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Integrating users' activity modeling in the design and assessment of hospital electronic patient records: the example of anesthesia

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Abstract

As computers become more and more an aid in the management of medical information, some specialists, such as anesthesiologists, demand tuned applications to support their own activity. The development of these specific applications is based upon the user's requirements analysis, and functional and technical specifications. But some failures show that a better understanding of human factors of acceptance could improve the usability and utility of these tools. In this study, we demonstrated that when the management of medical information is closely intertwined with the physician's activity, it is necessary to perform a precise analysis of this activity in order to identify the cognitive and organizational constraints that affect the usability and acceptance of the tool. We focused our study on the pre-operative anesthetic consultation. After recording and analyzing 50 consultations, we were able to identify the key points to fulfill in order to meet users' acceptance. From this study, we propose some strong recommendations to handle the constraints imposed by the anesthesiologists' activity in their daily working environment. We applied this method to evaluate an electronic patient record (EPR) for the pre-anesthetic consultation. The results of this evaluation validate our hypotheses and the importance of the activity constraints. In conclusion, human factors, and particularly those linked with the activity of healthcare professionals, have to be carefully studied before any development and installation of an EPR into a specialty domain.

Keywords: Usability; Electronic patient record; Anesthesia; Activity modeling; Cognitive ergonomics

1. Introduction

In many hospitals, departments, such as emergency, intensive care and anesthesiology, tend to remain cut from the general development of hospital information systems (HIS): they are still badly or not well computerized, at least from the medical information management point of view. However, on the other hand, most of the intensive care or anesthesiology machines (respirators, moni-

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tors) have been working with computers for several years. Then, most of the companies providing these machines: Datex-Ohmeda*, Agilent Technology* (Care-Vue), Drager*, Picis* (Care-Suite), Thermaco* (Idacare), progressively developed software applications designed to automatically record the physiological parameters gathered by the machines during intensive care episodes. In the past 10 years, those software were progressively adapted for the anesthetic process during surgery, thus providing the anesthesiologists with an elementary anesthetic patient record, reduced to an archive containing the main physiological parameters automatically recorded during the anesthesia.

Following users' requirements, most of these tools now try to incorporate in their software, some parts devoted to handling medical information during the other phases of the anesthetic process, especially the anesthetic consultation, which takes place 1 week before the surgery. But, according to the vendors of those tools themselves, these parts of the software are difficult to use and meet acceptance problems. Thus, the users who cannot integrate them properly in their daily working environment often reject them.

On the other hand, some prototypes have been developed on a smaller scale, specifically to handle medical information during the anesthetic consultation. These tools are usually developed by a user cooperating with a small company, following a specific demand of a single department of anesthesia. These anesthetic computerized records are usually successfully utilized by the anesthesiologists who created them, but they often fail to spread to other departments of anesthesiology and remain confined to a small amount of users [1,2].

Some evaluation studies have been performed in order to assess the efficiency and usability of software applications in intensive care units (ICU) or during the pre-operative anesthetic process [3–5]. Most of these studies focus primarily on establishing time saving due to automated data recording; their methodology relies mainly on task decomposition, allowing them to compare the time spent in performing each elementary task with and without the computer. The results usually confirm time savings [4,5] for the tasks devoted to physiological parameters recording, but they also emphasize usability problems for the sub-tasks dealing with medical information management, such as drug prescriptions and shift changeovers [4]. Then, these authors call for a deeper behavioral and cognitive analysis of users' activity, in order to properly design or redesign the applications.

Probably because they are more recent and not yet disseminated in many anesthesiology departments, software applications specifically designed for the preoperative phase of anesthesia (pre-evaluation or consultation) have hardly been assessed and when they are [1,2,6], the evaluation reveals deep usability or transferability problems.

For example, in a previous study [6], we performed the usability assessment of a prototype named Anesthesia Mobile System (AMS) specifically designed to support direct data entry during the anesthetic consultation. The AMS was developed within the context of a European project (Isar-T), following a standard conception cycle, including an extensive users requirements phase performed by both engineers and consultants of the project. Moreover, two expert anesthesiologists participated in the phase of elicitation of expertise, which was performed by an expert physician specialized in hospital information systems databases. Unfortunately, this software application proved to be totally unusable. Part of the failure was due to the poor ergonomic quality of the graphic user interface (GUI) and to the slow rate of the application, which were assessed through a standard heuristic evaluation [7]. But, some more fundamental problems could be identified as well. As with most similar products, the AMS was unable to deal with human factors and especially with the cognitive aspects of the users' activity [6].

The applications that are intended to handle medical data are closely intertwined with the physician's medical activity. This close physician–machine cooperation involves complex cognitive processes: the medical and anesthetic expertise of physicians is deeply involved in dialog with the interface. Under those circumstances, standard usability methods, such as heuristic evaluation or cognitive walkthrough [7], which are mostly task-oriented, do not allow the identification of the major cognitive problems the physicians will encounter when dealing with the interface. Then, those complex cognitive processes underlying the actual activity must be carefully analyzed to ensure proper usability and acceptance of the software. This dynamic and cognitive approach constitutes a new trend in the design and assessment of new software [8], especially in the domain of anesthesia and emergency [9,10]. This paper comes within the scope of this cognitive approach and presents an analysis and modeling of the physician's activity during the anesthetic consultation. From this model, we identify some constraints the software must respect and we draw up some recommendation for the human–machine interface. We then illustrate these specific points with the assessment of an anesthetic computerized record developed in one of the departments of anesthesiology in the University Hospital of Lille.

2. Analysis and modeling of the anesthesiologists' activity during their consultation

2.1. Background

According to Gaba [11], Nyssen and Javaux [12] and Xiao et al. [13] the anesthetic process mainly involves a dynamic situation management (DSM) activity [14,15]. The characteristics of this situation are complexity, time pressure and risks (the patient's life may be at stake). The main goal of the anesthesiologists is to ensure that the patient survives the surgery. It is important for the anesthesiologist to be able to anticipate and to plan the anesthetic process for each patient. This planning activity relies on the elaboration and adjustment of a schematic representation of the patient's medical case, which acts as a 'conductor' of the activity [15,16]. Gaba [11] shows that for each particular anesthesia, the physician elaborates a plan from a preoperative evaluation. This plan includes a representation of the patient's physiological and medical state, the goal of the surgery and an evaluation of the available mental, physical and material resources. All through the anesthetic process, this plan guides the anesthesiologist's activity and supports his decisions. The representation supporting the plan (and thus the plan itself) may be continuously adjusted according to the patient's evolving physiological state.

The whole anesthetic process can be divided into four phases: (i) pre-operative preparation; (ii) induction; (iii) maintenance; and (iv) survey of the recovery phase [9,10].

The pre-operative phase is devoted to the planning of the three remaining phases. The anesthesiologists try to anticipate the potential problems and to assess the risks of the anesthesia for the patient. In this respect, the anesthesiologist has to exhaustively scan the patient's medical background.

In many countries, the pre-operative phase is set on legal grounds. The patient has a medical consultation with an anesthesiologist ≈ 1 week (≮ 2 days) before the actual surgical operation. The anesthesiologist who performs this consultation may not be the same person in charge of the remaining phases. Therefore, the anesthetic file completed by the physician during the consultation is of major importance because:

- it is a legal medical record
- it has the important function of transmitting the relevant medical information to the anesthesiologist on duty during surgery.

Thus, it conveys all necessary medical information to manage the induction and maintenance tasks and it allows the anesthesiologist in charge to assess those plans and eventually to modify them according to the evolution of the patient's medical status during the surgery.

The following section is dedicated to the analysis and modeling of the anesthesiologist's activity during this pre-operative phase.

2.2. Material and methods

We performed the observation, description and analysis of the anesthesiologists' activity during the consultation with a special focus on the interview of the patient and on data acquisition. The methods were interviews, video and audio recording and auto-facing interviews.

Thirteen anesthesiologists participated in this specific phase of the study; 11 were experienced anesthesiologists and two were novices. They were observed and audio- or video-taped while performing a consultation with real patients volunteering to participate in the study or with trained actors playing the patient's part. Each anesthesiologist had to face at least one simple and one complex case. Up to 50 consultations could be recorded.

The main objective of this analysis was to identify the procedures for searching, selecting and writing down the relevant information. From the analysis of the patient/anesthesiologist dialogs and of the corresponding paper files, we reported for each consultation, the order of the questions asked by the physician, the answers of the patient and the resulting written data.

2.3. Results

The medical data collected by the anesthesiologists during the interview with the patient are written down on a specific one-page sheet of paper. Those paper files ordinarily contain nine fields (administrative data, medical and surgical antecedents, etc.); each field is divided into several zones, each zone devoted to one main physiological system. Throughout the interview of the patient, the anesthesiologist fills in the given fields and zones.

2.3.1. Information recording (hand writing)

Relevant data are handwritten on the anesthetic consultation one-page paper-file. A lot of abbreviations are used to quicken handwriting; important information and recommendation are underlined. The data are written down as the corresponding information occur in the dialog, leading the anesthesiologist to frequently jump from one field to another of the paper sheet. Those handwritten files are sometimes very difficult to read. In a statistical study, covering 261 completed consultation files coming from five different anesthetic departments of the University Hospital of Lille, we found 21 files (8%) containing at least one undecipherable data; for one of the departments, the percentage came up to 24% (12 out of 50); those illegible data may belong to any field, including crucial ones. Moreover, a lot of files are incomplete, although the missing data may vary significantly from one department to another: for example, the ASA score is systematically missing (100%) in one department and systematically completed (100%) in another, the percentage of missing scores being 11, 16 and 68%, respectively in the three other departments. However, all the anesthesiologists claim this data to be positively required in the consultation files. Those results are coherent with Falcon's extended study of the quality of anesthetic records [17].

The observation of the anesthesiologist's activity during the consultation demonstrated that most of them tend to emphasize important data and eventually to set alerts in some cases. Out of the 261 completed files which were analyzed, 32 (12.26%) contained explicit 'alarm' signs, 52 (20%) had highlighted data, some of them acting like an alert (for example, circled in red) and 126 (48%) contained emphasized data (underlined) (Fig. 1).

These observations show that it is not only raw data that are transmitted to the anesthesiologist on duty for the surgery: the consultation file also conveys interpreted data which are parts of the representation of the patient's medical case and elements of the planning for the anesthetic process.

2.3.2. Strategies for information gathering

All patients are asked the same general set of questions, but the interview does not usually go through the successive fields in a systematic way. We observed that the order of the questions differs from one case to another. This order depends on two independent factors: the degree of complexity of the case and the procedure for exploring the patient's medical background. We could identify three different procedures for the exploration of the patient's medical case. Each procedure accounts for an observed order of the questions. All three procedures can be used alternately during the same examination.

- *Procedure 1*: the anesthesiologist follows a standard and systematic order when questioning the patient, field by field and system by system.
- *Procedure 2*: from an answer given by the patient, the anesthesiologist infers some further relevant information and sets specific questions to confirm this hypothesis. This procedure leads to significant short cuts in the exploration of the patient's medical framework.
- *Procedure 3*: at times, the anesthesiologist may allow the patient to 'tell his story' as far as it is relevant to the purpose of the consultation.

Procedures 2 and 3, for which the order of the questions is no longer the standard and systematic order, are not used by novice anesthesiologists.

2.3.3. Expert/novice comparison

There are important differences between expert and novice anesthesiologists in the way they gather and record relevant information.

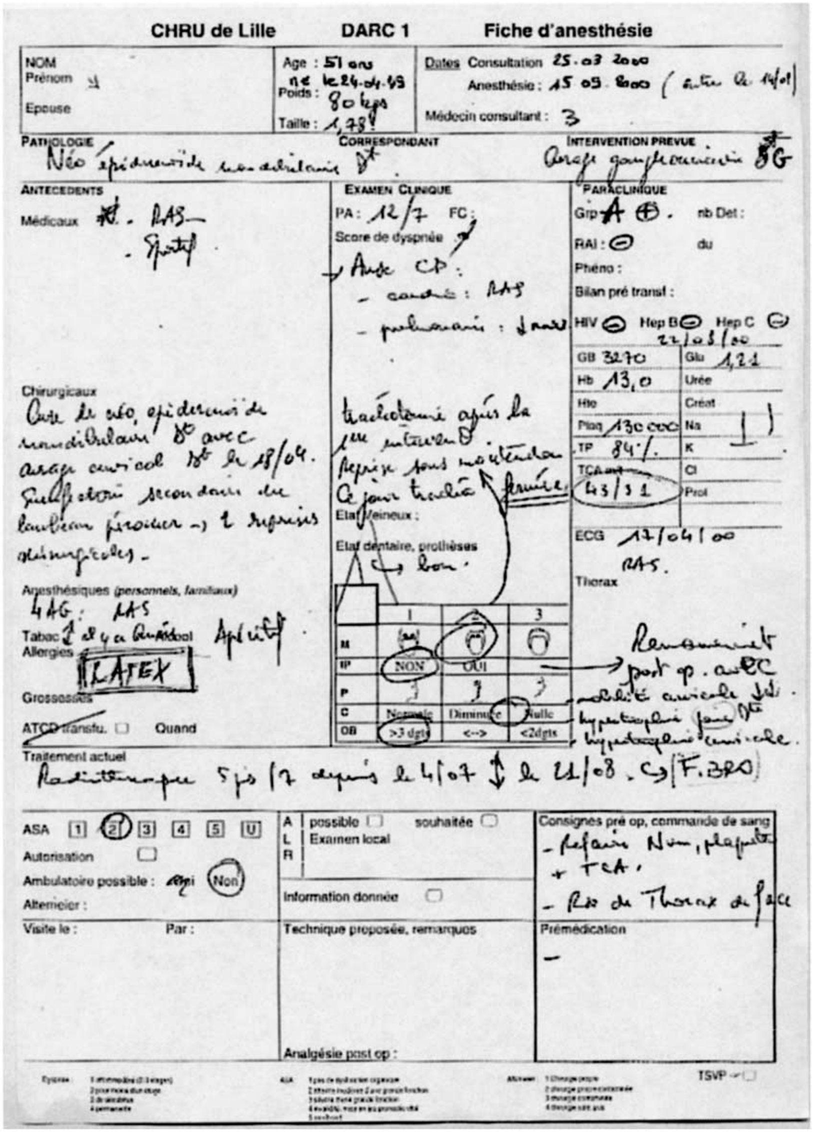
The novice anesthesiologists:

- Follow the systematic order of the paper file, whatever the complexity of the medical case.
- Ask all the questions
- Write down all the answers
- Do not interpret the data and make no differences according to their importance for the anesthetic process
- Never underline, nor circle or emphasize any information
- Do not provide any element for the planning of the anesthesia itself
- Try to reassure the patient at the end of the interview

- Are unable to question the patient in the form of a natural dialog.

The expert anesthesiologists:

- Do not follow the standard order of the paper file, except sometimes for simple cases
- Jump from one field to another following significant expert inferences
- Write down only relevant data
- Interpret the data collected and categorize them according to their importance for the anesthetic process.
- Underline or emphasize crucial information
- Give significant clues for the planning of the anesthesia itself, sometimes set alarms


CHRU de Lille DARC 1 Fiche d'anesthésie

NOM
Prénom
Epouse
Age : 51 ans
Poids : 80 kgs
Taille : 1,78
Dates Consultation 25.03 2000
Anesthésie : 15 05 2000
Médecin consultant : 3
PATHOLOGIE
CORRESPONDANT
INTERVENTION PREVUE
ANTECEDENTS
Médicaux
RAS
Chirurgicaux
Anesthésiques (personnels, familiaux)
Tabac
Allergies
LATEX
Grossesses
ATCD transfu. Quand
EXAMEN CLINIQUE
PA : 12/7 FC :
Score de dyspnée
Etat veineux :
Etat dentaire, prothèses
PARACLINIQUE
Grp A ⊕ nb Det :
RAI : ⊖ du
Phéno :
Bilan pré transf :
HIV ⊖ Hep B ⊖ Hep C ⊖
GB 3270
Glu
Hb 13,0
Urée
Hte
Créat
Plaq
Na
TP 84 %
K
TCA
Cl
Prot
ECG
RAS.
Thorax
Traitement actuel
ASA 1 2 3 4 5 U
Autorisation
Ambulatoire possible : Oui Non
Alterneior :
Visite le : Par :
A L R possible souhaitée
Examen local
Information donnée
Technique proposée, remarques
Analgésie post op :
Consignes pré op, commande de sang
Prémédication
TSVP

Fig. 1. An example of a typical anesthetic consultation paper file completed by an expert anesthesiologist. It contains explicit alarm signs, emphasized data and it is somehow uneasy to read.

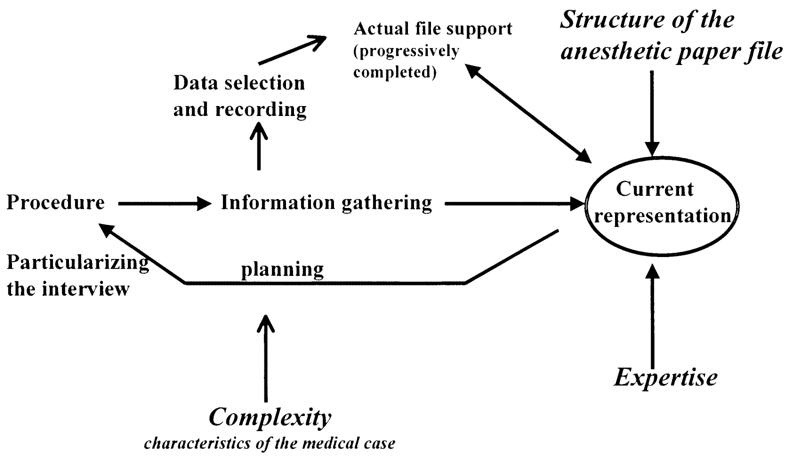


Fig. 2. Model of the anesthesiologist's activity for information gathering and recording during the consultation.

- Pay attention to the patient's anxiety and reassure him all along the consultation
- Are able to give the clinical interview the form of a natural dialog.

When presented with this analysis of their activity, all the anesthesiologists, experts as well as novices, acknowledged its authenticity. But unfortunately, only two novices participated in that part of the study. Then, one must be careful when trying to generalize from the results obtained here: the succeeding model will need further experiments for broader verification.

2.4. Interpretation and elaboration of the model

The three different procedures identified in the expert medical interviews (described in Section 2.3.2) reveal specific strategies and thus planning activities for information gathering. The expert alternate use of these three procedures constitute a mixed bottom-up/top-down planning [16], usually called opportunistic planning [18], which is partly supported by the actual acquisition of data. We can draw up a model representing this particular activity; this model relies on the Rasmussen's general architecture, modified by Hoc and Amalberti [19] to adapt to planning activities in dynamic environments. This approach emphasizes the role of the current representation and can be represented as shown in Fig. 2.

The anesthesiologist always begins the interview in a standard way, with the administrative data and the type of surgery expected. Then, he usually goes through the patient's medical history. He then begins to gather relevant information and this information feeds the emerging representation of the patient's medical case, which allows the anesthesiologist to identify significant patterns in the information given by the patient. Relying on the representation of the patient's medical framework, the anesthesiologist begins to plan the search for further information and ends up particularizing the procedure for the interview and adapting it to the characteristics of the patient's medical case. Amongst the information given by the patient, the anesthesiologist selects and writes down the relevant data on the paper file. This file becomes a kind of external support for the representation, which is an important point given the limited capacity of the human memory. In this model, the current representation of the patient's medical case is a key concept, acting as a kind of conductor of the activity, as in an orchestra.

The construction of this representation is influenced by three main factors. (1) The anesthesiologist's expertise, which allows him to interpret and assemble the data in significant patterns and to select, record and emphasize relevant or important information. (2) The structure of the anesthetic paper file, which leads to a specific categorization of the data. (3) The complexity of the medical case, which orients the planning of information gathering and influences the adjustment of the interview.

3. Constraints for the software and recommendations for the man–machine interface

From the analysis of the activity and its modeling, we can identify some constraints the software should respect in order to ensure proper usability and acceptance of the tool. Taking into account these cognitive constraints implies some specific developments for the human machine interface. In Table 1, we present the more important of these recommendations.

Obviously, Table 1 can be used as a basis for the assessment of any software application designed to handle medical data synchronously during the anesthetic consultation. This evaluation of the interface must take place between the technical verification and the functional assessment phase [20–23]. It must be performed with end users and in real work environment or in closely simulating situations. As far as possible, the key variables, identified by the model as influencing the performance, must be controlled. In Section 4, we present an example of such an assessment of a software application for the anesthetic consultation.

4. Evaluation of a software application for anesthetic consultation

Tabellar* is a computerized medical record specific for the anesthetic consultation. It was developed on behalf of an anesthesiologist in charge of a department of anesthesiology in the University Hospital of Lille. It has been used routinely for 3 years in this specific anesthetic department, but at the time of the evaluation study (1997/1998), the main user (if not the only one) remained the author of the tool.

Tabellar* fulfills the strong users' requirements for the exhaustiveness of the database: the anesthesiologists want to be able to enter any relevant information. Thus, the software contains a lot of catalogs comprising lists of numerous items. The structure of the database is close to the structure of the anesthetic paper file; it is then divided into six domains, each containing several fields.

The interface can be characterized as follow:

- it is closely linked to the database; the natural (by default) order of appearance of the screens follows the structure of the database;
- the resulting interface is made up of more than ten screen pages. There is a synthesis screen dynamically updated as the data are entered, but this screen is unavailable while the user goes through the successive catalogs devoted to medical and surgical antecedents, which concerns the major part of the medical interview. The user has to quit (shutdown) these screen-pages to retrieve the synthesis screen;
- the anesthesiologist may choose not to follow the order set by the interface to

Table 1
Constraints for the software and recommendations for the GUI

Constraints	Consequences	Recommendations
The anesthesiologist relies on the progressing representation of the patient's medical framework to drive the clinical interview. The paper file acts as an external support for this representation.	All along the clinical interview, the anesthesiologist must have before his eyes all the data already gathered. At least, he must be able to access this information very rapidly.	The software must provide the physician with a summary screen page, continuously updated with each new data and always available while he questions the patient and enters new data.
The anesthesiologist relies partly on the structure of the paper file to plan the clinical interview and to categorize the items.	The anesthesiologist must have this structure before his eyes all along the interview.	The summary screen page must include this structure. Each new data must be entered in the proper field or zone of the structure. The order of data gathering set by default should follow this structure.
Expert anesthesiologists particularize the interview according to the characteristics of the patient's medical framework.	The anesthesiologist must be able to jump from one field to another in order to enter a new data easily and rapidly enough to deal with the speed of a natural dialog.	The software must allow the physician to enter the data randomly and very rapidly. If the software contains several screens and catalogs, the shift from one screen to the other must be easy and fast.
Expert anesthesiologists may transmit to the anesthesiologist on duty for the surgery interpreted data, part of their representation of the medical case and elements of planning.	Expert anesthesiologists underline, circle or emphasize important data, sometimes they add alarms.	The software must allow the anesthesiologist to emphasize crucial data and to set specific alarms.

enter the data and is thus allowed to jump from one field to another. But, then he has to shutdown the actual catalog and/or screen page to open the targeted one and this procedure is quite slow;

- there is no specific procedure to allow the anesthesiologist to emphasize crucial data or to add personal remarks, recommendations or warnings.

4.1. A priori assessment of the Tabellar application*

The comparison of these characteristics with the recommendations listed above provides the a priori evaluation in Table 2.

This a priori evaluation allows some forecasts for the usability and acceptance of this software application:

- Due to the synthesis screen and the visibility of the structure, the anesthesiologists should be able to gather and record the relevant data while performing their consultation; the resulting anesthetic record should be of satisfactory quality.
- Due to the poor capacity of the tool to adapt to different orders for data gathering, the expert anesthesiologists should feel uncomfortable with the interface because they will be unable to rely on their expertise to drive the interview of the patient. Conversely, novice anesthesiologists should not be disturbed by the order set by the interface for data gathering; they should rely on the interface for driving the medical interview.
- The expert anesthesiologists should be less disturbed with the interface for simple cases than for complex cases.

Table 2
A priori assessment of the Tabellar application

Recommendation	Tabellar interface
Dynamically updated synthesis screen page	Medium
Possibility of particularizing the order of data gathering	Low
Visibility of the structure for data gathering	Good
Possibility to emphasize crucial data	Low

4.2. Experimental assessment of the Tabellar application*

In order to validate the above hypotheses, we performed an experimental evaluation of the Tabellar* application, which involved three independent variables corresponding to the three main influencing factors of the model of activity: expertise, complexity of the medical case and the structure of the file.

- Subjects (Expertise):
  - One expert anesthesiologist, unfamiliar with the Tabellar* application
  - Two novice anesthesiologists, unfamiliar with the application.
  - One expert anesthesiologists, familiar with the application (author of Tabellar*), who represents the optimal performance that can be obtained with the application after a 2-year period of daily utilization. Each subject (unfamiliar) had three 1-h training sessions.

- Experimental design (complexity, structure): Each anesthesiologist performed four consultations corresponding to the combination of a two degrees of complexity variable (Simple × Complex cases) and a two conditions variable (Paper file × Tabellar*).
- Quantitative results (Fig. 3;; Table 3)):The consultation with the paper file and for simple cases is always faster than the con-

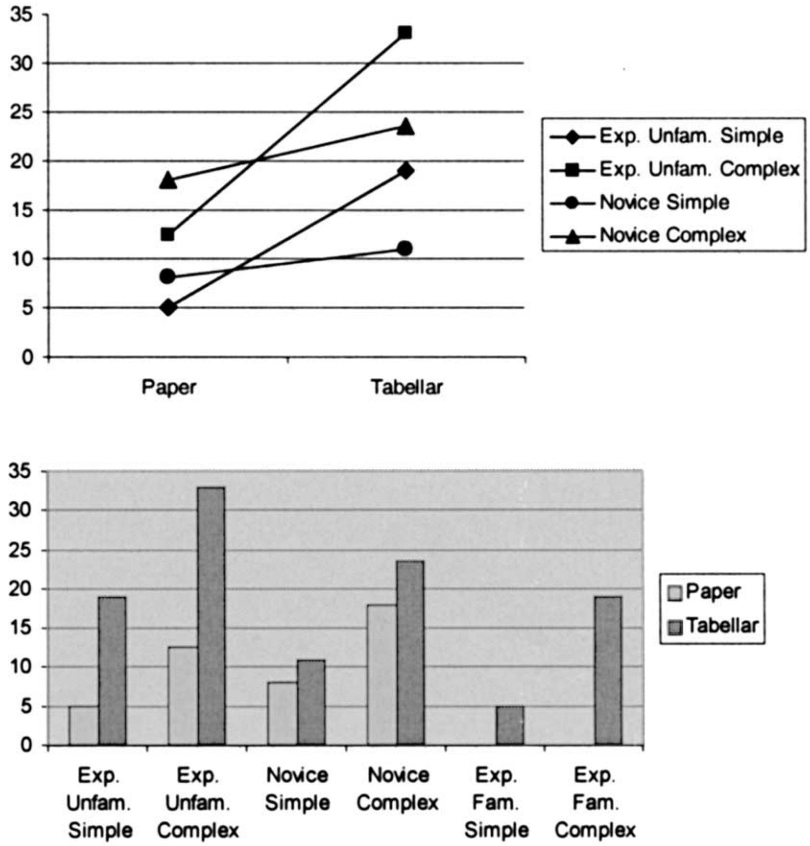


Fig. 3. Duration of the consultation (minutes) according to the type of support for the record (Tabellar × Paper), the complexity of the medical case (Simple × Complex) and the expertise of the anesthesiologists (Expert × Novice).

sultation with the computer and for complex cases. The expert anesthesiologists are faster than the novices, but as we expected, they are much more disturbed by the computer condition, where they become even slower than the novices. But this main effect is not influenced by the complexity of the case. For simple cases, the anesthesiologist familiar with the tool is as fast as the other experts with the paper file, but for complex cases, she remains slower than any of the other experts working with the paper file.

- Qualitative results:The expert anesthesiologists enter the same data (same number, same quality) on the paper file and on the computer. But the novices tend to enter less data on the computer and these data are less precise. Expert anesthesiologists feel uneasy whenever the summary screen is not available and they have some difficulties with the categorization of the items and data or with the catalogs each time this categorization is slightly different from the one they are used to (paper file and personal expertise). As expected, expert anesthesiologists feel 'less in control' in the computer condition and they get the impression they cannot drive the interview of the patient exactly the way they want, that they are compelled to follow the order set by the computer. They usually end the session claiming that 'their personal habits do not fit the computer way' and they are reluctant toward the utilization of this tool in their daily working environment. In summary, the experimental results validate the a priori evaluation of the Tabellar* application, which demonstrates medium usability and poor acceptance, at least from the experts point of view.

When faced with the completed Tabellar* consultation files (edited on paper), anesthetic nurses in charge of the induction phase with the anesthesiologists find it easier and faster to read than the previous paper file because it is typewritten. But they complain about the lack of explicit categorization of the data and their non-differentiation; they ask for important data to be highlighted.

5. Discussion

5.1. The 'usability' problem

The quantitative and qualitative results of the experimental evaluation of Tabellar* are coherent with the hypothesis derived from the model of activity and the a priori assessment. The problems of usability are actually due to the incompatibility between the software application and the main characteristics of the anesthesiologist's activity, especially if we consider the complex cognitive aspects of this activity:

- Strategies for information gathering in order to elaborate a proper representation of the patient's medical case and to set preliminary elements for the planning of the anesthetic process.
- Strategies for transmitting the relevant information to the anesthesiologist and anesthetic nurse in charge of the per-operative phase of the anesthesia. In this highly complex communication process, the particularization of data notation acts as a specialized operative language.

Understanding these essential features of the anesthesiologists activity helps to interpret correctly the usability problems. It is then possible to give reliable recommendations for the design of new tools or for the redesign and improvement of existing tools.

Such recommendations were provided for the Tabellar* software, which has hence been significantly enhanced:

Table 3
Duration of the consultation (in minutes) according to the expertise, the complexity and the file support

Conditions/ subjects	Expert anesthesiologist familiar with the application	Expert anesthesiologists unfamiliar with the application	Novice anesthesiologists unfamiliar with the application
Simple case Paper file		5 min = max = 5	8 min: 7; max: 9
Simple case Tabellar	5	19 min: 14; max: 28	11 min: 9; max: 13
Complex case Paper file		12.5 min: 4.5; max: 18.5	17.5 min: 17; max: 18
Complex case Tabellar	19	33 min: 20; max: 46	23.5 min: 22; max: 25

Table 4
Differential efficiency of the computer and paper files according to the functionalities considered

Functionalities/support	Paper	Computer
To support the activity:		
Elaboration of the representation	++	−−
Information gathering	++	−−
Transmission of interpreted information (representation)	+	−
Transmission of raw information	+−	++
Data management:		
Archiving	−−	++
Statistics	−−	++
Data retrieving and data availability	+−	++
Editions, complementary services	−−	++

- Improvement of the synthesis screen: more fields are visible altogether; the synthesis screen now includes complementary data such as laboratory results.
- When a user searches a catalog, the corresponding field and the items already entered in this field remain in view.
- The GUI is faster.

All those amendments support the elaboration of the current representation and allow the user to browse more easily among the fields of the consultation file. Therefore, the usability of the application seems positively improved. It is currently utilized routinely by all the expert anesthesiologists of the department (three) and by the novices as well.

5.2. Usability versus efficacy

When they claim that the paper file is 'easier to use', the anesthesiologists express the fact that this paper file suitably supports their activity in the preoperative phase of the anesthetic process (Table 4). But the software application somehow helps solve some usability and quality problems induced by the use of handwritten paper files, such as the legibility and the missing information problems. Moreover, if we consider the quality of the anesthetic patient record and the quality of information management, the software application becomes unavoidable (Table 4).

For example, Tabellar* includes a sophisticated and accurate intubation's score [24] which is automatically computed; in case of a difficult intubation, the appropriate anesthetic technique is suggested. Similar to most of the current EPR, the Tabellar* application entails an automatic check for the completeness of the critical fields, automatic loading of the previous anesthetic file in case of repeated anesthesia, a specific link with the nurses' file and so on. Most of these functionalities could be considered as 'another way' of supporting the anesthesiologists' activity.

6. Conclusion

The continuous extension of HIS, as well as the increase in quality requirements for anesthesiology, allows the consideration of the anesthetic computerized record as very probable in most hospitals within the next 10 years. Then, these software applications must be readily acceptable in the anesthesiologist's daily working environment. The acceptance of these tools will rely on their ability to support both essential functions:

- To provide a reliable archive;
- To support the users' activity by providing them with an adequate external support of the current representation that allows a proper management of dynamic situations.

Most of the existing tools actually reach the first target. But, they still have to improve their capacity to deal with the second target.

This statement could be extended to most of the major applications proposed to the physicians. This paper demonstrated the usefulness of the activity modeling approach in this domain.

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