DXplain

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- Computer-based, web-based medical decision support system - designed to help health professionals make clinical decisions
- Accept a list of clinical manifestations and **proposes** diagnostic hypotheses. **NOT Greek Oracle – not claim CORRECT DX**
- Explains interpretations, offers suggestions for further work up
- Access medical knowledge, references

Symptoms

- Backache
- Diarrhea
- Generalized abdominal pain
- Hematemesis (vomiting of blood)
- Pain in epigastrium (mid-upper abdomen)
- Fever

- **?? What is diagnosis**
- **What set of diagnoses should be considered**

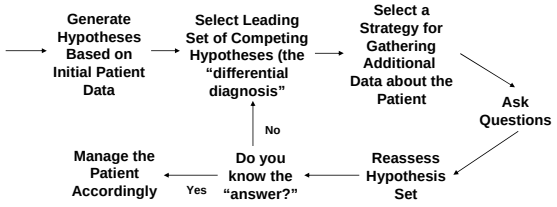
Computer-Assisted Decision Support

Examples of functionalities

- Generic information access tools (e.g., Medline)
- Patient-specific consultation systems
  - Advice regarding diagnosis (DXplain)
  - Advice regarding optimal workup
  - Advice regarding therapy or patient management
  - Critiques: reactions to users' hypotheses regarding patients and their proper management
- Browsing tools that mix generic and patient-specific elements (e.g., "electronic textbooks of medicine")
- Monitoring tools that generate warnings or advice as needed (advice as a byproduct of patient care and data recording)

Shortliffe – Stanford Columbia

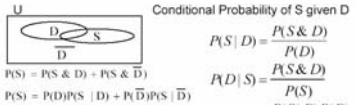
The Hypothetico-Deductive Approach [Shortliffe]



Bayes – Clinical Manifestions Disease

Symptom S

Diseases D such that $\Sigma P(D_j) = 1$



Conditional Probability of S given D

$$P(S \mid D) = \frac{P(S \& D)}{P(D)}$$

$$P(D \mid S) = \frac{P(S \& D)}{P(S)}$$

$$P(D \mid S) = \frac{P(S \mid D)P(D)}{P(S)}$$

$P(S) = P(S \& D) + P(S \& \overline{D})$

$P(S) = P(D)P(S \mid D) + P(\overline{D})P(S \mid \overline{D})$

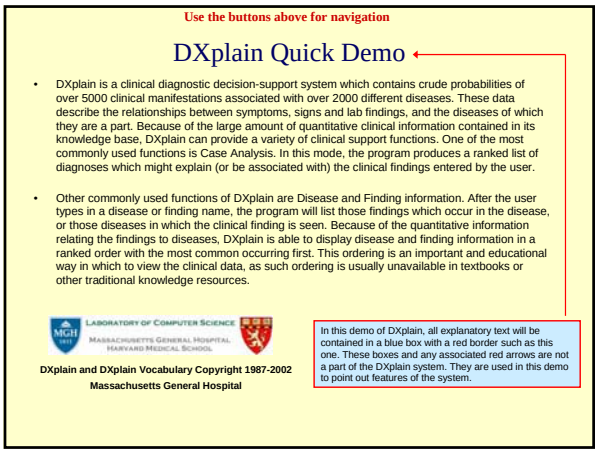
$$P(S) = \sum_j P(D_j) \times P(S \mid D_j)$$

$$P(D_i \mid S) = \frac{P(S \mid D_i) \times P(D_i)}{P(S)}$$

6.871, 2004 -Uncertainty , Page 7

Typical Assumptions with the Use of Bayes' Theorem

- Completeness (for example, all men either have or do not have prostate cancer; there are no other possibilities)
- Mutual exclusivity (for example, if a man has prostate cancer, he cannot simultaneously NOT have prostate cancer)
- Conditional independence (for example, acid phosphatase and a biopsy result ARE conditionally independent tests; rectal exams and acid phosphatase may NOT be conditionally independent)


Use the buttons above for navigation
DXplain Quick Demo
DXplain is a clinical diagnostic decision-support system which contains crude probabilities of over 5000 clinical manifestations associated with over 2000 different diseases. These data describe the relationships between symptoms, signs and lab findings, and the diseases of which they are a part. Because of the large amount of quantitative clinical information contained in its knowledge base, DXplain can provide a variety of clinical support functions. One of the most commonly used functions is Case Analysis. In this mode, the program produces a ranked list of diagnoses which might explain (or be associated with) the clinical findings entered by the user.
Other commonly used functions of DXplain are Disease and Finding information. After the user types in a disease or finding name, the program will list those findings which occur in the disease, or those diseases in which the clinical finding is seen. Because of the quantitative information relating the findings to diseases, DXplain is able to display disease and finding information in a ranked order with the most common occurring first. This ordering is an important and educational way in which to view the clinical data, as such ordering is usually unavailable in textbooks or other traditional knowledge resources.
LABORATORY OF COMPUTER SCIENCE
MASSACHUSETTS GENERAL HOSPITAL
HARVARD MEDICAL SCHOOL
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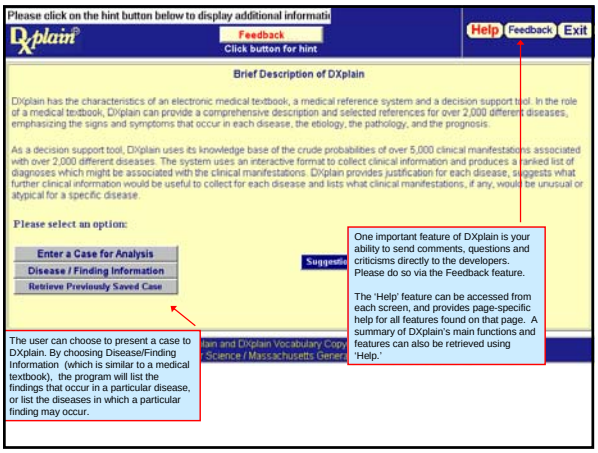
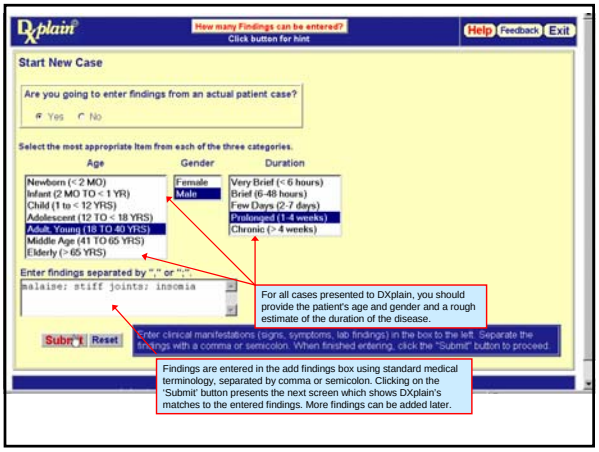
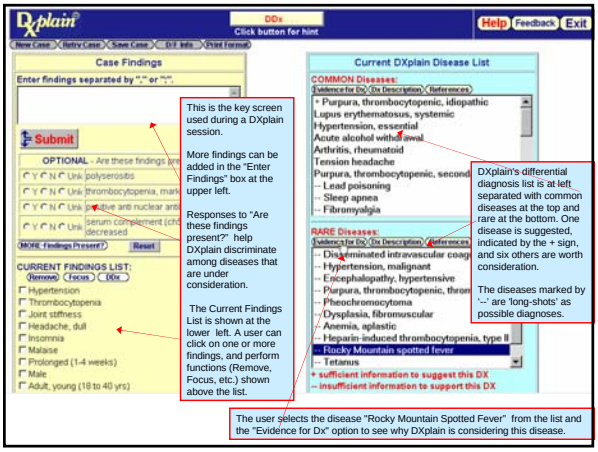
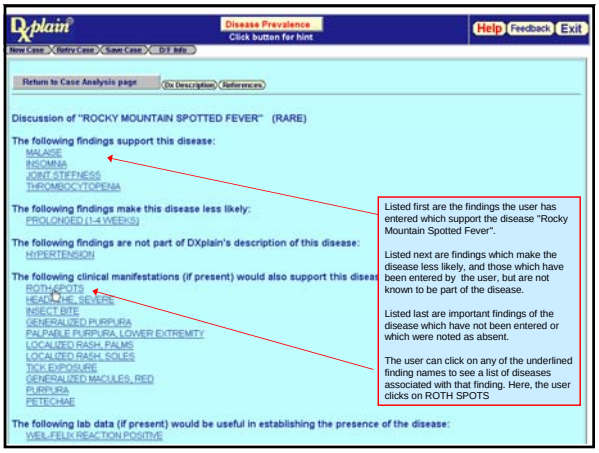
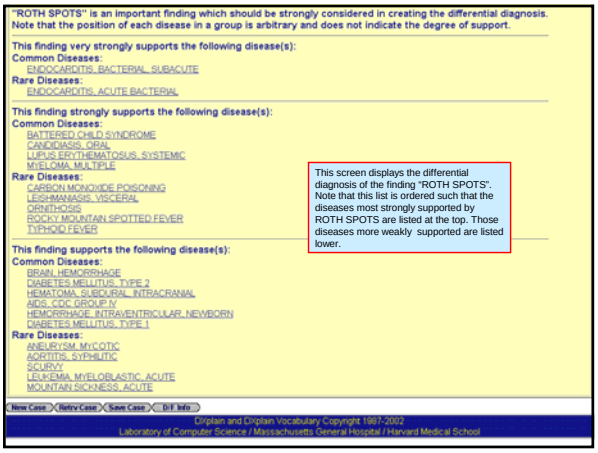
Massachusetts General Hospital
In this demo of DXplain, all explanatory text will be contained in a blue box with a red border such as this one. These boxes and any associated red arrows are not a part of the DXplain system. They are used in this demo to point out features of the system.


Please click on the hint button below to display additional informati
DXplain
Feedback
Click button for hint
Help
Feedback
Exit
Brief Description of DXplain
DXplain has the characteristics of an electronic medical textbook, a medical reference system and a decision support tool. In the role of a medical textbook, DXplain can provide a comprehensive description and selected references for over 2,000 different diseases, emphasizing the signs and symptoms that occur in each disease, the etiology, the pathology, and the prognosis.
As a decision support tool, DXplain uses its knowledge base of the crude probabilities of over 5,000 clinical manifestations associated with over 2,000 different diseases. The system uses an interactive format to collect clinical information and produces a ranked list of diagnoses which might be associated with the clinical manifestations. DXplain provides justification for each disease, 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 a specific disease.
Please select an option:
Enter a Case for Analysis
Disease / Finding Information
Retrieve Previously Saved Case
Suggestio
One important feature of DXplain is your ability to send comments, questions and criticisms directly to the developers. Please do so via the Feedback feature.
The 'Help' feature can be accessed from each screen, and provides page-specific help for all features found on that page. A summary of DXplain's main functions and features can also be retrieved using 'Help.'
The user can choose to present a case to DXplain. By choosing Disease/Finding Information (which is similar to a medical textbook), the program will list the findings that occur in a particular disease, or list the diseases in which a particular finding may occur.


DXplain
How many Findings can be entered?
Click button for hint
Help
Feedback
Exit
Start New Case
Are you going to enter findings from an actual patient case?
Yes
No
Select the most appropriate item from each of the three categories.
Age
Gender
Duration
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)
Female
Male
Very Brief (< 6 hours)
Brief (6-48 hours)
Few Days (2-7 days)
Prolonged (1-4 weeks)
Chronic (> 4 weeks)
Enter findings separated by "," or ";"
malaise; stiff joints; insomia
Submit
Reset
Enter clinical manifestations (signs, symptoms, lab findings) in the box to the left. Separate the findings with a comma or semicolon. When finished entering, click the "Submit" button to proceed.
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.
Findings are entered in the add findings box using standard medical terminology, separated by comma or semicolon. Clicking on the 'Submit' button presents the next screen which shows DXplain's matches to the entered findings. More findings can be added later.


DXplain
DDx
Click button for hint
Help
Feedback
Exit
Case Findings
Enter findings separated by "," or ";"
Submit
OPTIONAL - Are these findings
polyserositis
thrombocytopenia
positive anti nuclear
serum complement
decreased
MORE Findings Present?
Reset
CURRENT FINDINGS LIST:
Remove
Focus
DDx
Hypertension
Thrombocytopenia
Joint stiffness
Headache, dull
Insomnia
Malaise
Prolonged (1-4 weeks)
Male
Adult, young (18 to 40 yrs)
Current DXplain Disease List
COMMON Diseases:
Evidence for Dx
Dx Description
References
+ Purpura, thrombocytopenic, idiopathic
Lupus erythematosus, systemic
Hypertension, essential
Acute alcohol withdrawal
Arthritis, rheumatoid
Tension headache
Purpura, thrombocytopenic, second
-- Lead poisoning
-- Sleep apnea
-- Fibromyalgia
RARE Diseases:
-- Disseminated intravascular coag
-- Hypertension, malignant
-- Encephalopathy, hypertensive
-- Purpura, thrombocytopenic, thron
-- Pheochromocytoma
-- Dysplasia, fibromuscular
-- Anemia, aplastic
-- Heparin-induced thrombocytopenia, type II
-- Rocky Mountain spotted fever
-- Tetanus
+ sufficient information to suggest this DX
-- insufficient information to support this DX
This is the key screen used during a DXplain session.
More findings can be added in the "Enter Findings" box at the upper left.
Responses to "Are these findings present?" help DXplain discriminate among diseases that are under consideration.
The Current Findings List is shown at the lower left. A user can click on one or more findings, and perform functions (Remove, Focus, etc.) shown above the list.
DXplain's differential diagnosis list is at left separated with common diseases at the top and rare at the bottom. One disease is suggested, indicated by the + sign, and six others are worth consideration.
The diseases marked by '--' are 'long-shots' as possible diagnoses.
The user selects the disease "Rocky Mountain Spotted Fever" from the list and the "Evidence for Dx" option to see why DXplain is considering this disease.


DXplain
Disease Prevalence
Click button for hint
Help
Feedback
Exit
New Case
Retry Case
Save Case
D-F Info
Return to Case Analysis page
Dx Description
References
Discussion of "ROCKY MOUNTAIN SPOTTED FEVER" (RARE)
The following findings support this disease:
MALAISE
INSOMNIA
JOINT STIFFNESS
THROMBOCYTOPENIA
The following findings make this disease less likely:
PROLONGED (1-4 WEEKS)
The following findings are not part of DXplain's description of this disease:
HYPERTENSION
The following clinical manifestations (if present) would also support this diseas
ROTH SPOTS
HEADACHE, SEVERE
INSECT BITE
GENERALIZED PURPURA
PALPABLE PURPURA, LOWER EXTREMITY
LOCALIZED RASH, PALMS
LOCALIZED RASH, SOLES
TICK EXPOSURE
GENERALIZED MACULES, RED
PURPURA
PETECHAE
The following lab data (if present) would be useful in establishing the presence of the disease:
WEIL-FELIX REACTION POSITIVE
Listed first are the findings the user has entered which support the disease "Rocky Mountain Spotted Fever".
Listed next are findings which make the disease less likely, and those which have been entered by the user, but are not known to be part of the disease.
Listed last are important findings of the disease which have not been entered or which were noted as absent.
The user can click on any of the underlined finding names to see a list of diseases associated with that finding. Here, the user clicks on ROTH SPOTS


"ROTH SPOTS" is an important finding which should be strongly considered in creating the differential diagnosis.
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
MYELOMA, MULTIPLE
Rare Diseases:
CARBON MONOXIDE POISONING
LEISHMANIASIS, VISCERAL
ORNITHOSIS
ROCKY MOUNTAIN SPOTTED FEVER
TYPHOID FEVER
This finding supports the following disease(s):
Common Diseases:
BRAIN, HEMORRHAGE
DIABETES MELLITUS, TYPE 2
HEMATOMA, SUBDURAL, INTRACRANIAL
AIDS, CDC GROUP IV
HEMORRHAGE, INTRAVENTRICULAR, NEWBORN
DIABETES MELLITUS, TYPE 1
Rare Diseases:
ANEURYSM, MYCOTIC
AORTITIS, SYPHILITIC
SCURVY
LEUKEMIA, MYELOBLASTIC, ACUTE
MOUNTAIN SICKNESS, ACUTE
New Case
Retry Case
Save Case
D-F Info
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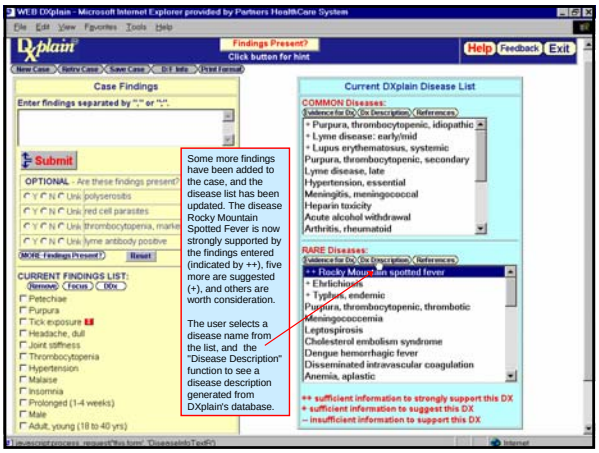
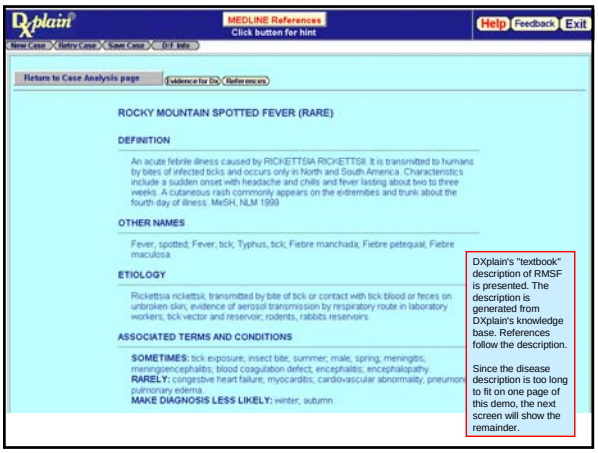
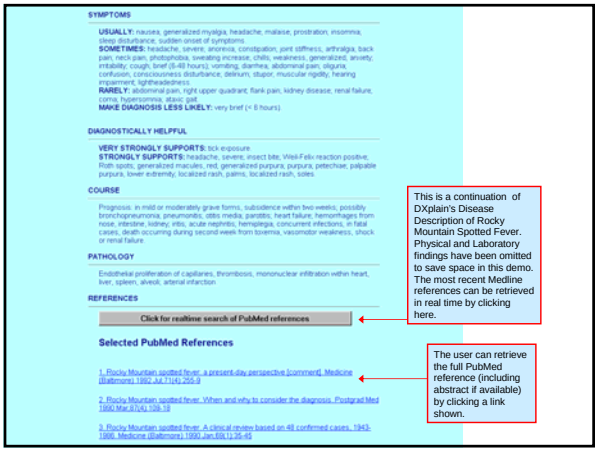
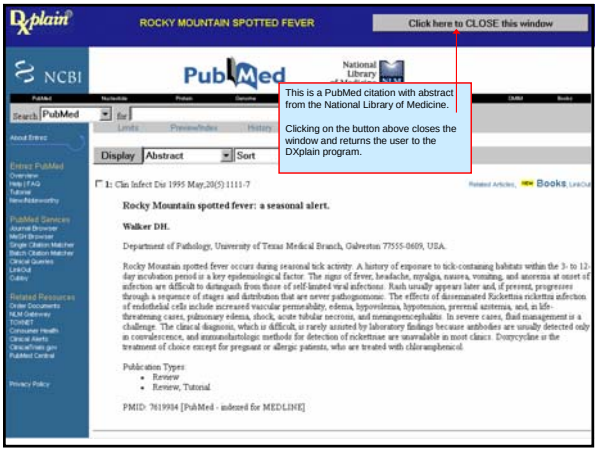
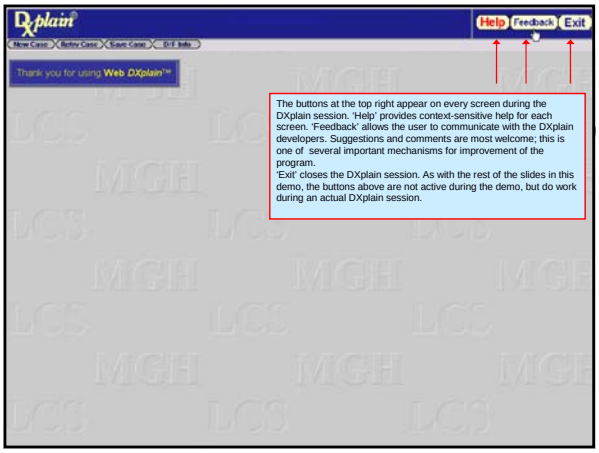
This screen displays the differential diagnosis of the finding "ROTH SPOTS". Note that this list is ordered such that the diseases most strongly supported by ROTH SPOTS are listed at the top. Those diseases more weakly supported are listed lower.











Issues Challenges - Development

- Nomenclature - Finding
  - Symptom, Sign, Clinical Manifestation
- Disease
  - Stage, severity, complication, duration
- How interact user
  - Spelling, synonym, specificity
- Frequency of Finding in Disease
  - Pathology, pathophysiology
  - Textbooks, literature
  - Clinical databases
- Conditional dependency: sex, race, age, culture, other diseases, geographical location, travel

Important features

- User Interface – no training necessary
- Ability to recognize/convert user entries
- Flexibility interaction – no limits user entry
- Ability to suggest findings to enter
- Ability to explain/defend interpretations
- Links to other knowledge resources
- Modular design –interaction separate from analysis
  - Links to medical record systems
- Evolution, dynamic changes
- User support, input, suggestions
- Combines consultation with teaching
- Stable long term web-based support, relatively inexpensive

So what - future

- Continue expand, improve database
- Enhance algorithm
  - cluster clinical manifestations
  - temporal reasoning
- Multimedia
- Integrate electronic medical record
- Evaluation – impact on accuracy, timeliness, efficiency clinical care

DXplain Use – Web

- Since 1996 – medical schools/hospitals
  - **Users 18838**
  - **Sessions 50317**
- Since 2001 – physicians
  - **Users 14351**
  - **Sessions 40164**

- **Total Users – 33,189**
- **Total Sessions – 90,481**

DXplain access

- DXplain annotated 'canned demo'

  http://dxplain.mgh.harvard.edu/dxp/dxp.sdemo.pl

- DXplain limited interactive program
  - http://dxplain.org/dxp

  account: webhst password: hst421