Evolution of DXplain: A Decision Support System

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ABSTRACT

DXplain is a computer-based system which analyzes a patient's historical, physical, and laboratory findings and generates a list of diseases which could account for the data. This demonstration reviews the patient case analysis, presents enhanced user HELP capabilities, and discusses new features to focus on a particular patient finding and to generate a printed case summary. Also introduced is the ability to use the database as a multi-indexed textbook.

DXplain is a decision-support tool which analyzes a patient's historical data, physical findings, laboratory tests and x-rays and then generates a ranked list of diseases that can explain these findings. The DXplain database currently contains over 2000 diseases described by over 4000 clinical terms. The program was developed at the Laboratory of Computer Science at the Massachusetts General Hospital and its objectives and function have been previously described [1]. It is currently available on the American Medical Association's AMA/NET which offers a free subscription as part of AMA membership. The system is also available to medical schools and teaching hospitals through an MGH user-supported network.

In the past year new user HELP capabilities and new functions have been added to the program. The objective of this demonstration is to present these new features of DXplain as well as review the analysis capability of the program.

I. Case Analysis

For those unfamiliar with the program, Figure 1 illustrates a typical case analysis by DXplain. The upper portion of the figure contains the user-entered case findings, the lower portion the top 10 of 61 diagnoses generated by DXplain.

II. New HELP capabilities

To assist the user, the program now provides a menu of detailed information options explaining available program functions and an example of a typical case (Figure 2). In addition, at any point within the program the user can display the appropriate responses to the current prompt, obtain a detailed overview of the current function, invoke the menu of information options, or send comments to the program developers.

FIGURE 1 - SAMPLE DXplain CASE

INPUT

Hx: FEMALE PE: HEPATOMEGALY
ELDERLY JAUNDICE
CHRONIC RUQ ABDOM TENDERNESS
VOMITING RIGHT LOW INTERCOSTAL
WEIGHT LOSS TENDERNESS
RECURRENT FEVER Lab: MILD ANEMIA
RUQ ABDOM PAIN ELEVATED ALK PHOS
FOREIGN TRAVEL Xray: UNILATERAL DIAPHRAGM ELEVATION

OUTPUT

Top 10 of 61 diagnoses:

1 ++ * SECONDARY CHOLANGITIS
2 ++ HEPATITIS, ACUTE TYPE B
3 ++ HEPATITIS, NON-A, NON-B
4 ++ LIVER ABSCESS, PYOGENIC Rare
5 ++ HEPATITIS, ACUTE TYPE A
6 ++ LIVER ABSCESS, AMEBIC Rare
7 ++ OBSTRUCTIVE JAUNDICE
8 + HEPATITIS, ACUTE DELTA Rare
9 + CHOLEDOCHOLITHIASIS
10 + HEPATITIS, ALCOHOLIC

* indicates DX requires immediate action
++ indicates DX strongly supported
+ indicates DX supported

FIGURE 2: DXplain INFORMATION MENU

WOULD YOU LIKE:

1. General overview of system
2. Pointers about how to enter terms
3. Short description of all DXplain functions
4. Detailed description of one of the DXplain functions
5. Example of a typical use of DXplain
6. Commands that are always available
7. Communication with the DXplain developers
8. EXIT this HELP function

Enter the number of your choice:

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III. New Functions

A. Focus on a finding:

In some clinical settings, a particular finding is key to the disease presentation, and the clinician wishes to flag that finding as worthy of special attention. Using the FOCUS function, one can increase the weight of that finding and request consideration of only diseases in which it is contained. In the case in Figure 1, if we FOCUS on the term UNILATERAL DIAPHRAGM ELEVATION, the diagnosis list shortens from 61 to 53 diseases. Of the original top 10, only 7 remain (see Figure 3).

FIGURE 3: TOP 7 OF 53 DISEASES FROM CASE IN FIG 1 WITH FOCUS ON TERM "UNILATERAL DIAPHRAGM ELEVATION"

1 ++ HEPATITIS, ACUTE TYPE B
2 ++ HEPATITIS, NON-A, NON-B
3 ++ LIVER ABSCESS, PYOGENIC Rare
4 ++ HEPATITIS, ACUTE TYPE A
5 ++ LIVER ABSCESS, AMEBIC Rare
6 ++ HEPATITIS, ALCOHOLIC
7 ++ HEPATITIS, ACUTE DELTA Rare

B. Case Summary:

After entering a case, one can now print a summary report of the terms entered and the results of DXplain's analysis. The report includes the top 10 diseases suggested by DXplain. The report can be included in a patient's chart or serve as documentation for third party reimbursement. Figure 4 is a sample report for the case in Figure 1.

C. Disease Information Database:

The Disease Information Database feature allows use of the database as a textbook of disease descriptions. A user can obtain a description of a particular disease as well as generate disease tables of contents organized by body system and disease etiology. Figure 5 is a sample table of contents page showing all protozoan gastrointestinal diseases in the database. Figure 6 shows the text description of the disease LIVER ABSCESS, AMEBIC.

Disease descriptions are derived mainly from the DXplain database; they include the frequency with which findings occur and indicate those findings strongly suggestive of the presence of a disease (See section DIAGNOSTICALLY HELPFUL in Figure 6). Disease descriptions also include supplementary material often of a pathophysiological, temporal, or descriptive nature not contained in the database (See headings ETIOLOGY, COURSE, and PATHOLOGY and subheadings ADDITIONAL NOTES in Figure 6). Using the knowledge base as the main source for the text is a new technique and replaces a text file of disease descriptions published by the American Medical Association. The supplementary material is taken from the AMA disease descriptions.

Disease synopses also now include references algorithmically retrieved via computer searches of the MEDLINE database. The titles of these references are reviewed by the DXplain editorial board to select a subset of relevant articles. Figure 7 is a partial list of the references for the disease LIVER ABSCESS, AMEBIC. The disease descriptions are regularly updated as the DXplain database evolves.

FIGURE 4: CASE SUMMARY FOR FIGURE 1

2 August 1989 Patient name: JOHN DOE
Account Code: LOCAL Chart Number: 23456
Session Number - 17965 Physician Name: M. PACKER
Session Time: 6 Min User Name: M. PACKER
SPECIAL SERVICE 99090 - Analysis of data stored in computers. If this analysis is used for billing, attach this summary to the claim submitted to the insurance carrier.

CLINICAL DATA ENTERED ON THIS PATIENT:
"FEMALE", "ELDERLY", "FOREIGN TRAVEL HISTORY"

Symptoms: "CHRONIC", "VOMITING", "WEIGHT LOSS", "RUQ ABDOMINAL PAIN"

Signs: "FEVER, RECURRENT", "JAUNDICE", "RUQ ABDOMINAL TENDERNESS", "HEPATOMEGALY", "RIGHT LOWER INTERCOSTAL TENDERNESS"

Lab Findings: "MILD ANEMIA", "ELEVATED ALKALINE PHOSPHATASE"

X-ray Labs: "UNILATERAL DIAPHRAGM ELEVATION"

DISEASE LIST:
The following diseases in the DXplain data base are supported by the signs, symptoms, and lab findings which have been entered:
"CHOLANGITIS, SECONDARY", "HEPATITIS, ACUTE TYPE B", "HEPATITIS, NON-A, NON-B", "LIVER, ABSCESS, PYOGENIC", "HEPATITIS, ACUTE TYPE A", "LIVER, ABSCESS, AMEBIC", "JAUNDICE, OBSTRUCTIVE"

The following diseases in the DXplain data base are partially supported by the signs, symptoms, and lab findings which have been entered:
"HEPATITIS, ACUTE DELTA", "CHOLEDODHOLITHIASIS", "HEPATITIS, ALCOHOLIC"

* indicates dx might require immediate action.

FIGURE 5: PROTOZOA GI DISEASES IN DATABASE

AMEBIASIS
BALANTIDIASIS
CHAGAS DISEASE
COCCIDIOSIS
GIARDIASIS
LIVER ABSCESS, AMEBIC
TOXOPLASMOSIS, CONGENITAL
DIENTAMEBIASIS
FIGURE 6 TEXT FOR LIVER ABSCESS, AMEBIC

ETIOLOGY
Entamoeba histolytica.

ASSOCIATED TERMS AND CONDITIONS
USUALLY: liver abscess; tropical climate.
SOMETIMES: adult, young; foreign travel history; effusion, pleural; male.

SYMPTOMS
USUALLY: intercostal pain, right lower.
SOMETIMES: shoulder pain, right; anorexia; abdominal fullness sensation, upper; nausea; vomiting; abdominal pain, right upper quadrant; abdominal pain, upper; shoulder pain; extremity pain, upper; malaise; sweating increase; weight loss; chills; abdominal pain, crampy; constipation; diarrhea; flatulence; weakness, generalized; cough.
ADDITIONAL NOTES: Progressive discomfort, vague heaviness, severe pain right upper quadrant of abdomen radiating to right shoulder.

PHYSICAL FINDINGS
USUALLY: fever.
SOMETIMES: abdominal tenderness, right upper quadrant; intercostal tenderness, right lower; hepatomegaly; liver tenderness; abdominal tenderness, upper; fever, recurrent; chest percussion dullness; stool mucus; stool blood.
RARELY: liver mass; abdominal mass, right upper quadrant; jaundice.
ADDITIONAL NOTES: Diaphragmatic pain; tenderness in posterolateral, lower right intercostal space.

LABORATORY FINDINGS
USUALLY: hypoalbuminemia.
SOMETIMES: anemia, mild or moderate; leukocytes increased; left shift; SGOT (AST), elevated; alkaline phosphatase, elevated; serum conjugated bilirubin elevated; SGPT (ALT), elevated; serum total bilirubin elevated.
ADDITIONAL NOTES: Complement fixation test positive. Stool: amebae occasionally present.

X-RAYS
USUALLY: chest x-ray diaphragm elevation unilateral.
SOMETIMES: chest x-ray pleural effusion.
ADDITIONAL NOTES: Dome of diaphragm limited movement, possibly irregularity most often on outer part of dome; in rupture, hydrothorax occasionally noted in upright projection; possibly atelectasis.

DIAGNOSTICALLY HELPFUL
STRONGLY SUGGESTIVE: liver abscess.
SUGGESTIVE: intercostal pain, right lower; intercostal tenderness, right lower; liver mass; abdominal mass, right upper quadrant; abdominal tenderness, right upper quadrant.

COURSE
Prognosis: possibly serious; rupture into adjacent areas; perforation of hollow viscus; pulmonary abscess.

PATHEOLOGY
Occlusion of smaller venules by amebae enmeshed in fibrin; focal necrosis of intrahepatic ....

D. Finding as Index to Diseases:

This feature generates a list of all diseases that include a finding entered by the user. The list is ordered first by the degree to which the finding suggests diseases (the EVOKING STRENGTH) and within this by disease prevalence (Very Common and Common vs Rare and Very Rare). Figure 8 illustrates this feature for the term UNILATERAL DIAPHRAGM ELEVATION.

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FIGURE 7: FIRST 4 OF 9 REFERENCES FOR LIVER ABSCESS, AMEBIC

FIGURE 8: DISEASES WITH TERM "UNILATERAL DIAPHRAGM ELEVATION"

Diseases suggested by the presence of UNILATERAL DIAPHRAGM ELEVATION:

Common Diseases:
"PNEUMONIA, PNEUMOCOCCAL", "ACUTE GASTRIC DILATATION", "HEPATITIS, ALCOHOLIC", "LUNG CARCINOMA, SMALL CELL", "AMEBIASIS", "LIVER, PASSIVE CONGESTION", "RIB, FRACTURE", "ATELECTASIS", "LIVER, FATTY"

Rare Diseases:
"ABSCESS, SUBPHRENIC", "LIVER, ABSCESS, PYOGENIC"

UNILATERAL DIAPHRAGM ELEVATION is considered a non-specific finding in the following 60 diseases:

Common Diseases:
"ALCOHOLISM", "HEPATITIS, CHOLESTATIC", "HEPATITIS, ACUTE TYPE B", "CARDIOMYOPATHY, ALCOHOLIC", "COR PULMONALE, CHRONIC (RIGHT HEART FAILURE)", "HELMINTHIASIS" , . . .

Rare Diseases:
"PRIMARY BILIARY ATRESIA", "ABSCESS, RETROPERITONEAL", "ADRENAL CORTEX, CARCINOMA", "AMYLOIDOSIS, PRIMARY", "OPISTHORCHIASIS (LIVER FLUKE)", "ACETAMINOPHEN TOXICITY", . . .

REFERENCE