Digital Radiography Reject Analysis: Results of a Survey Among Dutch Hospitals

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Medical imaging practice changed dramatically with the introduction of digital imaging. Although digital imaging has many advantages, it also has made it easier to delete images that are not of diagnostic quality. Mistakes in imaging—from improper patient positioning, patient movement during the examination, and selecting improper equipment—could go undetected when images are deleted. Such an approach would preclude a reject analysis from which valuable lessons could be learned.

In the analog days of radiography, saving the rejected films and then analyzing them was common practice among radiographers. In principle, reject analysis can be carried out easier and with better tools (ie, software) in the digital era, provided that rejected images are stored for analysis. Reject analysis and the subsequent lessons learned could reduce the number of repeat images, thus reducing imaging costs and decreasing patient exposure to radiation.

The purpose of this study, which was conducted by order of the Dutch Healthcare Inspectorate, was to investigate whether hospitals in the Netherlands store and analyze failed imaging and, if so, to identify the tools used to analyze those images.

Literature Review

The authors conducted a limited literature review using PubMed and Scopus databases using the following keywords: *reject analysis, repeat analysis, retake analysis, radiography, radiology, x-ray,* and *CT*. The search was limited to papers in English published in the past 10 years. The searches led to 33 sources in PubMed and to 43 sources in Scopus. Titles and abstracts of all articles were studied and, in several instances, the full papers were retrieved and studied. In some cases, this practice led to new references that also were studied. Issues found in the literature were used as input for a questionnaire. In addition, the information in the authors' original report (in Dutch) about reject analysis also was used to help shape this study.[1]

Questionnaire

The results of the literature review were translated into a questionnaire with 13 questions (in Dutch). The questionnaire asked about:

- the frequency of image rejection for various modalities
- the reasons for image rejection
- whether rejected images are logged, discarded, or saved for future evaluation
- whether a policy exists regarding rejected images
- whether the hospital has initiatives for reducing the number of rejected images
- whether rejected image evaluation is performed, and if not, would it be useful
- whether software is used to evaluate rejected images, and if not, would it be useful
- how the evaluation takes place and with whom
- whether rejected images are used for clinical lessons and to improve existing imaging protocols

The questions were used to guide interviews with quality managers from radiology departments at 13 Dutch hospitals. These quality managers were approached through contacts at 2 universities that have a medical imaging and radiation therapy educational program. These universities are in close contact with radiology departments because their students intern there. The managers were selected on the basis of their willingness and the willingness of the students to participate in the study, and the responses were kept anonymous.

The hospitals that contributed to the survey constitute approximately 16% of the 80 hospital conglomerates in the Netherlands; therefore, the results are not representative of all hospitals in the Netherlands but do indicate current practice. On average, the participating hospitals reject 0.7% of all images, but this number often is estimated (61% of the cases) and ranges from 0.023% to 7.5%.

Common reasons for rejection are improper positioning and a lack of imaging the required anatomy (mentioned by nearly all hospitals). About 60% of the respondents also mentioned incorrect equipment settings and motion blurring. Finally, about 30% mentioned equipment failure as a reason for image rejection (see **Figure**). All hospitals reported that Bucky imaging was the most error prone, and half indicated that imaging of the knee most often failed because the image typically is captured with the patient standing. This position can strain the knee, making it difficult for the patient to stand still, which makes positioning more difficult and contributes to motion artifacts on the image. Two hospitals mentioned bedside imaging to be error prone, and 1 said imaging that is completed infrequently often causes image rejection.

For technologists to learn from common imaging mistakes, rejected images must be stored for future evaluation and reference; however, this often is not done. In 69% of cases, the rejected images are deleted, and in another 8%, it is unknown what happens with them. Images are stored in 23% of cases. Although most hospitals do not store rejected images, 85% reported they do evaluate them; it is unclear what this evaluation entails. Four of these hospitals (31%) reported a yearly evaluation of all rejected images and subsequent deletion.

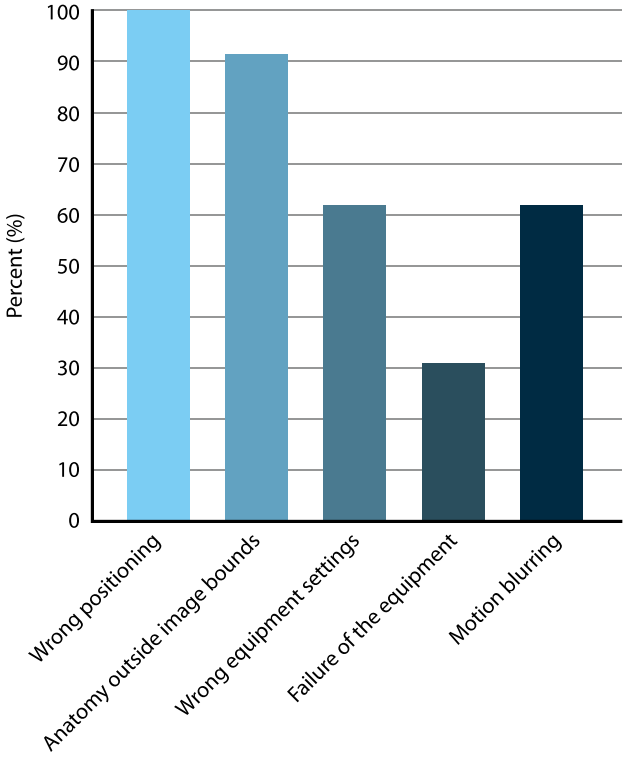

Figure. *Reasons hospitals reject images. Graph courtesy of the authors.*

Several software packages have been developed to help with reject image storage, evaluation, and analysis. Although most of the responding hospitals (77%) are aware of this software only 8% use it. The software is expensive, and some hospitals prefer to perform the analysis by hand.

The presented numbers are for radiography, but there are differences between modalities. For example, 83% of the hospitals reported evaluating rejected Bucky images, 20% reported this for angiography and fluoroscopy, and 40% reported this for computed tomography.

Discussion

Because participation in this study was voluntary and reported anonymously, it might have introduced some bias. Hospitals that are confident in the skills of their medical imaging personnel might have been inclined to participate more than those that were less confident. However, the results do not seem to indicate such a bias.

The reported reject rates (0.023-7.5%) are comparable to what has been reported in the literature. Foos et al, for example, reported a reject rate of 4% to 5% at 2 U.S. hospitals. In their study, approximately half of rejected images were caused by improper positioning or anatomy cutoff.[2] Hofmann et al calculated a deletion rate of 11% for 2 Norwegian hospitals in which 51% were caused by incorrect positioning.[3] Jones et al reported a reject rate of 8% to 10% in 1 hospital in which 77% of rejections were caused by improper positioning.[4] Lau et al mentioned a reject rate of 1% to 2% in their Chinese hospital in which 55% of rejections were caused by improper positioning.[5] Finally, Lin et al reported a retake rate of 5% in a Taiwanese hospital in which 56% of the rejected images were caused by inaccurate positioning.[6] In general, reject rates range from 1% to 11%, which are comparable to but slightly higher than what was found in this current study.

Similar to what is reported in the literature, improper positioning and motion blurring often were mentioned in this current study as reasons for failed imaging. In many cases, this involved Bucky imaging of knees and back in an upright position of elderly patients. It should be noted that radiation risk for these images and for this population is low. Retaking these images generally carries a lower risk than with computed tomography and fluoroscopic imaging. With these higher-dose modalities, for which radiation risks are higher, evaluation of rejected imaging seldom is performed.

Conclusion

The rejection rate for medical imaging is low in the Netherlands, but most hospitals do not store rejected images and have no policy guiding image rejection analysis. Many hospitals do perform some reject analysis on a sample of rejected images but usually without software tools and not for all imaging modalities. The reject analyses that are performed usually are for procedures that use a Bucky and carry low radiation risk. Because reject image analyses are related to radiation awareness, it would be beneficial to include higher-dose modalities such as computed tomography and fluoroscopy in these analyses. However, the authors acknowledge that it might be difficult for facilities to find time to implement reject analyses because of the high workload in radiology departments.

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To view the survey and supplemental figures, visit asrt.org/as.rt?cNsJ4x.

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