Modeling for effective collaboration in telemedicine

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ABSTRACT

Telemedicine is a remote medical practice, which utilizes advanced telecommunications and information technologies for the delivery of healthcare and the exchange of heath information across distances. The development of telemedicine has significantly changed the medical collaborative decision making and doctor–patient relationships and has an impact on the responsibilities of physicians to patients and how to treat them. Moreover, in the chain of medical care information exchanged between a requesting physician and medical expert should assist in decision making. In this regard, we propose means for the formalization of exchanges, which is very important because it facilitates a transparent and traceable understanding of the remote process. So, we engage knowledge-based modeling for supporting collaborative activities in telemedicine. This includes the engagement of formal ontologies to ensure structuration of terminology and identification across all entities in a domain so that multiple sources of data can be aggregated through comparable reference terms. The provided benefit is the generated support for logic-based intelligent applications that are able to perform complex reasoning tasks such as checking for errors and inconsistencies and deriving logical inferences.

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1. Introduction

The European Union (EU) and its European Commission (EC) have implemented policies, models with conceptual and technical guidelines for supporting and encouraging research projects related to telemedicine. In addition, the draft directive on patients' rights in cross-border healthcare advocates cooperation in health including the establishment of referral networks, evaluation of medical technologies, data collection, quality, and safety (Saliba et al., 2012). These projects include the creation of a network of Community Technology Assessment health centers to promote collaboration between national health authorities and the provision of timely, objective, reliable, transparent, and transferable solutions. Sharing of health technologies, in the short and long term, enable effective exchange of information within the network and support the decision making by EU Member States related to the effectiveness and sustainability of actions related to improving and controlling quality patient care. This objective has been implemented successfully in recent years with cross-border teleneuromonitoring collaboration between hospitals in the Netherlands, Germany, and Switzerland (Doering et al., 2013).

Especially with a view to the widespread deployment of telemedicine services in Europe, it is necessary to rely as much as possible on standards, infrastructure, and exchange formats. The European Community organizes the implementation of interoperability standards on three levels:

- *High-level:* national or regional projects (e.g., the interoperability framework of ASIP Santé—the shared healthcare information systems agency, European projects such epSOS, adapted to the French context).
- *Intermediate level:* integration Profiles to address key issues (e.g., IHE, Continua Health Alliance).
- *Low level:* standards (e.g., HL7, DICOM, IEEE, W3C, Oasis, etc) and interfaces between systems.

The aims of this study include ensuring the structuring of exchanges (e.g., clinical data associated with the request for an opinion, formalizing the response of the expert sought by means of guidelines assuring collaboration, identification of the professionals involved), and guaranteeing security (confidentiality, integrity, traceability, centralized archiving).

The rest of the paper is structured as follows. Section 2 exposes the collaboration in telemedicine with activities and actors involved and types of exchanged data and challenges for data sharing in telemedicine. Section 3 presents requirements and modeling for collaboration in Telemedicine through ontology modeling for semantic specification and knowledge capitalisation from remote collaborative expertise for the effective deployment of telemedicine. Finally, Sections 4 and 5 conclude and discuss lessons learned and future challenges.

2. Collaboration in telemedicine practices: state and necessities

2.1. Activities and actors involved

Telemedicine is a remote medical practice, which utilizes advanced telecommunications and information technologies for the delivery of healthcare and the exchange of heath information across distances, including the following medical activities (see Fig. 1) (Simon and Pellitteri, 2012):

- **Tele-consultation**, a procedure whereby medical professionals can consult a patient remotely and interpret the necessary data remotely for medical follow-up;
- **Tele-expertise**, whereby a medical professional can seek remotely an opinion of other medical professionals who have the relevant training or skills;
- **Tele-monitoring**, the ability to monitor and supervise patients remotely;
- **Tele-assistance**, a procedure, which enables a medical professional to assist remotely another healthcare professional during the realization of a medical act.

Telemedicine is becoming an integrated tool in the delivery of health care and will soon be a part of mainstream medicine, but the practice of telemedicine is difficult and complex. Telemedicine assists collaborating medical professionals with shared decision-making in medical diagnosis and treatment. Referring (requesting) physicians should involve patients in the decision to seek further medical actions involving the choice of a specialist/consultant, as a starting point for more in-depth investigations into underlying causes. The procedure allows the specialist to investigate more thoroughly the compatibility
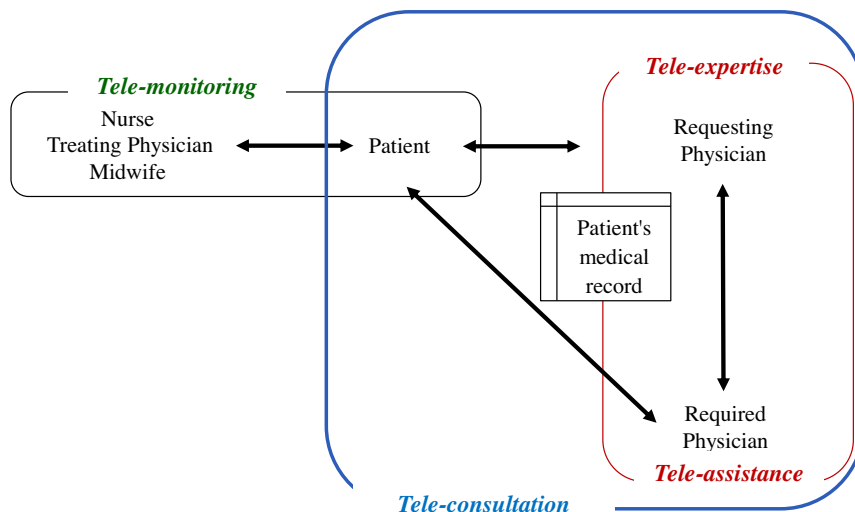

Fig. 1. Typology of telemedicine activities.