Development of Web-based Programs for Pathology Education

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2001 Advances in Teaching & Learning
Outline

- Design and implementation of three web-based programs for teaching pathology residents
  - **WEB COAG**: teaching coagulation disorders
  - **CPCases**: archiving presentation cases
  - **CD MarkerDX**: teaching immunophenotype of hematologic neoplasms
WEB COAG

- An interactive program for teaching coagulation disorders
Introduction

- Coagulopathy is encountered frequently in medicine, associated with high morbidity and fatality
- Many cases present a diagnostic challenge, may lead to suboptimal testing strategy or misdiagnosis
- WEB COAG: teaching laboratory diagnosis of coagulopathy (pathology residents)
Design

- Three modules
  1. Coagulation profile: to display typical laboratory results
  2. Differential diagnosis: to narrow down the list of possible disorders
  3. Synopsis of disorders and therapy
Design (cont’d)

- Codes: Hypertext Markup Language (HTML), JavaScript (functions and subroutines)
- Servers: MS Windows NT Server 4.0 running MS Internet Information Server 4.0
Design (cont’d)

- Knowledge base: 41 coagulation disorders
- Validation of the differential diagnosis module:
  - 61 clinical cases
  - The correct diagnosis was ranked in the list of 5 differential diagnoses in 93% of the cases [previous publication]
WEB COAG

Decision Support System for Coagulopathy

Andy Nguyen, M.D. / UT-Medical School at Houston, Pathology / Last Revision on: 8/20/99

WEB COAG is a WWW-based decision-support system for diagnosis of coagulopathy. Currently, there are three main features in this system:

- **Coagulation Profile**: displays pattern of seven screening coagulation tests for each disorder. The tests include: prothrombin time (PT), activated partial thromboplastin time (PTT), fibrinogen (FIB), thrombin time (TT), fibrin split product (FSP), platelet count (PLT), and bleeding time (BT).
- **Differential Diagnosis**: displays differential diagnoses that fit the coagulation results given by the user.
- **Synopsis of Coagulopathy and Therapy**: displays essential information on coagulopathy and therapeutic modalities.

Back to Home Page   <-Back   Forward->
WEB COAG: SCREENING LABORATORY PROFILES OF COAGULATION DISORDERS

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Select a disorder from the drop-down list to see its coagulation profile:

Hemophilia A

Coagulation Profile:
- TT: Normal 🟡 Abnormal 🔴
- PT: Normal 🟡 Abnormal 🔴
- PTT: Normal 🟡 Abnormal 🔴
- FIB: Normal 🟡 Abnormal 🔴
- PLT: Normal 🟡 Abnormal 🔴
- BT: Normal 🟡 Abnormal 🔴

Show Profile Now  Help

<-Back  WEB COAG Home Page
WEB COAG: DIFFERENTIAL DIAGNOSIS

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### Enter Coagulation Data:

- **TT:** 〇 Normal 〇 Abnormal
- **PT:** 〇 Normal 〇 Abnormal
- **FSP:** 〇 Normal 〇 Abnormal
- **PTT:** 〇 Normal 〇 Abnormal
- **PLT:** 〇 Normal 〇 Abnormal
- **FIB:** 〇 Normal 〇 Abnormal
- **BT:** 〇 Normal 〇 Abnormal

### Diagnose now  Start Over  Help

### LIST OF DIFFERENTIAL DIAGNOSES:
- Factor VII deficiency
- Vitamin K deficiency
- Coumadin treatment

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WEB COAG: Synopsis of Coagulopathy and Therapeutic Modalities

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Hereditary Disorders of Coagulation Proteins:

- Factor XII Deficiency, Hereditary
- Prekallikrein Deficiency
- Factor XI Deficiency
- Factor IX Deficiency (Hemophilia B)
- Factor VIII Deficiency (Hemophilia A)
- Acquired Factor VIII Inhibitor in Hemophilia A
- vonWillebrand's Disease, type I
- vonWillebrand's Disease, type IIA
- vonWillebrand's Disease, type IIB
- vonWillebrand's Disease, type III
- Factor VII Deficiency
- Factor X Deficiency
- Factor V Deficiency
- Afibrinogenemia
- Hypofibrinogenemia
- Dysfibrinogenemia
- Factor XIII Deficiency
- Antithrombin III Deficiency
- Alpha-2 Antiplasmin Deficiency
- Protein C Deficiency

Acquired Disorders of Coagulation Proteins:

- Coagulopathy in Vitamin K Deficiency
VON WILLEBRAND'S DISEASE (TYPE I)

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• **Biochemical aspects:**
  von Willebrand factor consists of a series of multimers that range in molecular weight from 800,000 to more than 12,000,000.

• **Pathological Basis:**
  ◦ Mode of inheritance: autosomal dominant.
  ◦ The biochemical abnormality in type I of von Willebrand's disease is strictly quantitative. In such patients, analysis of the multimeric structure of von Willebrand factor with crossed immunoelectrophoresis or sodium dodecyl sulfate-agarose gel electrophoresis is normal. There are concordant decreases in the levels of factors VIII R:RCo, VIII R:Ag, and VIII:C.

• **Treatment:**
  ◦ DDAVP (1-desamino-8-D-arginine vasopressin).
  ◦ Cryoprecipitate: 1 bag per 10 kg of body weight, twice a day.
  ◦ Epsilon-aminocaproic acid (EACA): is a useful adjuvant in dental surgery. The usual loading dose is 5 gm, followed by 1 gm per hour for 5 - 7 days.

Diagnostic Criteria:

1. Family_history_of_coagulation_disorders: positive
2. Factor_VIII:C_activity: abnormal
3. Factor_VIII_R:Ag: abnormal
4. Factor_VIII_R:RCo: abnormal
5. Factor_VIII, cross_immunoelectrophoresis: normal
6. Bleeding_time: abnormal
PLATELET CONCENTRATE

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Random-donor platelet:

• **Composition:**
  platelets ($\geq 5.5 \times 10^{10}$/unit), WBC's, plasma, RBC's.

• **Supply format:**
  one unit (bag) contains 50 ml. One dose consists of 6 units. Shelf life is 3-5 days.

• **Indication:**
  thrombocytopenia or thrombocytopeny.

• **Dosage:**
  For a 70 kg adult, one unit of random-donor platelets will increase the platelet count by 3,000-10,000/ul. For children, one unit of random-donor platelet will increase the platelet count by 3,000/ul per 1 kg of body weight.

Single-donor platelet:

• **Composition:**
  platelets ($\geq 3 \times 10^{11}$/units), WBC's, plasma, RBC's.

• **Supply format:**
  one bag contains 300 ml. Shelf life is 24 hours.
Calculating Units of Cryopectipitate Needed for Fibrinogen

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Baseline Fibrinogen Level (mg/dl): 50
Desired Fibrinogen Level (mg/dl): 150
Patient's Body Weight (Kg): 65

Calculate Units of Cryo Needed: 10

Start Over  Help

<-Back  WEB COAG Home Page
Coagulation Cascade Diagram

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Click on the factors in the diagram below to see associated disorders.
WEB COAG: Platelet Aggregation Patterns

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Select a disorder from the drop-down list to see its aggregation pattern:

Storage Pool Disease

Aggregation with Reagents:

ADP: ○ Normal ○ Abnormal
EPI: ○ Normal ○ Abnormal
COL: ○ Normal ○ Abnormal
RIS: ○ Normal ○ Abnormal

Show Profile Now  Help

<-Back  WEB COAG Home Page
Discussion

- WEB COAG has been used as supplemental teaching material for our residents since 1996
- Favorable response by residents and web site visitors. Comments and suggestions were incorporated
- Other web sites on coagulation (academic, commercial)
- Current project: “A comprehensive web-based program for coagulation training”, grant from University Association for Research and Education in Pathology
CPCases

- An image database to archive cases presented in our resident teleconference

Resident Teleconference

- Residents to share interesting cases between Memorial Hermann and LBJ
- Axis video web servers to transmit video on high-speed T1 connection (bidirectional)
- Audio communication: speakerphone
Design of CPCases

Objectives:
- Save images and text data to database
- Retrieval at a later time for various uses

Two components:
- Input module: to save a case
- Viewing module: to view an archived case
Design of CPCases (cont’d)

Codes: MS Active Server Pages (ASP), VBScript, Active Data Object (ADO), structured query language (SQL)

Servers:
- MS SQL Server 7.0 (database for text data)
- File server (images)
- MS Windows NT 4.0 server
- MS Internet Information Server 4.0
PCases: Saving the Image into Database

Right click on the image and save it into S:/PathImage

Enter the texts for the case, then Submit Data

Case Number: 0018
Image File Name: PathImage/0018.jpg
Diagnosis: AML, hypocellular bone marrow
COMED Code: 
Additional Data: 68 y/o male with AML. Bone marrow cellularity was 25%.
Presenter(s): Andy Nguyen
Conference Date: 12/7/2000
## Browsing all the Archived CP Cases

Note: Click on any Case Number to get a full record for that case

<table>
<thead>
<tr>
<th>Case Number</th>
<th>Diagnosis</th>
</tr>
</thead>
<tbody>
<tr>
<td>0001</td>
<td>Pneumocystis carinii in BAL fluid</td>
</tr>
<tr>
<td>0002</td>
<td>Mucormycosis in blood vessel</td>
</tr>
<tr>
<td>0004</td>
<td>Cryptosporidium in stool</td>
</tr>
<tr>
<td>0005</td>
<td>Histoplasma in brain abscess- PAS</td>
</tr>
<tr>
<td>0006</td>
<td>Histoplasma in brain abscess- GMS</td>
</tr>
<tr>
<td>0007</td>
<td>Babesiosis</td>
</tr>
<tr>
<td>0008</td>
<td>HIV bone marrow</td>
</tr>
<tr>
<td>0008-1</td>
<td>Mastocytosis</td>
</tr>
<tr>
<td>0008-2</td>
<td>Mastocytosis-higher magnification</td>
</tr>
<tr>
<td>0008-3</td>
<td>Mastocytosis-Giemsa</td>
</tr>
<tr>
<td>0009-1</td>
<td>Anaplastic large cell lymphoma</td>
</tr>
<tr>
<td>0009-2</td>
<td>Anaplastic large cell lymphoma-CD30</td>
</tr>
<tr>
<td>0009-3</td>
<td>Anaplastic large cell lymphoma-Bone marrow</td>
</tr>
<tr>
<td>0010</td>
<td>Megaloblastic changes</td>
</tr>
<tr>
<td>0011</td>
<td>India ink for Cryptococcus</td>
</tr>
<tr>
<td>0012-1</td>
<td>Cryptococcus in bone marrow</td>
</tr>
</tbody>
</table>
Diagnosis: Idiopathic myelofibrosis

Clinical Data: 55 y/o male with anemia. Peripheral blood smear showed many teardrop cells, a few blasts and NRBCs. Bone marrow biopsy showed diffuse fibrosis.

MED Code: M49000

Author: Andy Nguyen

Date: 7/26/2000
CP Cases: Find Cases with a given Diagnosis

Enter a key word then click the "Find" button:

Diagnosis: lymphoma  Find

Archived CP Cases Home Page
Case Number: 4074

Image Location: PathImage/4074.jpg

Diagnosis: Hodgkin's Lymphoma

Additional Data: 22 Year Male with Hodgkin's disease Stage IV. The biopsy is hypercellular and is diffusely infiltrated by Hodgkin's disease. The infiltrate is comprised of Reed Sternberg cells, eosinophils, plasma cells and lymphocytes. There is diffuse increase in fibro-connective tissue.

HODMED Code:

Presenter(s): Deepali Gupta

Reference Date: 9/19/2000

Case Number: 2070

Image Location: PathImage/2070-1.jpg

Diagnosis: Burkitt's Lymphoma
Discussion

- Our residents have saved > 100 cases to date
- Future studies:
  - a better index system to categorize diseases
  - connection with a more sophisticated image database at the back end
CD MarkerDX

- A Web-based database for diagnosis of hematologic neoplasms using results of immunophenotyping by flow cytometry.

Introduction

- Interpretation of immunophenotyping results by flow cytometry: pattern recognition
- Difficulty in interpretation: similar patterns, numerous markers
- CD MarkerDX: database to teach pathology residents interpret immunophenotypes
Design

Five modules:
- Display of markers
- Display of disorders
- Differential diagnosis
- Archived cases
- Summary of results for archived cases
Design (cont’d)

Web Browser:
- HTML
- JavaScript

Internet Information Server:
- Active Server Pages (ASP)
- Active Data Object (ADO)

Transaction Server:
- Active X DLL

Database Server
Design (cont’d)

- Knowledge base: 33 hematologic neoplasms. 43 immunologic markers
- Validation of the differential diagnosis module:
  - 92 clinical cases
  - The correct diagnosis was ranked in the list of 5 differential diagnoses in 93% of cases [previous publication]
CD MARKER DX: a dynamic Web-based database for differential diagnosis and data warehouse of hematologic neoplasms using immunophenotyping data obtained with flow cytometry

Andy Nguyen, M.D./ UT-Medical School at Houston, Pathology/ Last Revision on: 11/4/98

1. Differential Diagnoses
2. Display of Disorders
3. Display of Markers
4. Display of Archived Cases for a disorder
5. Display of Summary for Archived Cases

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Counter=740 Since 9/15/98
Active Sessions=1
Session Started=9/22/99 12:20:14 PM
CD MARKER DX: List of Markers for a Disorder

**Disorder:** Chronic lymphocytic leukemia (B cell)/Small lymphocytic lymphoma

<table>
<thead>
<tr>
<th>CD1</th>
<th>CD14</th>
<th>CD38</th>
<th>CD103</th>
</tr>
</thead>
<tbody>
<tr>
<td>CD2</td>
<td>CD15</td>
<td>CD41</td>
<td>HLA-DR</td>
</tr>
<tr>
<td>CD3</td>
<td>CD16</td>
<td>CD42</td>
<td>sIg</td>
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<tr>
<td>CD4</td>
<td>CD19</td>
<td>CD43</td>
<td>cIg</td>
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<tr>
<td>CD5</td>
<td>CD20</td>
<td>CD45</td>
<td>PC-1</td>
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<tr>
<td>CD7</td>
<td>CD21</td>
<td>CD56</td>
<td>TdT</td>
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<td>CD8</td>
<td>CD22</td>
<td>CD57</td>
<td>FMC7</td>
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<tr>
<td>CD10</td>
<td>CD23</td>
<td>CD61</td>
<td>Glyco A</td>
</tr>
<tr>
<td>CD11b</td>
<td>CD24</td>
<td>CD71</td>
<td>Keratin</td>
</tr>
<tr>
<td>CD11c</td>
<td>CD25</td>
<td>CD77</td>
<td>CD5/19</td>
</tr>
<tr>
<td>CD13</td>
<td>CD33</td>
<td>CD79a</td>
<td>+</td>
</tr>
</tbody>
</table>

CD MARKER DX Home Page
Cd Marker DX: Data Input For Differential Diagnosis

Enter the marker results (+ or -) for the case, then Submit Query:

CD1:      CD14:  -  CD38:  -  CD103:  -
CD2:      CD15:  -  CD41:  -  HLA-DR:  +
CD3:      CD16:  -  CD42:  -  sIg:   +   
CD4:      CD19:  +  CD43:  -  cIg:   -
CD5:      CD20:  +  CD45:  +  PC-1:  -
CD7:      CD21:  -  CD56:  -  TdT:  -  
CD8:      CD22:  +  CD57:  -  FMC7:  -
CD10:     CD23:  +  CD61:  -  Glyco A: -
CD11b:    CD24:  -  CD71:  -  Keratin: -
CD11c:    CD25:  -  CD77:  -  CD5/19: +
CD13:     CD33:  -  CD79a: -

Submit Query
## Cd Marker DX: Differential Diagnosis

<table>
<thead>
<tr>
<th>DISORDER</th>
<th>C</th>
<th>M-N</th>
<th>M</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chronic lymphocytic leukemia (B cell)/Small lymphocytic lymphoma</td>
<td>1</td>
<td>13</td>
<td>13</td>
<td>0</td>
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<tr>
<td>Prolymphocytic leukemia (B cell)</td>
<td>1</td>
<td>12</td>
<td>12</td>
<td>0</td>
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<tr>
<td>Mantle cell lymphoma</td>
<td>0.88</td>
<td>7</td>
<td>8</td>
<td>1</td>
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<tr>
<td>Diffuse, mixed cell lymphoma</td>
<td>0.87</td>
<td>6</td>
<td>7</td>
<td>1</td>
</tr>
<tr>
<td>Large B-cell lymphoma</td>
<td>0.85</td>
<td>5</td>
<td>6</td>
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</tbody>
</table>

**Legends:**
- M= the number of attributes of a disease that match the input data
- N= the number of attributes of a disease that do not match the input data
- \((M-N)\)= M minus N
- C= matching factor, defined as the ratio of \(M/(M+N)\)

**Notes:** the higher the values of C and \((M-N)\), the higher the probability of a disease.
## Disorder: Chronic lymphocytic leukemia (B cell)/Small lymphocytic lymphoma

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<th>Case Number</th>
<th>CD1</th>
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</tbody>
</table>
CD MARKER DX: Summary of Results from Archived Cases

**Disorder:** Chronic lymphocytic leukemia (B cell)/Small lymphocytic lymphoma

| Markers | CD1 | CD2 | CD3 | CD4 | CD5 | CD7 | CD8 | CD10 | CD11b | CD11c | CD13 | CD14 | CD15 | CD16 | CD19 | CD20 | CD21 | CD22 |
|---------|-----|-----|-----|-----|-----|-----|-----|-----|-------|-------|------|------|------|------|------|------|------|------|------|
| Diagnostic Criteria | -   | -   | -   | +   | -   | -   | -   | -    |        |       |      |      |      |      |      |      |      |      |      |
| No of (+)Cases | 0   | 0   | 0   | 0   | 11  | 0   | 0   | 0    | 0     | 4     | 0    | 0    | 0    | 0    | 13   | 13   | 0    | 7    |      |
| No of (-)Cases | 0   | 0   | 13  | 7   | 2   | 13  | 7   | 7    | 0     | 3     | 0    | 0    | 12   | 0    | 7    | 0    | 0    | 0    | 0    |
Discussion

CD MarkerDX has been used as supplemental teaching material for pathology residents since 1998.

Future project: data warehouse of clinical cases for marker analysis -> to fine-tune the diagnostic criteria.
CONCLUSION

- Three web-based programs for pathology education
- Minimum hardware requirement
- Work on all operating systems, all browsers
- Favorable response from residents (clinical use/ scientific presentations/ articles)
CONCLUSION (cont’d)

- Advantages of web-based programs: access from anywhere, any computer platforms, ease of updating materials
- Web-based education may eventually form the core materials for life-long learning, especially at the point-of-service
- Our web site: http://dpalm.med.uth.tmc.edu/