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Argumentative reasoning and taxonomic analysis for the identification of medical errors



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ABSTRACT

Telemedicine consists of the use of information and communication technologies (ICTs) in the practice of medicine. The massive digitalisation of the society is changing the behaviour of ordinary people even in medical sectors. The impact of digitisation is also having impacts on teleexpertise, where a medical professional can remotely ask some advices through the use of ICTs to provide treatment to a patient in critical conditions in remote environment. However, sometimes the outcome of such advice obtained remotely can lead to medical errors. In these situations, it is important to determine whether the causes of the errors could have been avoidable or not for the purposes of establishing the truth and assuring justice for the victims of medical errors. The proposed work fits this perspective with the objective to formalise elements of argumentation in collaborative medical organisations using telemedicine. In other words, a technique that extends the Dung's argumentation framework in order to bring out the errors committed following a remote medical procedure has been proposed. The proposed technique is underpinned by graphical reasoning. The reasoning is represented through a directed graph in which the extended nodes specify the arguments with their source(s) and the identification of errors is done according to the Makeham's and Tempos taxonomies. To illustrate the functioning of the proposed technique or solution, an example of the practice of teleexpertise (between two French hospitals) that leads to litigation is presented.

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1. Introduction

In an increasingly digital society, there is a shift in the ways of designing efficient health care system and health management information system. Thus, health professionals and patients must prepare themselves to take advantage of established and enhanced healthcare processes that improve the quality of the service delivered. This is particularly important given the amount of scientific and practical evidence that the digital technologies and their numerous applications have significantly improved performance in many other domains and gradually doing the same in the healthcare sector. The opportunities being generated by these emerging ICTs must not be missed.

The French law on hospitals, patients, healthcare and local areas (HPST) proposes a prescriptive framework for the promotion

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and protection of equitable access to health care (<http://www.legifrance.gouv.fr/>). In particular, Article L6316-1 of the law contains provisions concerning the services of the telemedicine: *telemedicine is a form of remote medical practice using ICTs. It enables communication among health professionals (which must include at least a qualified medical professional) or with their patients and, where appropriate, of other professionals involved in the provision of care to the patient. It provides the means to establish: a diagnosis, of a risky or very vulnerable patient, to ensure, monitoring for preventive purposes or post-treatment surveillance, to ask for specialised advice, to prepare a therapeutic decision, to prescribe products, to prescribe or to perform the services or acts or to conduct monitoring of patient conditions.* In fact, the telemedicine facilitates the efficient provision of healthcare services. In particular, telemedicine bridges the challenges often encountered across different service levels including primary care, regional and national care services, coordination between health care institutions, mobile medicine, medical and medical-social actors, promotion of regional or virtual clustering, new modalities for collaboration among medical partner organisations (Kamsu-Foguem et al., 2015a; Kamsu-Foguem et al., 2015b; Sené et al., 2015; Kamsu-Foguem and Foguem, 2014a;

Kamsu-Foguem and Foguem, 2014b; Doumbouya et al., 2014; Kamsu-Foguem, 2014c, Kamsu-Foguem, 2014d). This contributes to improve regional attractiveness and valuation of certain health professions and optimal operating efficiency, and convergence plans towards strategic scheduling. The procedures of telemedicine do not fundamentally undermine the essential principle of a personal practice of medicine, each physician remaining responsible for his or her own actions or inactions. In the case of a remote diagnosis, the requesting physician who uses (through a computer network) the services of an expert colleague has no liability for the acts or omissions of this external collaborator. The diagnosis made by the expert is the entire responsibility of this required physician. However, the liability of the requesting physician might be initiated by the patient if it were demonstrated that this doctor made errors or omissions in the content of the information communicated to the expert. If the requesting physician participates in the elaboration of a diagnosis, his liability might be mentioned in this regard and in such circumstances, the responsibility of both doctors might be considered.

Teleexpertise is one of the five important practices of telemedicine (Doumbouya et al., 2015a), which is sometimes used to save life in critical care and emergency situations. It allows remote collaborations between several medical professionals and optimises the management of patient with complex illness. Furthermore, the emergence and the growth of the Internet and digital technologies offer universal access to information, allowing a larger involvement of patients by encouraging the establishment of a more open dialogue with physician. More importantly, the introduction and adoption of these emerging digital technologies provide opportunities for victims of medical errors, the understanding of the causes of errors and their impact on diagnosis or therapy. It is important to note that medical error is not the only requirement for a medical review and hence litigation. For example a litigation can be occurred when a patient is not satisfied of his treatment. The patient or his legal representatives may apply to a judicial procedure or may refer to the Regional Commissions for Conciliation and Compensation for Medical Accidents (CRCI). The CRCI will cover the cost of required medical expertise and based on the seriousness of the potential prejudice, the procedure will be the conciliation or the amicable or mutual agreement. So when this situation occurs, it is important to facilitate the work of legal experts by offering them a way to easily collect all the data they need for the expertise. It is against this backdrop that this study is developed i.e. providing a tool to legal experts to help them in their practice when a litigation occurs.

This paper is divided into 7 sections. Section 1 introduces the research context while the rationale is discussed in Section 2. To facilitate understanding and also ground this research, a state-of-the-art review of common medical errors is conducted in Section 3. Based on the review in Section 3, research methods adopted are discussed in Section 4. In Section 5, real-life case study illustrating the challenges faced teleexpertise and proposed solutions has been examined. Section 6 is about a discussion of the major issues in this study. The study concludes by a way of summary in Section 7.

2. Motivation and objective

Nowadays with the rising of technological and electronic devices, the practice of telemedicine is in the process of taking a considerable place in the medical community. But we need to be aware that this practice sometimes raises complex medico-legal issues. So to clarify the legal responsibilities of each participant, we must have an information modelling approach that allows the judicial system to get a valuable insight into understanding the circumstances of the considered medical accidents. The quality of

forensic evidence must be examined in its entirety, from the beginning of the procedure with detailed information according to the applicable procedural rules. The diverse participants of the judicial system must be supported by the development of consistent tools allowing to provide and distinguish arguments according to their weight or importance of evidence and to highlight the more credible elements of the analysis, as well as those which are of less relevance. Telemedicine has the obligation to deliver services with associated information and reasoning that are based on documented, conclusive and convincing evidence. It is thus expected that telemedicine must implement health information management modules that ensure traceability of coherent and reliable evidences to enable enlightened and well-founded decisions of the judicial system. Consequently, the aim of this study is to provide an information system architecture that will allow or help key judicial or legal actors (e.g. judges and prosecutors) to draw a clear and assessable representation of the examined litigious medical case for evaluating relative responsibilities. To achieve the aim of this study, a combination of the Dung's argumentation framework and semantic modelling principles was employed. Dung's argumentation framework is based on mathematical foundations that guarantee formal reasoning. The framework models arguments with graphs such that nodes represent arguments and arrows represent the attack relation. Semantic modelling offers taxonomic analysis of medical errors. Our work is aimed at producing added value with the integration of available sources of arguments proposed by medical professionals directly in the node of the graph of attack to consolidate the decision making process and medical collaboration through the telemedicine.

3. State of the art of medical errors in healthcare systems

3.1. Diagnosis errors

Since the 1970s, scientists study clinical decision-making in order to improve its processes. Clinical decision-making is also called clinical reasoning, clinical judgement, clinical inference or diagnostic reasoning (Ge et al., 2012). Scientific context, clinical decision-making can be categorised into two modes (Ge et al., 2012):

- *Deductive mode*: When decisions are based on theoretical knowledge of diseases and the mechanisms of different treatments.
- *Empirical mode*: When decisions are based on past experiences.

Different techniques have been used in clinical decision-making process. Some common techniques are decision trees, Markov models, and simulation. Clinical reasoning is an important contributor to the quality of healthcare, but to achieve this quality of healthcare, the provided decisions in the clinical reasoning have to be safe. Some works such as Goal Structuring Notation (GSN) (Ge et al., 2012) have been made in this way. It enhances communication between medical professionals and is more suitable and convenient for analysis of medical errors.

Lawson and Daniel (2011) propose a work in which they attempted to reduce and even eliminate diagnosis errors. The diagnosis errors encountered in healthcare care systems are generally caused by cognitive errors. These errors represent 80% of diagnosis errors (Lawson and Daniel, 2011). To facilitate understanding, these errors are illustrated in Fig. 1 using the Makeham's taxonomy. This taxonomy is divided into two main categories of errors:

- *Process errors*: This category covers care system errors coordination, errors due to complementary examinations such as

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