An Arden-Syntax-Based Clinical Decision Support Framework for Medical Guidelines - Lyme Borreliosis as an Example

Alexander SEITINGER\textsuperscript{a,b,1}, Karsten FEHRE\textsuperscript{b}, Klaus-Peter ADLASSNIG\textsuperscript{b,c}, Andrea RAPPELSBERGER\textsuperscript{c}, Elisabeth WURM\textsuperscript{a}, Elisabeth ABERER\textsuperscript{d}, and Michael BINDER\textsuperscript{a}

\textsuperscript{a}Department of Dermatology, Division of General Dermatology, Medical University of Vienna, Austria
\textsuperscript{b}Medexter Healthcare GmbH, Vienna, Austria
\textsuperscript{c}Section for Medical Expert and Knowledge-Based Systems, Center for Medical Statistics, Informatics, and Intelligent Systems, Medical University of Vienna, Austria
\textsuperscript{d}Department of Environmental Dermatology and Venereology, Medical University Graz, Austria
Objectives

- Usable for all text-based guidelines without having to adapt the system
- Support clinicians by displaying relevant information - saving time, and therefore facilitate decisions
- Easy medical knowledge management
Lyme borreliosis

- Discovered by Allen Steere et al. in 1975
- Transmitted by ticks
- Caused by *Borrelia burgdorferi sensu lato* bacteria

**High risk of infection:**

*Vienna, lower Austria, upper Austria, Styria, Carinthia*

**Challenges:**

- Symptoms
- Multiple guidelines
For all diagnoses:
Interpretation of serological findings only in connection with a clinical diagnosis

- If IgG is positive:
  - Clinical diagnosis: early disseminated stage?
    - Yes: IgG concentration level?
      - Low: Joint and muscular pain?
        - Yes: Borreliosis: early disseminated stage
        - No: Borreliosis: probably crossed-reactive antibodies
      - High: IgG concentration level?
        - Yes: Probably elapsed borrelia infection
        - No: Borreliosis: early stage (in this stage IgM only for 50-80% of the patients positive, clinical diagnosis important)
    - No: Joint and muscular pain?
      - Yes: Borreliosis: probably crossed-reactive antibodies
      - No: Borreliosis: early stage (in this stage IgM only for 50-80% of the patients positive, clinical diagnosis important)

- If IgM is positive:
  - Clinical diagnosis: early stage?
    - Yes: Borreliosis: early stage (in this stage IgM only for 50-80% of the patients positive, clinical diagnosis important)
    - No: No evidence for infection
  - Joint and muscular pain?
    - Yes: Borreliosis: early disseminated stage
    - No: Probably crossed-reactive antibodies
  - IgG concentration level?
    - Low: IgG concentration level?
      - Yes: Probably elapsed borrelia infection
      - No: Borreliosis: early stage (in this stage IgM only for 50-80% of the patients positive, clinical diagnosis important)
Swiss Society for Infectious Diseases
Combined guideline
Clinical decision support framework

Client-server architecture

- Arden Syntax Server
  - Arden Syntax v2.9 (medical logic modules)
- Web client
  - HTML, PHP, CSS
- Patient database
Key elements

• Transfer object:

  result: List of strings - recommendations by the support system

  next_questions: List of question objects

    – q_label: actual question
    – q_type: question type (e.g., Boolean, fuzzy)
    – q_info: additional information

• Flexible lists

  [object, object, object, ...]
Client-server communication

Implemented in 4 steps:

1) Retrieve known patient data
2) Call the Arden Syntax server service
3) Receive results
4) Generate user interface

Save patient data in patient database
## Patient database

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<th>Collation</th>
<th>Attributes</th>
<th>Null</th>
<th>Default</th>
<th>Extra</th>
<th>Action</th>
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</thead>
<tbody>
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<td>No</td>
<td></td>
<td>auto_increment</td>
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<tr>
<td>patient_id</td>
<td>varchar(30)</td>
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</tbody>
</table>

<table>
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<th>patient_id</th>
<th>doctor_id</th>
<th>key_term</th>
<th>date</th>
<th>data</th>
<th>data_type</th>
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</thead>
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<td>1.0</td>
<td>truthvalue</td>
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<td>test</td>
<td>Fever</td>
<td>2014-01-12 11:00:39</td>
<td>0.8</td>
<td>truthvalue</td>
</tr>
<tr>
<td>71</td>
<td>patient1</td>
<td>test</td>
<td>Tick bite</td>
<td>2014-01-12 11:00:07</td>
<td>0.5</td>
<td>truthvalue</td>
</tr>
</tbody>
</table>
Fuzzy Arden Syntax

- Used to process linguistic uncertainty
### Client

#### Alternative 1 – Truth value: 0.81

**Recommendation:**
1. Check patient for neurologic symptoms.
2. Check patient for carditis

**Neurologic symptoms** *Certainty level*

- **Carditis** *Certainty level*

- **Submit**

**Reasoning:** Findings: erythema.migrans: false  -->  erythema.migrans: present: true

#### Alternative 2 – Truth value: 0.1

**Recommendation:**
1. Did erythema migrans persist for more than a week?

#### Alternative 3 – Truth value: 0.09

**Recommendation:**
1. Search for other symptoms.