Linking Medical Records to an Expert System

Frank Naeymi-Rad Ph.D.\(^1\), David Trace M.D.\(^1\), and Fabio De Souza Almeida M.D.\(^2\)

\(^1\)University of Health Sciences/The Chicago Medical School, North Chicago, Illinois 60064, (708) 578-3212
\(^2\)Santa Clara Kaiser Medical Center, Department of Medicine, Santa Clara, California 95051

This presentation will be done using the IMR-Entry (Intelligent Medical Record Entry) system. IMR-Entry is a software program developed as a front-end to our diagnostic consultant software MEDAS (Medical Emergency Decision Assistance System).

MEDAS (the Medical Emergency Diagnostic Assistance System) is a diagnostic consultant system using a multimembership Bayesian design for its inference engine and relational database technology for its knowledge base maintenance. Research on MEDAS began at the University of Southern California and the Institute of Critical Care in the mid 1970's with support from NASA and NSF. The MEDAS project moved to Chicago in 1982; its current progress is due to collaboration between Illinois Institute of Technology, The Chicago Medical School, Lake Forest College and NASA at KSC. We acknowledge the support provided by Dr. Daniel Woodard, Dr. Paul Buchanan and Dr. Ronald White.

### MEDAS DISORDER PATTERN

<table>
<thead>
<tr>
<th>Screen No.</th>
<th>MED S20</th>
</tr>
</thead>
</table>

**Name:** PULMONARY THROMBOEMBOLISM  
**Category:** RESPIRATORY  
**Date Created:** 02/13/87  
**Prevalence Rate:** 0.07  
**# OF F:** 75  
**SORT ID:** Post+

<table>
<thead>
<tr>
<th>F#</th>
<th>Feature Name</th>
<th>P</th>
<th>Pbar</th>
<th>Post, When +</th>
<th>Post, When -</th>
</tr>
</thead>
<tbody>
<tr>
<td>1)</td>
<td>V/P LUNG SCAN: MMATCH VENT &amp; (+) JOP</td>
<td>.949</td>
<td>.050</td>
<td>.588</td>
<td>.064</td>
</tr>
<tr>
<td>2)</td>
<td>ANGIO: PULMONARY PERFUSION DEFECT</td>
<td>.899</td>
<td>.050</td>
<td>.575</td>
<td>.088</td>
</tr>
<tr>
<td>3)</td>
<td>ECG - S1-Q3-T3 PATTERN</td>
<td>.100</td>
<td>.009</td>
<td>.455</td>
<td>.064</td>
</tr>
<tr>
<td>4)</td>
<td>CXR: PULMONARY INFLTRATE UNILATERAL</td>
<td>.200</td>
<td>.029</td>
<td>.342</td>
<td>.058</td>
</tr>
<tr>
<td>5)</td>
<td>S/O DEEP VEIN THROMBOPHLEBITIS</td>
<td>.300</td>
<td>.100</td>
<td>.184</td>
<td>.055</td>
</tr>
<tr>
<td>6)</td>
<td>M.S. DEEP MUSCULAR TENDERNESS</td>
<td>.300</td>
<td>.100</td>
<td>.184</td>
<td>.055</td>
</tr>
<tr>
<td>7)</td>
<td>PVS PITTING EDEMA UNILATERAL</td>
<td>.300</td>
<td>.100</td>
<td>.184</td>
<td>.055</td>
</tr>
<tr>
<td>8)</td>
<td>V/P LUNG SCAN: EMBOLISM</td>
<td>.600</td>
<td>.200</td>
<td>.184</td>
<td>.036</td>
</tr>
<tr>
<td>9)</td>
<td>H/O DEEP VEIN THROMBOSIS</td>
<td>.300</td>
<td>.100</td>
<td>.184</td>
<td>.055</td>
</tr>
<tr>
<td>10)</td>
<td>CXR: ATELECTASIS</td>
<td>.050</td>
<td>.019</td>
<td>.165</td>
<td>.068</td>
</tr>
<tr>
<td>11)</td>
<td>CXR PLEURAL EFFUSION UNILATERAL</td>
<td>.300</td>
<td>.119</td>
<td>.159</td>
<td>.056</td>
</tr>
</tbody>
</table>

1) Look  2) Create  3) Delete  4) Change prob  5) Sort option  6) Exit

This screen demonstrates the disorder pattern for Pulmonary Thromboembolism. Since the purpose of an expert system is to derive a hypothesis, its communication vocabulary is limited to features used by its knowledge base. Recognizing this problem our team in Chicago, for the last five years, has been working on the development of a comprehensive problem based medical record entry system which could handshake with an expert system while creating an electronic medical record at the same time.

IMR-E is a computer based patient record that serves as a "front end" to the expert system MEDAS. IMR-E is a graphically oriented comprehensive medical record. We demonstrate the program's major components in the following article:

© Intelligent Medical Systems, Inc.

International Telemedicine/Disaster Medicine Conference
IMR-Entry requires the provider to identify themselves before he or she is allowed to use the system. This identification is used to tag all of the data created for the given session by the entry person's identification.

The patient identification screen will appear by clicking on the Patient Information icon:

The patient selection screen can be integrated with any in-place demographics screen to eliminate the duplication of entry.
By clicking on the icon the user will return to the following screen.

```
As you can see this is comprehensive and covers all of the sections for the physician's entry. The navigational icons were designed to aid the physician at each step of entry.

By clicking on the icon , the following screen appears:
```

© Intelligent Medical Systems, Inc.
International Telemedicine/Disaster Medicine Conference
There are 95 complete complaint programs. Each program allows the physician to custom create a paragraph for a given complaint by using the computer mouse. Each program manages between 20 to 50 objects which are displayed on 3 to 5 screens.

This is the first screen for Abdominal Pain Chief Complaint. We can select the appropriate options by simply clicking on them.

![Abdominal Pain Chief Complaint Screen]

By clicking on the we get the second screen for Abdominal Pain.

![Abdominal Pain Chief Complaint Screen]
The onset of the abdominal pain has been sudden and has been occurring for 12 hours. The pattern of the abdominal pain has been persistent. It's course has been increasing. The abdominal pain is located in the right lower quadrant with radiation to the left flank and left lower quadrant. It is aggravated by coughing, standing and walking while relief is obtained by nothing. The abdominal pain is characterized as sharp and stabbing. The severity of the pain is

- colicky
- a dull ache
- a pressure sensation

Previous Evaluations
- barium enema
- upper gastrointestinal X-ray
- proctoscopy

Abdominal Pain

Associated With
- chest pain
- constipation
- dark urine
- diarrhea
- dysuria
- fever
- heartburn
- hematuria
- jaundice
- melena
- nausea
- passing worms
- pica
- use of alcohol

Not Associated With
- abdominal distension
- amenorrhea
- anorexia
- bloating
- bloody stools
- bone pain
- bulky stools
- chest pain
- constipation
- dark urine
- diarrhea
- dysuria
- fever
- heartburn
- hematemesis

We can review text generated to this point by clicking on the icon  

The last screen for this complaint will appear by clicking on the icon 

© Intelligent Medical Systems, Inc.
International Telemadicine/Disaster Medicine Conference
When we continue clicking on the Additional Complaints, we move to the Additional Complaints Screen.

After selecting additional complaints, the system displays all the appropriate complaints that it has programmed for you. We could describe these complaints in more detail.
By selecting HISTORY folder we can enter all of the history information.

We must note that the Travel History is incomplete since it does not include space travel history.

By selecting the PAST MEDICAL HISTORY Folder we get to the next screen.
Please note: as the mouse moves over the Icons, the dialog window on the lower right displays the function of the icon.

By clicking the text icon system displays the current status of the final electronic report.

The patient is a 41 year old married white male who presents with complaints of abdominal pain. The onset of the abdominal pain has been sudden and has been occurring for 12 hours. The pattern of the abdominal pain has been persistent. Its course has been increasing. The abdominal pain is located in the right lower quadrant with radiation to the left flank and left lower quadrant. It is aggravated by coughing, standing and walking while relief is obtained by nothing. The abdominal pain is characterized as sharp and stabbing. The severity of the pain is severe. It is associated with fever and

Note: the first paragraph does not have any information about significant past medical or surgical history.

We can go back to where the report generation was launched from by clicking this icon. by selecting the Gastrointestinal section and identifying the history to the system as significant to the present illness.
When clicking the text icon, the system displays the current status of the final electronic report with the significant history within the first paragraph.

For the purpose of time, we will return to the first screen and show you other important features needed for a complete electronic medical record.

The next screen is the result of clicking on the REVIEW OF SYSTEM icon from the main screen. When the selections are made, the system requests the user to respond to the Positive or Negative of the given finding. This insures that significant negatives are entered into the system since the MEDAS expert system uses the negative of the finding as well as the positive.
The next screen is the result of clicking on the VITAL SIGN icon from the main screen.

Vitals

Supine       Standing

Systolic BP  120       Systolic BP  
Diastolic BP  80  Diastolic BP  
Heart Rate  88  Heart Rate  

Resp Rate  22
Temp  102
Weight  170
Height  

Respiri
Tachypnea (rapid shallow breathing)
Hyperventilation
Bradypnea
Cheyne-Stokes breathing
Atonic breathing
Sighing respiration
Obstructive breathing

Physical Exam

Normal Normal Not
Except Examined

Normal Normal Not
Except Examined

Normal Normal Not
Except Examined

© Intelligent Medical Systems, Inc.
International Telemedicine/Disaster Medicine Conference
There are three options for each selection: Normal, Normal Except, and Not Examined. Not Examined will print "not examined" on the report. The Normal will automatically print the significant normal on the report.

The next screen demonstrate the output by our selection. The HEET was selected as normal. Please note that the object that generates the significant normal can be modified to print more, or less information on the report.
To select "normal except" for the abdominal exam, click on the Abdomen icon.

This action will start the abdominal exam program (the following screen). Each Physical Exam has its own unique options. In this exam the options are Inspection, Percussion, and Auscultation.
When selecting "Inspection" the screen controlling the Inspection objects is launched.

Each of the screens within the physical exam module manage 50 to 300 unique objects.

The following is an example of the "Percussion" screen.
The following is an example of the "Auscultation" screen.

This next screen demonstrates the output generated by the physical exam.
When clicking on the FD button on the lower part of the screen, the system generates the term dictionary that can be used to communicate to the expert system.

<table>
<thead>
<tr>
<th>Back</th>
<th>Medas Dictionary</th>
</tr>
</thead>
<tbody>
<tr>
<td>1111443333</td>
<td>Frank</td>
</tr>
<tr>
<td>Naevi-Red</td>
<td>SEX. 1+, male</td>
</tr>
<tr>
<td>RACE. 1+, white</td>
<td>Status. 2+, married</td>
</tr>
<tr>
<td>CC. 1+, Abdominal pain</td>
<td>CCAC. 37+, fever</td>
</tr>
<tr>
<td>CCAC. 56+, nausea</td>
<td>CCAC. 82+, Vomiting</td>
</tr>
<tr>
<td>CC. 1.O2+, abdominal pain onset sudden</td>
<td>CC. 1.O2+, abdominal pain duration hours</td>
</tr>
<tr>
<td>CC. 1.P2+, abdominal pain pattern persistent</td>
<td>CC. 1.C1+, abdominal pain course increasing</td>
</tr>
<tr>
<td>CC. 1.L5+, abdominal pain location right lower quadrant</td>
<td>CC. 1.R5+, abdominal pain radiation left flank</td>
</tr>
<tr>
<td>CC. 1.R12+, abdominal pain radiation left lower quadrant</td>
<td>CC. 1.A5+, abdominal pain aggravated by coughing</td>
</tr>
<tr>
<td>CC. 1.A7+, abdominal pain aggravated by standing</td>
<td>CC. 1.A6+, abdominal pain aggravated by walking</td>
</tr>
<tr>
<td>CC. 1.RE1+, abdominal pain relieved by nothing</td>
<td>CC. 1.CH2+, abdominal pain characterized as sharp</td>
</tr>
<tr>
<td>CC. 1.CH3+, abdominal pain characterized as stabbing</td>
<td>CC. 1.AS13+, abdominal pain associated with fever</td>
</tr>
<tr>
<td>CC. 1.AS19+, abdominal pain associated with nausea</td>
<td>MEDS. 87+, BENZATHINE PENICILLIN G.97</td>
</tr>
<tr>
<td>PMHCV. 38+, Cardiovascular Pulmonary Hypertension</td>
<td></td>
</tr>
</tbody>
</table>

As you can see, the system generates many terms for this very simple exam. The current system generates over 65,000 terms while the current MEDAS data dictionary has only 1,750 of these terms.

In conclusion we have demonstrated the need of an independent and complete front-end to a medical expert system.