

Do double reading and a radiograph discussion at the emergency department influence radiology discrepancies?

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Abstract

Objective: To assess the added value of the double reading of the radiograph and the presence of a daily radiograph meeting at the emergency department by comparing the occurrence and type of discrepancies made in plain musculoskeletal radiographs requested by the general practitioner (GP) and the emergency department (ED).

Methods: Information about 138 discrepancies in plain musculoskeletal radiographs requested by the GP and 50 discrepancies in plain musculoskeletal radiographs requested by the ED was derived from a Dutch hospital information system. Information about the organization of care in the different care pathways for diagnosing fractures used within the hospital was collected from the hospital information system and on-site visits. The differences in discrepancies were analysed using the Pearson Chi-square test, Fisher's Exact test and ANOVA.

Results: The hospital has a discrepancy rate of 0.14 and 0.03 in plain radiographs requested by the GP and ED. The discrepancies in plain radiographs requested by the GP do not significantly differ from the discrepancies in the same type of imaging requested by the ED on the type of discrepancy, the severity of the discrepancy, method of discrepancy discovery, the maker of the discrepancy, the presence of supervision and the discovery time of the discrepancy.

Conclusion: The discrepancies in plain radiographs requested by the GP and ED do not significantly differ from each other and there is no added value to the double reading of the radiograph. No clear conclusion can be given about the influence of the radiograph meeting on the discrepancies.

Keywords: Discrepancies, plain musculoskeletal radiograph, general practitioner, emergency department, double reading, multidisciplinary team meeting, care pathway

Introduction

Missed fractures are one of the most common discrepancies found in radiology reporting [1]. Discrepancies are differences of opinions between conscientious practitioners which can lead to misdiagnosis or missing diagnosis [2]. Discrepancies can be of clinical importance and influence the clinical management and health outcome of the patient [2, 3]. Plain musculoskeletal radiographs are the primary imaging modality to diagnose fractures [1, 4]. Patients with a suspected fracture can follow three different care pathways leading to the radiology department in the Netherlands; (1) the patient is directly referred for a musculoskeletal radiograph by the general practitioner (GP), (2) the patient is referred to the emergency department (ED) by the GP or (3) the patient goes directly to the ED, where after assessment, the patient is referred for a musculoskeletal radiograph [5].

In the first care pathway, the patient is treated within the primary care setting, while in the second and third care pathway the patient is treated within the hospital setting. Additionally, other differences include differences in communication and feedback between the physician and radiologist, and differences in organizational aspects [6, 7].

The failure to identify fractures is the most common error in EDs and may account for 41-80% of the diagnostic errors made within these settings [8]. In contrast to when the radiograph is requested by the GP, in the ED multiple medical professionals can assess the radiological image and direct communication can take place between the radiologist and physician [6, 7]. In addition, to decrease the risk of errors, it is mandatory in the Netherlands to discuss the radiographs of all patients that go through the ED during a radiograph meeting a day later [9, 10].

The influence of this meeting and the other differences in the care pathway for diagnosing fractures between the GP and ED on the occurrence of discrepancies is unknown. Nevertheless, it is assumable that the differences in the care pathways influence the occurrence and type of discrepancies made in plain radiographs and since the failure to identify fractures accounts for a very high percentage of errors made within the ED, the failure to identify fractures might be an even bigger problem within the primary care setting.

Previous research has focused on identifying the cause of misdiagnoses, errors or discrepancies in radiology reports by looking at the behaviour of the radiologist [8, 11, 12]. Possible causes of radiology discrepancies can, however, also be found within the organization of care and care pathways applied in a hospital. No previous research has focused on exploring the influence of the double reading of the radiograph and the radiograph meeting present in the ED pathway for diagnosing fractures on the occurrence and type of discrepancies. To fill the gap in existing literature, this study aims to determine if the discrepancies made in plain musculoskeletal radiographs requested by the GP differ from the discrepancies made in the same type of imaging requested by the ED and if the double reading of the radiograph and the presence of a radiograph meeting at the ED influence those difference.

Method

Data about discrepancies in plain musculoskeletal radiographs was derived from a Dutch teaching hospital information system. The hospital has two different locations in the East of the Netherlands, location Almelo and Hengelo, and plain radiographs can be made at the radiology department present at both locations.

The discrepancy database included several variables that could be used to categorize the discrepancies. Within the database the following characteristics about the discrepancies were provided: (1) the date and time of discrepancy registration, (2) the specialisation that requested the radiographic image, (3) the transaction code of the radiographic image e.g. the area of imaging, (4) the radiology report and when applicable the addendum, (5) who did the reading of the radiograph e.g. the maker of the discrepancy and if the discrepancy was made under

supervision, (6) a classification of the discrepancy, (7) an explanation of the discrepancy, (8) how the discrepancy was discovered, and (9) the severity of the discrepancy based on the scoring system described by Melvin et al [13]. Two additional variables were created (10) the time it took to discover the discrepancy and (11) a classification of the radiologist that made the original radiology report into radiology resident or radiologist.

Included in this research were plain radiographs requested by the GP or the ED between February 2017 and February 2019. Duplications of discrepancies as well as discrepancies with missing information on any of the previously mentioned variables were excluded. This resulted in a dataset with 138 discrepancies in plain radiographs requested by the GP and 50 discrepancies in plain radiographs requested by the ED.

Information about the organization of care and care pathways used within the radiology and emergency department of the Dutch hospital was collected using desk research and on-site visits. Where possible, information about the organization of care and care pathways was derived from the hospital information system. The outcomes of the on-site visits were compared to the protocols and care pathways used within the hospital. Any deviation was discussed with the relevant doctor, radiologist and/or department.

The dataset was analysed using SPSS Statistics 25. For all the categorical variables, a Pearson Chi-square test or, when possible, the Fisher's Exact Test was used to determine if there were significant differences in the discrepancies found in plain radiographs requested by the GP compared to the discrepancies made in the same type of imaging requested by the ED. For the continuous variables, a one-way analysis of variance (ANOVA) was used. P values $\leq .05$ were considered statistically significant.

Results

Data-analysis

This research found a discrepancy rate of 0.14 percent and 0.03 percent in plain radiographs respectively requested by the GP and ED. An overview of the characteristics of the discrepancies can be found in Table 1.

Table 1 shows that the discrepancies made in plain radiographs can often be described as a perception and observation error, followed by cognitive and interpretation error. Most of the discrepancies in the radiographs are discovered by a second assessment by the radiologist and are primarily of slight and significant consequence for the patient. Most of the discrepancies are made by the radiology resident and almost all discrepancies are made without supervision by a radiologist. The median discovery time of the discrepancy is 5 days when the radiograph is requested by the GP and 1 day if the radiograph is requested by the ED.

The results of the Pearson Chi-square test, Fisher's Exact Test and the ANOVA are also provided in Table 1. Those results show that no significant difference ($p \geq .05$) was found in the discrepancies based on the referral, either by the GP or ED.

Table 1: Comparing discrepancies in plain musculoskeletal radiographs per referral.

Discrepancy classification		General Practitioner		Emergency department		P-value
		n=138	%	n=50	%	
Discrepancy classification	Cognitive/interpretation	34	24,6	18	36,0	0.519 ^a
	No fault	2	1,4	-	-	
	Overdiagnosis	1	0,7	-	-	
	Perception/observation	98	71,0	31	62,0	
Method of discovery	System-related	3	2,2	1	2,0	0.361 ^a
	Assessment by non-radiologist	6	4,3	2	4,0	
	Repeat research	28	20,3	9	18,0	
	New advanced research	34	24,6	7	14,0	
Severity of the discrepancy	Second assessment radiologist	70	50,7	32	64,0	0.272 ^a
	1. Not clinically relevant	12	8,7	4	8,0	
	2. Slight	76	55,1	21	42,0	
	3. Significant	47	34,1	22	44,0	
Addendum necessary	4. Grave	3	2,2	3	6,0	0.312 ^b
	Yes	82	59,4	34	68,0	
Reader of the radiograph	No	56	40,6	16	32,0	1.000 ^b
	Radiology resident	83	60,1	30	60,0	
Supervision	Radiologist	55	39,9	20	40,0	0.327 ^b
	Yes	5	3,6	0	0	
Days between imaging and finding of discrepancy	No	133	96,4	50	100	0.102 ^c
	Median (std.)	5	(54)	1	(28)	

^a results Pearson Chi-square test^b results Fisher's Exact test^c results ANOVA based on medians

Organization of care and pathway analysis.

An overview of the care pathways used within the hospital is provided in Figure 1, which depicts the differences within the care delivery process for diagnosing fractures based on referral. There are two main differences in the care delivery process for diagnosing fractures, namely the presence of a multidisciplinary team meeting and the number of people that look at the plain radiograph. Independent on who initially requested the plain radiograph, when the patient is referred to the ED, the radiograph and the corresponding diagnose are discussed a day later during a mandatory ED radiograph meeting [14]. This radiograph meeting takes places every day at 8.00 hr in the morning at location Almelo with a radiological, surgical and orthopaedic resident, a radiologist, a surgeon, an orthopaedist and interested residents, doctors or physicians' assistants from the ED and can therefore be classified as a multidisciplinary team meeting [7, 15]. When a patient is not referred towards the ED, the plain radiograph is not discussed during the meeting.

The number of people that look at the plain radiograph also differs between the care pathways. All plain radiographs are first assessed by the laboratory technician, to see if the results of the radiographs correspond with the protocols [16]. Beside the assessment of the laboratory technician, a radiologist or a radiology resident, possibly under the supervision of a radiologist, assesses the radiograph [16]. If the patient is referred from the ED for a plain radiograph, the image is also looked at by an emergency doctor and/or an emergency physician assistant [6].

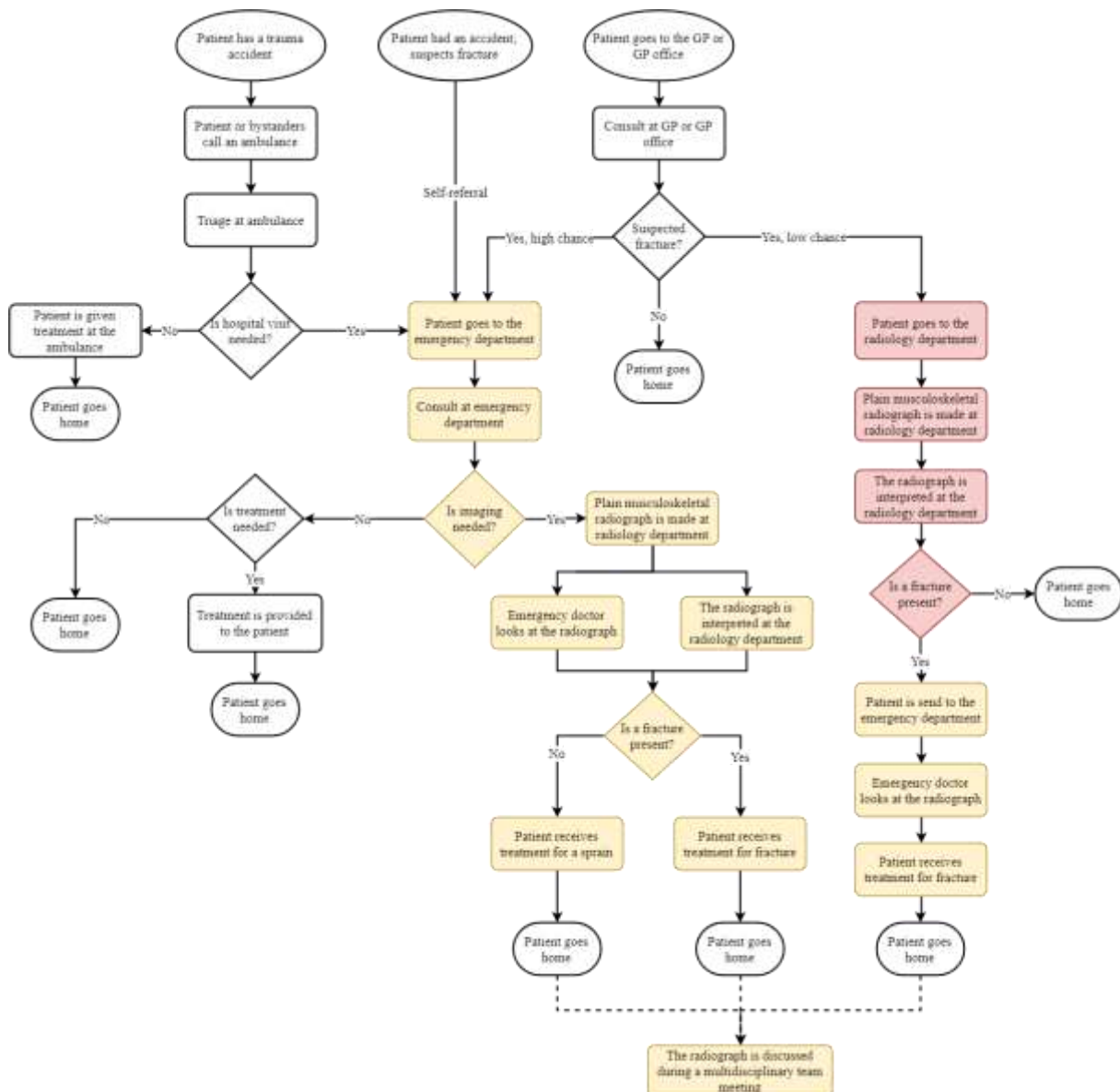


Figure 1: Flow chart for diagnosing fractures

Discussion

This study found a discrepancy rate of 0.14 percent and 0.03 percent in plain radiographs requested by the GP and ED. This study also found that regardless of the referral, discrepancies in plain radiographs can often be classified as perception/observation or cognitive/interpretation errors and are primarily of slight and significant severity for the patient. On all the characteristics included in this research, the discrepancies in plain radiographs do not significantly differ, which suggest that the type and the number of discrepancies made in plain radiographs are not influenced by the referral.

The description of the care pathway for diagnosing fractures shows that the double reading of the radiographs at the ED by means of the multi-disciplinary meeting occurs after the radiologist has written the radiology report. However, this is not the chronological order of clinical treatment in practice. Sometimes the emergency physicians diagnose and initiate treatment on their own perspective, thus before a radiology report is written by the radiologist. The double reading at the ED, therefore, does not influence the pure radiology discrepancies in plain radiographs requested by the ED and GP.

The mandatory radiograph meeting at the ED department is partly implemented to discuss possible discrepancies in the assessment of the radiograph between the emergency physician and the radiologist. This research did not include information about the occurrence of this type of discrepancies between the emergency physician and the radiologist. Previous research has found a discrepancy rate between the emergency physician and the radiologist of only two percent [17]. Nevertheless, it is premature to conclude that the multidisciplinary radiograph meeting does not influence the occurrence and type of discrepancies made in plain radiographs. Further research is necessary to determine the influence of the radiograph meeting on the occurrence and type of discrepancies in plain radiographs between emergency physicians and the radiologists.

The findings of this study confirm that perception errors are the most common radiology discrepancy in plain radiographs requested by the GP and ED as described in radiology literature [18]. The discrepancy rates found within this research, however, are lower than expected. Previous research has found discrepancy rates between 0.7 and 6.0 percent in plain radiographs [19-21]. The low discrepancy rates found within this study could possibly be attributed to the focus area of this research; plain radiographs requested by the GP and ED [22]. Radiologists interpret and report a whole range of different images by a wide variance of requesters, and plain radiographs requested by the GP and ED form only a part of their radiological interpretations. Nevertheless, plain radiographs account for around 60-70 percent of the images being taken at a Dutch radiology department and a higher discrepancy rate would have been justified [23].

The recording of the discrepancies could also have led to the low number of discrepancies found within this research [22]. Within the hospital, radiologist and radiology residents are responsible for reporting any discrepancies that occur in the hospital system. Consistent reporting of the discrepancies asks for a blame-free culture and a focus on quality improvement within the radiology department [24, 25]. Recording a discrepancy can be confronting and any radiologist or radiology resident that does not see the need for recording, is not completely sure of the discrepancy or is afraid of repercussion may neglect to report the discrepancy. The actual number of discrepancies in plain radiograph can, therefore, be higher than reported in this study. It is however unlikely that the hospital reports proportionately fewer discrepancies in comparison to other hospitals.

This research also has some limitations. First, this study was based on a relatively small number of discrepancies that occurred in one hospital in the Netherlands and therefore the results might not be generalisable to other hospitals or other regions. To validate the results of this research more discrepancies in one hospital or across multiple hospitals should be analysed, preferably in a prospective study.

Second, the retrospective design of this study made it impossible to collect additional information about the discrepancies in plain radiographs or the discrepancies between the emergency physician and the radiologist. It was also not possible to explicitly test the influence of the double reading by the emergency physician and the multidisciplinary radiograph meeting on the occurrence and type of discrepancies in plain radiographs requested by the GP and ED. Future research should, therefore, have a prospective design to provide a more elaborate investigation on the discrepancies in plain radiographs requested by the GP and ED and on the added value of the double reading by the emergency physician and the mandatory radiograph meeting at the ED.

This is the first study that explicitly compared the discrepancies in plain radiographs requested by the general practitioner and emergency department. In addition, this study also looked at the influence of the double reading of the radiograph and the multidisciplinary radiograph meeting in the ED care pathway on the discrepancies. This study found that fewer discrepancies occur in plain radiographs requested by the ED, but when a discrepancy occurs

the characteristics of the discrepancies in plain radiographs are equal across radiographs requested by the GP and ED. The double reading by the emergency physician at the ED has no influence on the discrepancies in plain radiographs requested by the GP and ED and based on the result of this research it is not possible to conclude if the radiograph meeting at the ED influences the occurrence and type of discrepancies in plain radiographs.

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