Integrating clinical data with information transmitted by implantable cardiac defibrillators to support medical decision in telecardiology: the application ontology of the AKENATON project

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Abstract
Implantable cardiac defibrillators along with telecardiology services provide improvements in health care delivery and clinical outcomes in the field of heart failure. This implies a shift from strictly device-centered follow-up to perspectives centered on the patient. In the AKENATON project, we have designed a formal ontology that supports integration of clinical data extracted from patient records with information transmitted by implantable cardiac devices, and offers reasoning capabilities to classify the alerts.

Keywords: ontology; decision support techniques; cardiac pacemaker, artificial; defibrillators

Introduction
Heart failure is a difficult and costly disease to manage. Nowadays, more and more patients benefit from cardiac resynchronization therapy/defibrillators and implantable cardioverter defibrillators (ICD). Despite optimal drug and device therapy, frequent hospitalizations due to decompensated heart failure or episodes of arrhythmia remain an issue. The recently introduced home monitoring functionality of ICDs is a promising telecardiology technique that could prevent hospitalizations [1]. However, ICDs send many remote alerts about arrhythmias to physicians, who have to assess their relevance and emergency level. Preventing the telecardiologists from being submerged by incoming data from their patients depends to a large extent on programming of the alerts and data triage [2]. The objective of the AKENATON project is to provide a framework for integrating the data transmitted by the ICDs with their clinical context, to improve alert management.

Methods
The AKENATON system is composed of several modules, including data extraction, ontology, and data integration. Ontology is used for modeling and instanciating structured patient information, for driving information extraction from text reports, and finally for reasoning about the data.

Results
The AKENATON ontology is based on DOLCE [3]. Rationale for choosing DOLCE is that it offers a better support than BFO for representing temporal qualities (e.g. heart rate, atrial fibrillation duration) and cognitive entities (e.g. prescriptions, diagnosis, therapy plan). The coverage and the reasoning capabilities of the ontology have been assessed by checking against competency questions related to the motivating scenarios. Up to now, we have implemented scenarios related to pacing lead failure where the additional presence of an atrio-ventricular block implies a risk of sudden death, as well as episodes of atrial fibrillation, e.g., where the thromboembolic risk depends on the medications taken by the patient (e.g. clopidrogel, warfarin). The ontology contains around 600 classes and 180 properties. Patient data are represented as instances of the ontology classes. The result is a classification of the alerts by the reasoner (Pellet) with pre-defined degrees of urgency (‘red’ and ‘yellow’ alerts), which helps with data triage. In both scenarios, all the alerts were correctly classified.

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References