Design of a safe computer-supported cooperative environment in radiotherapy: exploratory identification of cooperation strategies

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ABSTRACT

Motivation – This research deals with the identification of collective production of a safe radiotherapy treatment and its potential assistance through computer-supported environments. It takes place at the beginning of a four years design project involving software companies and and scientific and clinical institutions.

Research approach – This work presents an exploratory analysis of cooperation between the four professionals involved in the production of radiotherapy treatment. Our general research objective is to investigate how to support managed safety in the design of a computer-supported cooperative environment. Uses and functions of cooperative tools have been outlined through observations and the "think aloud" technique.

Findings/Design – We identify three types of cooperation tools (computer-based tools, including an existing workflow, unformal verbal exchanges, and the patient body) involved in the production of a safe treatment. Their main functions are : to produce shareable data between professionals, to share the progress in the construction of a treatment and to share procedures and work practices.

Research limitations/Implications – This paper aims at contributing to the articulation of two research approaches: CSCW and safety in healthcare.

Originality/Value – Our study reveals informal strategies that participate to a "managed" healthcare safety performed by professionals.

Take away message – Our work may contribute to transform the initial technocentric approach of the design project into a more anthropocentric design project and flexible CSCW tool.

Keywords: Healthcare safety, managed safety, participatory design, radiotherapy, computer-supported cooperative work.

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INTRODUCTION

This research deals with collective production of saferadiotherapy treatment and its potential assistance through computer-supported environments. Radiotherapy exposes tumour cells to ionizing radiation in order to prevent their proliferation and to destroy them. Approximately 1.900.000 patients are concerned with radiotherapy each year in Europe. It represents about 60% of cancer patients. This technique is very efficient insofar as 40% of treated patients can be cured. However, it remains risky and unmanaged risks can have huge health impacts, as revealed by the Zaragoza accident in 1990 in Spain or by the Epinal accident in France in 2005 (Cook, Nemeth & Dekker, 2008; Peiffert, Simon & Eschwege, 2007).

The development and administration of a safe radiotherapy treatment requires the participation of four types of professionals providing their own area of expertise: radiation oncologists, medical physicists, dosimetrists and radiographers. Thus, radiotherapy may be regarded as the outcome of a cooperative activity, in which all the professionals are in charge of the safety of care.

In order to support cooperative work and to improve safety, the treatment process tends to be automated by computers systems. This study takes place in this context as it is integrated in a large design project involving software design companies as well as scientific and clinical institutions. The objective of this project is to design a computer platform including a set of software applications. It aims at providing a technological answer to healthcare safety by supporting data workflow and more particularly professionals' coordination.

In this frame, our research addresses a pragmatic issue dealing with ergonomics contribution to design specifications and a theoretical issue dealing with ergonomics participation in the design of healthcare safety in computer supported environments. By environments we mean, not only the software itself but also the organisational context in which it will take place. In

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this context, this communication deals with exploratory identification of cooperative tools used by professionals to produce a safe care in radiotherapy.

THEORETICAL BACKGROUND

Cooperation in radiotherapy

Radiation treatment is distributed in time, space and between the different professionals. Professionals cooperate to produce a safe treatment in an asynchronous way (Nascimento, Falzon, Thellier & Jeffroy, 2008; Munoz, 2010). Their work consists in the definition of three main parameters that are essential to produce a safe treatment (Munoz, 2010):
• the radiation dose. Professionals have to define the "appropriate" radiation dose that will be administrated to the patient ;
• the anatomical target area to be irradiated, in order to provide the patient with the appropriate dose "at the appropriate place" ; • the moment of the treatment, in order to provide the patient with the appropriate dose at the appropriate place at "the right time".
To reach these goals, the treatment process is decomposed, in time and space, into five steps (treatment planning, simulation, contouring of the area to be irradiated, treatment implementation, and medical follow-up) involving the different professionals:

- radiation oncologists initiate the treatment chains by prescribing the specific plan for treatment of a patient (numbers of sessions, type of radiationtechniques…);
- radiographers acquire anatomical data of the patient. These data are essential for the simulation of the future treatment. Indeed, this simulation aims to define the position to be adopted by the patient during the treatment implementation in order to ensure the precision of irradiation (the "appropriate place" parameter);
- these area are determined by radiation oncologist in the contouring phase and a dosimetrists precisely fixed the irradiation dose and ionizing parameters;
- once the treatment is stabilized and validated by radiation oncologists and medical physicists, it is implemented to the patient by radiographers;
- the patient is followed-up by oncologist during all the treatment (from five to 30 days)

Tools supporting cooperation in radiotherapy: a focus on workflow system

Compared to synchronous cooperation, temporal pressure is relatively low in this type of cooperative work (Nascimento & Falzon, 2008). Consequently, coordination between professionals can be achieved trough written or computer-based asynchronous tools. Patient "paper" medical records circulating between professionals according to the treatment phase is one of the example of such asynchronous mediation. Beside these "classical" coordination methods, software tools oriented to group work organization or automation have been developed in such medical context. The design of the software platform in which we are involved takes place in this perspective as it integrates several tools addressing: (1) a specific profession, such as automated positioning (addressing radiographers) of the patient or automated verification of the irradiation dose (for medical physicists or dosimetrists), or (2) cooperation between professionals such as electronic medical record file and a workflow management software.

In our study, we will focus on workflow system as a key tool for computer-supported cooperation. The aim of workflow tools is to support the progress in the design of treatments between different phases of the process. Workflow systems describe and automate some procedural steps and exchanges (data, files…) that have to be performed by professionals - such as transition between steps - or provide professionals with information they need to perform their tasks. The goal of such tools in radiotherapy is to control and to followup the elaboration of a treatment. Figure 1 presents a prescribed model of the processing chain structured by workflow system in radiotherapy. At the end of each phase, the validation of the concerned actor allows the system to advance to the next step. Information is automatically transferred from a computerized workstation to another in order to prevent the risk of error associated with manual entry of treatment parameters (Rosenwald, 2002).

These tools are presented as essential to manage the complexity of the treatment and to ensure safety. They aim at preventing “errors” due to coordination difficulties, and contribute to manage patient data in a safe way. However, several concerns regarding this objective can be outlined in an ergonomics perspective.

Figure 1.Modelization of the radiation treatment included on a workflow system

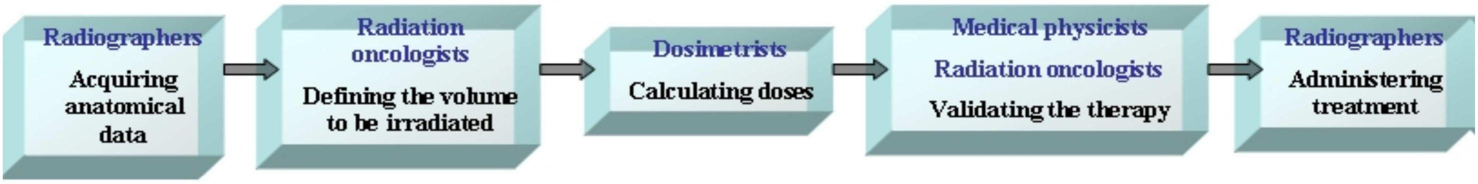

Fig. 1. Modelization of the treatment chain

From a technocentric perspective to the identification of managed safety strategies

Despite the claims that workflow systems may really assist cooperation and are essential to promote safety in healthcare, an issue for ergonomics is to integrate models of human and work activity in the design of such tools. Indeed, the project we are concerned with was initially centered on errors prevention in treatment elaboration in a technocentric perspective of safety production in healthcare. Human was considered as non-reliable and a “zero risk target” was supposed to be reached thanks to an increase of control automatically performed by software (Reason, 1990).

However, such a perspective is limited to a prescribed model of the treatment chain and does not take into account the daily “managed safety” collectively performed by professionals to cope with two objectives that may be contradictory: ensuring safety and implementing the treatment (Morel, Amalberti &Chauvin, 2008; Nascimento, 2009; Nacsimento &Falzon, 2008). “Managed safety” mainly occurs throughinformal regulations and requires flexibility of systems in order for professionals to cope with unforeseen events (Müller & Rahm, 2000), such as collective culture of safety shared by professionals (Nascimento, 2009).

In this perspective, moving from a technocentric approach of safety in healthcare to an approach taking into account “managed safety” requires to identify informal regulations and strategies daily performed by professionals in real work settings. As production of radiotherapy treatment is a cooperative activity, identification of strategies dealing with coordination, cognitive synchronization and the development of situation awareness (related to action, situation and social context) may be of particular interest. Here, we consider situation awareness as an updated representation of work situations that requires information about the context of production of work. In cooperative work, situation awareness helps operators to adjust their own activity to a particular situation. Thus, it promotes coordination and support collaborative work (Schmidt, 2002; Carroll & al., 2003; Detienne, 2006; Barcellini, Détienne, & Burkhardt, 2010).

RESEARCH OBJECTIVES

Our general research objective is to investigate how to support managed safety in the design of a computer supported cooperative environment, i.e. how to design an environments that take into account Human and their activities as a key element for enabling collective production of safety. This objective articulated two main fields of research:

- the collective production of safety. In the continuity of some authors' works such as Amalberti's, Morel's and Nascimento's, we aim at understanding the collective production of safety, and more particularly the conditions of development of a collective safety culture.
- automation and safety. Radiotherapy is a more and more automated domain. In this context, we aim at better understand the links between automation and safety, and the role of Human in automated safety management.

To do so, we need to identify cooperative strategies performed by professionals to manage safety and their links with cooperative tools. In this sense, the questions addressed by this communication are exploratory and concern:

- the identification of tools used by professionals for cooperation all along the treatment chain and their functions linked in particular to coordination and development of situation awareness;
- the identification of the specific use and functions of an existing workflow system compared toother tools.

METHODOLOGY

Fields of research

Considering our research objectives, a key methodological issue is the real work analysis on fields oriented to the identification of collective production of safety. Consequently, we conduct our research in the most important radiotherapy center in France, which is a department of a Parisian cancer institute. This center is involved both in the research about mechanisms of emergence and progression of cancer, and in the treatment of patients.

The technical equipment of the radiotherapy unit includes two simulation stations and seven treatment stations. Simulation stations aim at defining patient positioning before the administration of the treatment, which is made on treatment stations. Each treatment station receives from 10 to 40 patients per day. Nearly 80 professionals from different specialties work on this technical platform. Moreover, this center has developed its own workflow system, which is essential for our research.

Analysis of cooperation tools

We conducted around 35 hours of work observations to understand the radiotherapy treatment, during planning, contouring and treatment implementation.
During 12 hours analyses, we systematically quantify:

- the types of tools used by professionals to cooperate (computer tool; paper tool; verbal communication; patient as a physical support).
- the tasks performed by professionals when using the tools.

Analysis of the workflow

The workflow developed by the information systems department of the cancer institute manages patient data file transfers between professionals. Workflow system has both an individual and shared functions: the individual function is available on personal computers and highlights the files that have to be treated by the concerned professional; the shared function - materialized by a shared board available in the dosimetry room - highlights the global state of patient files and their coverage. To analyse uses and functions of the shared board, the researcher was positioned beside it and used the “think aloud” technique (Bisseret, Sebillotte & Falzon, 1999). This technique helps in accessing the cognitive activity performed by professionals while using this workflow system. We requested the operators who stopped to view the shared workflow board. We asked them to think aloud while they were consulting the shared board: "Looking at this picture say what you're thinking about, what are your associations of ideas, your deductions?". 16 professionals were interviewed corresponding to 20 interactions and 8 hours of observations. All the interviews were recorded and qualitatively treated by extracting and by categorizing the topics verbalized by operators.

RESULTS

Our analysis reveals that professionals use several types of cooperative supports to implement the treatment: verbal exchanges, computer-based tools in which the workflow, paper tools and the patient him/herself. In the following we will first described globally the enhanced “real” workflow model revealed by these analyses to focus lately on the functions of the cooperative tools for professionals.

Enhanced workflow model: a multiplicity of tools supporting cooperation all along the chain

This section presents the findings regarding the 12 hours of systematic analyses about the tools utilisation. Our findings about cooperation tools highlight a more complex system than the model presented by the existing workflow tool (Figure 1). Figure 2 represents this model by integrating the diversity of cooperation tools between the different professions to perform safe radiation treatments.

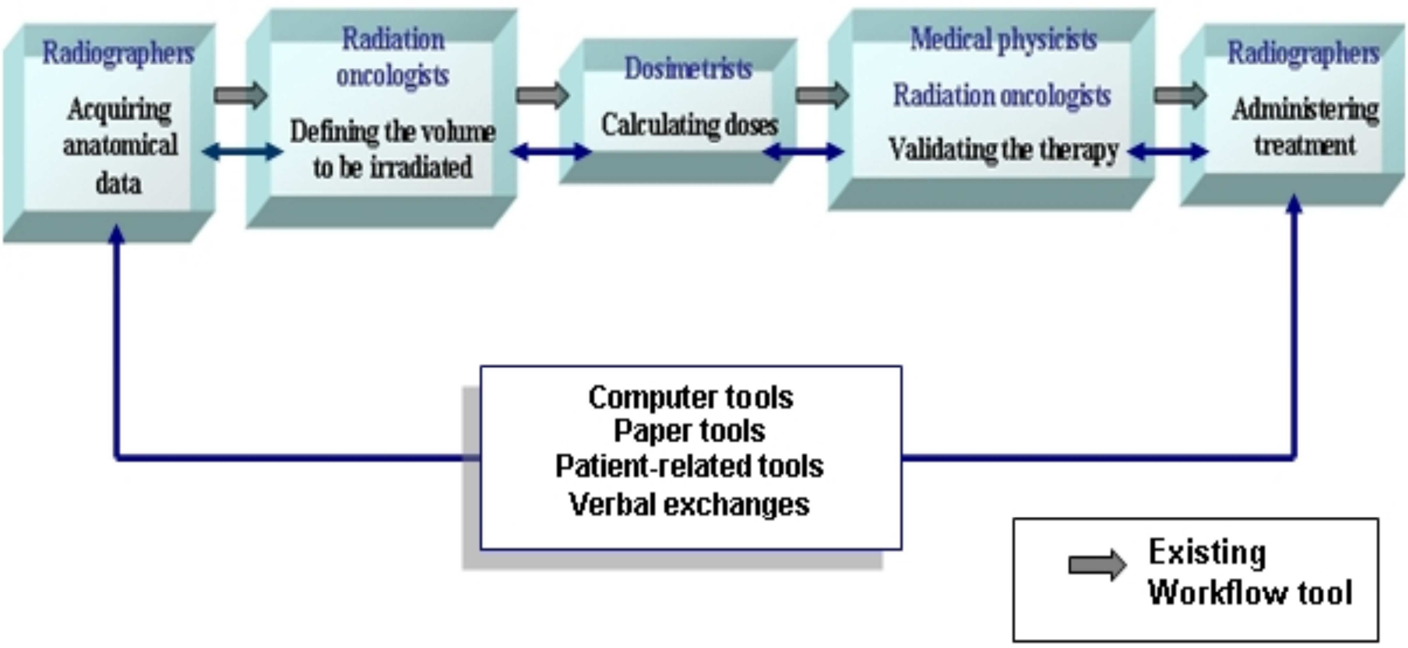

Fig 2. Model of the mediated cooperation supports daily used between the different professions.

In 12 hours of systematic observation we have noted 347 uses of tools. Informal communications are the most used strategies to cooperate as they represent 45% of mobilisation of cooperative tools revealed during our observations (158 from 347 mobilisations of tools observed). These communications are mainly verbal exchanges and can be telephonic or face-to-face. Computer tools are the second most important strategies of cooperation, representing around 38% of uses (133 from 347 mobilisations of tools observed).

There are 17 different computer tools used by professionals such as the workflow tool, planning applications, software dedicated to each treatment machine, software managing the data of treatment…. Among these computer supports, workflow represents only 12% of uses, i.e. 4% of mobilization of all cooperative tools. Paper tools represent 15% of mobilization of cooperative tools (50 from 347 mobilisations of tools observed).

The patient paper file is the most important paper tool mobilized among all paper tools. It represents around 10% of all support mobilized. This patient paper file contains information about each phase of treatment, by printed documents: pictures about patient position on the treatment table, copies about dosimetry calculation. This patient paper file is used in parallel to the software tool for managing the data of a treatment. Another example of paper tools is a notebook allowing physicists and radiographers to communicate about the files to verify and validate data before treatment. This notebook can be added by manual annotations, post-its etc….

Finally, patient-related tools are a specific support of cooperation, and represent 2% of the mobilized tools (50 from 347 mobilisations of tools observed). Patient positioning is a key parameter that determines the precision of irradiation of the tumor area (the "appropriate place" parameter described above).

Professionals must ensure the reproducibility of patient positioning through treatment sessions in order to reach the target area and to avoid risk to achieve healthy organs near this area. To achieve this reproducibility, individualized positioning tools or "retention tools" are developed. Those artifacts determine the position of the patient when lying on the treatment table. On the surface of these tools, radiographers write annotations regarding the patient and the use of the tools. This positioning information is transferred from the simulation station to the treatment station.

Moreover, in order to reproduce the spatial position of the target area to be irradiated all along the treatment (the appropriate place), professionals make marks on patients' skin. These marks constitute additional information for the reproducibility of patient positioning. These elements show that in real situations the workflow tool is not the single reference for cooperation: there are collective uses of a set of supports to produce a safe treatment. Radiation professionals develop multiple ways to exchange in order to conceive a treatment and to share about the work situation.

The issue treated in the following section concerns the functions of this set of tools for professionals and the specificity of two cooperative tools which are of particular concerns: the existing workflow tool and the patient, which is interestingly a non-technological tool.

Functions covered by cooperative tool

Three mains functions of cooperative tools

Three functions related to the use of cooperative tools have been identified: (1) updating the knowledge concerning the production of the treatment status, (2) producing of useful data for other professionals about a specific treatment and (3) sharing practices between professionals.
The main function of cooperative tools is the update of the "system status". It represents 61% (217/347) of uses of all cooperative tools. A professional consults a tool in order to obtain information that allows him/her to develop and update his/her representation of the work situation. Some examples of data that allows professionals to actualize their knowledge about the situation and orient their activities are:

- the name of the radiographer concerned by an urgent file;
- the number of files that have to be validated by physicists;
- the size of the patient;
- the appropriate moment to meet an operator;
- the status of a current file.

Cooperative tools are also used and updated in order to produce useful data for other professional about a specific treatment. These useful data can be consulted asynchronously by at least one other type of professional. These updates of all cooperative tools correspond to 19% (67/347) of uses revealed. For instance, radiographers at the simulation step use marks on the patient's skin, or photo of the patient, or the notification of ways of retention to assist and cooperate with radiographers at the treatment station.
Finally, cooperative tools, and essentially verbal exchanges, are used to share practices between professionals (19% of use). This function refers to the mobilization of a support to define the way of reaching a goal, or the way of realizing certain tasks. This kind of information concerns mainly the definition of procedures of action e.g.:

- the procedure to approve a file;
- the solution to implement in case of error of a computer application;
- the rules defining the radiation beams, according to the anatomical regions to be irradiated;
- the procedure to obtain some type of expendable element.

The results concerning the collective sharing and exchange of procedures have been presented to the interlocutors of the Parisian Institut during a workshop.
Their reaction was: "we know how and where to find information, but we prefer to ask and to exchange verbally". This shows the importance of exchanges to share procedures and practices to achieve a safe treatment.

Existing workflow tool to support coordination and to prevent the late administration of a treatment

This section presents the findings regarding the "think aloud" technique about the shared workflow board. As represented in Figure 3, three main functions of the shared functionality of the existing workflow tool have been identified.

- the evaluation of the overall charge shared by professionals and their individual charge. The information mediated by the shared board allows professionals to have information about their colleagues' activity and about their advancements in the treatment of a file, as illustrated by verbatim of interviewees:
  "…and I said to myself that next week there will be a lot of work. Lots of files have been not validated." (Physicist);

• the evaluation of the emergency to treat a particular file:
“I look after the priorities, in particular, this treatment starts in early next week, so we will absolutely have to validate it today.” (Physicist);

• to organize their own individual activity, in particular the information about the beginning of a treatment is an important criterion to start the treatment of a file:
“…we see that there is a metastasis for tomorrow. So I'll start doing that. I will look for the medical record file in the box then I'll start by doing that and then I continue after to the breast (cancer) that I have in progress.” (Dosimetrist).

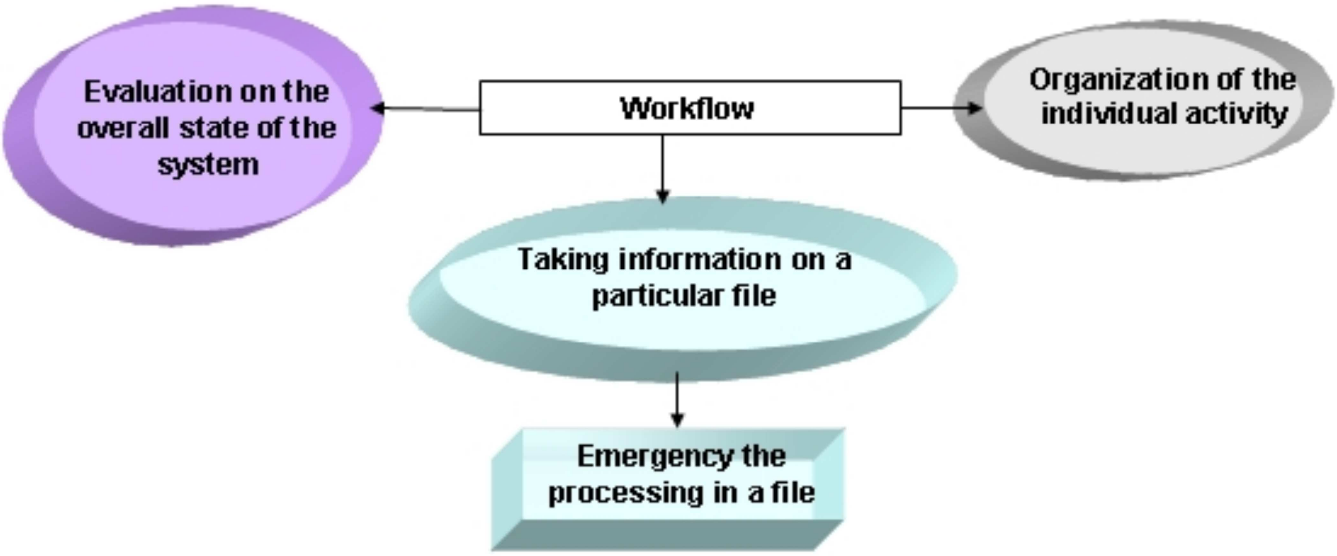

Figure 3. Main functions of the existing workflow shared tool

Functions of the shared board help coordination between professionals, which is crucial to produce a safe treatment. Indeed, thanks to the information provided by the shared board, some professionals may mobilize colleagues who are considered to be late and may impact the safe production of a treatment. Thus, the shared board allows the group to develop strategies to anticipate and to prevent degraded situations. Indeed, the beginning of a treatment is planned in advance.

The delay of achievement of a phase by a profesionnal determines the time allocated to the following ones in the treatment chain to achieve the next phases. If an profesionnal of the chain doesn’t have enough time to accomplish his/her tasks, a “degraded” situation in the treatment of a file (i.e. the elaboration of a treatment) could appear, and so a possible factor leading to production of errors. If delays are accumulated, the treatment will not be ready when it is due to and its administration should be delayed. It has implications for the safety of care regarding the "right time" parameters defined for a safe treatment. We show that the existing workflow tool is used as a mean to prevent errors by professionals, however another interesting tools is used specifically by radiographers to cooperate: the patient body.

DISCUSION AND PERSPECTIVES

This study is a first exploratory work focusing on the identification of cooperation tools used in radiotherapy. We show that workflow tool is not the only resource used by professionals but that there are a multiplicity of tools used to produce collective safety. Professionals mobilize these tools to produce shareable data for a specific treatment, but not only. Cooperative tools are used to share the progress in the construction of a treatment and to share procedures and work practices. Transmitting and sharing this kind of information, through cooperative tools, supports the construction and the update of the collective situational awareness. Situation awareness is a critical condition for success in the integration and in the coordination of activities in collaborative work (Schmidt, 2002, Carroll et al., 2003). Moreover, updating the situation awareness thanks to cooperative tools can be considered as a basis for coordination within the group, which goal is the production of a safe care.

One of the collective tools, the current workflow tool, provides the information concerning the beginning of the treatment which gives a shared temporal reference and determines the degree of emergency in processing the treatment. So, different members of the group may share the same data concerning the temporal progress in the treatment. The information shown by this tool participates in the coordination between different professionals involved in the treatment chain. Situation awareness facilitates the temporal management of treatments. This tool allows the coordination and the development of some non-prescribed strategies in order
to avoid delays all along the treatment production chain. The group develops strategies to anticipate situations in order to respect the beginning of the treatment and to preserve sufficient time for the task of each member of the chain. They address the safety criterion of patient care: "right time".

Several perspectives of this work can be developed to highlight the important role of professionals in the daily management of the variability taking into account constraints and specific strategies of each profession. The aim is thus to enrich the design of the computer tool with the results of the real work analysis, including informal strategies. The goal is to design a computer tool that supports not only the production of the radiotherapical care, but also that allows operators the production of safety outside the prescribed areas.

One first perspective concerns complementary analysis radiotherapy work. Indeed, the situation involves different types of professionals and specificities of each of them may be explored regarding cooperation strategies. In this sense, we conducted a first study about radiographers cooperation at each ends of the chain (Munoz et al., to appear). Another perspective should be to analyse more finely the “pivot “position of dosimetrists who appears to be essential in the management of delay as they mobilize “late” professionals. Finally, another perspective is to identify variability that professionals have to cope with in order to integrate different levels of flexibility to the definition of the computer environments. Highlighting informal strategies used to manage variability can led to take into account in the design process both “managed” safety (Nascimento, 2009; Morel, Amalberti & Chauvin, 2008) and constrained safety (procedures, norms), the latter being the only one included in the existing workflow tool. Those perspectives lead us to a general theoretical question related to participation to the design process of a safe computer-supported environment in radiotherapy. This raises a theoretical question about the distribution of tasks and information between operators and the technological environments and the links between automated approach and healthcare safety. Finally, an approach taking into account the whole system in radiotherapy would have to consider the active participation of the patient in his/her care (Pernet &Mollo, to appear).

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REFERENCES

Barcellini, F., Détienne, F., & Burkhardt, J. (2010). distributed design and distributed socialawareness: exploring inter-subjective dimensions of roles. In P. Lewkowicz, P. Hassanaly, M.

Rodhe, & V. Wulf (Ed.), Proceedings of the COOP'10 Conference (p. 3-24). The Netherlands: Springer.

Bisseret A., Sebillotte S., Falzon P. (1999). Techniques pratiques pour l'étude des activités expertes, Toulouse (France) : Octarès. (Practical techniques to analyse expert activities).

Carroll, J.M., Neale, D.C., Isenhour, P.L., Rosson, M.B. & McCrickard, D.S. (2003). Notification and awareness: Synchronizing task-oriented collaborative activity, International Journal of Human Computer Systems, 58, 605-632.

Cook, R., Nemeth, C. & Dekker, S. (2008). What went wrong at the Beaston Oncology Center? In E. Hollnagel, C. Nemeth & S. Dekker (Eds.), Resilience Engineering Perspectives: Remaining Sensitive to the Possibility of Failure (Vol. 1). Aldershot, England: Ashgate Studies in Resilience Engineering.

Daniellou, F. (2007). Simulating future work activity is not only a way of improving workstation design. @ctivités,4, p.84-90. http://www.activites.org/v4n2/v4n2.pdf

Detienne, F. (2006). Collaborative design: Managing task interdependencies and multiple perspectives. Interacting with computers, 18, 1-20.

Mollo, V. (2006). Managing and improving the reliability of healthcare systems. Proceedings of the XVIth Triennial Congress of International Ergonomics Association, "Meeting diversity in ergonomics", July 10-14, 2006, Maastricht, Netherlands.

Morel, G., Amalberti, R. & Chauvin, C. (2008). How good micro/macro ergonomics may improve resilience, but not necessarily safety. Safety Science, 47(2), 285-294.

Müller, R., Rahm, E.(2000). Dealing with logical Failures for Collaborating Workflows Etzion, O.; Scheuermann, P. (eds.): Proceedings of Fifth International Conference on Cooperative Information Systems (CoopIS), Eilat, Israel, Sep. 2000. LNCS 1901, Springer, Berlin, Alemagne, 210-223. http://www.springer.de/comp/lncs/index.html

Munoz, M.I., Barcellini F. et Mollo, V. (2010). Produire la sécurité des soins en radiothérapie : supports à la coopération dans le collectif de travail. In 45th SELF conference, Liège, Belgium, 13-15 September. (To produce safety care in radiotherapy: cooperation supports between professionals).

Munoz, M.I., Barcellini, F & Mollo,V. (to appear). Collective elaboration of care for safety in radiotherapy: Cooperative management of patient variability. In proceedings of HEPS'2011 (Healthcare ergonomics and patient safety). Oviedo, Spain, 22-24 june 2011.

Nascimento, A. & Falzon, P. (2008) Organizational reliability in radiotherapy. In proceedings of HEPS'2008 (Healthcare ergonomics and patient safety). Strasbourg, France, 25-27 juin 2008.

Nascimento, A., Falzon, P., Thellier, S. & Jeffroy, F. (2009) Entre soigner et protéger : récupérations des écarts et arbitrages raisonnés des manipulatrices en radiothérapie. 44th Self conference. Toulouse, France 22-24 september. (Between cure and protection : gaps and spans recoveries performed by radiographers).

Nascimento, A. (2009). Produire la santé, produire la sécurité. Développer une culture de sécurité en radiothérapie. Ergonomics Ph. D. thesis, CNAM, Paris. (To produce health, to produce safety. Developing a safety culture in radiotherapy).

Peiffert, D., Simon, J. M. & Eschwege, F. (2007). L'accident d'Epinal: passé, présent, avenir. Cancer/Radiothérapie, 11(6-7), 309-312.

Pernet, A. & Mollo, V. (to appear). Patient participation to patient safety in radiotherapy: Reality or Necessity? Healthcare systems Ergonomics and Patient Safety (HEPS)

International Conference: “An alliance between professionals and citizens for patient safety and quality of life”, June 22/24, 2011,Oviedo, Spain.
Reason, J. (1990). Human error. New York (USA): Cambridge University Press.
Rosenwald, J.C. (2002). Sécurité en radiothérapie: le contrôle de logiciels et des systèmes informatiques. Cancer/Radiotherapy, 6 (2002) Suppl 1: 180-186.
Schmidt, K. (2002). The Problem with ‘Awareness’, Computer Supported Cooperative Work, 11, 285- 298.