CADIAG-II: Methods

• knowledge representation
  – symptom and disease hierarchies
  – crisp rule and fuzzy set based data-to-symbol conversion
  – symptom/disease, symptom/symptom, disease/disease relationships, and complex diagnostic rules with frequency of occurrence and strength of confirmation

• inference mechanism
  – manifold application of the compositional rule of fuzzy inference
Examples

Example 1 (indicating):

IF  \textit{elevated amylase level in serum}  
THEN  \textit{acute pancreatitis}  
WITH  \((\lambda_O = \textit{very often} [\mu_O = 0.90], \lambda_B = \textit{strong} [\mu_C = 0.70])\).

Example 2 (necessary and sufficient):

IF  \textit{rheumatoid arthritis and splenomegaly and leukopenia less than 4 giga/l}  
THEN  \textit{Felty’s Syndrom}  
WITH  \((\lambda_O = \textit{always} [\mu_O = 1.00], \lambda_C = \textit{confirming} [\mu_C = 1.00])\).
<table>
<thead>
<tr>
<th>Pancreatic cancer</th>
<th>[Hpi]</th>
<th>[Hsu]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anamnesis/known present disorder(s)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>age, 17-29 years</td>
<td>0.93</td>
<td></td>
</tr>
<tr>
<td>age, 30-50 years</td>
<td>0.98</td>
<td></td>
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<tr>
<td>age, 51-60 years</td>
<td>0.09</td>
<td>0.01</td>
</tr>
<tr>
<td>sex, male</td>
<td>0.59</td>
<td></td>
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<tr>
<td>sex, female</td>
<td>0.41</td>
<td></td>
</tr>
<tr>
<td>(heavy) smoker</td>
<td>0.35</td>
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</tr>
<tr>
<td>alcoholism</td>
<td>0.20</td>
<td>0.01</td>
</tr>
<tr>
<td>diabetes mellitus</td>
<td>0.20</td>
<td>0.02</td>
</tr>
<tr>
<td>latent diabetes</td>
<td>0.55</td>
<td>0.02</td>
</tr>
<tr>
<td>venous thrombosis</td>
<td>0.35</td>
<td>0.03</td>
</tr>
<tr>
<td>Present symptoms</td>
<td></td>
<td></td>
</tr>
<tr>
<td>tiredness</td>
<td>0.52</td>
<td></td>
</tr>
<tr>
<td>weakness</td>
<td>0.55</td>
<td>0.01</td>
</tr>
<tr>
<td>lack of concentration</td>
<td>0.23</td>
<td></td>
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<tr>
<td>malaise</td>
<td>0.60</td>
<td></td>
</tr>
<tr>
<td>decrease in physical/mental powers</td>
<td>0.50</td>
<td></td>
</tr>
<tr>
<td>major debilitation</td>
<td>0.26</td>
<td>0.02</td>
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<tr>
<td>jaundice</td>
<td>0.54</td>
<td>0.02</td>
</tr>
<tr>
<td>nausea</td>
<td>0.44</td>
<td></td>
</tr>
<tr>
<td>vomiting</td>
<td>0.34</td>
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</tr>
<tr>
<td>anorexia</td>
<td>0.50</td>
<td>0.01</td>
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<td>weight loss</td>
<td>0.82</td>
<td>0.05</td>
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<tr>
<td>subfebrile temperature</td>
<td>0.25</td>
<td>0.01</td>
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<tr>
<td>bleeding</td>
<td>0.18</td>
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<tr>
<td>pain, abdominal</td>
<td>0.86</td>
<td>0.06</td>
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<tr>
<td>pain, abdominal, epigastric region, diffuse</td>
<td>0.08</td>
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<tr>
<td>pain, abdominal, right epigastric region</td>
<td>0.54</td>
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<tr>
<td>pain, abdominal, mid-epigastric region</td>
<td>0.20</td>
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<tr>
<td>pain, abdominal, left epigastric region</td>
<td>0.04</td>
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<tr>
<td>pain, abdominal, denteration at hyperpontosis</td>
<td>0.80</td>
<td>0.03</td>
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<tr>
<td>pain, abdominal, radiation to the back</td>
<td>0.33</td>
<td>0.05</td>
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<tr>
<td>pain, abdominal, radiation to the side(s)</td>
<td>0.05</td>
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<tr>
<td>pain, abdominal, radiation to the hypogastrum</td>
<td>0.03</td>
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<tr>
<td>pain, abdominal, persistent, mild</td>
<td>0.09</td>
<td>0.01</td>
</tr>
<tr>
<td>pain, abdominal, persistent, intense</td>
<td>0.16</td>
<td>0.01</td>
</tr>
<tr>
<td>pain, abdominal, intermittent, mild</td>
<td>0.45</td>
<td>0.02</td>
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<tr>
<td>pain, abdominal, intermittent, colicky</td>
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<td>0.01</td>
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<td>pain, abdominal, acute onset</td>
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<tr>
<td>pain, abdominal, initial onset</td>
<td>0.70</td>
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<td>pain, abdominal, unrelated to food intake</td>
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<td>pain, abdominal, postprandial</td>
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<tr>
<td>defecation, constipation</td>
<td>0.18</td>
<td>0.01</td>
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<tr>
<td>defecation, diarrhea</td>
<td>0.23</td>
<td>0.01</td>
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<tr>
<td>defecation, steatorrea</td>
<td>0.09</td>
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<tr>
<td>defecation, light stools</td>
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<td>defecation, tarry stools</td>
<td>0.07</td>
<td>0.03</td>
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<tr>
<td>miction, dark urine</td>
<td>0.38</td>
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<tr>
<td>anemia, antimon</td>
<td>0.45</td>
<td>0.02</td>
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<tr>
<td>depression</td>
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<tr>
<td>Physical examination</td>
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<td>general condition, normal</td>
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<td>general condition, ill</td>
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<td>0.01</td>
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<td>nutritional status, normal</td>
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<tr>
<td>nutritional status, reduced</td>
<td>0.75</td>
<td>0.02</td>
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<tr>
<td>strength, normal</td>
<td>0.30</td>
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<tr>
<td>strength, reduced</td>
<td>0.70</td>
<td>0.01</td>
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<tr>
<td>skin, subicteric</td>
<td>0.06</td>
<td>0.02</td>
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<td>skin, icteric</td>
<td>0.54</td>
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<td>skin, subcutaneous fat necrosis</td>
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<td>skin, thrombophlebitis, migrans</td>
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<tr>
<td>lymphnodes (LN), palpable LN metastasis</td>
<td>0.09</td>
<td>0.30</td>
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<tr>
<td>eyes, sleale, icteric</td>
<td>0.60</td>
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<tr>
<td>abdomen, ascites</td>
<td>0.28</td>
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<td>abdomen, systolic murmur, left epigastritis</td>
<td>0.17</td>
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<td>abdomen, palpable abdominal mass</td>
<td>0.30</td>
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<td>abdomen, liver, hepatomegaly</td>
<td>0.50</td>
<td>0.01</td>
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<td>abdomen, liver, palpation, suspicion (susp.) of liver metastasis</td>
<td>0.55</td>
<td>0.30</td>
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<td>abdomen, gall bladder, Courvoisier's sign</td>
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<td>0.07</td>
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<td>abdomen, spleen, splenomegaly</td>
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<td>0.01</td>
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<td>Laboratory findings</td>
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<td>blood sedimentation rate (BRS), increased</td>
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<td>serum, alkaline phosphatase (AP), elevated</td>
<td>0.72</td>
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<td>serum, glucose, elevated</td>
<td>0.48</td>
<td>0.02</td>
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<td>serum, bilirubin, elevated</td>
<td>0.60</td>
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<tr>
<td>serum, glutamic-oxaloacetic transaminase (SGOT), elevated</td>
<td>0.65</td>
<td>0.02</td>
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<tr>
<td>serum, glutamic-pyruvic transaminase (SGPT), elevated</td>
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<tr>
<td>serum, lactate dehydrogenase (LDH), elevated</td>
<td>0.46</td>
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<td>serum, gamma-GT (y-GT), elevated</td>
<td>0.65</td>
<td>0.02</td>
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<tr>
<td>serum, amylase, elevated</td>
<td>0.21</td>
<td>0.02</td>
</tr>
<tr>
<td>serum, lipase, elevated</td>
<td>0.21</td>
<td>0.02</td>
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<tr>
<td>serum, electrophoresis, alpha-2 globulin, elevated</td>
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<tr>
<td>serum, electrophoresis, beta-globulin, elevated</td>
<td>0.60</td>
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<tr>
<td>serum, pancreatic oncofetal antigen (PON), elevated</td>
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<td>serum, CA-19-9, elevated</td>
<td>0.80</td>
<td>0.65</td>
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<td>serum, carcinoembryonic antigen (CEA), elevated</td>
<td>0.68</td>
<td>0.20</td>
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<td>homogram, leucocytes</td>
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<tr>
<td>urine, amylase, elevated</td>
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<tr>
<td>urine, glucose, elevated</td>
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<td>stool, hemocult test, positive</td>
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<td>stool, chymotrypsin, pathological finding</td>
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<td>0.20</td>
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<td>stool, fat content, increased</td>
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<td>0.20</td>
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<tr>
<td>Clinical investigations</td>
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<tr>
<td>exocrine pancreatic function test(s), pathological finding</td>
<td>0.80</td>
<td>0.50</td>
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<tr>
<td>X-ray, hypotonic duodenography, sus. of inflammatory/malignant pancreatic tumor</td>
<td>0.58</td>
<td>0.65</td>
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<tr>
<td>X-ray, endoscopic retrograde cholangiopancreatoctography (ERCP), sus. of pancreatic tumor</td>
<td>0.65</td>
<td>0.80</td>
</tr>
<tr>
<td>X-ray, selective arteriography, sus. of pancreatic tumor</td>
<td>0.65</td>
<td>0.85</td>
</tr>
<tr>
<td>X-ray, computerized tomography (CT), sus. of pancreatic tumor</td>
<td>0.65</td>
<td>0.85</td>
</tr>
<tr>
<td>ultrasound (US), sus. of pancreatic tumor</td>
<td>0.65</td>
<td>0.70</td>
</tr>
<tr>
<td>percutaneous aspiration biopsy (US/CT-pailance), positive cytology</td>
<td>0.65</td>
<td>1.00</td>
</tr>
</tbody>
</table>
Relationships in CADIAG-II

frequency of occurrence

\[ \mu_{SDO}(S_i, D_j) = \sum \text{Count}(S_i / D_j) \]
\[ = \sum \text{Count}(S_i \cap D_j) \]
\[ = \sum \text{Count}(D_j) \]
\[ = \sum_{k=1}^{N} \min[\mu_{PS}(P_k, S_i), \mu_{PD}(P_k, D_j)] \]
\[ = \frac{\sum_{k=1}^{N} (\mu_{PD}(P_k, D_j))}{\sum_{k=1}^{N} (\mu_{PD}(P_k, D_j))} \]

strength of confirmation

\[ \mu_{SDC}(S_i, D_j) = \sum \text{Count}(D_j / S_i) \]
\[ = \sum \text{Count}(S_i \cap D_j) \]
\[ = \sum \text{Count}(S_i) \]
\[ = \sum_{k=1}^{N} \min[\mu_{PS}(P_k, S_i), \mu_{PD}(P_k, D_j)] \]
\[ = \frac{\sum_{k=1}^{N} (\mu_{PS}(P_k, S_i))}{\sum_{k=1}^{N} (\mu_{PS}(P_k, S_i))} \]
Inferenz und Verkettung

Wenn $P_k S_i$ mit $\mu_{PS}(P_k, S_i)$ hat, und
wenn $S_i D_j$ mit $\mu_{SDc}(S_i, D_j)$ impliziert,
dann hat $P_k D_j$ mit $\mu_{PD}(P_k, D_j)$.

$$\mu_{PD}(P_k, D_j) = \max_{s_i} \min_{s_j} \left[ \mu_{PS}(P_k, S_i), \mu_{SDc}(S_i, D_j) \right]$$

Wenn $P_k S_i$ mit $\mu_{PS}(P_k, S_i)$ hat, und
wenn $S_i S_j$ mit $\mu_{SSc}(S_i, S_j)$ impliziert, und
wenn $S_j D_i$ mit $\mu_{SDc}(S_j, D_i)$ impliziert, und
wenn $D_i D_j$ mit $\mu_{DDc}(D_i, D_j)$ impliziert,
dann hat $P_k D_j$ mit $\mu_{PD}(P_k, D_j)$. 
Inference mechanism

Compositional rule of inference

\[ \mu_{PD}(P, D_j) = \max_{S_i} \min \left[ \mu_{PS}(P, S_i), \mu_{SDC}(S_i, D_j) \right] \]
Kombination von Evidenz

• Berechnung einer Punktzahl
  – Anzahl der auf eine Diagnose hinweisenden Symptome
  – Bewertung des Symptoms
  – Wert für das Auftreten
  – Wert für die Beweiskraft

\[
\sum = \sum_{i=1}^{n} \left[ \mu_i \right] \cdot \left[ \beta_i \right] \cdot \left[ \alpha_i \right]
\]

\[
\begin{align*}
D1 & = (0.8) \cdot (0.8) \\
S1 & = (0.7) \cdot (0.6) \\
S2 & = (0.3) \cdot (0.4) \\
S3 & = (1.0) \cdot (0.2) \\
S4 & = (1.0) \cdot (0.2)
\end{align*}
\]

\[
183.7
\]

\[
\begin{align*}
D2 & = (0.8) \\
S3 & = (1.0)
\end{align*}
\]

\[
74.6
\]
1. finding-to-finding inferences
2. evaluation of intermediate criteria
3. diagnostic criteria-to-disease inferences
4. finding-to-disease inferences
5. diagnostic criteria-to-disease inferences
6. disease-to-disease inferences
****** W A M I S ******
RHEUMA-SKA BADEN PRIM. DOZ. DR. G. KOLARZ 08.03.1999

67-00001-9 TEST PATIENT

AUSKUNFT ÜBER : < LABOR-BEFUNDE EINGABE VON : < LABOR-BEFUNDE
< VERLAUF EINZELN < DOKUMENTATIONEN
< DOKU UND KGSS

AUSDRUCKEN : < LABOR VERLAUF KORRIGIEREN: < LABOR-BEFUNDE
< SOFORT BRIEF < DOKUMENTATIONEN

AUFNAHME < WIEDER-AUFNAHME

INFORMATION: < MED. FORMELN
< CADIG-KONSULT.

PF8=STORNO PF9=MENU

MB a 24/080
***** W A M I S *****

RHEUMA-SKA BADEN
PRIM. DOZ. DR. G. KOLARZ
08.03.1999

DOKUMENTATIONS-SYSTEM (DOKU): RHEUMA-ANAMNESE
GESTARTET 09 Uhr 57

67-00001-9 TEST PATIENT
ALTER=049 J. RHEUMA-STATION
KORREKTUR ODER LÖSCHEN

? FAMILIENANAMNESE
? FRÜHERE ERKRANKUNGEN
? KRANKHEITSBEGINN
? ALLGEMEINSYMPTOME
? Gelenke vor mehr als 3 Monaten
? Gelenke in den letzten 3 Monaten
? Derzeitige Gelenksschmerzen
? Begleiterkrankungen
? Therapieanamnese

ANAMNESE

Untersucht um 09.10 Uhr am 03.11.1980

*
***** W A M I S *****

RHEUMA-SKA BADEN
PRIM. DOZ. DR. G. KOLARZ 08.03.1999

DOKUMENTATIONS-SYSTEM (DOKU):
RHEUMA-ANAMNESE
GESTARTET 09 UHR 57

67-00001-9 TEST PATIENT
ALTER=049 J. RHEUMA-STATION

KORREKTUR ODER LÖSCHEN ----- DATEN ----- VOM:
UNTERSUCHT UM 09.10 UHR AM 03.11.1980

FAMILIENANAM.
? NICHT BEKANNT

> DIABETES  ? TUBerkulose  ? HYPERTONIE  ? GEISTESKH.
? KREBS

? RHEUMA NNB  ? GICHT  ? RHEUM.ENTZ.
? PSOR. ARTRIT.  ? Kollagenose

*
***** WAMIS *****

RHEUMA-SKA BADEN PRIM. DOZ. DR. G. KOLARZ 08.03.1999
DOKUMENTATIONS-SYSTEM (DOKU): RHEUMA-ANAMNESE GESTARTET 09 UHR 57
67-00001-9 TEST PATIENT ALTER=049 J. RHEUMA-STATION

KORREKTUR ODER LÖSCHEN ----- DATEN ----- VOM:
UNTERSUCHT UM 09.10 UHR AM 03.11.1980

GEL.LETZ.3 MO ? UNAUFFÄLLIG
? ELLBOGEN ? SCHULTER > HWS ? SCHULTER ? ELLBOGEN
> BWS
> LWS

? HÜFTGEL. ? SACRUM ? HÜFTGEL.
> KNEIGEL.
> SPRUNGGEL.

? ZEHENGG.1 ? VORFUSS ? ZEHENGG.1
? ZEHENGG.2 ? VORFUSS ? ZEHENGG.2
? ZEHENGG.3
? ZEHENGG.4
? ZEHENGG.5

3=KOMM 6=VOR.DOKU 8=STORNO 9=MENU 10=VOR 11=RÜCK SEITE: 10 VON 20

24/073
RHEUMA-SKA BADEN
PRIM. DOZ. DR. G. KOLARZ
09.03.1999
DOKUMENTATIONS-SYSTEM (DOKU): RHEUMA-STATUS
GESTARTET 09 UHR 18
67-00001-9 TEST PATIENT
ALTER=049 J. RHEUMA-STATION
KORREKTUR ODER LÖSCHEN ------ DATEN ------ VOM:
UNTERSUCHT UM 09.06 UHR AM 03.11.1980

Kniegelenk re
> Schw +  ? Schw ++  ? Schw +++  ? Schw ++++
? Dol +  > Dol ++  ? Dol +++  ? Dol ++++
? In Ruhe  > Bewegung  > Druck  ? Periartikulär
> Inn/Auss 5  ? Inn/Auss 0  ? Inn/Auss 10  > Inn/Auss 30  ? Inn/Auss 40

3=Komm 6=Vor. Doku  8=Storno 9=Menu 10=Vor 11=Rück Seite: 21 von 39

MB
a

24/073
***** W A M I S *****
RHEUMA-SKA BADEN PRIM. DOZ. DR. G. KOLARZ 10.03.1999
VERLAUF: LABOR-BEFUNDE KORRIGIEREN
67-00001-9 TEST PATIENT ALTER=045 J.

SYNOVIA

ZELLZAHL (+) 0.8 GIGA/L
GRANULOZITEN * * %
RAGOZITEN  3 %
RF >NEGATIV ?POSITIV
VISKOSITAT ?ERNIEDR ?NORMAL ?ERHOHT

ABNAHME_DATUM 03.11.1980 UHR: 08

PF2=KORR PF5=ELIM PF8=STORNO PF9=MENU PF10=VOR PF11=RÜCK FREIG 24/080
****** W A M I S ******
RHEUMA-SKA BADEN   Prim. Doz. Dr. G. Kolarz   08.03.1999

67-00001-9 TEST   PATIENT

AUSKUNFT UEBER :  < LABOR-BEFUNDE   EINGABE VON:   < LABOR-BEFUNDE
< VERLAUF EINZELN   < DOKUMENTATIONEN

< DOKU UND KGSS   < ENTLASSUNGEN

AUSDRUCKEN :   < LABOR VERLAUF   KORRIGIEREN:   < LABOR-BEFUNDE
< SOFORT BRIEF   < DOKUMENTATIONEN

AUFNAHME   < WIEDER-AUFNAHME

INFORMATION:
< MED. FORMELN
< CADIAG-KONSULT.

PF8=STORNO   PF9=MENU

MB  a  24/080
PATIENTENDATENDISPLAY

SYMPTOME [+,-] 606 [+] 54
ZWISCHENKOMBINATIONEN [+] 52 (+) 8
SYMPTOMKOMBINATIONEN [+] 34 (+) 5

===== START DIAGNOSEPROZESS

PF1=INFO PF2=PERS PF3=SYEING PF4=GRWECH
PF7=NEUPAT PF8=STORNO PF12=DRUCK

MB a 11/040
PATIENTENSYMPTOME

1 ** +, * BESCHWERDEN IN DEN LETZTEN 3 MONATEN, WS, LUMBALGIE
1 ** +, * => BESCHWERDEN IN DEN LETZTEN 3 MONATEN, EXTREMITÄTEN, GELENKSBEFALL
1 ** +, * BESCHWERDEN IN DEN LETZTEN 3 MONATEN, EXTREMITÄTEN, BEFALL EINES ODER BEIDER KnieGelenke
1 ** +, * => BESCHWERDEN VOR 3 MONATEN, WS, SCHMERZEN
1 ** +, * BESCHWERDEN VOR 3 MONATEN, WS, NACKENSCHMERZEN
1 ** +, * BESCHWERDEN VOR 3 MONATEN, WS, SCHMERZEN DER BWS
1 ** +, * BESCHWERDEN VOR 3 MONATEN, WS, LUMBALGIE
1 ** +, * FAMILIENERKRANKUNGEN, MORBUS BECHTEREW
1 ** +, * WS, BEWEGUNGSEINSCHRÄNKUNG
1 ** +, * WS, FINGER-BODENABSTAND GRÖSSER ALS 5 CM
1 ** +, * WS, INSPIRATORISCH-EXSPIRATORISCHE DIFFERENZ KLEINER ALS 4 CM
1 ** +, * WS, INSPIRATORISCH-EXSPIRATORISCHE DIFFERENZ KLEINER ALS 8 CM
1 ** +, * WS, HWS, BEWEGUNGSEINSCHRÄNKUNG
1 ** +, * WS, LWS, BEWEGUNGSEINSCHRÄNKUNG
1 ** +, * WS, LWS, PATHOLOGISCHE SCHOBER'SCHE DISTANZ
1 ** +, * WS, SAKROILIAKALGELENKEN, POSITIVER MELNELLSCHER HANDGRIFF

PF1=INFO    PF2=PERS
PF7=NEUPAT    PF8=STORNO    PF9=HINAUF   PF10=VOR   PF11=RUECK

03/070
PATIENTENSYMPTOME

1 * +, * WS, MUSKULATUR, DRUCKSCHMERZEN
1 * +, * WS, MUSKULATUR, HARTSPANN
1 * +, * EXTREMITÄTEN, Kniegelenke, Befall
1 * +, * EXTREMITÄTEN, Kniegelenke, Schwellung eines oder beider Gelenke
1 * +, * EXTREMITÄTEN, Kniegelenke, Schwellung des rechten Gelenks
1 * +, * EXTREMITÄTEN, Kniegelenke, Schwellung und Schmerzen eines oder beider Gelenke
1 * +, * EXTREMITÄTEN, Kniegelenke, Schmerzen
1 * +, * EXTREMITÄTEN, Kniegelenke, Krepitation
1 * +, * EXTREMITÄTEN, Kniegelenke, Bewegungseinschränkung
1 * +, * EXTREMITÄTEN, Kniegelenke, Erguss eines oder beider Gelenke
1 * +, * EXTREMITÄTEN, Kniegelenke, Erguss des rechten Gelenks
1 * +, * EXTREMITÄTEN, Kniegelenke, Schmerzen bei Bewegung
1 * +, * EXTREMITÄTEN, Kniegelenke, Schmerzen bei Druck
1 * +, * EXTREMITÄTEN, Fuß, Pes transversus
1 * +, * EXTREMITÄTEN, Fuß, Pes planus
1 * +, * EXTREMITÄTEN, Muskulatur, Atrophie

PF1=INFO  PF2=PERS  PF7=NEUPAT  PF8=STORNO  PF9=HINAUF  PF10=VOR  PF11=RUECK

03/070
PATIENTENSYMPTOME

2 ++ * BSG, ERHÖHT
   32.00 MM N.W. 11-03-1980
B ++ * RHEUMA-LATEX-TEST, NEGATIV
2 * 28 * ERYTHROZYTEN, VERMINDERT
   4.30 TERA/L 11-03-1980
B ++ * THROMBOZYTEN, NORMAL
   251.00 GIGA/L 11-03-1980
B ++ * LEUKOZYTEN, NORMAL
   8.50 GIGA/L 11-03-1980
3 ++ * GELENKSPUNKTAT, ZELLZAHL, VERMEHRT
   0.80 GIGA/L 11-03-1980
3 ++ * GELENKSPUNKTAT, RAGOZYTEN, < = 5 %
   3.00 % 11-03-1980

PF1=INFO PF2=PERS
PF7=NEUPAT PF8=STORNO PF9=HINAUF PF10=VOR PF11=RUECK
MB 03/070
DAG2-08-02  *** CADIA-2 ***  17-03-1999 08:08

AUSGESCHLOSSENE DIAGNOSEN

1. SYSTEMISCHE SKLERODERMIE
2. DIFFUSE PROGRESSIVE SKLERODERMIE
3. SYSTEMISCHE SKLERODERMIE, CREST
4. CHEMISCH ODER MEDIKAMENTÖS INDUZIERTE SKLERODERMIE
5. FELTY-SYNDROM
6. JUVENILE CHRONISCHE ARTHRITIS, SYSTEMISCHE FORM (STILL)
7. JUVENILE CHRONISCHE ARTHRITIS, POLYARTIKULÄRE FORM, SEROPOSITIV
8. JUVENILE CHRONISCHE ARTHRITIS, POLYARTIKULÄRE FORM, SERONEGATIV
9. JUVENILE CHRONISCHE ARTHRITIS, OLIGOARTIKULÄRE FORM
10. JUVENILE CHRONISCHE ARTHRITIS
11. COXARTHROSE
12. RHIZARTHROSE
13. MIGRAINE CERVICALE

PF1=INFO  PF2=PERS  PF3=SYEING  PF4=GRWECH  PF5=DIAGWH
PF7=NEUPAT PF8=STORNO PF9=HINAUF PF10=VOR  PF11=RUECK

MB a  03/070
DAG2-11-02  *** CADIAG-2 ***  17-03-1999 08:08

BEGRUNDUNG ZUR AUSGESCHLOSSENEN DIAGNOSE

FELTY-SYNDROM

DURCH SYMPTOMKOMBINATIONEN:
* - . * FELTY-SYNDROM (OB)
--------------------------
UND
1 * - . * MILZ, VERGRÖSSERT
UND
2 * - . * LEUKOZYTEN, VERMINDERT

PF1=INFO   PF2=PERS    PF3=SYEING    PF4=GRWECH    PF5=DIAGWH
PF7=NEUPAT  PF8=STORNO  PF9=HINAUF  PF10=VOR    PF11=RUECK

03/070
DAG2-09-00  *** CADIA_2 ***  17-03-1999  08:08

DIAGNOSEHYPOTHESEN

GONARTHROSE ................................................................. ?<=  ?<=
CHRONISCHE POLYARTHRITIS ............................................... ?<=  ?<=
MORBUS BEchterew ............................................................ ?<=  ?<=
SPONDYLITIS N.N.BEZ ......................................................... ?<=  ?<=
ARTHROSIS DEFORMANS (PRIMAR) ......................................... ?<=  ?<=
BEGRUNDISUNG ZUR DIAGNOSEHYPOTHESE

* * * CADIA2-2 ***

SEITE: 001 VON 003

DURCH SYMPTOME: 37 SY: 428.6 PUNKTE

1 * * * KRAKKEITSBEGINN, ZWISCHEN DEM 16. UND 29. LEBENJSJAHN 0.07 0.10
1 * * * KRAKKEITSBEGINN, SCHLEICHEND 0.46 0.10
1 * * * JETZTGE BESCHWERDEN, WS, SCHMERZEN 0.37 0.10
1 * * * JETZTGE BESCHWERDEN, WS, NACKENSCHMERZ 0.30 0.10
1 * * * JETZTGE BESCHWERDEN, WS, SCHMERZ DER BRUSTWIRBELSAULE 0.07 0.10
1 * * * JETZTGE BESCHWERDEN, WS, SCHMERZEN, LUMBALGIE 0.19 0.10
1 * * * JETZTGE BESCHWERDEN, EXTREMITATEN, ANLAUFSCHERZEN 0.54 0.10
1 * * * JETZTGE BESCHWERDEN, EXTREMITATEN, MORGENSTEIFIGKEIT 0.60 0.80
LÄNGER ALS 30 MINUTEN

1 * * * JETZTGE BESCHWERDEN, EXTREMITATEN, GELENKSEBENFALL 0.95 0.06
1 * * * JETZTGE BESCHWERDEN, EXTREMITATEN, BEFALL EINES ODER
BEIDER KNYGELEKENKE

1 * * * BESCHWERDEN IN DEN LETZTEN 3 MONATEN, WS, SCHMERZEN 0.36 0.05
1 * * * BESCHWERDEN IN DEN LETZTEN 3 MONATEN, WS, NACKENSCHERZEN 0.30 0.05

PF1=INFO PF2=PERSON PF3=SYEING PF4=GRWECH PF5=DIAGWH
PF7=NEUPAT PF8=STORNO PF9=HINAUF PF10=VOR PF11=RUECK

MB a 03/070
BEGRUNDETZUR DIAGNOSEHYPOTHESE

* 80 * CHRONISCHE POLYARTHRITIS

1 **. ** BESCHWERDEN IN DEN LETZTEN 3 MONATEN, WS, SCHMERZEN DER BWS

1 **. ** BESCHWERDEN IN DEN LETZTEN 3 MONATEN, WS, LUMBARLIE

1 **. ** BESCHWERDEN IN DEN LETZTEN 3 MONATEN, EXTREMITÄTEN, GLENSKSBEFAL

1 **. ** BESCHWERDEN IN DEN LETZTEN 3 MONATEN, EXTREMITÄTEN, BEFALL EINES ODER BEIDER KNIEGelenke

1 **. ** BESCHWERDEN VOR 3 MONATEN, WS, SCHMERZEN

1 **. ** BESCHWERDEN VOR 3 MONATEN, WS, NACKENSCHMERZEN

1 **. ** BESCHWERDEN VOR 3 MONATEN, WS, SCHMERZEN DER BWS

1 **. ** BESCHWERDEN VOR 3 MONATEN, WS, LUMBARLIE

1 **. ** WS, BEWEGUNGSEINSCHRÄNUNG

1 **. ** WS, FINGER-BODENABSTAND GRÖSSER ALS 5 CM

1 **. ** WS, HWS, BEWEGUNGSEINSCHRÄNUNG

1 **. ** WS, LWS, BEWEGUNGSEINSCHRÄNUNG

1 **. ** WS, MUSKULATUR, DRUCKSCHMERZEN

PF1=INFO PF2=PERS PF3=SYEING PF4=GRWECH PF5=DIAGWH
PF7=NEUPAT PF8=STORNO PF9=HINAUF PF10=VOR PF11=RUECK

MB a 03/070
**BEGRÜNDUNG ZUR DIAGNOSEHYPOTHESE**

*80*  CHRONISCHE POLYARTHRITIS

<p>| | | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td><strong>.</strong></td>
<td>WS, MUSKULATUR, HARTSPANN</td>
<td>0.63</td>
<td>0.02</td>
</tr>
<tr>
<td>1</td>
<td><strong>.</strong></td>
<td>EXTREMITÄTEN, KNIEGELENKE, BEFALL</td>
<td>0.70</td>
<td>0.05</td>
</tr>
<tr>
<td>1</td>
<td><strong>.</strong></td>
<td>EXTREMITÄTEN, KNIEGELENKE, SCHWELLUNG EINES ODER BEIDER GELENKE</td>
<td>0.38</td>
<td>0.10</td>
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<td>1</td>
<td><strong>.</strong></td>
<td>EXTREMITÄTEN, KNIEGELENKE, SCHMERZEN</td>
<td>0.61</td>
<td>0.02</td>
</tr>
<tr>
<td>1</td>
<td><strong>.</strong></td>
<td>EXTREMITÄTEN, KNIEGELENKE, KREPITATION</td>
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<td>0.05</td>
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<td>1</td>
<td><strong>.</strong></td>
<td>EXTREMITÄTEN, KNIEGELENKE, BEWEGUNGSEINSCHRÄNKUNG</td>
<td>0.55</td>
<td>0.03</td>
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<tr>
<td>1</td>
<td><strong>.</strong></td>
<td>EXTREMITÄTEN, MUSKULATUR, ATROPHIE</td>
<td>0.36</td>
<td>0.15</td>
</tr>
<tr>
<td>2</td>
<td><strong>.</strong></td>
<td>BSG, ERHÖHT</td>
<td>0.70</td>
<td>0.02</td>
</tr>
<tr>
<td>B</td>
<td><strong>.</strong></td>
<td>RHEUMA-LATEX-TEST, NEGATIV</td>
<td>0.95</td>
<td>0.05</td>
</tr>
<tr>
<td>2</td>
<td><strong>28</strong></td>
<td>ERYTHROZYTEN, VERMINDERT</td>
<td>0.06</td>
<td>0.02</td>
</tr>
<tr>
<td>3</td>
<td><strong>.</strong></td>
<td>GELENKSPUNKTAT, ZELLZAHL, VERMEHRT</td>
<td>0.08</td>
<td>0.05</td>
</tr>
<tr>
<td>3</td>
<td><strong>.</strong></td>
<td>GELENKSPUNKTAT, RAGOZYTEN, &lt;=5 %</td>
<td>0.12</td>
<td>0.05</td>
</tr>
</tbody>
</table>

PF1=INFO  PF2=PERS  PF3=SYEING  PF4=GRWECH  PF5=DIAGWH
PF7=NEUPAT  PF8=STORNO  PF9=HINAUF  PF10=VOR  PF11=RUECK
DAG2-12-01

*** CADIAG-2 ***
17-03-1999 08:08

UNTERSUCHUNGSVORSCHLÄGE ZUR DIAGNOSEHYPOTHESE

* 60 * MORBUS BECHTEREW

1 * . * BESCHWERDEN VOR 3 MONATEN, EXTREMITÄTEN, BEFALL DES SCHULTERGÜRTELS
   0.60 0.01

1 * . * BESCHWERDEN VOR 3 MONATEN, EXTREMITÄTEN, BEFALL DES BECKENGÜRTELS
   0.80 0.01

1 * . * WS, BWS, BEWEGUNGSEINSCHRÄNKUNG
   0.50 0.40

3 * . * HLA B27, POSITIV
   0.90 0.80

3 * . * RÖNTGEN, GELENKE, ARTHRITIS MUTILANS
   0.00 0.00

3 * . * RÖNTGEN, GELENKE, ANKYLOSE DER KLEINEN WIRBELGELENKE
   0.30 0.80

3 * . * RÖNTGEN, WS, BEWEGUNGSEINSCHRÄNKUNG DER LWS
   0.60 0.10

3 * . * RÖNTGEN, WS, SPONDYLARTHRITE
   0.50 0.80

3 * . * RÖNTGEN, WS, SAKROILIAKALARTHRITE
   0.70 0.75

3 * . * RÖNTGEN, WS, BAMBUSSTABPHÄNOMEN
   0.90 0.80

C * . * WAALER-ROSE-TEST, NEGATIV
   0.95 0.01

PF1=INFO   PF2=PERS   PF3=SYEING   PF4=GRWECH   PF5=DIAGWH
PF7=NEUPAT   PF8=STORNO   PF9=HINAUF   PF10=VOR   PF11=RUECK

03/070
Results

• Rheumatology
  – more than 200 disease profiles, more than 2,000 findings
  – more than 50,000 finding-disease-relationships
  – more than 160 complex rules

• Hepatology and Gastroenterology
  – more than 100 disease profiles, more than 1,000 findings
  – more than 30,000 symptom-disease-relationships
  – more than 40 complex rules
ICU-Based Monitoring of Nosocomial Infections

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\textsuperscript{2} Ludwig Boltzmann Institute for Expert Systems and Quality Management in Medicine, Vienna, Austria

\textsuperscript{3} Division of Hospital Hygiene
Clinical Institute for Hygiene and Medical Microbiology
Medical University of Vienna, Austria

\textsuperscript{4} Department of Computer Science
Meiji University Tama-ku, Kawasaki, 214-8571, Japan
Computers in Clinical Medicine

• step 1: patient administration
  – admission, transfer, discharge, and cost billing

• step 2: documentation of patients’ medical data
  – electronic health record: life-long, multimedia

• step 3: patient data retrieval
  – medical research databases
  – quality assurance in the medical institution

• step 4: software-based clinical decision support
  – quality assurance for the particular patient
Knowledge-Based Quality Assurance

- quality assurance is an information problem
  - IT-based information systems to document administrative, medical, and workflow data

⇒ quality assurance in the medical institution
  - adherence to acquired statistical standards

⇒ quality assurance for the particular patient
  - knowledge-based medical decision support
Significance of Nosocomial Infections

- 3 to 14% of patients admitted to acute care hospitals acquire one or more NIs
- in consequence, 5 to 7% of them die

Vienna General Hospital, about 2,200 beds, year 2002:
- patients admitted to wards: 94,715
- days of care: 688,619
- average length of stay: 6.09 days
- costs / patient / day: 678.- €

- NIs: 4,262 patients / year (NI rate of 4.5% assumed)
- 213 out of them die / year (5% mortality assumed)
- additional costs: 14,448,180.- € (5 days of prolonged stay, in average)

source: Univ.-Prof. Dr. med. Ojan Assadian, Division of Hospital Hygiene, Medical University of Vienna
Knowledge-Based Methodology in Medicine

• knowledge
  – modeling of knowledge
    * diagnostic knowledge, therapy recommendations, prognostic information, best medical-practice management guidelines
  – modeling based on linguistic concepts
    * recounted patient history, perception of characteristic signs, interpreted laboratory measurements, concepts of pathophysiological states, diagnostic, therapeutic, and prognostic concepts
  – objective and subjective medical knowledge
    * definitional, causal, statistical, and heuristic knowledge
  – health knowledge
    * medical standards, work plans, legal requirements, etc.

• data-to-symbol conversion
  – mapping of patient data to higher-level medical concepts
    * patient data preprocessing, abstraction, and interpretation
    * crisp and fuzzy rules; type-1 and multi-dimensional fuzzy sets
    * 1st step to intelligence

• data
  – recounted, perceived, observed, and measured medical data
    * patient history, physical examinations, laboratory tests, and clinical investigations
Monitoring Of Nosocomial Infections

- Artificial intelligence
- Fuzzy theories
- Knowledge-based systems
- Fuzzy sets and logic
- ICU clinical data
- Microbiology data on micro-organisms
- Natural-language definitions of nosocomial infections
- Medicine
- ICU patient-specific alerts
- Infection control cockpit surveillance
**INFECTION SITE:** Symptomatic urinary tract infection

**CODE:** UTI-SUTI

**DEFINITION:** A symptomatic urinary tract infection must meet at least one of the following criteria:

- **Patient has** at least one of the following signs or symptoms with no other recognized cause: fever (>38°C), urgency, frequency, dysuria, or suprapubic tenderness.
- **Patient has a positive urine culture** that is, ≥10⁵ microorganisms per cm² or urine with no more than two species of microorganisms.
- **Patient has at least two** of the following signs or symptoms with no other recognized cause: fever (>38°C), urgency, frequency, dysuria, or suprapubic tenderness and at least one of the following:
  - Positive dipstick for leukocyte esterase and/or nitrate
  - Pyuria (urine specimen with ≥10 wbc/mm³ or ≥3 wbc/high power field of unspun urine)
  - Organisms seen on Gram stain of unspun urine
  - At least two urine cultures with repeated isolation of the same uropathogen (gram-negative bacteria or *S. saprophyticus*) with ≥10⁵ colonies/ml in nonvoided specimens.

- ≤10⁵ colonies/ml of a single uropathogen (gram-negative bacteria or *S. saprophyticus*) in a patient being treated with an effective antimicrobial agent for a urinary tract infection.
- Physician diagnosis of a urinary tract infection.
- Physician institutes appropriate therapy for a urinary tract infection.

**Patient ≤1 year of age has at least one of the following signs or symptoms with no other recognized cause: fever (>38°C), hypothermia (<37°C), apnea, bradycardia, dysuria, lethargy, or vomiting and**
- Patient has a positive urine culture, that is, ≥10⁵ microorganisms per cm² of urine with no more than two species of microorganisms.

**Patient ≤1 year of age has at least one of the following signs or symptoms with no other recognized cause: fever (>38°C), hypothermia (<37°C), apnea, bradycardia, dysuria, lethargy, or vomiting and**
- Positive dipstick for leukocyte esterase and/or nitrate
- Pyuria (urine specimen with ≥10 wbc/mm³ or ≥3 wbc/high power field of unspun urine)

- At least two urine cultures with repeated isolation of the same uropathogen (gram-negative bacteria or *S. saprophyticus*) with ≥10⁵ colonies/ml in nonvoided specimens.

- Organizer seen on gram stain or unspun urine.
- At least two urine cultures with repeated isolation of the same uropathogen (gram-negative bacteria or *S. saprophyticus*) in a patient being treated with an effective antimicrobial agent for a urinary tract infection.
- Physician diagnosis of a urinary tract infection.
- Physician institutes appropriate therapy for a urinary tract infection.

**COMMENTS:**

- A positive culture of a urinary catheter tip is **not** an acceptable laboratory test to diagnose a urinary tract infection.
- Urine cultures must be obtained using appropriate technique, such as clean catch collection or catheterization.
- In infants, a urine culture should be obtained by bladder catheterization or suprapubic aspiration; a positive urine culture from a bag specimen is unreliable and should be confirmed by a specimen aseptically obtained by catheterization or suprapubic aspiration.

Surveillance of Nosocomial Infections in Intensive Care Units

Protocol
Version 6.1
(Based on Version 5.0 including technical amendments)
SEPTEMBER 2004

Project commissioned by the EC / DG SANCO/ F/ 4
Agreement Reference number: VS/1999/5235 (99CVF4-025)
# Table of Contents

**Main Changes since version 5.0**

1. **Rationale and objectives for surveillance of nosocomial infections in intensive care units**

2. **Elaboration of the HELICS protocol for the surveillance of nosocomial infections in intensive care units**

3. **Indicators to be produced at the European level on the occurrence and characteristics of nosocomial infections in intensive care units**

4. **Case definitions of ICU-acquired infections**
   - 4.1 Case definition of bloodstream infection
   - 4.2 Case definition of ICU-acquired pneumonia
   - 4.3 Case definition of CVC-related infection
   - 4.4 Case definition of urinary tract infection

5. **Procedures for participation**
   - 5.1 Participation to the HELICS network
   - 5.2 Minimal participation period

6. **Data collection**
   - 6.1 Population under surveillance
     - 6.1.1 Eligibility criteria for Intensive Care Units
     - 6.1.2 Inclusion of patients
   - 6.2 Type of infections under surveillance
Bloodstream Infections (BSI) (four out of six)

**CODE: BSI**

**BSI-A:**
- 1 positive blood culture for a recognised pathogen

or

- Patient has at least one of the following signs or symptoms: fever (>38°C), chills, or hypotension and 2 positive blood cultures for a common skin contaminant (from 2 separate blood samples drawn within 48 hours).

Skin contaminants = coagulase-negative staphylococci, Micrococcus sp., Propionibacterium acnes, Bacillus sp., Corynebacterium sp.

**BSI-B:** Patient has at least one of the following signs or symptoms: fever (>38°C), chills, or hypotension

And either

- 1 positive blood culture with a skin contaminant in patient with an intravascular line in place and in whom the physician instituted appropriate antimicrobial therapy.

or

- positive blood Antigen test (e.g. H.influenzae, S.pneumoniae, N. meningitidis or Group B Streptococcus)

**Comment:**
BSI-A is the definition used by the majority of NI surveillance networks in Europe. BSI-B extends this definition to the CDC definition of laboratory-confirmed bloodstream infection. Networks should specify in the network data (table icu_net, see 6.3.1) whether only BSI A or both BSI B and BSI A are included in the surveillance (i.e. networks using CDC definition of laboratory confirmed bloodstream infection [CDC_cr=BSI-A+B]). If this is the case, then BSI A and BSI B categories should be specified in the data collection.

- bloodstream infection with
  - recognized pathogen
  - clinical signs and growth of same skin contaminant from two separate blood samples
  - clinical signs and growth of same skin contaminant from blood and intravascular line
  - clinical signs and positive antigen test from blood
Bloodstream Infection with Clinical Signs and Growth of Same Skin Contaminant from Two Separate Blood Samples

- Patient has at least one of the following signs or symptoms: fever (>38°C.), chills, or hypotension and 2 positive blood cultures for a common skin contaminant (from 2 separate blood samples drawn within 48 hours).

skin contaminants = coagulase-negative staphylococci, *Micrococcus* sp., *Propionibacterium acnes*, *Bacillus* sp., *Corynebacterium* sp.

```
BSI-A2
1
⇐
clinical_signs_of_BSI (t-1d, t, t+1d)
∧
same_skin_contaminant_from_two_separate_blood_samples
```
Decomposition—Clinical Signs

\[
\text{clinical} \_\text{signs} \_\text{of} \_\text{BSI} (t-1d, t, t+1d) [\text{yesterday, today, tomorrow}] =
\]

\[
\text{clinical} \_\text{signs} \_\text{of} \_\text{BSI} (t-1d) =
\]

\[
\lor
\]

\[
\text{clinical} \_\text{signs} \_\text{of} \_\text{BSI} (t) =
\]

\[
\lor
\]

\[
\text{clinical} \_\text{signs} \_\text{of} \_\text{BSI} (t+1d) =
\]

\[
\left\{
\begin{align*}
\text{fever} (t-1d) \\
\text{hypotension} (t-1d) \\
\text{leucopenia} (t-1d) \\
\text{leucocytosis} (t-1d) \\
\text{CRP increased} (t-1d)
\end{align*}
\right.
\]

\[
\left\{
\begin{align*}
\text{fever} (t) \\
\text{hypotension} (t) \\
\text{leucopenia} (t) \\
\text{leucocytosis} (t) \\
\text{CRP increased} (t)
\end{align*}
\right.
\]

\[
\left\{
\begin{align*}
\text{fever} (t+1d) \\
\text{hypotension} (t+1d) \\
\text{leucopenia} (t+1d) \\
\text{leucocytosis} (t+1d) \\
\text{CRP increased} (t+1d)
\end{align*}
\right.
\]
Commonly-Known Aspects of Knowledge Representation and Reasoning in Medicine

• fuzziness of medical concepts
  – due to the unsharpness of boundaries of linguistic concepts; gradual transition from one concept to another
  – due to only partially known explanations of medical phenomena; meta-studies indicate numerical range of study results

  \[ \downarrow \]

  modeled by fuzzy sets

• uncertainty of medical conclusions
  – due to the uncertainty of the co-occurrence of medical concepts

  \[ \downarrow \]

  modeled by fuzzy logic
Clinical Signs—Fever

\[
\begin{align*}
\text{fever (t-1d)} & \iff \ldots \\
\text{fever (t)} & \iff \\
& \quad \lor \\
& \quad \text{body temperature } \uparrow \\
& \quad \text{thermoregulation applied } \ldots \\
\text{fever (t+1d)} & \iff \ldots \\
\end{align*}
\]
Clinical Signs—CRP Increased

CRP increased (t-1d) ⇐ ...

CRP increased (t) ⇐

CRP increased (t+1d) ⇐ ...

data import
intensive care unit
maximum value of the day e.g., 5 mg/dl
Decomposition—Skin Contaminant

first blood culture
- coagulase-negative staphylococci
- Micrococcus sp.
- Propionibacterium acnes
- Bacillus sp.
- Corynebacterium sp.

same skin contaminant from two separate blood samples \(\leftarrow\) (within 48 hours) \(\leftarrow\) data import

second blood culture
- coagulase-negative staphylococci
- Micrococcus sp.
- Propionibacterium acnes
- Bacillus sp.
- Corynebacterium sp.
Data Sources and Data Integration

HIS: hospital information system (here: of the City of Vienna)
PDMS: patient data management systems (here: CareVue by Philips)
CDA: clinical data archive
ISM: information support mart
LIS: laboratory information system of the microbiology (here: HIS of the City of Vienna)
LDB: laboratory data base (Schmid base)
PDMS CareVue
by
Philips Medical Systems
Moni/HELICS-ICU
by
Medexter Healthcare
Cockpit Surveillance
at the infection control unit
Catheter-Associated Symptomatic Urinary Tract Infection completely fulfilled (100%)
Backtracking of the Logical Chain of Reasoning

patient has urinary catheter
Elevated CRP as a Clinical Sign
present (100%)
Elevated CRP is Present

6 mg/dl is measured

<table>
<thead>
<tr>
<th>Bezeichnung</th>
<th>Zu treff. %</th>
<th>Heikunt</th>
<th>ermittelt</th>
<th>Benennung</th>
</tr>
</thead>
<tbody>
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<td>CRP</td>
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<td>Moni-IV Daten-Symbo.</td>
<td>2005-06-14 09:39:08</td>
<td></td>
</tr>
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</table>

**quantitativer Wert:**

<table>
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<th>Bezeichnung</th>
<th>Wert</th>
<th>Heikunt</th>
<th>ermittelt</th>
<th>Benennung</th>
</tr>
</thead>
<tbody>
<tr>
<td>CRP</td>
<td>6 mg/dl</td>
<td>Import: CareVue</td>
<td>2005-06-14 09:17:43</td>
<td>2005-06-01 07:00:00</td>
</tr>
</tbody>
</table>
Other Signs of Urinary Tract Infection

germs found
Results

- 24 definitions of ICU-acquired infections
  - 6 definitions of bloodstream infections (BSI and BX)
  - 9 definitions of ICU-acquired pneumonias (PN)
  - 6 definitions of urinary tract infections (UTI)
  - 3 definitions of central venous catheter-related infections (CRI)
- MONI is operated at 12 ICUs at the Vienna General Hospital (96 beds)
- MONI is connected with HIS, LIS, and PDMS
- cockpit surveillance for infection control unit
  - automated daily and manual activation
- 13 NIs as output for the European Surveillance System HELICS
- fine-tuning, evaluation, and clinical studies on the way
Knowledge-Based Recognition and Monitoring of Nosocomial Infections

• potentials
  – surveillance of state of infections in the hospital; selection of optimal anti-infectious agents, e.g., antibiotics
  – early detection of nosocomial infections; prevention of complications and deaths; massive reduction of costs
  – legal protection for the medical institution

• present state
  – analysis of laboratory data, e.g., from microbiology/virology, through integrated software
  – stand-alone software for the analysis of nosocomial infections; manual data entry, limited coverage of patients

• risks
  – access to the various medical information systems necessary including HIS, LIS, departmental systems, PDMS
DXplain
GENERAL INFORMATION

The Laboratory of Computer Science is a computer science research and development group which is a unit of the Department of Medicine at Massachusetts General Hospital / Harvard Medical School. It offers a Medical Informatics research training program for qualified postdoctoral physicians.

- More about the Lab of Computer Science
- National Library of Medicine (NLM) training program at LCS

DXPLAIN

DXplain is a decision support system which uses a set of clinical findings (signs, symptoms, laboratory data) to produce a ranked list of diagnoses which might explain (or be associated with) the clinical manifestations. DXplain provides justification for why each of these diseases might be considered, suggests what further clinical information would be useful to collect for each disease, and lists what clinical manifestations, if any, would be unusual or atypical for each of the specific diseases. DXplain does not offer definitive medical consultation and should not be used as a substitute for physician diagnostic decision making.

- Usage and availability
- DXplain Demonstration
This program is a canned demo. Any changes made to the form will not be reflected in the subsequent frames. Please click on the right arrow and left arrow buttons located at the bottom right corner of the screen to navigate through this demonstration. Do NOT use the Browser’s [BACK] button.

Patient Demographic Information:
Select the most appropriate item from each category then click on the CONTINUE button.

Age
- Newborn (< 2 MO)
- Infant (2 MO TO < 1 YR)
- Child (1 to < 12 YRS)
- Adolescent (12 TO < 18 YRS)
- Adult Young (18 TO 40 YRS)
- Middle Age (41 TO 65 YRS)
- Elderly (> 65 YRS)

Gender
- Female
- Male

Condition
- Acute (Hours)
- Subacute (few days)
- Chronic (> few days)

Continue to add finding ○ Help ○ Comment

Demo Notes:
For all cases presented to DXplain, you should provide the patient's age and gender and a rough estimate of the duration of the disease.

Pressing the continue button presents the next screen which allows entry of more case-specific findings.

One of the most important features of DXplain on the Web is your ability to send comments, questions and criticisms directly to the developer. Please do so via the Comment feature, and we will try to respond promptly.
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Enter findings separated by ";".

malaise; stiff joints; insomnia

– Add Finding(s) – Clear text field and RESET

Current Findings List:

CHRONIC (> FEW DAYS)
MALE
ADULT, YOUNG (18 TO 40 YRS)

– Remove Finding(s) – Focus on Finding(s) – Finding Information –
– List Possible Diseases – Enter Disease Name for Information –
– New Case – Help – Comment –

Process Request
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More specific findings for "stiff joints":

- ANKYLOSIS
- BACK STIFFNESS
- EXTREMITY STIFFNESS
- HIP STIFFNESS
- LOWER EXTREMITY STIFFNESS
- FOOT STIFFNESS
- METATARSOPHALANGEAL JOINT STIFFNESS
- KNEE STIFFNESS
- SHOULDER STIFFNESS

Matches for "insomnia":

- ABDOMINAL WALL RETRACTION
- INSPIRATORY
- AORTIC VALVE REGURGITATION
- DIABETES INSIPIDUS
- EMOTIONAL INSTABILITY
- HAND MOVEMENT SLOWNESS
- ADRENAL INSUFFICIENCY
- INSECT BITE
- INSOMNIA
- INSPIRATION, PROLONGED
- INSTEP ARTHRITIS

Added to findings list: "MALAISE".
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DXplain Disease List

- ARTHRITIS, RHEUMATOID
- LUPUS ERYTHEMATOSUS, SYSTEMIC
- Spondylitis, ANKYLOSING
- FIBROSIS
- ALCOHOLISM
- CHRONIC FATIGUE SYNDROME
- HERPES ZOSTER
- AIDS, CDC GROUP IV
- COLITIS, ULCERATIVE
- ENTERITIS, REGIONAL (CROHN'S DISEASE)
- RHINITIS, ALLERGIC
- ACUTE ALCOHOL WITHDRAWAL
- ARTHRITIS, VIRAL
- KIDNEY, FAILURE, CHRONIC
- LYMPHOCYTOMA VENEREUM

-- insufficient information to support this disease

NOTE: None of the above diseases are well supported.

Does this DXplain disease list suggest plausible diseases which you had not previously considered.

- Yes
- No

If there are any additional diseases you feel should be on the disease list, please enter them below:

- acute leukemia

C Explain Disease □ C Disease Information □ C Enter Disease not on List □
C Return to Add Finding □
C New Case □ C Help □ C Comment □

Scroll down to view finding list
Enter findings separated by ":".

headache; thrombocytopenia

Current Findings List:

INSOMNIA
JOINT STIFFNESS
MALAISE
CHRONIC (> FEW DAYS)
MALE
ADULT, YOUNG (18 TO 40 YRS)

Demo Notes:

Two additional terms are added to the case findings.
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More specific findings for "headache":

- HEADACHE, DULL
- HEADACHE, FRONTAL
- HEADACHE, MIGRAINE
- HEADACHE, OCCIPITAL
- HEADACHE, POSTAURICULAR
- MASTOID PAIN
- HEADACHE, RECURRENT
- HEADACHE, SEVERE
- HEADACHE, TEMPLE

Added to findings list: "THROMBOCYTOPENIA".
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DXplan Disease List

+ PURPURA, THROMBOCYTOPENIC, IDIOPATHIC
  - LUPUS ERYTHEMATOSUS, SYSTEMIC
  - ARTHRITIS, RHEUMATOID
  - PURPURA, THROMBOCYTOPENIC, SECONDARY
  - Spondylitis, Ankylosing
  - AIDS, CDC GROUP IV
  - ANEMIA, APLASTIC
  - CHRONIC FATIGUE SYNDROME
  - ROCKY MOUNTAIN SPOTTED FEVER
  - LEPTOSPIROSIS
  - MYCOSIS FUNGOIDES
  - TUBERCULOSIS, MILIARY
  - LEUKAEMIA, PRONEUMOCYTIC
  - ENCEPHALITIS, RUBELLA
  - DISSEMINATED INTRAVASCULAR COAGULATION

+ indicates sufficient information to suggest this DX
-- insufficient information to support this disease

Does this DXplan disease list suggest plausible diseases which you had not previously considered.

- Yes
- No

If there are any additional diseases you feel should be on the disease list, please enter them below:

Demo Notes:

Four diseases are now felt to be worth consideration, and one is strongly supported.

Additional diseases suggested by one or more findings are not felt overall to be supported.

The user selected the "Explain Disease" option and the disease "Rocky Mountain Spotted Fever" from the list to see why DXplan is considering this disease.

- Explain Disease  - Disease Information  - Enter Disease not on List
- Return to Add Finding  - New Case  - Help  - Comment

Process Request

Scroll down to view finding list

Current Findings List:
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--- ROCKY MOUNTAIN SPOTTED FEVER
- LEPTOSPIROSIS
- MYCOSIS FUNGOIDES
- TUBERCULOSIS, MILARY
- LEUKEMIA, PROMYEOLOGYC
- ENCEPHALITIS, RUBELLA
- DESEMINATED INTRAVASCULAR COAGULATION

+ indicates sufficient information to suggest this DX
-- insufficient information to support this disease

If there are any additional diseases you feel should be on the disease list, please enter them below.

- Explain Disease - Disease Information - Enter Disease not on List
- Return to Add Finding - New Case - Help - Comment

Process Request

Scroll down to view finding list

Current Findings List:

HEADACHE
THROMBOCYTOPENIA
INSOMNIA
JOINT STIFFNESS
MALAISE
CHRONIC (> FEW DAYS)
MALE
ADULT, YOUNG (18 TO 40 YRS)
Discussion of disease ROCKY MOUNTAIN SPOTTED FEVER. This is a rare disease.

The following findings support this disease:

- MALAISE
- JOINT STIFFNESS
- INSOMNIA
- THROMBOCYTOPENIA
- HEADACHE

The following clinical manifestations (if present) would also support this disease:

- ROTH SPOTS
- RUMPFL LEEDER SIGN POSITIVE
- INSECT BITE
- TICK EXPOSURE
- EXTREMITY MACULAR ERYTHEMA
- EXTREMITY PURPUR
- FACIAL MACULAR ERYTHEMA
- ANKLE MACULAR ERYTHEMA
- ANKLE PURPUR
- WRIST MACULAR ERYTHEMA

The following lab data (if present) would be useful in establishing the presence of the disease:

- WELFELIX REACTION POSITIVE
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"ROTH SPOTS" is an important finding which should be strongly considered in creating the differential diagnosis. The following diseases should be considered given the finding "ROTH SPOTS". Note that the position of each disease in a group is arbitrary and does not indicate the degree of support.

This finding very strongly supports the following disease(s):
Common Diseases:
ENDOCARDITIS, BACTERIAL, SUBACUTE
Rare Diseases:
ENDOCARDITIS, ACUTE BACTERIAL

This finding strongly supports the following disease(s):
Common Diseases:
BATTERED CHILD SYNDROME
CANDIDIASIS, ORAL
LUPUS ERYTHEMATOSUS, SYSTEMIC
Rare Diseases:
CARBON MONOXIDE POISONING
LEISHMANTIASIS, VISCERAL
MYELOMA, MULTIPLE
ORNITHOSIS
ROCKY MOUNTAIN SPOTTED FEVER
TYPHOID FEVER

This finding supports the following disease(s):
Common Diseases:
BRAIN HEMORRHAGE
DIABETES MELLITUS, NON-INSULIN DEPENDENT
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DXplain Disease List

++ RICKY MOUNTAIN SPOTTED FEVER
+ ENRICHOSIS
+ LYME DISEASE, EARLY/IMD
+ PURPURA, THROMBOCYTOPENCIA, IDIOPATHIC
+ LUPUS ERYTHEMATOSUS, SYSTEMIC
+ ARTHRITIS, RHEUMATOID
+ LYME DISEASE, LATE
+ BABESIOSIS
+ PNEUMONIA, TULAREMIC
+ PURPURA, SENILIS
+ PURPURA, THROMBOCYTOPENCIA, SECONDARY
+ HEPARIN TOXICITY
+ ARTHRITIS, ONOCCO.CAL
+ TYPHUS, SCRUB
+ AIDs, CDC GROUP IV

++ indicates sufficient information to strongly support this DX
+ indicates sufficient information to suggest this DX
-- insufficient information to support this disease

Does this DXplain disease list suggest plausible diseases which you had not previously considered?

C Yes
C No

If there are any additional diseases you feel should be on the disease list, please enter them below.

C Explain Disease C Disease Information C Enter Disease not on List C
C Return to Add Finding C
C New Case C C Help C C Comment C

Scroll down to view finding list
ROCKY MOUNTAIN SPOTTED FEVER  (RARE)

OTHER NAMES
Fever, spotted; Fever, tick; Typhus, tick; Fiebre manchada; Fiebre petequial; Fiebre maculosa.

ETIOLOGY
Rickettsia rickettsii; transmitted by bite of tick or contact with tick blood or feces on unbroken skin; evidence of aerosol transmission by respiratory route in laboratory workers; tick vector and reservoir; rodents, rabbits reservoirs.

ASSOCIATED TERMS AND CONDITIONS
SOMETIMES: tick exposure; insect bite; summer; male; spring; blood coagulation defect.
RARELY: congestive heart failure; cardiovascular abnormality.
MAKE DIAGNOSIS LESS LIKELY: winter; autumn.

SYMPTOMS
USUALLY: nausea; generalized myalgia; headache; malaise; rigor; prostration; insomnia; sleep disturbance; sudden onset of symptoms.
SOMETIMES: anorexia; constipation; joint stiffness; arthralgia; back pain; photophobia; headache, severe; chills; weakness, generalized; anxiety; irritability; cough; vomiting; abdominal pain; oliguria; confusion; consciousness disturbance; delirium; stupor; muscular rigidity; hearing impairment; lightheadedness.
RARELY: abdominal pain, right upper quadrant; flank pain; kidney disease; renal failure; coma; hypersomnia.

PHYSICAL FINDINGS
USUALLY: ankle macular erythema; ankle purpura; wrist macular erythema; facial macular erythema; dehydration; fever; skin erythema; maculopapular
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**PHYSICAL FINDINGS**

**USUALLY:** ankle macular erythema; ankle purpura; wrist macular erythema; facial macular erythema; dehydration; fever; skin erythema; maculopapular erythema; skin lesion(s) or rash; generalized rash.

**SOMETIMES:** spleen enlargement; hypotension; muscle tenderness; meningismus; agitation; cyanosis; ecchymosis; palmar erythema; upper extremity rash; palmar rash; sole rash; Rumpel-Leede sign positive; abdominal distention; hepatosplenomegaly; hepatomegaly; liver tenderness; peristaltic sound decrease; shock; back tenderness; skin ulceration.

**RARELY:** Roth spots; flank tenderness; abdominal tenderness; gangrene; seizure; unresponsiveness; jaundice.

**ADDITIONAL NOTES:** Incubation 3-12 days; flushing of skin; macular bright red lesions, appearing on wrists, ankles, later becoming generalized; later petechial, possibly hemorrhagic lesions; fever high during second week.

**LABORATORY FINDINGS**

**SOMETIMES:** Weil-Felix reaction positive; thrombocytopenia; hypoxia; prolonged bleeding time; leukocytes decreased; hemocrit increased; monocytes, increased; hypoalbuminemia.

**RARELY:** blood urea nitrogen elevated; creatinine, elevated; serum total bilirubin elevated; SGOT (AST), elevated; alkaline phosphatase, elevated; serum conjugated bilirubin elevated; SGPT (ALT), elevated; serum creatine phosphokinese BB fraction elevated.

**ADDITIONAL NOTES:** Complement fixation test positive.

**DIAGNOSTICALLY HELPFUL**

**VERY STRONGLY SUPPORTS:** ankle macular erythema; ankle purpura; Rumpel-Leede sign positive; wrist macular erythema; tick exposure.

**STRONGLY SUPPORTS:** extremity macular erythema; extremity purpura; facial macular erythema; insect bite; Weil-Felix reaction positive; Roth spots.

**COURSE**
macular erythema; insect bite; Weil-Felix reaction positive; Roth spots.

PROGNOSIS: in mild or moderately grave forms, subsidence within two weeks; possibly bronchopneumonia; pneumonitis; otitis media; parotitis; heart failure; hemorrhages from nose, intestine, kidney; iritis; acute nephritis; hemiplegia; concurrent infections; in fatal cases, death occurring during second week from toxemia, vasomotor weakness, shock or renal failure.

PATHOLOGY
Endothelial proliferation of capillaries, thrombosis; mononuclear infiltration within heart, liver, spleen, alveoli; arterial infarction.

REFERENCES
7. When to be rash about a fever and headache. Chest 1986 Aug;90(2):290-1
This program is a canned demo. Any changes made to the form will not be reflected in the subsequent frames. **Please click on the right arrow and left arrow buttons located at the bottom right corner of the screen to navigate through this demonstration. Do NOT use the Browser's [BACK] button.**

**Note: Disease list generated with FOCUS finding(s).**

"TICK EXPOSURE"

**DXplain Disease List**

+ ++ ROCKY MOUNTAIN SPOTTED FEVER  
+ EHRlichiosis  
+ LYMIE DISEASE: EARLY/MID  
LYMIE DISEASE, LATE  
BABESIOSIS  
PNEUMONIA, TULAREMIC  
TYPHUS, SCRUB  
BARTONELLOSIS  
LEISHMANIASIS, OLD WORLD CUTANEOUS  
- CHAGAS DISEASE  
- TRYPANOSOMIASIS, AFRICAN  
- DESEMINATED INTRAVASCULAR COAGULATION  
- ENCEPHALITIS, JAPANESE B  
- SEPTICEMIC PLAGUE  
- RELAPSING FEVER

Does this DXplain disease list suggest plausible diseases which you had not previously considered.

- [ ] Yes  
- [ ] No

If there are any additional diseases you feel should be on the disease list, please enter them below.

- [ ] Explain Disease  
- [ ] Disease Information  
- [ ] Return to Add Finding  
- [ ] New Case  
- [ ] Help  
- [ ] Comment
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**TICK PARALYSIS  (RARE)**

-----------------------  ETIOLOGY  -----------------------
Paralysis caused by neurotoxin found in tick saliva.

-----------------------  ASSOCIATED TERMS AND CONDITIONS  -----------------------
USUALLY: tick exposure; insect bite.
SOMETIMES: female; summer; child; African; European; North American; North American, Northwestern; Australian; African, South; Canadian.
RARELY: respiratory failure.

-----------------------  SYMPTOMS  -----------------------
USUALLY: extremity muscle weakness, lower; muscular weakness; cerebellar ataxia; progressive symptoms.
SOMETIMES: diarrhea; flaccid paralysis; motor disorder; irritability; skin lesion pain; dysphagia; communication impairment; involuntary movement, gross; equilibrium disorder; Romberg sign positive.
RARELY: coma; consciousness disturbance; stupor; extremity paresthesia; hyperesthesia; sensory disorder.

-----------------------  PHYSICAL FINDINGS  -----------------------
USUALLY: hyporeflexia; areflexia.
SOMETIMES: eye deviation; strabismus; speech impairment; facial paralysis; nystagmus.
RARELY: hyperreflexia; unresponsiveness; cyanosis.
MAKE DIAGNOSIS LESS LIKELY: fever.

-----------------------  LABORATORY FINDINGS  -----------------------
RARELY: cerebral spinal fluid lymphocytes increased.
MAKE DIAGNOSIS LESS LIKELY: leukocytes increased; cerebral spinal fluid neutrophils increased, slight; cerebral spinal fluid protein increased, slight; cerebral spinal fluid neutrophils increased, marked; cerebral spinal fluid.
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SOMETIMES: eye deviation; strabismus; speech impairment; facial paralysis; nystagmus.
RARELY: hyperreflexia; unresponsiveness; cyanosis.
MAKE DIAGNOSIS LESS LIKELY: fever.

------------------------ LABORATORY FINDINGS ------------------------
RARELY: cerebral spinal fluid lymphocytes increased.
MAKE DIAGNOSIS LESS LIKELY: leukocytes increased; cerebral spinal fluid neutrophils increased, slight; cerebral spinal fluid protein increased, slight; cerebral spinal fluid neutrophils increased, marked; cerebral spinal fluid protein increased, marked.

------------------------ DIAGNOSTICALLY HELPFUL ------------------------
STRONGLY SUPPORTS: tick exposure.

------------------------ REFERENCES ------------------------