INTEROPERABLE END-TO-END ECG STANDARDS FOR REMOTE PATIENTS MONITORING BASED ON ISO / IEEE 11073

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INTRODUCTION

The Electrocardiogram (ECG) is a widely conducted cardiac test. With the development of Information and Communication Technologies (ICT), New telemonitoring systems developed based on the expeditious growth of information and communication technologies (ICT), the transmission, storage and management of digital ECG signals turned into major topics of discussion (Trigo *et al.*, 2012).

Within this discussion, the standardization of these digital ECG signals becomes a major issue for the past several years. Several competing formats and standards were created in response to medical organization initiatives, based on the particular organization's needs. These requirements lead to different ECG standards, making the interoperability between the standards almost impossible.

In reality, all these standards and formats are complex and part of a widening and ever-changing context. This heterogeneity makes difficulties in the design and development of end to end standards-based systems. It entails critical integration issues for Healthcare Information Systems of the hospitals and medical institution. To solve this problem, for home and hospital systems adopting a single digital ECG format is required for a versatile, integrated and efficient way to exchange ECG signals.

MATERIALS AND METHODS

For this study, the existing reviews on these topics were found in the literature based on keywords ECG, electrocardiogram, format, standard, digital exchange, interoperability, and standardization. Furthermore, the articles found led to other existing formats and relationships that widen the literature search. A homologous procedure was followed during the literature search. The search string list included terms such as mapping, harmonization, converter or relationship.

RESULTS

Through the study, different ECG standards and relationships among them are outlined. As the ECG is considered part of different use cases (ranging from diagnostic examinations to homecare, emergency care, and clinical trials), a wide variety of standards have been proposed and developed to achieve semantic interoperability (Bond *et al.*, 2011). The four most widely known formats include: Digital Imaging and Communications in Medicine waveform supplement 30 (DICOM-WS 30), Health Level Seven annotated Electrocardiogram (HL7 aECG), Standard Communications Protocol for computer-assisted Electrocardiography (SCP-ECG), Medical waveform Format Encoding Rules (MFER) and so on. Currently, HL7 aECG, SCP-ECG, DICOM are most predominant ECG formats (Stamenov, Gusev and Armenski, 2018).

ISO/IEEE 11073 (x73 PHD) personal health device standard family define optimized exchange protocol, and modelling techniques need to use by implementers of personal health devices to create interoperable devices (*BSI Standards Publication Health informatics — Personal health device communication*, 2017).

Various mappings between digital ECG formats and standards have been proposed in the literature to solve this problem partially. Examples of such research processes include mappings between SCP-ECG and DICOM, SCP-ECG and HL7 aECG using general data format (GDF) as intermediate structure SCP-ECG and ISO/IEEE11073, to mention only a few. SCP-ECG, which has become an international standard as ISO/IEEE11073-91064:2009, part of the X73 family.

DISCUSSION

A method to uniformly administer the various formats would enhance the hospital information system and physicians' daily practice. A potential solution for this problem is providing converters for the different ECG formats to a central format to be homogeneously handled at the hospital information system and uniformly visualized after that. The single digital ECG format using ISO/IEEE 11073 as a base standard helps translate the predominant standards HL7 aECG, SCP-ECG, and DICOM into one common format. Therefore, the framework's development to convert the diverse formats uniformly is necessary and a software application to allow users' easy implementation.

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