7)	2.27 (1.65, 3.13)	< 0.001
>80	418	39 (9.3)	2.17 (1.42, 3.33)	< 0.001
Gender				
Female	2,227	173 (7.8)	1.00	
Male	1,783	152 (8.5)	1.11 (0.88, 1.39)	0.761

In phase 2 of the study, repeat rates of chest examinations due to inadequate inspiration 2-months before and 2-months after launch of the instructive video were compared (Table 3). The overall repeat rate of chest examinations caused by inadequate inspiration was reduced from 8.4% to 7.6%. When stratified by age, the repeat rate for those 41-60 years old (compared with 18-40-year-olds) decreased significantly (*p*-value < 0.05) from 10.1% to 5.7%, while changes in other age groups were negligible.

Table 3 Comparison of repeat rates of chest examinations caused by inadequate inspiration 2-months before and 2-months after launch of instructive video (phase 2)

Age (Years)	Before using the instructive video			During use of the instructive video			*p*-value
	Number of images	Number of repeated images	Repeat Rate (%)	Number of images	Number of repeated images	Repeat Rate (%)	
Total	2,591	218	8.4	2,391	181	7.6	0.273
18 - 40	729	33	4.5	540	23	4.3	0.819
41 - 60	601	61	10.1	751	43	5.7	0.002
61 - 80	968	97	10.0	900	96	10.7	0.647
> 80	293	27	9.2	200	19	9.5	0.915

Discussion

This study explored the association of patient age and gender with the repeat rates of chest examinations due to inadequate inspiration. Patients seen in this medical center presented without any special selection or referral process, and were considered to be representative of the wider population of adults in central Thailand. Our analysis showed that the repeat rate was especially high in older patients (more than age 40). This is consistent with a previous report[8] of high rejection rates in elderly patients. Of note, patient age is an important factor in the success of patient-centered instruction[11].

This study showed that our instructive video significantly reduced the need to repeat chest x-rays due to inadequate inspiration in patients aged 41- 60 years. Rates did not change

significantly in patients older than 60 years. We experienced some limitations in cooperation from patients regarding voluntarily watching the instructive video. Patient age is known to influence the perception of health care communications[10]. Among our patients 61 years and older, the repeat rates caused by the inadequate inspiration were not reduced. This may have been due to physical constraints common to geriatric patients[12] in terms of taking a deep breath during x-ray exposure. A limitation of this study was that pathological conditions of patients were not recorded and so could not be analyzed. Such factors may explain the lack of a reduction of repeat rates in the oldest age groups.

Conclusion

In conclusion, there was a direct relationship between the frequency of repeat chest x-ray due to inadequate inspiration and patient age. When an instructive video was utilized to better inform patients about the chest examination procedure, the repeat rate caused by inadequate inspiration was reduced for patients aged 41 - 60 years, but not those older. Analyses of repeat x-rays, stratified by causes and type of examination, assist in identifying problems and focusing effective corrective actions. Effective communication and instruction are important tools to improve health care service and radiographic practices for geriatric patients.

Take home messages

Effective patient-centered communication and instruction are fundamental to the success in health care services and radiologic procedures, and thus improve the quality of patient care and satisfaction.

Conflicts of interest

The authors declare no conflict of interest.

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References

1. Papp J. Quality management in the imaging sciences. 4th ed. St. Louis: Mosby Elsevier; 2011.
2. Foos DH, Sehnert WJ, Reiner B, Siegel EL, Segal A, Waldman DL. Digital radiography reject analysis: data collection methodology, results, and recommendations from an indepth investigation at two hospitals. J Digit Imaging 2009; 22(1): 89-98.
3. Andersen ER, Jorde J, Taoussi N, Yaqoob SH, Konst B, Seierstad T. Reject analysis in direct digital radiography. Acta Radiol 2012; 53(2): 174-8.
4. Owusu BJ, Darko EO, Hasford F, Addison EK, Asirifi JO. Film reject analysis and image quality in diagnostic Radiology Department of a Teaching hospital in Ghana. J Radiat Res Appl Sci 2014; 7(4): 589-94.
5. Little KJ, Reiser I, Liu L, Kinsey T, Sánchez AA, Haas K, et al. Unified database for rejected image analysis across multiple vendors in radiography. J Am Coll Radiol 2017; 14(2): 208-16.
6. Atkinson S, Neep M, Starkey D. Reject rate analysis in digital radiography: an Australian emergency imaging department case study. J Med Radiat Sci 2020; 67(1): 72-9.
7. Jones AK, Heintz, P, Geiser W, Goldman L, Jerjian K, Martin M, et al. Ongoing quality control in digital radiography: Report of AAPM Imaging Physics Committee Task Group 151. Med. Phys 2015; 42: 6658-70.
8. Lin CS, Chan PC, Huang KH, Lu CF, Chen YF, Lin Chen YO. Guidelines for reducing image retakes of general digital radiography. Advances in Mechanical Engineering 2016; 8(4): 1-6.

9. Itri JN. Patient-centered Radiology. RadioGraphics 2015; 35(6): 1835-46.
10. DeVoe JE, Wallace LS, Fryer GE, Jr. Patient age influences perceptions about health care communication. Fam Med 2009; 41(2): 126-33.
11. Peck BM. Age-related differences in doctor-patient interaction and patient satisfaction. Curr Gerontol Geriatr Res 2011; 2011: 137492.
12. Gossner J, Nau R. Geriatric chest imaging: when and how to image the elderly lung, age-related changes, and common pathologies. Radiol Res Pract 2013; 2013: 1-9.