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The frequency of diagnostic errors in radiologic reports depends on the patient's age

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Abstract

Background: Patients who undergo treatment may suffer preventable medical errors. Some of these errors are due to diagnostic imaging procedures.

Purpose: To compare the frequency of diagnostic errors in different age groups in an urban European population.

Material and Methods: A total of 19 129 reported radiologic examinations were included.

During a 6-month period, the analyzed age groups were: children (aged 0 - 9 years), adults (40 - 49 years) and elderly (86 - 95 years).

Results: The frequency of radiologic examinations per year was 0.3 in children, 0.6 in adults and 1.1 in elderly. Significant errors were significantly more frequent in the elderly (1.7%) and children (1.4%) compared to adults (0.8%). There were 60 false positive reports and 232 false negative reports. Most errors were done by staff radiologists after hours when they reported on examinations outside their area of expertise.

Conclusion: The frequency of diagnostic errors is more frequent in children and elderly compared to middle-aged adults.

Key words

Diagnostic radiology – Elderly, Geriatrics, Observer performance, Quality assurance, Radiology reporting system, Radiological error

Subspecialties in radiology are usually based on organ systems, i.a. musculoskeletal-, gastrointestinal-, and neuroradiology. This subdivision is in line with the clinical subspecialties that we as radiologists serve. The reason for this subspecialization among clinicians as well as among radiologists is the huge amount of knowledge and the complexity of that knowledge confined in contemporary medicine. In contrast to clinical subspecialization, radiology may also use modalities as subspecialization criteria, i.a. ultrasound, cross-sectional imaging, and nuclear medicine. Radiology as well as clinical medicine also has a subspecialization based on age, i.e. pediatric radiology. However, clinical medicine has identified another age dependant specialty: geriatric medicine. The number of patients in the geriatric age group is increasing in industrialized countries. In 1950 the persons in Europe over 65 years constituted 8 % of the population. In 2000 this had increased to 15 %. The proportion is projected to reach 25 % in the year 2025 (1, 2). This increase in the proportion of elderly in the population is reflected also in the proportion of elderly that are examined in radiology departments. Moreover, we have observed that radiology in these elderly is often more complex compared to middle-aged and younger persons. Our assumption was that the frequency of erroneous radiology reports should reflect this complexity.

The aim of the study was to analyze the frequency of diagnostic errors in radiologic reports in relation to the patients' age.

MATERIAL AND METHODS

The study was performed at the Department of radiology in a university hospital in a city of 300 000 inhabitants. This is the only hospital in the city. The department performs about 150 000 examinations each year. The department has 30 staff radiologists (full-time equivalence) and 12 residents. All staff radiologists served in a “subspecialty branch” during day-time. After-hours they reported on the whole spectrum of radiologic examinations. The hospital does not have any thoracic surgery or neurosurgery departments.

We evaluated, in detail, three age-groups: patients 0 - 9 years of age – 3 640 examinations, patients 40 - 49 years of age – 6 049 examinations, and patients 86 - 95 years of age – 9 440 examinations.

The number of inhabitants was 28 500 in the age group 0 – 9 years, 35 000 in the age group 40 – 49 years, and 13 100 in the age group 86 – 95 years.

Our RIS (Sectra®, Linköping, Sweden) was searched for corrected reports during a 6-month period (Jan-June 2008).

Work-flow concerning radiologic reports

Radiologic examinations are reported in the majority of examinations by a staff radiologist. However, residents are also expected to write reports either when on call or when reading elective cases. All examinations are then subject to a second reading. The second reading is usually done by a staff radiologist or senior resident supervised by a staff radiologist. This is done either in connection to a conference, which are scheduled daily or weekly for the majority of the clinical departments. Also examinations that are not part of such a conference

are subject to a second reading. A regular exception from this second reading is out-patient musculoskeletal examinations that have been reported by one of the staff radiologists.

Insignificant comments

These were comments that did not add any new diagnostic information. These comments elucidated the original findings, putting them into a clinical context that might have changed since the original report. As such they could be highly important for the clinical situation. However, in this study these comments were not further elaborated or analyzed. Most of them were administrative and had no medical impact whatsoever.

Significant comments: Errors

These were corrections and alterations of the original report that could have significant impact on the patients' care. When an error is detected and corrected before a patient is harmed, the event is termed a *near-miss event* or a *close call*. Some errors go undetected and result in adverse outcomes to the patients; these are termed *adverse events* (3). In the past, a responsible individual was typically identified as the cause of an adverse event (4).

These errors were categorized according to the following: If the original report was done by a resident or a staff radiologist; if the examination was or was not of sufficient image quality; if the examination was done as an elective or as an emergency examination; the anatomical area examined; if the error constituted a false negative (FN) or a false positive (FP) reading in relation to the second reading of that particular examination.

Statistical analysis

Statistics were performed using Microsoft Office Excel 2003[®] (Microsoft Cooperation, Redmond, Washington) and SPSS 16.0[®] (SPSS Inc., Chicago, IL). Statistical tests were determined to be significant at $\alpha=0.05$ level. The data was analyzed with the Chi-square test (non-parametric test with Yate's correction) in order to know if there was a relationship between error and age in the different age groups.

RESULTS

The frequency of radiologic examinations per year and inhabitants was 0.3 in the age group 0-9 years, 0.6 in the age group 40-49 years, and 1.1 in the age group 86-95 years.

Out of 19 129 reported examinations, significant errors were found in 292 (1.53%). Evidence was found in support of an association between frequency of error and age when we compared adults and elderly groups ($p < 0.001$) (Table 1). The frequency was higher in elderly than in adults and similar to those in children (Table 1). In addition, there were 157 insignificant comments without medical significance (Table 1).

There were 60 FP and 232 FN reports. No examination was of significantly inferior image quality.

Errors were found in 95 skeletal, 92 chest, 59 abdominal and genito-urinary and 36 neuroradiology reports. There were also 10 other examinations with errors (Table 2). Errors were more common in chest reports and in abdominal and genito-urinary reports (Table 2). Errors were found in the reports of 112 (38%) examinations that were elective while 180 (62%) were performed after hours as emergency examinations. Residents did errors three times more often than staff radiologists (Table 3). However, over all most errors (83%) were done by staff radiologists reporting on examinations outside their area of expertise (Tables 3 and 4).

DISCUSSION

In a newly published study, the Swedish Health and Welfare Board found that almost 9 % of the patients treated as in-patients in somatic hospitals suffered from a medical error that could have been prevented (5). Such errors were particularly common in those over 65 years of age. One tenth of these errors led to permanent lesions and in 3 % the patients died. One tenth of the errors were due to deficient diagnosis including different types of imaging procedures. The same results have been shown in Denmark (6), Spain (7), the Netherlands (8), and in Canada (9).

Prior literature reviews indicate a high level of error within radiology (10, 11). The etiology of radiologic error is multifactorial. Those studies, however, did not take into account the importance of the patients' age as a confining factor. A search on PubMed on "radiology and geriatrics" gives 819 hits. A search on "radiology and pediatrics" gives 13197 hits. This reflects the profession's interest in these different age groups. Is this really justified? In this study we have shown that the number of elderly outnumber the number of children. We have also shown that the frequency of radiologic examination is far higher in the elderly (1.1 examinations per year) than in children (0.3 examinations per year). Our finding is that errors in the diagnostic reports are just as high in the elderly compared to children and twice as high as in the middle-aged. This speaks in favor of that geriatric radiology should attain more attention. This 1 % frequency of erroneous reports in our series is in line with the 1 % diagnostic error found in the study by Soop et al (5).

The fact that the frequency of radiographic examinations in the elderly is twice the frequency in the adult group reflects that many diseases have an age-dependent incidence. However, in

our experience it also reflects that disease presentation is usually complex and spurious in the elderly, and thereby is likely to generate more examinations in order to come to a diagnosis and thereby a correct therapy.

Image quality did not have any crucial impact on the number of deviating or erroneous reports. This indicates that contemporary imaging techniques can take care of most of the obstacles that hamper good image quality in the elderly, such as difficulty in positioning. Image quality can supposedly be hampered by the patient's inability to cooperate in breath holding. Short exposure time and acquisition time obviously compensate for this. This is particularly true for multi-slice CT where artifacts due to breathing and motion are much less of a problem today.

An interesting observation was that the vast majority of errors was made by staff radiologists who worked after-hours in areas outside their area of expertise. In a prior study, Branstetter (12) reported that subspecialized attending radiologists who interpreted emergency examinations outside their area of expertise had error rates similar to those of radiology residents. Non-radiologists had even higher error rates when interpreting examinations in the emergency room. Senior staff had an error rate of 0.5% for plain radiograms and an error rate of 2.0% for CT. A "substantial discordance" in that study was defined as difference in interpretation that might impact the care of the patient in the time between a preliminary report and a final interpretation. Such an incorrect interpretation might reasonably have lead to an inappropriate care. Several studies have reported different aspects of errors in radiology (13-20). Major discrepancies have been found in as much as 13% (14) and as low as 0.1% (15). Many of the studies that have reported a much higher frequency of errors than the result in our report have had a much less strict criterion for categorizing an error as major and of clinical significance. There is a tradition in Sweden to give relatively short reports that only

takes into account findings that are relevant for the clinical situation at hand. In contrast, there is a tradition in the US to give a complete description of the radiograms and to make a summary and clinically relevant statement at the end, i.e. the impression.

Our study did not focus on the absolute error rates but had another focus. We wanted to provide the radiologic society with the relative figures for errors in reports in relation to the patients' age. This showed a much higher frequency of error in the elderly compared to adults. Health care failure mode and effect analysis (FMEA) is a qualitative method used to proactively detect risks to the patient in a particular health care process and correct potential errors before adverse events occur (21). Basically, most errors are initiated by system or process failure (4). This study is the first to document the correlation between errors in radiology and the age of the patients'. One limitation of the study is that it is retrospective. It also specifically addresses errors in reporting. This can be considered a surrogate endpoint. The true endpoint would have been to measure morbidity and mortality of erroneous reporting of radiologic examinations. However, we feel that any discrepancies in this respect would hit all three age groups in the same way.

In conclusion we found that the frequency of errors in radiologic reports was high in children and even more so in elderly. In a situation where the elderly population is increasing it is important to consider that these elderly are examined radiologically much more frequently than younger individuals. The radiologic presentation is often complex. This leads to a higher proportion of errors in the radiologic reports. Patient safety is a major priority for healthcare services and one of the cornerstones of clinical governance. Is it time to introduce a new "subspecialty": geriatric radiology? At least we must focus on more education and training in

geriatric radiology. This should focus on the vague clinical presentation as well as on the complexity of the radiologic findings of different disease entities in the elderly.

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Table 1. Diagnostic errors in different age groups

Age group	Total	Insignificant comments	Errors
0-9 years	3 640	34	52 (1.4%)
40-49 years	6 049	64	61 (1.0%)*
86-95 years	9 440	59	179 (1.9%)*
Total	19 129	157	292 (1.5%)

* $p < 0.001$

Note: in the errors column, in parenthesis, the percentage of error related to the total (n) examinations in each age group.

Table 2

Diagnostic errors per anatomical area.

	Total	Errors	
		Total	%
Chest	3 826	92	2.4
Neuroradiology	2 104	36	1.7
Abdominal/ Genito-urinary	2 295	59	2.6
Skeletal	9 565	95	1.0
Others*	1 339	10	0.7
Total	19 129	292	1.5

All differences were significant ($p < 0.005$)

* Including phlebography, endovascular procedures, mammography, odontologic examinations

Table 3

Errors related to the reporting radiologist's experience, *i.e.* residents compared to staff radiologists.

		Errors	
	Total	Total	%
Residents	1 148	47	4.1
Staff radiologist	17 981	245	1.4
Total	19 129	292	1.5

The difference is significant ($p < 0.01$)

Table 4

Errors in relation to if the examination was done as an emergency examination or an elective examination.

		Errors	
	Total	Total	%
Emergency examination	10 608	180	1.9
Elective examination	8 521	112	1.3
Total	19 129	292	1.5

The difference is significant ($p \leq 0.05$)