Empowering Clinicians by eHealth Technologies in Decision-Making Tasks

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Medical decision-making

• Sound diagnostic, therapeutic and prognostic decisions are derived from
  – collection of sufficient amount of data and knowledge,
  – skills to combine data and knowledge appropriately.
Medical decision-making

• Growing number of eHealth applications for decision support have oriented many physicians to pay more attention to
  – the logic of dealing with clinical problems,
  – to give a more formal description of decision-making processes.
Further we will show three eHealth applications supporting medical decision-making considering also e3Health concept.
New medical knowledge in addition to existing knowledge creates two groups of e-health decision-support applications for:
- clinicians
- health authorities
to act according to practical evidence.
e-Health Decision-Support Applications

- Support *clinicians* in their *diagnostic*, *therapeutic* and *prognostic* activities. They are characterized by
  - relying on *multiple sources of codified medical knowledge*, e.g. current clinical guidelines,
  - exploring *electronic health documentation*, e.g. existing clinical databases,
  - acting in an “intelligent” way, e.g. issuing suggestions, warnings or alarms,
  - considering *economic* and *environmental* features of e-health applications.
Examples of eHealth Applications for Clinicians

1. Formalized Electronic Clinical Guidelines,

3. Testing Competency in Clinical Decision-Making

5. Knowledge Evaluation and Dissemination
Formalized Electronic Clinical Guidelines

- to use the knowledge gathered by experts in the form of clinical guidelines written in free text form,
- to find knowledge in free text may be difficult,
- to create computer interpretable representation of medical knowledge.
Formalized Electronic Clinical Guidelines

- Many knowledge representing languages have been introduced (e.g. Arden Syntax, Asbru, EON, GUIDE, PRODIGY, PROforma, GLIF),
- Guideline knowledge representation model (GLIKREM) contains some changes and extensions of the definition and implementation of the original GLIF model.
Formalized Electronic Clinical Guidelines

The GLIKREM is described in

- its construction,
- implementation in XML,
- realization of the data interface,
- use of GLIKREM in Medical Knowledge Representation System (MEKRES).
Formalized Electronic Clinical Guidelines

There are about 200 of Czech electronic free text guidelines stored in the database of clinical guidelines. About 25 of clinical guidelines have been already formalized.
An important part of teaching medical decision-making is the method of measuring the increase in the decision-maker's ability to make correct decisions.

System TECOM (TEsting COMpetency) can evaluate decision-making ability of decision-makers for any decision-making task.

The use of the TECOM system is demonstrated by an example from cardiology using real cases from the Municipal hospital in Caslav.
Testing Competency in Clinical Decision-Making

• The system acquires information for a clinical decision-making task from a data matrix that contains information on cases (e.g. patients) in the rows and correct decisions as headings of rows.

• Correct decisions in the data matrix (e.g. correct diagnosis, optimal therapy, validated prediction of a patient health state) should be carefully validated by experts (e.g. physicians).
Testing Competency in Clinical Decision-Making

- We show an example of clinical decision-making among patients suffering from
  - Chest pain,
  - Myocardial infarction,
  - Pulmonary embolism.

- The data matrix is based on real cases described in medical reports generated in the Municipal hospital in Caslav. 76 patients (cases) were included in the data matrix and the data model contains 75 features describing each patient.
Testing Competency in Clinical Decision-Making

For marked questions the answers are generated.

- **Age:**
  61 years

- **Sex:**
  Female

- **KV diseases:**
  Stt replacement of aortic valve by prosthesis of St. Jude Medical 21 AMP 105 in the year 1999, chronic anticoagulant therapy, according to aortography 2005-11 good function of aortic replacement, according to SCG - hypoplastic ACD, left ventricular ejection fraction approximately 35 %, left ventricular cardiac failure in the history - 2005-09, currently NY-HA of the II-III degree, Chronic ischaemic coronary disease, without angiography, stt plastic surgery of tricuspidal valve, vascular nephropathy, obesity magna, hypertension of the III degree according to WHO definition, compensated on pharmaco therapy. Syncope vs. of the arrhythmia origin in 2006-01, normocyte anaemia of the light degree, vs. anaemia in the chronic illness.
Testing Competency in Clinical Decision-Making

Possible decisions with subjective probabilities are given and the evaluation appears.

Choose the correct diagnosis and set the percentual value of your belief it is correct. It is necessary to divide the whole 100%.

Chest pain
Myocardial infarction
Pulmonary embolism

Total 100

EVALUATION

Your prediction rate is 0.06 (if the subjective probability was uniformly distributed, it would be 0.33)

1. case: NO! You estimated the correct answer Pulmonary embolism with the subjective probability of 6%.
Testing Competency in Clinical Decision-Making

We calculate a prediction rate

\[ Q = \frac{1}{n} \sum_{i=1}^{n} \log_2 (p_i + 1), \]

where \( n \) is the number of cases and \( p_i \) is the probability of the correct outcome at the \( i \)-th case.
The prediction rate was calculated as 0.54 for a sequence of 4 patients.
Knowledge Evaluation and Dissemination

- eHealth applications **supporting learning processes** can increase knowledge to improve quality of clinical decision-making,
- **ExaMe system**, used for knowledge evaluation, supports also learning processes,
- **European Journal for Biomedical Informatics** supports knowledge delivery in national languages,
The evaluation by the system ExaMe is based on the knowledge base created for a specified target, mostly for knowledge covered by a special course.

The knowledge base consists of generalized multiple-choice questions (number of answers is not limited, at least one answer is true and at least one false).
ExaMe System

• For each question, score define its importance and difficulty.
  – Importance is given in five categories (very important, important, moderately important, little important, not important),
  – Difficulty is given in five categories (very easy, easy, standard, difficult, very difficult).

• For each answer, its weight is defined.
  – The weight is given by number of points (integers) from the range \([-5; +5]\), except 0.
  – Weights should be positive for true answers and negative for false answers. Moreover, explanations of true or false answers are formulated.
Fixed and Automated Tests

• The **fixed test** is appropriate for evaluation of the group of students in computer classroom connected to Internet.

• The **automated test** is appropriate for self-evaluation on remote places. Students can pass evaluations by automated tests by themselves and the final results of the tests are displayed immediately.
European Journal for Biomedical Informatics

- EJBI is reacting on the great European need to share the electronic information in the multilingual and multicultural European area.
- EJBI (http://www.ejbi.eu/) is publishing peer-reviewed papers submitted in English with their other European languages versions simultaneously.
European Journal for Biomedical Informatics

• The editorial board presumes that presentation of English versions of scientific papers with their professional translations to other languages will significantly contribute to unification of applied scientific terminology in European languages.
European Journal for Biomedical Informatics

EJBI is now a Schattauer related journal.

You may find more information in Editorial of Methods of Information in Medicine, Issue 2, 2008.
This cooperation is concentrated on preparation of a multilingual special issue.

- **English versions** of papers will be published by the *Methods of Information in Medicine*.
- **Translated versions** to several other European languages will be published by the *European Journal for Biomedical Informatics*. 
Thank you for the attention