

Collection and Management of EMG Examination Cases

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As a part of EMG-net project, researchers at the Slovak University of Technology developed a software tool for collection and management of electromyography (EMG) examination cases called EMMA. They concentrated on data representation, which is a crucial task in such data intensive area as the EMG examination. The proposed data model serves as a basis for a multifunctional platform for EMG studies aiming at assisting EMG practitioners in developing standard examination procedures as well as in analysing and evaluating of existing EMG procedures.

The European Research Network for Intelligent Support of Electromyographic Studies (EMG-net) is an INCO Copernicus research project which aims at establishing a research network combining electromyography and information technology (IT). EMG-net comprises teams of physicians and IT experts from nine Western and Central/ Eastern European countries. EMG-net is a successor of ESTEEM (European Standardised Telemetric tool to Evaluate knowledge-based EMG systems and Methods) project that introduced a set of standards for EMG studies.

EMG is a standard method for monitoring neuromuscular activity at the level of bioelectrical signals. A physician has to deal with large amount of data. Computer based information processing supporting diagnostic process in neurophysiology may enhance the physician's ability to make appropriate decisions and find the right diagnosis. A software tool for collecting and managing EMG examination cases is useful because of its capability of:

- storing EMG examinations, which enables retrieving previous examinations and comparing or evaluating them
- exchanging and distributing EMG examinations, which serves as a communication between physicians
- tracking condition of a patient by effective retrieving of EMG examinations for a particular patient at different times.

EMG data can be collected at several levels: the local level, the national level, and the European level.

The local level is represented by a particular EMG workplace. The national and the European level are intended mainly for exchange of the EMG expertise accumulated during the years of practice. This would improve the quality of an early diagnosis and prevention of neuromuscular diseases in each particular country, or a whole region.

The national level of EMG data collection becomes also important when the aim of data collection is development of normative EMG data.

Data Representation

During the ESTEEM project, the software tool for EMG data collection (called CASETOOL) was developed together with Communication Protocol EPC/ECCO 3.2 for exchange of EMG data. Binary ECCO format has been designed as an efficient format from the point of view of storage. Several existing tools (including the CASETOOL) use it. Moreover, EMG laboratories, which form EMG-net consortium, have collected in the last years together more than 1000 EMG cases stored in this format. There exists so called golden EMG data collection, which stores more than 200 cases resulted from the consensus of partners. The problem with ECCO format lies mainly in its inflexibility with respect to extensions. The problem arose during the EMG data collection and evaluation.

Binary format is also not very suitable for exchange using the Internet for obvious reasons. In order to preserve continuity in the EMG-net project as well as to support future developments, we use several data representation formats:

- binary format (Communication Protocol EPC/ECCO 3.2)
- relational format (represented by a relational database)
- text format (represented in the eXtensible Markup Language).

New software tool supports all the three formats. The ECCO binary format is retained in the form of export/ import capabilities.

Relational format is used for storing EMG examination cases. Design of the relational format is based on the ECCO format, which defines all the necessary data and data types stored in a database. Moreover, we proposed additions, which are inevitable for efficient data management and extensions proposed by EMG experts – users of the CASETOOL. Proposed relational data model is further capable to store normative EMG data.

The relational format is advantageous because of its flexibility and extensibility. Created database can be easily used by different tools through standard interfaces to the relational database and can be shared between different applications. This increases the portability of the final solution. Relational format presents also a base for data mining. What we should pay for this flexibility is less effective storing than the one that is achieved by binary format (such as ECCO).

We identified some parts of the data model, which were designed with the likely future changes of requirements in mind. The identified entities contain their symbolic values in separate tables. Each of such tables contains attribute, which determines version of the given code

table (at the present the values correspond to ECCO, v. 3.2 values). This allows changes and support of different symbolic value assignment versions without a change of the software tool. As an example we can mention flexible representation of clinical diagnosis names and their numeric representations, or EMG conclusion names and their numeric representations.

The described approach complicates the data model, so we had to carefully decide between simple data model and its flexibility. A complete report of the proposed relational model is available at the Slovak EMG-net local webpage. Finally, the XML format is suitable for distribution of EMG expertise between the users of the system. Information exchange is important in the process of consensus exercises, where physicians discuss particular EMG cases in order to reach consensus regarding an EMG diagnose as well as a clinical diagnose.

The proposed markup language for EMG data exchange (EMG-ML) is based on the proposed relational model. EMG-ML document contains information about all the patient's examinations. Using XML files as the exchange format has several advantages:

- the content of the document is dynamic, depending on the actual anatomical structures that are examined and used examination techniques
- the content of the document is self-describing because of the text-based nature of XML files
- the EMG data transmission is highly error-free because its non-binary character
- the transmitted data are 'open' for third party software processing.

The main disadvantage of such a format is the length of the document and inefficient manipulation of the data. However, its combination with a relational database solves the mentioned problems.

Design and Implementation of EMMA

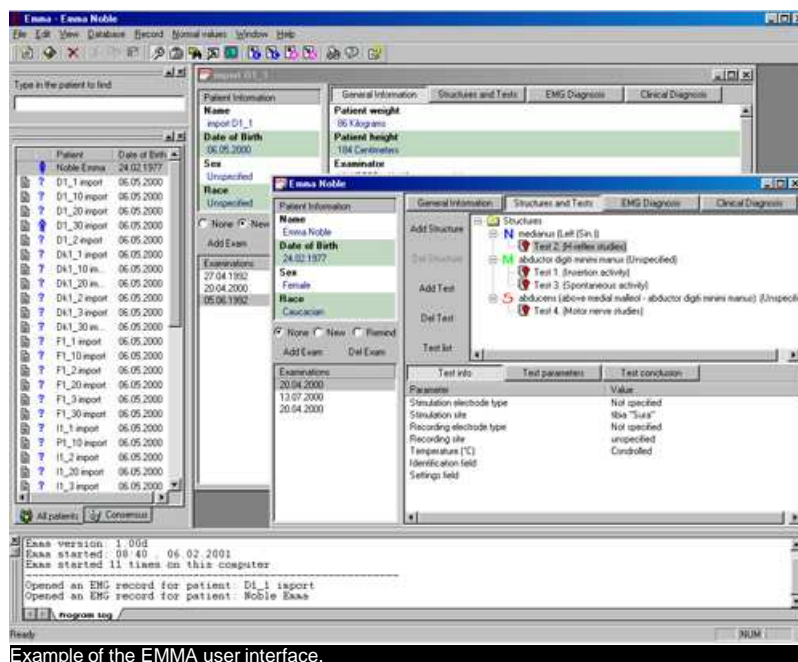
A software tool for collection and management of EMG cases, EMMA, is developed in Visual C language in the Windows operating system. The user interface comprises several windows and a set of forms for filling and maintenance of EMG data. Relational database is built in Microsoft Access. The design of EMMA follows the process of EMG examination, in which a physician works with three groups of data:

1. General data: patient information, examination information, clinical information
2. Examination data: test conditions, parameters
3. Inferred data: symbolic parameter values, pathophysiological test conclusions, pathophysiological structure conclusions, EMG diagnoses, clinical diagnoses.

We also incorporated into the design EMG normative data, which serve for accurate interpretation of an examination. EMMA supports inputting and modification of normative data in several formats (eg, in table format, functional format) and calculating symbolic parameter values according these data in an actual test.

EMMA is designed in such a way that a patient is considered a central entity in the system. A physician can create several EMG examinations for the patient, which enables observing changes in subsequent examination of a particular patient.

The designed data representation allows future extensions of EMG data management features: support of tests and techniques selection during EMG examination; support of conclusion statements determination (on all levels, ie structure conclusion, EMG diagnose conclusion and clinical diagnose conclusion); support of retrieving cases based on their similarity; support of monitoring patient's course of illness.



Example of the EMMA user interface.

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Links:

EMG-net project web page: http://www.inrialpes.fr/sherpa/emgnet/emg_index1.html

Slovak node page: <http://www.dcs.elf.stuba.sk/emg/>

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