STUDY OF CLINICAL WORKFLOW AND INFORMATION FLOW OF A BREAST CARE UNIT

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Keywords: Clinical protocols, Information flows, Processes, Breast diseases, Hospital communication systems.

Abstract: Introduction. The study of the clinical workflows and information flows in healthcare institutions is of vital importance to improve its effectiveness and efficiency. At Hospital São João, Oporto – Portugal, a Diagnostic Breast Unit (DBU) was recently created. The implementation of a new Electronic Patient Record (EPR) called Breast.Care triggered the need to better understand the DBU processes and suggest improvements. Aim. To describe clinical workflows and information flows in DBU, detect problems and propose solutions for better communication among different actors. Methods. The study started with a direct observation period with a total of 24 hours. The observed processes and flows were transcribed into free text and then into structured text, tables and Unified Modeling Language (UML) diagrams (activity and partition-activity). The structured text and diagrams were analysed to find possible improvements. Results. Seven main processes were identified representing how different actors (humans and computers) work together. Three communication process improvements between humans were detected (e.g. changing timing of patient data insertion to facilitate reading access to others), three human–machine improvements (e.g. changing computer medical forms) and one between machines (creating specific links between information systems). Discussion. Analysing workflow and information flow in DBU allowed the detection of communication problems and the improvement of those through changes in EPR and in DBU current processes.

1 INTRODUCTION

The Diagnostic Breast Unit (DBU), a part of the Hospital Breast Center was created to improve health care delivery to patients with breast problems at Hospital São João (HSJ). A team of experts on breast diseases work together in the Unit optimizing the diagnosis of breast problems. The Unit provides an integrated monitoring of patients, creates greater comfort and prevents increase of hospital patient's visits, greatly reducing the waiting time to diagnosis.

This unit aims at being credited by the European Society of Mastology (EUSOMA) and therefore meets all the requirements needed. As a new unit within the community hospital and having their own team of experts, problems and difficulties on communication and information flow patterns with the "outside world", including other hospital departments, are to be expected.

Managing the diversity of medical data and its communication in DBU, is not an easy task, due to the existence of many heterogeneous processes. Understanding those processes, workflows and its information flows is of vital importance to improve its effectiveness and efficiency. Currently, most of clinical data are handled by software applications, which are known to become the engine of data management (Keizer 2005) (Oroviogoicoechea 2007).

Often the terms process and workflow are used as synonyms or side by side without any distinctive differences (Knolmayer 2000) (Reijers 2003). In

Silva V., João Cardoso M., Fonseca J. and Cruz-Correia R. (2010).
STUDY OF CLINICAL WORKFLOW AND INFORMATION FLOW OF A BREAST CARE UNIT.
In *Proceedings of the Third International Conference on Health Informatics*, pages 294-301
DOI: 10.5220/0002744502940301

this paper, the following definitions will be used: a) Process - a way for an enterprise to organize work and resources (people, equipment, information, computer applications, etc.) to accomplish its aims. Nowadays, organizations try to arrange work and resources to achieve a specific output – a result – for a specific costumer. It can be simply defined as a collection of interrelated work tasks, initiated in response to an event, that achieve a specific result for the process' costumer (Sharp 2001); b) Workflow - simply refers to tasks, resources and triggers associated with a specific process. It is dependent on the process and contains the sequence of tasks and information about data and facilities the execution of functions (Becker 1999); c) Information flow - can be defined as a serie of successive events, between the generation of information from a source of information and acceptance by a receiver. It is designed to promote some kind of change (Silva 2008). With the advance of information technologies, information flows tend to be a multifocal and multioriented. All organizations need systematic and consistent efforts to influence and monitor all their information flow by promoting strategies for that purpose (Krovi 2003). The retrieve of information flow is essential to recognize its efficiency (Jacoski 2005).

Numerous authors have discussed the theoretical benefits of a well established clinical workflow (Duitshof 1995; Holland 2006; Becker 2007; Malhotra 2007). It leads to detailed, organized, formalized, communicated, managed and streamlined processes. The workflow becomes clear and potentiates process efficiency, better organization, improved quality and better identification and characterization of possible medical errors (Becker 2007; Malhotra 2007; Peleg 2007).

In healthcare today we are faced with the problem of departmental applications that support specific functions and limited workflow. Most of the data captured by these systems reside within the application and are not easily retrieved and made available to other processes that may require them (Berg 1999; Nielsen 2000; Lorenzi 2003).

Delivering healthcare today is a complex task often undertaken by multidisciplinary teams, whit the obvious output of a great amount of information. Additionally organizations have complex infrastructures with poor communication between different departments and staff. To optimize operational efficiencies they require means to automate and manage these processes making sure that the right information is made available to the right individual at the right time. An established workflow can support such care processes by executing agreed models of care (Berg 1999; Nielsen 2000; Lorenzi 2003).

For information management and communication with other healthcare institutions (e.g. hospitals or primary care) and other hospital departments (e.g. radiology or pathology), DBU uses the following computer applications: a) SONHO – the ADT (Admission-Transfer-Discharge) system of the hospital, which manipulates administrative data (e.g. demographic patients' data); b) SAM (Portuguese initials for Medical Support System) - the outpatient medical scheduling system and multipurpose hospital patient; c) Siima (Portuguese initials for Clinical Imaging Management System) - the imaging system responsible for the record and visualizing of mammography and ultrasound exams at DBU; d) Breast.Care - a specific departmental electronic patient record built for the DBU, to record and analyse clinical data from patients with breast problems; and e) Alert P1 – a system that receives requests for consultation from primary care physicians (this system is not available on DBU).

All described applications help in the integration of outside and inside information contributing to improve its efficiency and effectiveness (Ammenwerth 2004; Keizer 2005).

2 AIM

To describe and analyse clinical workflows and information flows in DBU, detect problems in the system and propose solutions for better communication among different actors, thereby trying to improve performance.

3 METHODS

Study Design. This study was undertaken in different days totalising a 24 hours period of participant, direct and semi-structured observation during January 2009.

Study Participants. Participants were all potencial users of computer applications existing in the DBU.

Data Method Collection. The main data collection method used was direct observation. This method allowed a thorough analysis of clinical workflows and information flows between different actors.

During a 24 hours period, one researcher (the first author of this paper) observed interactions, information flow, clinical workflow and processes between different actors, in different offices (consultation rooms, waiting rooms, main reception areas, and technical work areas). Information was gathered while shadowing study participants. During this process, open-ended questions were asked to develop insights about how events happened, experienced and reported. In this phase extensive field notes were collected.

Variables Description. Free-text was used to extract the following variables: i) local of observation; ii) actors observed; iii) stage of clinical workflow; iv) software applications used.

Data Analysis. Data were collected through observation method with field notes. The gathered notes were then passed into structured text to allow better analysis and comprehension. That structured text described and analysed the different clinical workflows and information flows in DBU. UML diagrams, like activity and partition activity diagrams, and tables were used and constructed.

4 RESULTS

We identified various types of clinical processes (n=7) with different actors and corresponding workflow (Table 1). Data about, where, how and when they occurred was registered. Multiple actors were present in all processes.

UML diagrams were used to analyse and illustrate all processes. As an example, Figure 1 represents an activity diagram of Process I described on Table 1. Table 2 shows the different types of information flows that exist in the DBU. To clarify some existing information flow described above, we used UML partition activity diagrams. The first partition diagram (see Figure 2) describes when the surgeon goes directly to the radiologist to know his opinion about a patient's case (communication between humans). The second diagram (see Figure 3) is related to radiologist performing examination reports in Breast.Care application and copying and pasting them to SIIMA application (communication between humans and computers). After analysing the processes, we have detected several possible improvements to information flows. Improvements were grouped together based on the type of actors involved (Table 3).

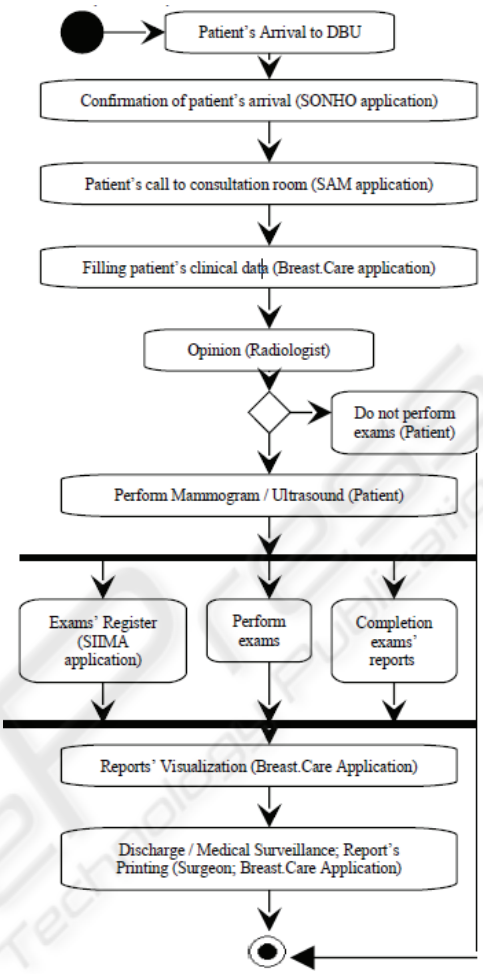

Figure 1: UML activity diagram of Process I (Table 1) - Patients (first consultation), do not perform invasive exams and are discharged from the Unit in the same day.

Figure 1 is an activity UML diagram that is recognized as the most suitable for modeling the functional vision of a system, because describes the logic of procedures or duties(Silva 2005).
These two tables show the most important clinical workflows and information flows that occur in DBU. Table 1 has seven processes with all description, the different actors involved and how, where and when they interact. Table 2 shows some information flows associated to clinical workflows and processes described on table 1, describing all information flow and the sequence of actors.
Figures 2 and 3 show two UML partition activity diagrams, which include division lines (called swim lanes), that describe in greater detail and specificity certain classes or subsystems, in this case actors during information flows.

Table 1: Description of the different processes in DBU.

N	Description	Actors	How	Where	When
I	Patients (first consultation) do not perform invasive exams and are discharged from DBU same visit.	Patient, Administrative staff, Surgeon, Radiologist, Radiographer	Patient arrives at DBU, gives all documents to administrative staff, who confirms the patient's arrival on SONHO application.	Reception	Patient's arrival
			Surgeon, through SAM application, confirms arrival and calls patient to consultation room. Next he starts Breast.Care application to introduce demographic and clinical data. Surgeon performs clinical breast exam on patient.	Consultation Room	Surgeon's interview and exam
			Surgeon observation of patients previous imaging exams. Discussion and observation of exams with Unit Radiologist.	Lecture Room	After consultation
			Radiologist could have two opinions: i) the patient doesn't need to perform any exam and is discharged from consultation; ii) patient needs to perform some extra non-invasive diagnostic exams, which will be reported through Breast.Care application.	Imaging Rooms	At imaging
			Patient is informed by surgeon of normal or benign results. Discharge and reference to attending physician.	Consultation Room	End of consultation
II	Patients perform invasive studies (breast biopsy) and have a subsequent visit for results.	Patient, Administrative staff, Surgeon, Radiologist, Radiographer, Pathologist	Similar to first 3 steps of process I.	Reception, Consultation Room	Patient's arrival, at consultation
			A guided breast biopsy (imaging rooms) and a histological exam will be undertaken (pathology department).	Imaging Rooms Pathology Department	At imaging At pathology after specimen prepared
			Patient informed of another visit date for results by the administrative staff.	Consultation Room	At consultation
III	Patients come to be informed of biopsy result.	Surgeon, Patient	The biopsy's result can be benign (with or without surgery) or malignant (surgery or primary non surgical treatments). If results are benign, patients may be discharged from consultation and be followed by attending physician. In some cases, surgery is advised or desired.	Consultation Room	At consultation
IV	Patients scheduled for surgical intervention.	Surgeon, Patient	All these patients must have a surgery scheduled in SAM application (national waiting list). In some cases where primary treatment is decided before surgery patient must be referred to oncologist. Surgery is schedulled subsequentially (7 months later).	Consultation Room	At consultation
V	Patients who are referred for a Genetics consultation.	Surgeon, Patient, Nurse in charge of genetics consultation	Patients, who have high risk for breast cancer (e.g. family history), are referred to Genetics consultation in DBU, which currently only occurs on Fridays. Surgeon refers those patients directly to nurse in charge of genetics appointments.	Consultation Room DBU	At consultation
VI	Patients who will be followed in DBU (patients with breast cancer that have already been treated)	Surgeon, Patient, Administrative staff	Patient arrives to DBU, gives and the administrative confirms the patient's arrival on SONHO application.	Reception	Patient's arrival
			Surgeon, through the SAM application, sees that the patient has arrived and calls him into consultation room. A clinical questionnaire and physical examination completes patient's clinical data into the Breast.Care application. Patients are referred for an outpatient consultation in HSJ. The surgeon usually uses SAM application to record and print drugs prescription.	Consultation Room	At consultation
VII	Diagnosis Multidisciplinary Team Meeting	Surgeon, Radiologist, Pathologist	All cases of patients who were submitted to biopsy are discussed in a diagnosis multidisciplinary team meeting.	Lecture Room	Periodically, proportional to number of biopsies

Table 2: Different types of information flow and actors that exist in DBU.

Information Flow	Actors
Surgeon searchs and requests, directly and personally, radiologist opinion about patient case. Radiologist reads patient's exams and informs surgeon. Surgeon informs patient (to perform or not to further exams).	Surgeon → Radiologist → Surgeon → Patient
Patient is referred to genetics consultation. Surgeon refers patient directly to nurse in charge of those consultations, who makes an appointment. Patient will receive notification at home.	Surgeon → Patient → Nurse → Patient
Patients need to perform a breast MRI (Magnetic Ressonance Imaging) to better characterize or stage the lesion. Surgeon informs patient of the decision and requests exam at SAM application. MRI unit receives that request, appoints it and notifies patient.	Surgeon → Patient → MRI Unit → Patient
Patient has benign breast disease and no need for further intervention she will be referred to her attending physician. Surgeon informs patient of decision and prints a report that will be delivered by hand to attending physician.	Surgeon → Patient → Attending Physician
Majority of requests for first appointment in DBU are requested by Alert P1 (system is not available directly in DBU). Surgeon in charge prints breast referrals from general surgery department and brings them to DBU. A classification of urgent, medium and non-urgent priority is done based on attending physician information.	Surgeon → Surgery Unit → Surgeon (Requests)
Radiographer knows of patient arrival, when personally warned by administrative staff.	Patient → Administrative → Radiographer
During consultation, surgeon fills data relative to that episode in Breast.Care application. It will create a PDF document with this data in SAM application.	Surgeon → Breast.Care Application → SAM Application
Radiologist has to copy and paste imaging reports in Breast.Care application to SIIMA application.	Radiologist → Breast.Care Application → SIIMA Application
Administrative staff takes patient information on printed sheets to surgeon.	Administrative (information in paper) → Surgeon

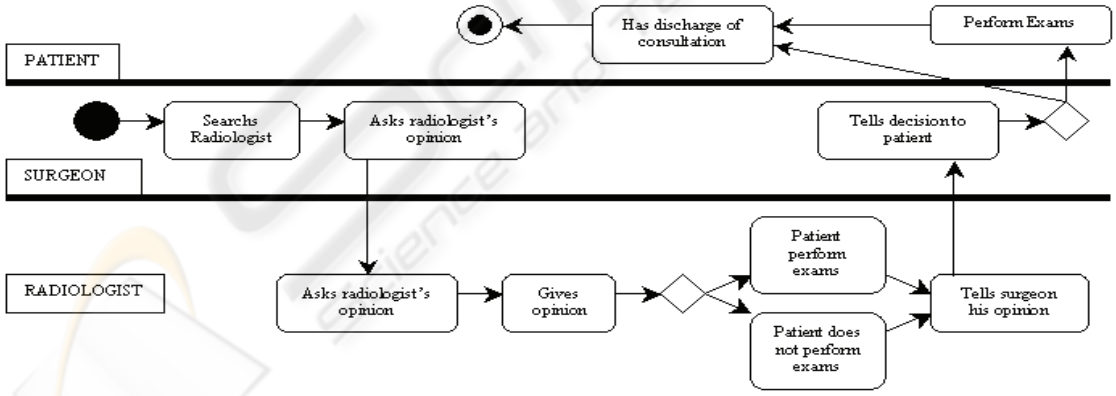

Figure 2: Partition Activity Diagram of an information flow in which the surgeon goes personally to know the radiologist's opinion about a patient.

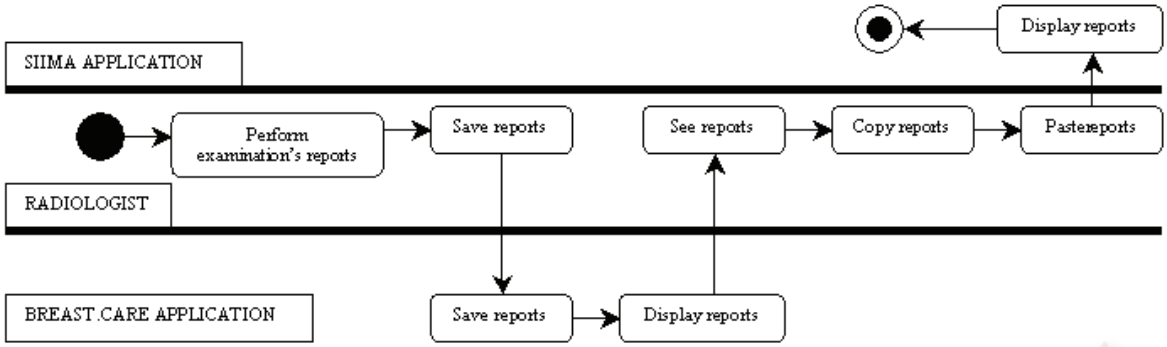

Figure 3: Partition Activity Diagram of an information flow in which the radiologist fills the report in Breast.Care application and has to copy and paste that report to another computer application (SIIMA).

Table 3: Suggested Improvements on communication processes.

	Current	Suggested Improvement
Communication between humans	Normally information related to patient is printed to attending physician.	Deliver all patient information in electronic format through one of the currently available systems.
	Radiographer only knows of patient arrival to DBU when administrative staff warns him personally.	Administrative staff could insert a patient's arrival hour at DBU, in SIIMA application.
	Surgeon has to search and ask, personally radiologist's opinion about a patient's case.	Surgeon's clinical evaluation is reported in Breast.Care, Radiologist could access all abstract and patient's exam over the same application. Radiologist would write his report back in Breast.Care.
Communication between human-machine	Alert P1 system is not available in DBU.	Information on Alert P1 system should be available to DBU users. This would avoid going to another department and also avoid printing requests.
	Surgeon has to print reports to patient. He has to go to reception room to get those reports.	Some printers could be available in some key-places, like in consultation rooms. Printed reports could be mailed in envelopes by administrative staff to handle to patients on their way out.
	Surgeons filling Breast.Care forms using free text components.	Implement sctrutured forms that force a logical sequential order (according to consultation progress). This modification in the software was suggested to Breast.Care development team and it is already implemented in DBU.
Communication between machines (Integration of IS)	Radiologist has to copy and paste all examination reports from Breast.Care to SIIMA application.	A link should be available in Breast.Care application connecting it to SIIMA application.

5 DISCUSSION

This method allowed detailed description of workflows and information flows, and also the detection of communication problems, suggesting some improvements. We feel that this methods when properly applyed provide useful results for improvement of information flow. With good observational methods, we can also identify appropriate and inappropriate patterns of communication (Caris-Verhallen 2004; Unertl K.M. 2006; Ash 2007). Through this method, we can analyse various information flows in a health unit, in order to develop general models of workflow for the improvement of process automation (Unertl K.M. 2006).

This study identified many processes involved in the unit that showed the high diversity and quantity of information that staff and computer applications deal with. This fact reinforces the need for well established clinical workflows and information flows, in order to provide better healthcare.

With suggested improvements, costs could be reduced (e.g. reducing the need to print in paper) and also additional time spared (e.g. the time needed for the radiologist to fill the examination reports in SIIMA and Breast.care software applications). Simple information flows would allow also avoid unnecessary participant travels between rooms.

With observation method, authors were able to see how doctors filled patients' data into Breast.Care application and thereby suggest some changes. Based on those suggestions, Breast.Care development team created a sequential method to enter patients' data in Breast.Care. This change affected positively DBU doctors' team, by fastening data entering into the application.

Future research will use other methods of data collection, like interviews and focus groups and computer systems log analysis, aiming at enriching the quality and quantity of data, and enable a process of triangulation when analysis the processes of the DBU (Bottorf 1993; Hewinson 1995; Ash 2007; Lessard-Hébert 2008).

ACKNOWLEDGEMENTS

We are grateful to all DBU staff for all the help and availability provided.

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