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Diagnostic Imaging Requisition Quality When Using an Electronic Medical Record: a Before-After Study

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Abstract. Diagnostic imaging requisition (DIR) content is legally constrained for care quality and patient safety concerns. A French national indicator, based on administrative and clinical data, has been introduced to monitor nationwide the conformity of such documents (CDIR). The purpose of this study was to assess the effect on CDIR of the deployment of the ORBIS™ electronic medical record at the Tenon hospital (Paris, France). A before-after study has been carried out. A significant increase of CDIR, from 37.0% (n=676) to 49.1% (n=800), was observed ($p < 10^{-5}$). Conformity of administrative criteria improved, but there was no statistical difference of clinical criteria conformity, despite the improvement of clinical history documentation (100%). Up to five different paper-based requisition forms were used by clinical departments in the before period. In the after period, only 27.1% of requisitions were ORBIS-edited with a CDIR of 66.8% (n=217). In both periods, CDIR was correlated to the level of standardization of the forms.

Keywords. Diagnostic imaging, Forms and Records Control, Medical Records.

Introduction

The content of imaging requisitions has an effect on the quality of imaging reports and services provided by radiologists [1]. Indeed, in order to determine the appropriate imaging procedures and correctly interpret them, radiologists require accurate clinical, laboratory, and historical patient information. In the USA, the Health Care Financing Administration regards billing for radiologic examinations without an appropriate indication as unlawful, and both the referring physician and the radiologist are liable. Similarly, in France, the referring physician is legally bound to provide the radiologist with information that justifies the exposure of her patient to ionizing radiation.

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However, inaccurate, inadequate, and missing information, which may have detrimental effects on patient management and health quality, are still observed in radiology requisitions [2]. Improvement actions to promote the provision of the medical justification of imaging requisitions have demonstrated their effectiveness [3]. For instance, the use of computerized physician order entry systems may improve the provision of clinical histories, and thus the quality of imaging requisitions [4,5]. However, it may not improve the communication of clinically relevant information [6].

In France, the Authority for Health (HAS) is the National Agency responsible for the improvement of the quality, safety, and effectiveness of health care. In 2008, HAS provided indicators to be yearly evaluated in all healthcare centres in order to assess care quality and safety nationwide. Among them, one indicator measures the conformity of diagnostic imaging requisitions (CDIR) defined as the proportion of diagnostic imaging requisitions using ultrasound, Computed Tomography scans (CT scan) and Magnetic Resonance Imaging (MRI), that include the information necessary to perform and interpret adequately radiographies. In 2013, the Tenon hospital, one of the 37 hospitals of the Assistance Publique – Hôpitaux de Paris (the largest University Medical Centre in Europe), has deployed the ORBIS™ hospital information system (HIS) from Agfa HealthCare. One of the system functionalities is to provide an electronic medical record (EMR) allowing the generation of computerized requisitions.

The aim of this work is to evaluate whether the deployment of ORBIS improved the quality of diagnostic imaging requisitions at the Tenon hospital. Another objective is to study the impact of the different forms used by clinical departments before the deployment of ORBIS, and the effect of standardization and computerization on the CDIR indicator.

1. Material and Methods

The national CDIR indicator is defined by HAS as the combination of eight criteria. Five are administrative criteria and pertain to the date of the requisition, the name of the referring physician, the referring department, the first and last names of the patient, and her birthdate. The three other criteria are clinical criteria and specify the anatomical region, the patient's clinical history, and the indication of the prescribed imaging procedures. The CDIR indicator is the percentage of radiology requisitions that simultaneously satisfy the eight criteria.

Prior to the deployment of ORBIS, the Tenon hospital used to be essentially paper-based. All documents in patient medical records were rather heterogeneous from one clinical department to the other. For instance, up to five different paper-based diagnostic imaging requisition forms could be used by clinical departments (see Figure 1). F^1 is similar to a letter, with few identified items, essentially administrative data (first and last names of the patient, requisition date, referring clinical department, and signature of the referring physician). F^1 is used by almost all departments. F^2 is a little bit more structured and mainly used by the Gynaecology and the Otolaryngology Departments. F^3 is the "old" hospital-recommended requisition form that should not be used since the release of F^5, the most recent requisition form, which is totally structured, with fields that exhaustively describe the patient condition, the whole clinical history, the anatomical region to explore, and the question to be answered by imaging exams. F^5 is expected to be used by all departments. F^4 is also quite well structured and used

by the sole Emergency Department. Some forms are hand-written. All forms are paper-based and sent by fax to the Radiology Department.

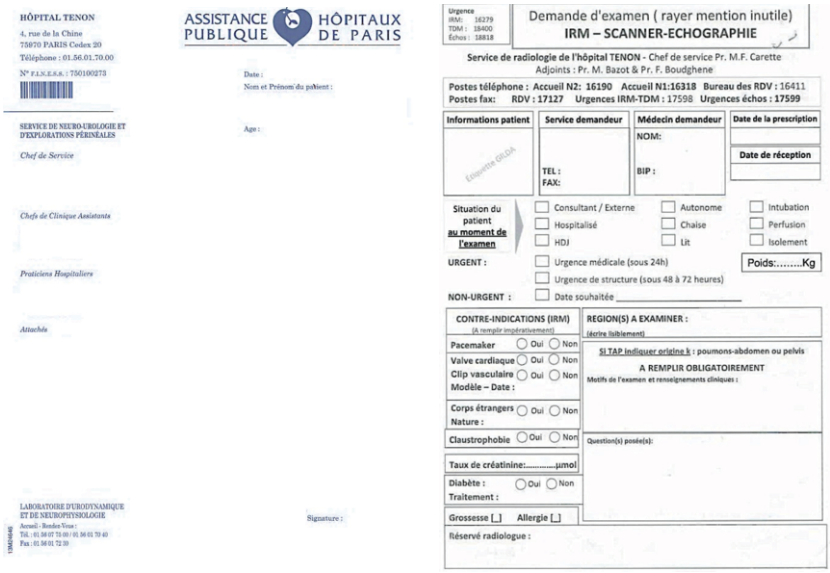

Figure 1. Requisition forms F^{1} (left) and F^{5} (right) illustrating the different levels of document structuring.

ORBIS is built as a shared patient-centric EMR, providing access to patients' histories, including images, clinical and administrative data. The view and usage of the EMR can be adapted by the specification of electronic forms for the different medical documents. A specific form (F^{ORBIS}) for diagnostic imaging requisitions has been developed to be used by all clinical departments from January 2014. Administrative fields are automatically filled. The clinical history of the patient and the emergency state of the requisition are mandatory to validate the requisition. Contraindications to imaging procedures and the clinical indication are optional.

We conducted a before-after study without control group. The *before* period corresponds to 2013, the year before the deployment of ORBIS. All requisition forms of 2013 were retrospectively collected among which the "before sample" was randomly extracted. The *after* period was between January 2014 and June 2014 where all requisition forms were prospectively collected to constitute the "after sample". In the before period, requisitions were paper-based and sent by fax, whereas they were either paper-based and sent by fax or ORBIS-edited in the after period. Inclusion criteria for the study were radiology requisitions with diagnostic purposes, directed to the Radiology Department of Tenon hospital, ordered by physicians of Tenon hospital, for patients hospitalized at the Tenon hospital. Besides the eight CDIR criteria, other variables were collected such as the medical imaging technique (MRI, CT, ultrasound), contraindications to imaging procedures, the type of the requisition form, and the length, in number of words, of clinical histories. Statistical tests have been done using Pearson's chi-squared test and One-Way ANOVA with a significance level of 0.05.

2. Results

A total of 1476 radiology requisitions were included in the study, 676 in the before sample, 800 in the after sample made of 583 paper-based requisitions sent by fax and 217 ORBIS-edited requisitions sent using the HIS. We observed a significant increase of the CDIR from 37.0% in the before period, to 49.1% (CI 0.95: 45.6%-52.6%) in the after period ($p < 10^{-5}$). More precisely, as displayed in Table 1, CDIR was 42.5% in the after/paper-based subgroup, and 66.8% in the after/ORBIS subgroup. Considering the three subgroups, before, after/paper-based, and after/ORBIS, the conformity of the five administrative criteria of the CDIR was improved, especially thanks to the date of requisition that went from 52.8%, to 64.5%, and 100% in the after/ORBIS subgroup. On the contrary, the global rate for the three clinical criteria remained stable. There was a statistical difference in the number of words used to describe clinical histories in the three subgroups ($p < 10^{-7}$). The provision of contraindications to imaging procedures was significantly different according to the subgroup ($p < 10^{-5}$).

Table 1. Rates of CDIR as well as administrative and clinical criteria in the three subgroups.

	Before	After	
	(n=676)	Paper-based (n=583)	ORBIS (n=217)
CDIR [CI 0.95]	37.0%[33.3%-40.7%]	42.5%[38.5%-46.7%]	66.8%[60.1%-73.0%]
Administrative criteria	49.3%	56.4%	84.3%
- Date of requisition	52.8%	64.5%	100.0%
Clinical criteria	74.3%	74.3%	77.9%
- Clinical indication	79.7%	82.2%	77.9%
- Clinical history	92.9%	90.2%	100.0%
(average # words)	(15)	(13)	(21)
Contraindications	78.8%	83.4%	17.3%

Table 2 reports the rates of CDIR for each type of requisition forms in both before and after periods. F^1 had a stable CDIR and a stable rate of use. F^2 wasn't improved (0% for both periods) and was poorly used. F^3 and F^5 were the most used forms in the before period, with a CDIR of 0.4% and 70.3%, resp. In the after period, F^3 usage decreased, with a CDIR that remained low ($\leq$1.0%), whereas F^5 usage and CDIR remained stable. F^4 had a high CDIR in both periods. F^{ORBIS}, only used in the after period, was poorly used (27.1%) with a CDIR of 66.8%.

Table 2. Distribution of CDIR and corresponding usage in the before and after subgroups.

	n	F^1	F^2	F^3	F^4	F^5	F^{ORBIS}
Before	676	27.9% (16.7%)	0.0% (3.4%)	0.4% (36.1%)	86.2% (8.6%)	70.3% (35.5%)	– –
After	800	23.5% (14.9%)	0.0% (3.0%)	1.0% (13.0%)	86.0% (5.4%)	62.1% (36.6%)	66.8% (27.1%)

3. Discussion and conclusion

As already reported by previous studies, conformity of administrative criteria, especially when they were automatically filled or mandatory, was significantly increased. However, the documentation of clinical criteria was not improved. If the provision of clinical history improved to reach 100%, with a significant increase of the number of words, which could be explained by the use of copy-paste within the EMR,

the clinical indication of imaging exams was often missing. In addition, the conformity of clinical history criterion may be overrated since it was only checked on a syntactic basis, and no assessment of the medical relevance was performed. Surprisingly, the provision of contraindications to imaging procedures decreased with ORBIS. The fact that the criterion does not belong to the CDIR indicator and was optional in F^{ORBIS} could explain this result. Referring physicians may also consider they don't need to provide an information that radiologists may find in the shared EMR. Yet, this could not be the case, which represents a potential hazard for patient safety.

F^1, F^2, F^4 and F^5 were used in comparable proportions in both before and after periods. Thus, the 27.1% of F^{ORBIS} forms in the after/ORBIS subgroup may mainly come from the decrease of F^3 use. Physicians were indeed ready to move to ORBIS from the old form F^3 they should already have abandoned. F^{ORBIS} has been used by a limited number of departments since its introduction, even though its usage is increasing over time. The high CDIR rates (86.2% and 86.0%) observed for F^4 are explained by the fact this form was used by the Emergency Department that has been using an EMR (UrQual, McKesson) for several years. F^4 is thus a computer-edited requisition form, printed and sent by fax because the two systems ORBIS and UrQual are not connected. Although F^4 CDIR was very high, the content of F^{ORBIS} form was not defined to be identical to that of F^4. However, even if this had been the case, F^{ORBIS} CDIR may have been lower than F^4 CDIR. Beyond the use of the form, F^4 CDIR may come from the maturity of Emergency Department physicians in the use of their EMR and from their compliance to fill up CDIR criteria.

This study has several limitations. It is a before-after study without control group which limits the interpretation of the impact of ORBIS. However, results showed that CDIR was significantly improved after the deployment of ORBIS in the Tenon hospital. We even observed a positive contamination of ORBIS with the improvement of CDIR for non-ORBIS paper-based forms that were still used after the deployment of ORBIS. The next step is thus to support the deployment of ORBIS by training physicians to the use of the system, and by encouraging them to change their habits and abandon paper-based forms and sending faxes.

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