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An ontological view in telemedicine

Une vue ontologique en télémédecine

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Summary The verification and validation of information system models impact on the adequacy and appropriateness of using the value of telemedicine services for continuously optimizing healthcare outcomes. We have defined a methodology to help the modeling and rigorous analysis of the requirements of information systems in telemedicine. On one hand, this methodology will be based on a formal representation of requirements (systemic, generic domain, etc.) within a knowledge base that will be a requirements repository. On the other hand, this methodology will use conceptual graphs for the formalization of ontology of activities and the production of arguments related to the formal verification of models built from this ontology. We describe an example illustrating the engagement of conceptual graph procedures to model the contextual situations in the telemedicine development. We also discuss the way in which ethical issues will actually take place in telemedicine applications.

MOTS CLÉS
Télémédecine ;
Sémantique formelle ;
Vérification et validation ;
Systèmes d'information ;
Questions éthiques

Résumé La vérification et la validation de modèles de systèmes d'information influent sur la pertinence et la justesse de l'utilisation de la valeur des services de télémédecine pour optimiser en permanence les résultats des soins. Nous avons défini une méthodologie pour aider la modélisation et l'analyse rigoureuse des besoins des systèmes d'information pour la télémédecine. D'une part, cette méthodologie sera basée sur une représentation formelle des exigences (systémique, domaine générique, etc.) au sein d'une base de connaissances structurant le référentiel des exigences. D'autre part, cette méthode utilise des graphes conceptuels pour la formalisation de l'ontologie des activités et la production des arguments liés à la vérification formelle des modèles construits à partir de cette ontologie. Nous décrivons un exemple illustrant l'engagement des procédures de graphes conceptuels pour modéliser les situations

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contextuelles dans le développement de la télémédecine. Nous discutons aussi de la manière avec laquelle les questions éthiques pourront effectivement prendre place dans les applications de télémédecine.

Introduction

Usually, the quality of a system is judged primarily on the satisfaction of the services provided and assigned by users, especially in terms of functionality, stability, integrity, dependability and performance objectives. These users are healthcare managers, decision makers, physicians and the engineers that are responsible for the development, piloting or maintaining this system. Their goals are varied and sometimes conflicting, according to their views and perspectives offered by the environment in which they operate.

Thus, the process of building a complex system must take into account all these expectations and check that, throughout the construction project, they are well respected. The modeling processes are subjected to regular inspections for the purpose of monitoring and verifying compliance with the specifications and constrains.

For this, System Engineering seems to offer a way to, on the one hand, comprehend the requirements of ''real world'' and to provide a common and consistent understanding among all actors and, on the other hand, to ensure the adequacy of the future system with a set of specific objectives [1]. To create a system, this engineering implements a series of activities in which an overview of methods, modeling languages and tools can be used to cover every phase of the life cycle of the system.

Particularly, the SEIPS (Systems Engineering Initiative for Patient Safety) model of work system and patient safety is a valuable systems approach to healthcare quality and patient safety [2].

The engineering must also take into account that the requirements of the various stakeholders of telemedicine are evolving: additional functional requirements, specific behavioral requirements, requirements of independence to hazards, etc. The scientific community has a body of work to model and understand how telemedicine activities are working. However, in each phase of the life cycle, the developed models are sometimes inadequate or tainted with errors that have negative effects on the following phases. For example, using the wrong model of the system control / command can cause machine downtime.

The need to ensure the satisfaction of the requirements expressed (qualities of activities and services, control of costs and time, etc.) is essential; therefore this makes more sense in a healthcare environment, and leads us to pay more attention on verification and validation issues.

Verification and validation

The activities of verification and validation aim to give confidence to all parties involved in ensuring that systems and activities comply with requirements and meet the design features expected. They must be able to highlight the shortcomings of the system and decide if it can be turned on or not.

The verification is:

> *''The confirmation by examination and by providing objective evidence (information which can be proved true, based on facts obtained through observation, measurement, test or other means) that specified requirements have been satisfied'' (ISO8402). Verification should allow to answer the question: are we building the model correctly?*

This check is usually done through expertise, or simulations based on the use by specialists in the field of mathematical demonstration tools such as ''theorem prover'' and ''model checker''. We must cope with increasing complexity: healthcare models are progressively difficult to verify by conventional simulation techniques and expertise that often reach their limits.

It is therefore necessary to consider alternative (or additional) formal approaches to provide evidence of specified requirements or to detect inconsistencies for effective verification of such models. Moreover, to ensure that the developed system meets the user, formal verification should be completed by the validation because, firstly, the formal requirements do not necessarily cover all the needs, and secondly, it is not impossible to have misinterpreted the requirements in both the requirements and the system.

The validation is:

> *''The confirmation by examination and by providing tangible evidence (investigations in practical situations) that the particular requirements for a specific planned purpose have been satisfied. Several validations can be made if there are different intended uses'' (ISO8402). The validation should answer the question: are we building the right model?*

Generally, the validation that often includes the audit may involve the development cycle itself, or focus on a single phase, ensuring that the resulting model corresponds to what is expected of him. As shown in Fig. 1 (adapted from [3]), validation is to ensure that all functions of the developed system meet the needs from the real world.

The ensuing challenge is:

> *How to help the modeler to carefully observe these two activities, to apply in the case of a complex engineering*

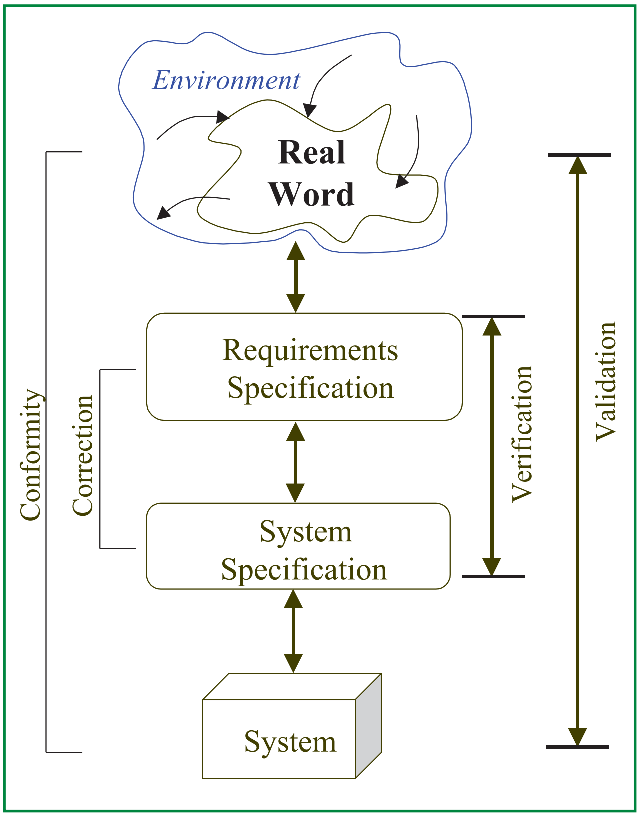

Figure 1. The substance of the verification and validation processes.
La substance des processus de vérification et de validation.

system, and finally the use of tools and mechanisms guaranteeing a sufficient quality of the analysis results?

Verification / validation criteria

To ensure the smooth running of the engineering process defined above, several criteria of verification and validation can usually be chosen (Figs. 1—2).

Firstly to facilitate the understanding of our criteria, some fundamental definitions may be useful [4]:

- domain requirements = set of axiomatic knowledge in the application domain that are (or are supposed to be) always true, regardless of the existence of the required system. The modeler must then use and take into account these requirements during the analysis phase;
- expressed needs = set of statements on the scope you want to see respected by the future system;

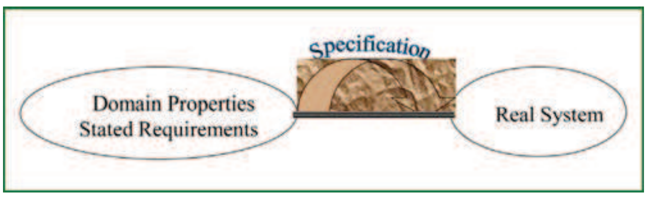

Figure 2. Formalization paradigm in systems engineering.
Le paradigme de formalisation dans le domaine de l'ingénierie de systèmes.

- specifications = set of statements describing the behaviors and functions that the system must have in order to meet the needs expressed.

Having made these observations, Steve Easterbrook and John Callahan gave a formulation of the formalization paradigm in requirements engineering [5] according to which we adjust the interpretation to system engineering. This means that the principle of the verification and validation processes can be formulated in systems engineering by the following equation:

$$\text{DomainRequirements} \wedge \text{Specifications} \Rightarrow \text{ExpressedNeeds?} \quad (1)$$

In other words, it is to find the specifications associated with the requirements of the modeling domain. They would meet the needs expressed by the various stakeholders (employees, customers, management) with potential users of the system.

This issue is divided into two aspects and requires three verification criteria and two validation criteria [6—11].

Verification criteria:

- expressed needs to be consistent and realistic in relation to the requirements of the domain;
- the specification model must take into account the requirements of the area concerned, and conform to the needs expressed;
- the functionality of the system must conform to the model specification.

Validation criteria:

- the resulting system must have the appropriate structure and perform the functions and behaviors satisfying the needs expressed correctly;
- the system must meet the requirement of ''completeness'' that is to say taking into account all the important needs of all stakeholders and the relevant requirements of the area in relation to the objectives of the modeler.

In practice the approach shown in Figs. 1 and 2, has often failed for several reasons:

- the needs are poorly expressed due to insufficient communication between actors, a lack of analysis, or the ignorance of the changing situation. A new dialogue between actors, a new modeling and formal validation can overcome these shortcomings;
- the specification is wrong due to misunderstanding of requirements, poor choice of language specification, ambiguity or incompleteness of the specification. This can be remedied by a formal audit or by recursive tests;
- the domain requirements are questionable, because there is a lack of expertise and thorough investigation of the area was rough. Also, taking into account specialized documents and expert advice is needed.

The need for a formal modeling language

The notion of process is strongly anchored in the methodological thinking in various fields in which process models now appear necessary for information systems and services best serve their purposes of management.

Succinctly, we review the modeling languages of business processes, and we found that most of them have a grammar defining the possible combinations of symbols associated with the various concepts handled and provide guidance for the inclusion of various views of a system. However, due to their informal semantics, they offer only the implementation of a limited number of arguments and therefore a fragmentary vision of the audit. Given a sample of initial data, we can experimentally test whether a method using the language leads to correct results, but that does not exclude other erroneous results. It is always a positive contribution even if it is insufficient, because the construction of non-trivial systems can sometimes lead to ambiguous models (useless and binding details, errors, inaccuracies, and incompleteness) and cause difficulties during analysis.

Therefore to overcome this limited expressiveness and the limited opportunities for verification and to reassure the user about the quality of the model (coherency, consistency, completeness, etc.) the use of a formal language is essential to us. Indeed, a formal language introduces some mathematical rigor to accurately describe the objects that are manipulated and better control the verification process.

> ''*It is hard to imagine how a leading-edge design company could remain competitive today without adopting a formal verification strategy.*''
>
> Scott Schroeder. Director of the verification, Cray Research Inc.

Such a formal language enables us to [12]:

- formalize the specifications in order to obtain a clear basis to check their compliance with the needs expressed. In addition, we can have an explicit model of the system behavior easily comparable needs;
- formalize the domain knowledge to be able to reason about its completeness and deduce consequences for the system. Similarly, this formalization will help us be specific and explicit about the environment;
- formalize the expressed needs to have the opportunity to test their consistency and completeness check;
- to ensure good audit coverage by offering the possibility of establishing the accuracy of reasoning means to ensure that methodology provides accurate results for any initial data.

Formal specification languages

Characteristics of approaches

A specification language is called formal if and only if it is a language with adequate mathematical semantics excluding (i) interpretation of rules that guarantee the absence of ambiguity in the descriptions produced and (ii) rules deduction that can reason about the specifications to discover potential incompleteness, inconsistencies or evidence requirements [13].

The first constraint allows the specification of a single reading. The second constraint is more difficult to obtain, but it is thanks to it that we can expect, state and verify behavioral or functional requirements. In addition, the operationalization of the models is partly automated, prototyping is facilitated.

Formal languages often differ in certain characteristics:

- the ontology that can be fixed (states, events, actions, as is the case with Statecharts) or extensible (meta-language defining new concepts);
- the mathematical basis can be expressed using logic applied to first order predicates or temporal logic. This foundation is also often based on algebraic languages or set theory;
- the processing of time may be accomplished through a state model or events. Time is sometimes symbolized by object classes.

Thus we distinguish three major traditions of formal modeling: approaches such as the transition system (based on the concepts of state and transition), the set-oriented coherent description of the system model considered approaches and finally conceptual approaches.

However, it is not possible to classify all languages based on these three criteria, some have a mixed or a general approach.

Focus on the conceptual approach

Conceptual formal languages are interested in knowledge representation of the real world, focusing on modeling entities, activities, actors and assertions of a domain.

Conceptual formal languages are very expressive and accurate because they offer opportunities to transcribe in a more or less directly expressed needs and the reality model in unambiguous terms. Their application to engineering systems is excellent since they provide three major advantages [14]:

- reading and management models are easier, especially since the produced formal descriptions are close to the vocabulary of the considered domain;
- they have inference mechanisms with logical foundations. These mechanisms allow easy implementation of procedures for formal verification;
- in terms of checks and validations made on formal models, presentation of the results in terms that are defined by and salient to the involved actors creates confidence in the quality and safety of the models.

We present below a language of this family, namely the conceptual graph formalism, which is used for complex systems modeling driven by ontologies (Fig. 3).

Conceptual graphs: presentation

The conceptual graph formalism is a language for knowledge representation inspired by semantic networks [15] which resulted in a number of studies since its introduction in 1984 by John Sowa.

A special feature of this language is to represent knowledge in a graphic form. More specifically, a conceptual graph [16] is a bipartite graph, the two classes of vertices being labeled by the respective names ''concepts'' and the names of ''conceptual relations'' between these concepts. Such a graphical representation of knowledge enables users to understand, create, or directly modify objects of this type, so much simpler with a logical representation of such formulas.

The ease of use of the formalism is reinforced by an explicit separation of different types of knowledge.

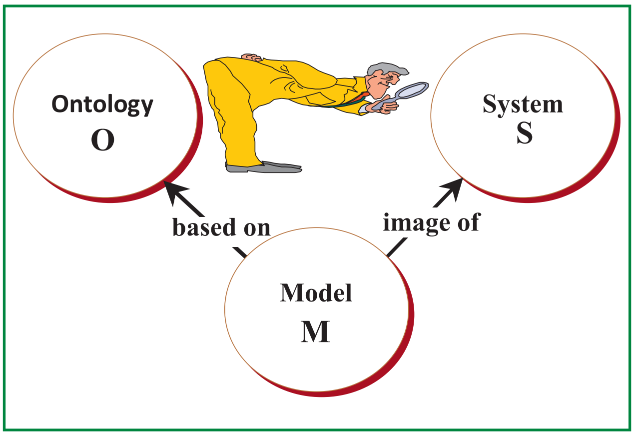

Figure 3. Systems modeling driven by ontologies.
La modélisation des systèmes entrainée par les ontologies.

Different types of knowledge are indeed represented by such dissimilar distinct objects and the structure leads to greater clarity in the use of this formalism concerning the acquisition or knowledge modeling. The vocabulary for representing knowledge (ontology) is structured in such a model object called ''support'' for representing simple way links ''*sort of*'' and ''*is*''.

The other advantage of the formalism is that reasoning can be performed on the knowledge represented. These arguments vary on the choice of a very abstract style to a more graphic style [17]. In particular in this paper, we prefer the second approach because it develops viewable arguments that rely on the work of algorithmic graph theory. Finally, the formalism has some semantics in first order logic that is adequate and complete with respect to the deduction. These characteristics are useful to generate formal models for the description of information systems architecture, in this particular case of telemedicine [18].

Conceptual graphs: handling

All the features mentioned above in the use of conceptual graphs for modeling complex systems can provide a better understanding of the scope, a fluid or harmonized communication, especially automation of the analysis with in premium detailed reasoning.

As part of our problem of verification in telemedicine models, we choose to read the conceptual graph formalism, because it has the following additional advantages [19]:

- first, its ability to model the knowledge in the field by producing a precise vocabulary that formalizes models;
- second, graphs are easily manipulated (join, decomposition) and understandable by a ''final'' user (a system engineer, or even a non-expert specialist field formalism), as they are not too large;
- third, the arguments can be made with graph operations that allow to rigorously analyze the requirements of models of telemedicine and eventually the emergence of new ones;
- and finally, predominant quality, these arguments ''with drawings'' can be easily explained to a user on the representation that he built. This explanatory power would be lost if the arguments were made logically.

In addition, applications relating to the recent outstanding advance of semantic web provide evidence of interest for the information system and knowledge management communities.

Semantic formalization with conceptual modeling

This work aims to provide a framework to aid the user in the modeling process, from writing specifications until the formal analysis of process models for telemedicine.

It seems necessary:

- to build a modeling framework that supports a rigorous formulation of the needs and knowledge of the considered domain;
- to have a methodology to collect and organize knowledge in a formal way for greater efficiency during the phases of verification and validation implying models of systems that may include telemedicine;
- to define mechanisms for verification and validation to ensure that all operations of the developed satisfy all the expressed needs and respect the knowledge axioms that are available in a domain and its environment according to a considered viewpoint.

For this we use a combination of two basic principles:

- an approach to modeling requirements,
- an approach using conceptual graphs.

These approaches are complementary and it is interesting to combine them into a coherent framework to take advantage of each of these formalisms and reduce their weakness. Indeed, the combination provides a very expressive formal framework that provides a wide range of concepts for modeling various aspects. This joint use also improves the simplicity of the modeling concepts by providing high levels adaptable to different areas of modeling. Finally, this formal framework provides the methodological means to ensure that the developed system meets the expectations of the end user.

There could be some similarities between these conceptual modeling procedures and other approaches from conceptual modeling to requirements engineering in information systems and software technologies [20—22]. However, to fully address the issues guiding and adapting changes in IT systems, a consistent taxonomy of process models, describing a set of models and associated methods can be helpful in choosing appropriate approaches adapted to contextual needs [23].

An approach using conceptual graphs

The design and development of computer systems are increasingly based on the assembly of tested and validated software components that can be reused in a personalized way (or semi- customized).

The idea to define reusable templates spread to several areas, including specific contextual language which defines in its modeling framework the notion of partial model that is intended to be reused by certain classes of telemedicine systems. More recently, works on ontologies emphasize aspects

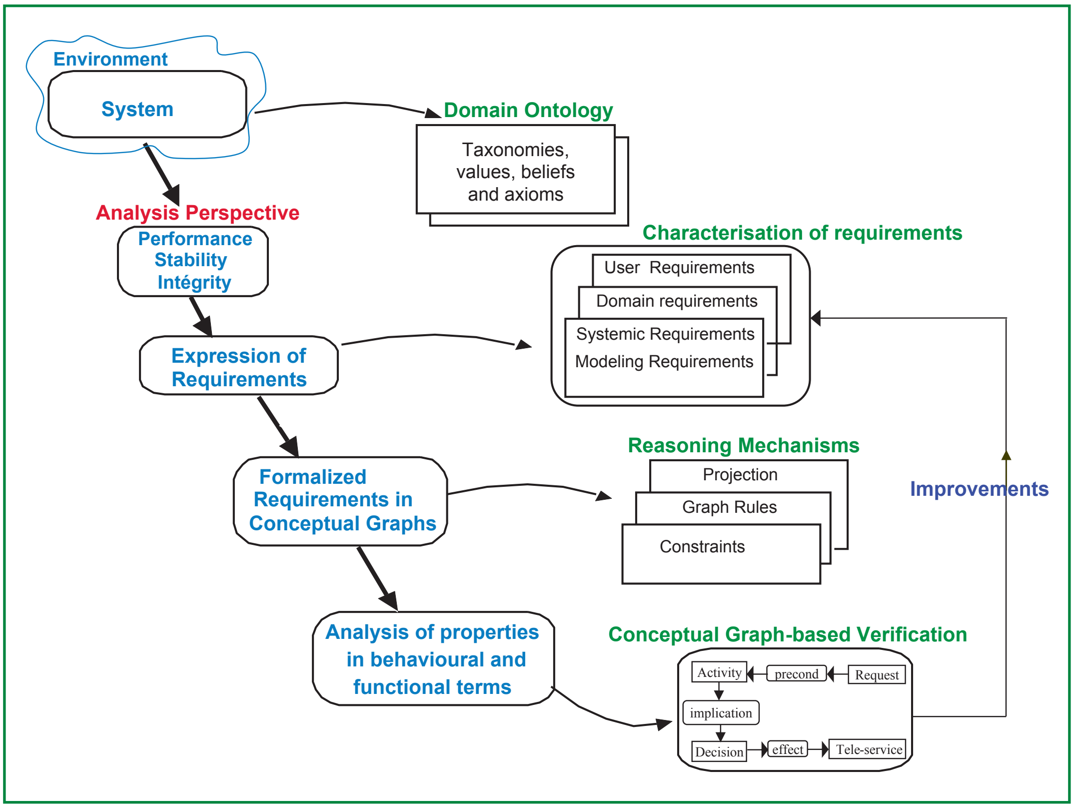

Figure 4. Steps of the proposed research approach.
Les étapes de l'approche de recherche proposée.

of reuse and formalization. An ontology is a formal description of entities, relationships and constraints in order to allow several groups to share and exchange knowledge [24]. The different steps of the suggested approach are described in Fig. 4.

Informative and illustrative guidance in specific situations

As a first step, we will develop an example of a telemedicine system of deploying a territory and for patients with chronic illness requiring regular monitoring, measurement and automatic recovery of data connected by electronic transmission to a hospital [25]. This method has the advantage of allowing the monitoring of certain parameters and trigger if need medical advice or emergency.

To begin with, define the purpose (experimentation, make it possible to monitor, save lives), mission (launch monitor patients and interventions) and the objectives of the system (improving the survival rate of x % improve the quality of life, reduce costs). This step requires, in most cases, several exchanges between the design and implementation at all levels. Indeed, every defined element is reassessed and possibly amended thereafter. Then it is necessary to identify the interfaces with the outside: the patient, the attending physician, the manufacturer of the device, the communication network, the hospital service, the funding institution, the patient's family. Then it is a question of determining the services that must be rendered or expected of each of the elements of the context (measuring physiological parameters on the patient, providing information to the nurse monitoring, reimbursement by the funding agency, using the communication network ADSL...). Moreover, it is useful to specify the interfaces of our system with its environment: the physical links (sensor, screen, form, network communication...) and flows that are traded (physiological measures, patient data encryption acts, encrypted data...).

For example, the cycle of care for breast cancer has been engineering work, a rich system of teachings, which helped to bring very noticeable benefits for its users (oncologists, radiologists, pathologists, surgeons...). At first, it was to conduct an analysis and then to model the current cycle. This phase is to identify how the information about the patient and the disease are processed in each stage (prevention, screening, diagnosis, characterization of the tumor, treatment, medical care) and to start engineering. Such an approach allows introducing naturally and fully integrated telemedicine: at screening (reading distance shots), diagnosis and characterization (teleconference peer), monitoring of long-term treatment (daily measurement and electronic transmission of certain physiological parameters) or the overall monitoring of remission.

The definition of need and requirements analysis can have a complete and consistent set of requirements and constraints validated by stakeholders. In our example, this will list both the functional needs (patient's blood pressure to check...) and performance (monitor patients throughout the territory covered by the hospital, measure and transmit certain parameters forcing the patient to remain still less than half an hour a week...). We can also formalize the security requirements for the operation (objectives of reliability, security, and privacy), cost constraints and compatibility with existing systems (computer systems, organization of hospital services).

The design of the functional architecture defines the main functions of the system (measuring, display, trigger a medical procedure...) and sees how they fit together from a static point of view (definition of flows exchanged) and a dynamic perspective (in relation to the states of the system and its operating modes: unplugged, in test, in use, in alert levels...). The design process of organic architecture, meanwhile, will identify the components of the system (medical device, communication device, computer workstation, software, technical support personnel, and doctors... in the border of the system that has been chosen) and the links between them, and the allocation of functions of these constituents.

Information system design for telemedicine implementation

The most important success factor in the information system design for telemedicine applications is the combined use of design science and participatory approaches to develop an ICT-based healthcare for rural communities through focusing on core indicators and the related sustainability challenges. The participatory approach is a social problem solving perspective for better analyzing the social and cultural dimensions in the user's context in order to ensure further compliance between information system design and local user reality [26]. The design science approach for information systems is a research strategy to gain knowledge and understanding about a known research problem [27], according to three cycles of inquiry: a relevance cycle for requirements of elicitation and contextual verification, a rigor cycle for determination of the pertinent knowledge base and frameworks, and a design cycle for prototype development and evaluation [28]. Hence, the designed research project is leading the assessment of this modality in order to improve on its practicality and effectiveness. Consequently, designing a sustainable support system for rural healthcare delivery in a specific country environment signifies the establishment of a successful development and implementation of the system. This goal can be achieved by actions guaranteeing research approaches that are more contextual, report more on setting factors, engage more participatory and pragmatic design processes and report results effectively and openly on topics significant to prospective approving patients, physicians and managerial decision makers [29].

It is still useful to clarify the contextual situation better, to examine potential improvements and to specify formal rules that must be established at information system level. These rules can allow us to describe the various types of required properties of the concepts in the telemedicine domain. Generally, rules within the information system are broadly classified into two distinct categories [30]. The first category refers mainly to organizational rules concerning resources management and procedures needed to guarantee legal and ethical compliance. In the second category, the communication rules are generally designed to process data of exchanged messages engendered by the telemedicine activities for making and prioritizing decisions and associated remote actions. The verification and validation of rules impact on the adequacy and appropriateness of using the value of telemedicine services for continuously optimizing healthcare outcomes. We represent below an example of conceptual graph rules to model the contextual situation in the telemedicine scenario that requires coronary catheterization (Fig. 5). It is performed for both cardiology diagnostic and treatment procedures.

Ethical considerations latent in global situations of telemedicine

Ethics in medicine examine the philosophy and core principles of how medical procedures and medical practices are executed. Medical ethical issues fall within the framework traditionally ascribed to the doctor-patient relationship and are grounded in the four fundamental ethical principles [31]:

- respect for the dignity of persons that recognizes respect for human rights (e.g., privacy, self-determination, and personal liberty);
- responsible caring that supports an active concern for the welfare of the persons. This includes actions, interpretations, choices and recommendations that try to avoid harm, minimize harm that cannot be avoided, and correct harm when it is possible;
- integrity in relationship that promotes completeness and openness of communication with contextual variances and expectations regarding appropriateness. This needs to monitor, and manage potential biases, multiple relationships, and other conflicts of interest;
- Responsibility to society that reflects common concerns for the welfare of all human beings in society in accordance with the established laws, social structures and the public interest. This implies choosing the most appropriate and beneficial use of available knowledge and technologies to improve the welfare of all human beings in society.

The introduction of new remote procedures with telemedicine adds a layer of complexity to the notion of ethical expectations. This complexity increases with the state of diffusion, adoption and application of new information and communication technologies in the stage of telemedicine [32] [33]:

- at the first stage of telemedicine, there is the use of multimedia and exchange tools (email, videoconferencing, joint development of websites). Compliance with a set of ethics, involves issues of data security, respect of medical confidentiality, and compensation policies for practitioners;
- at the second stage of telemedicine, there is the involvement of non-medical third parties (medical devices or non-medical staff). Such is the case, for instance, of the telemonitoring in which the main problem concerns people who are medically dependent, but also in the remote robotized transmissions for teleassistance activities. Ethical problems then shift to the legal domain with the notion of individual or shared responsibility in interprofessional relationships;

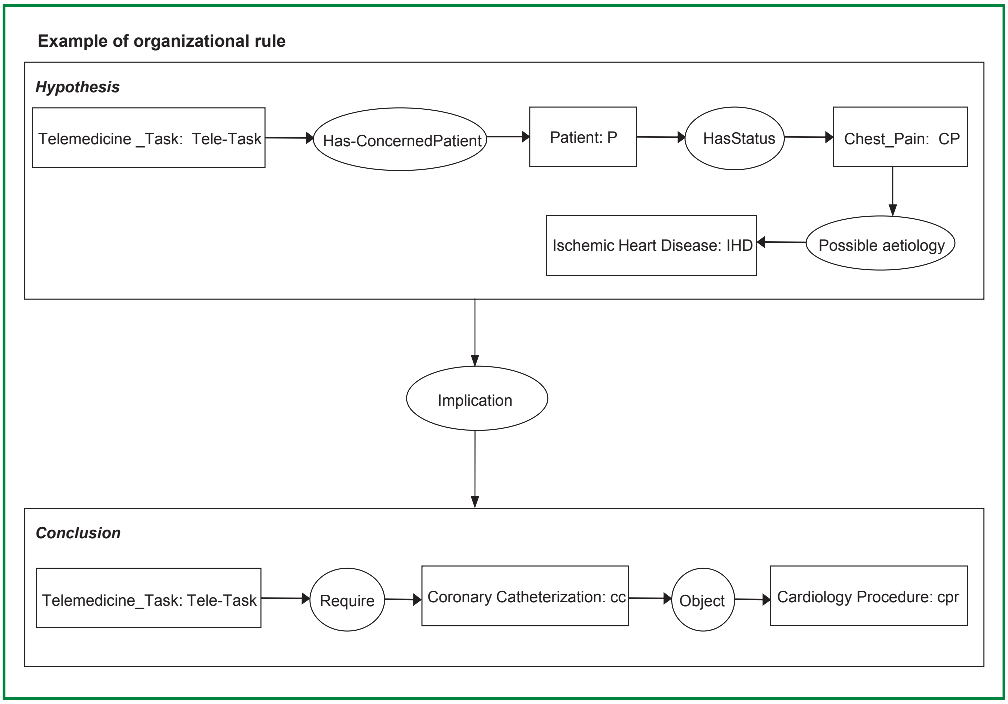

Figure 5. Example of a conceptual graph rule.
Exemple d'une règle organisationnelle en graphes conceptuels.

- at the third stage of telemedicine, there is the deployment of intelligent systems with knowledge-based information components for visual support in critical decision-making. These systems pave the way to the integration of numerical and symbolic processing for learning and explanations of reasoning. This generates a new complementary style of human-computer interaction, in which the computerized device becomes a smart, active and personalized collaborator. Therefore, intelligent systems are directly involved in the decision processes that are ultimately performed and assumed by the medical practitioners. The determination of comprehensive medical care for the well-being of patients is a sensitive topic and subject to various representations.

By the remote medical services which they have delivered, the activities of telemedicine have opened ethical issues that impose new requirements and create some legal challenges concerning many different interpretations of human rights and fundamental freedoms. The priority projects of telemedicine would generate certain experiences, knowledgeable approaches and best practices that can be shared for the common good.

Conclusion

A control step analysis model becomes essential, since it conditions the proper implementation of the system. Any approach facilitates formal analysis of models, *verification* of compliance with expected requirements, contributes to the reduction of time inherent in the completion of this step, as the following steps. An additional requirement to achieve this goal and ensure the *validity* of the models developed is to *formalize* the maximum specifications while producing understandable constructions.

Despite the substantial body of existing languages and methods in modeling activities, most of the procedures lack verification tools and validation. Hence, the difficulty of ensuring that the obtained models lead to compliance with the requirements expressed in a studied system.

Based on this observation, we set the objective of defining a methodology to help the modeling and rigorous analysis of the requirements of telemedicine systems. On one hand, this methodology will be based on a formal representation of requirements (systemic, generic domain, etc.) within a knowledge base that will be a requirements repository. On the other hand, this methodology will use conceptual graphs (CG) for the formalization of ontology of activities and the production of arguments related to the formal verification of models built from this ontology [34].

The importance of this modeling and rigorous analysis of the requirements of telemedicine systems is even more apparent since the recognition of the generic representation is declined in two meta-models: the first covers the activities of teleconsultation, teleexpertise and teleassistance; the second concerns the telemonitoring. The framework designed for the analysis of the associated information system needs to be considered in this perspective. Actions and modalities aimed at putting the telemedicine applications into place, therefore, must be compatible with and contribute to the broadest operational deployment of the remote healthcare services. It is really believable and significant to gather technology intelligence on telemedicine implementation [35], to support the general purpose of improving healthcare delivery.

Telemedicine is a wonderful tool for the continuous improvement of patients' health by its quality, timeliness, information and communication technologies that are increasingly innovative and specialized [36]. However, there are still ethical and legal issues (e.g. confidentiality, free choice, individual and collective responsibility) [37]. They would find adaptability to progress, if possible, correct responses, to the questioning and relevant reflection needed to bring about operational change. Finally, it is important to consider that the integration of telemedicine in the healthcare setting is the promotion of innovation as contributing to a sustainable increase in the growth potential of the medical programs or services [38]. In the interest of patients, all stakeholders must conform to a certain number of general rules, codes and principles to put the patient's needs first and build a health care system that would provide medical services for the individual who is sick.

Disclosure of interest

The author declares that he has no conflict of interest concerning this article.

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