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
- Nguyen, A.N.D., Uthman, M.O., Johnson, K.A.: A web-based teaching program for laboratory diagnosis of coagulation disorders. Archives of Pathology & Laboratory Medicine. 2000; 124:588-593

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 screenning 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.

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WEB COAG: SCREENNING 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	**FSP:**	◉ Normal ○ Abnormal
PTT:	○ Normal ◉ Abnormal	**PLT:**	◉ Normal ○ Abnormal
FIB:	◉ Normal ○ Abnormal	**BT:**	◉ Normal ○ Abnormal

Show Profile Now | Help

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WEB COAG: DIFFERENTIAL DIAGNOSIS

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Enter Coagulation Data:					
TT:	(•) Normal	( ) Abnormal			
PT:	( ) Normal	(•) Abnormal	FSP:	(•) Normal	( ) Abnormal
PTT:	(•) Normal	( ) Abnormal	PLT:	(•) Normal	( ) Abnormal
FIB:	(•) Normal	( ) Abnormal	BT:	(•) Normal	( ) 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:
- Prekalikrein 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 (>5.5*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 thrombocytopathy.
- **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 (>3*10^{11} /units), WBC's,plasma, RBC's.
- **Supply format:**
  one bag contains 300 ml. Shelf life is 24 hours.

Calculating Units of Cryopecipitate 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

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Coagulation Cascade Diagram

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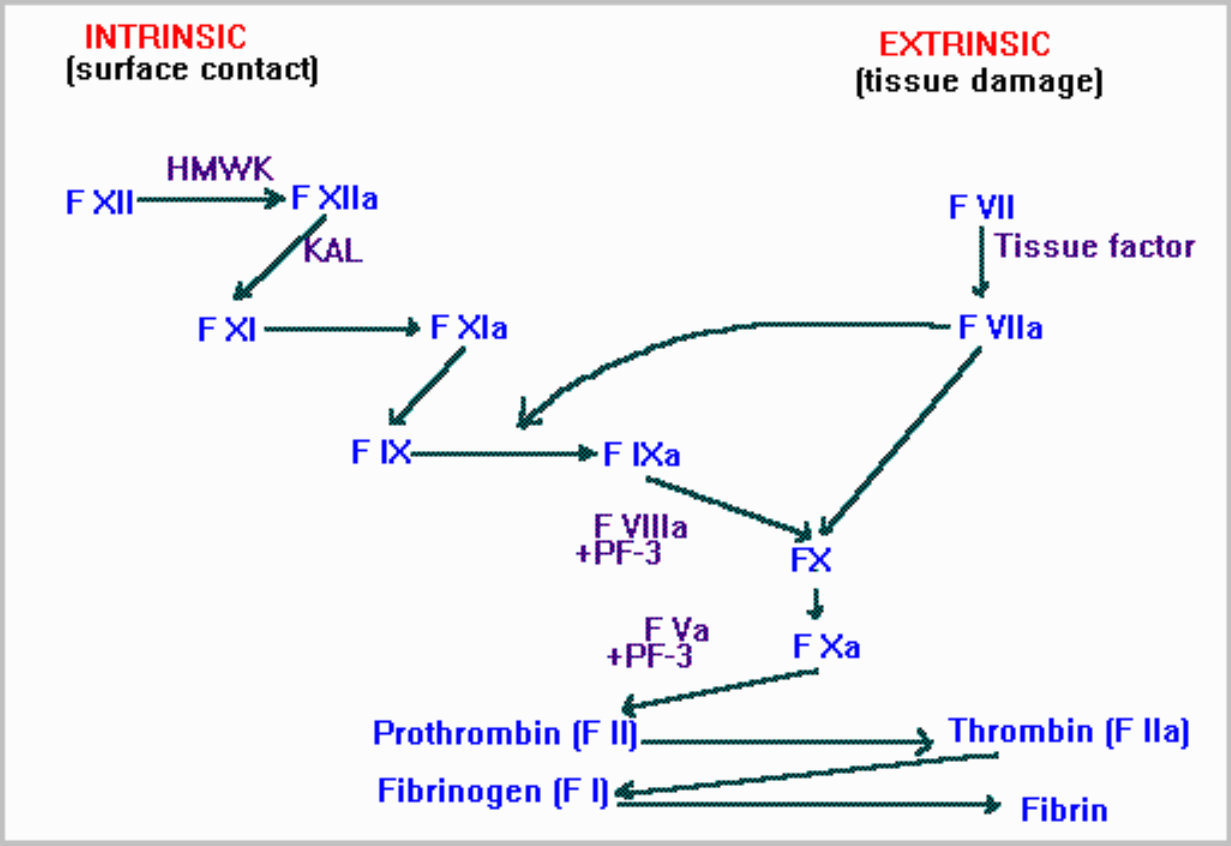
Click on the factors in the diagram below to see associated disorders



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

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Discussion

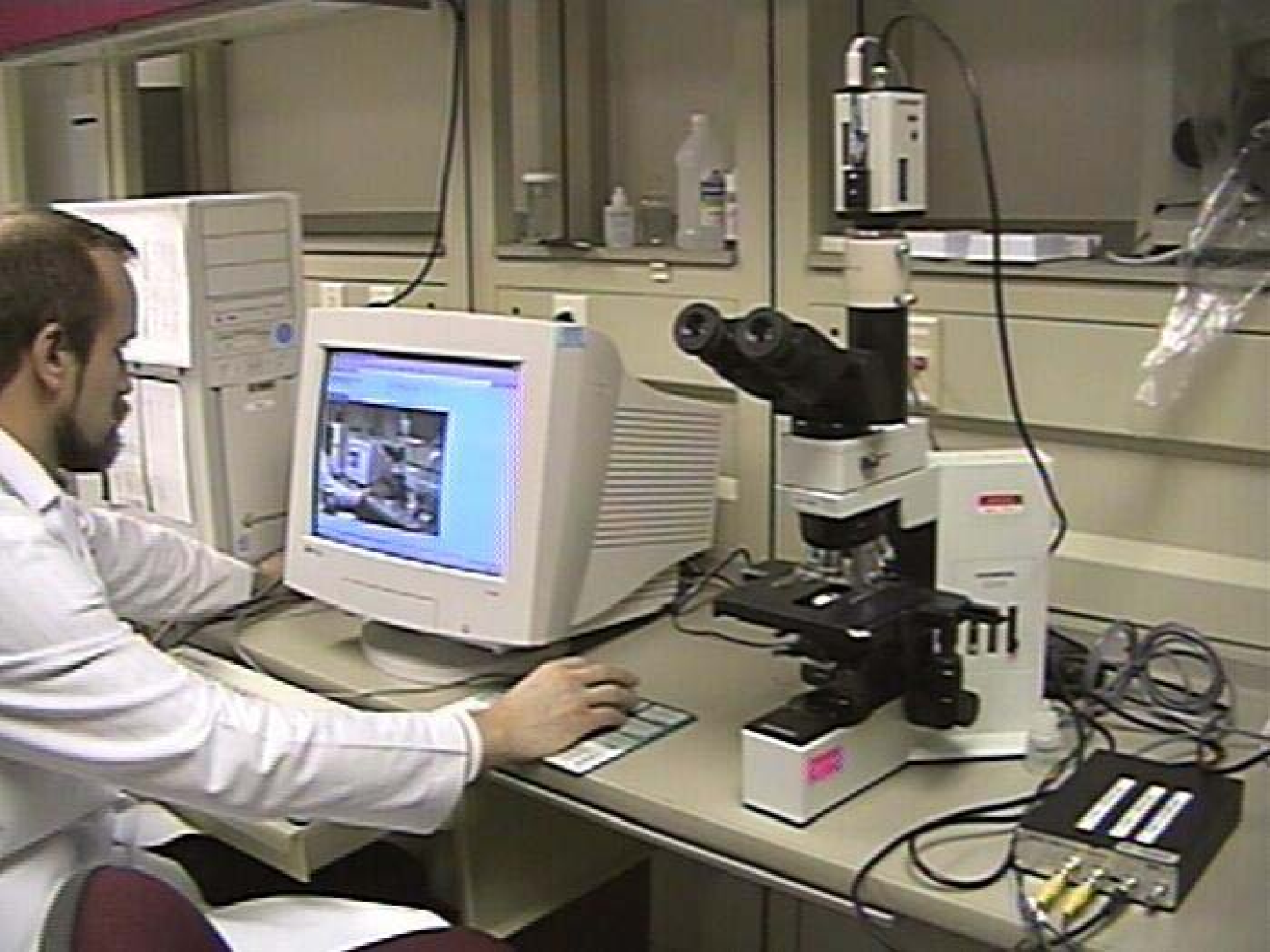
- WEB COAG has been used as supplemental teaching material for our residents since 1996
- Favorable response by residents and web site visitors. Comments and suggestions were incorporated
- Other web sites on coagulation (academic, commercial)
- Current project: “A comprehensive web-based program for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

CPCases

- An image database to archive cases presented in our resident teleconference
- Gupta, D., Wu, S., Nguyen, A.: An Image Database for Archived Presentation Cases. The 80 th Annual Meeting of Texas Society of Pathologists, Jan., 2001, Galveston, Texas

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



H Pathology Conference Cameras

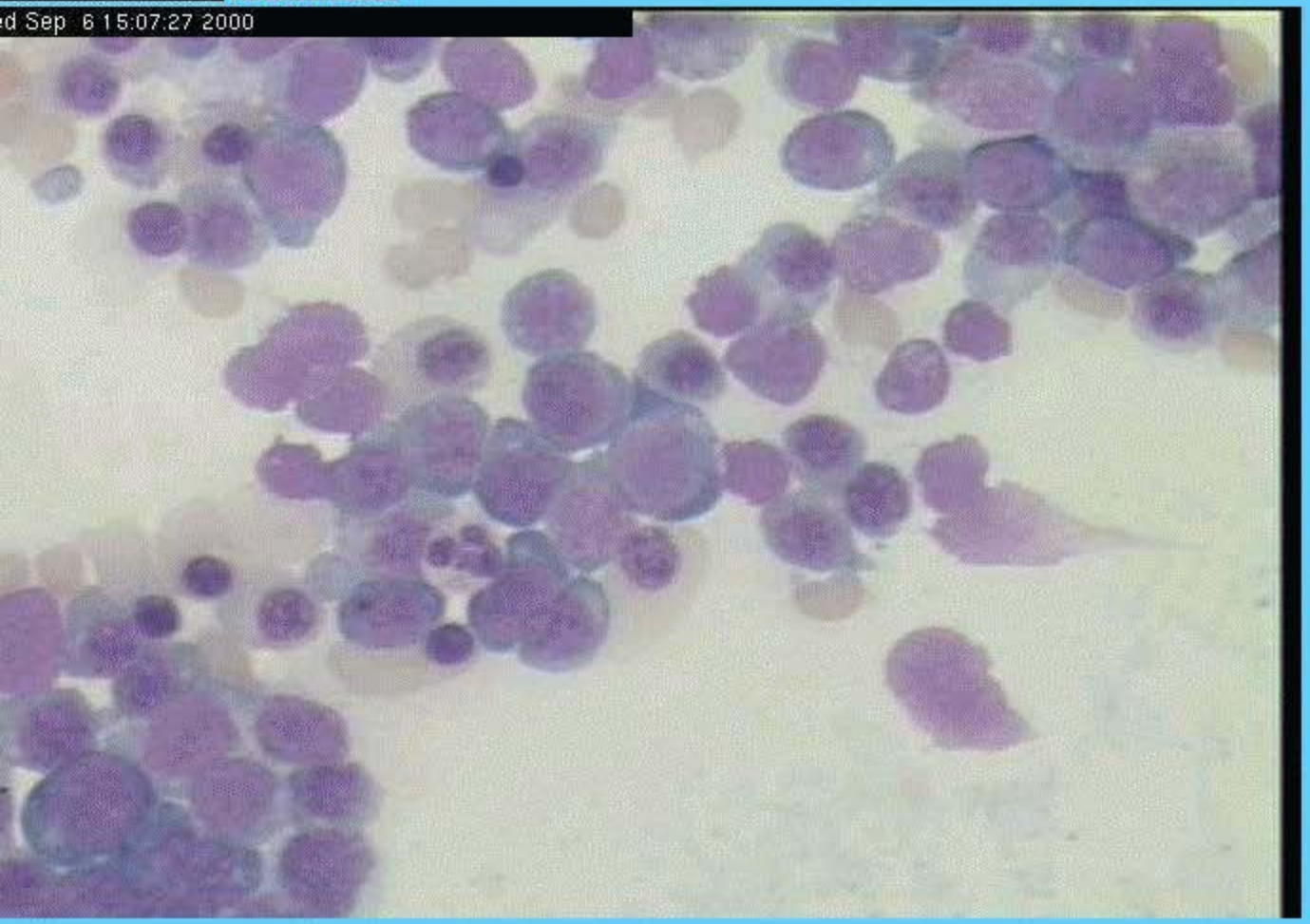
eturn to camera selection

Does not work with Internet Explorer use Netscape.

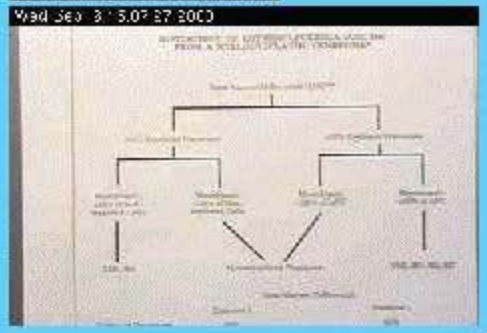
Click any small image to enlarge

HELP

J Signout ScopeCam Get a still image



LBJ Signout GrossCam



MSB Conf. PeopleCam

LBJ Signout PeopleCam

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

Edit View Go Communicator Help

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Bookmarks Location: http://hawk.uth.tmc.edu/conference/reorder.asp?LargeImage=7&SmallFirst=3&SmallSecond=6&SmallThird=5

TH Pathology Conference Cameras

Return to camera selection

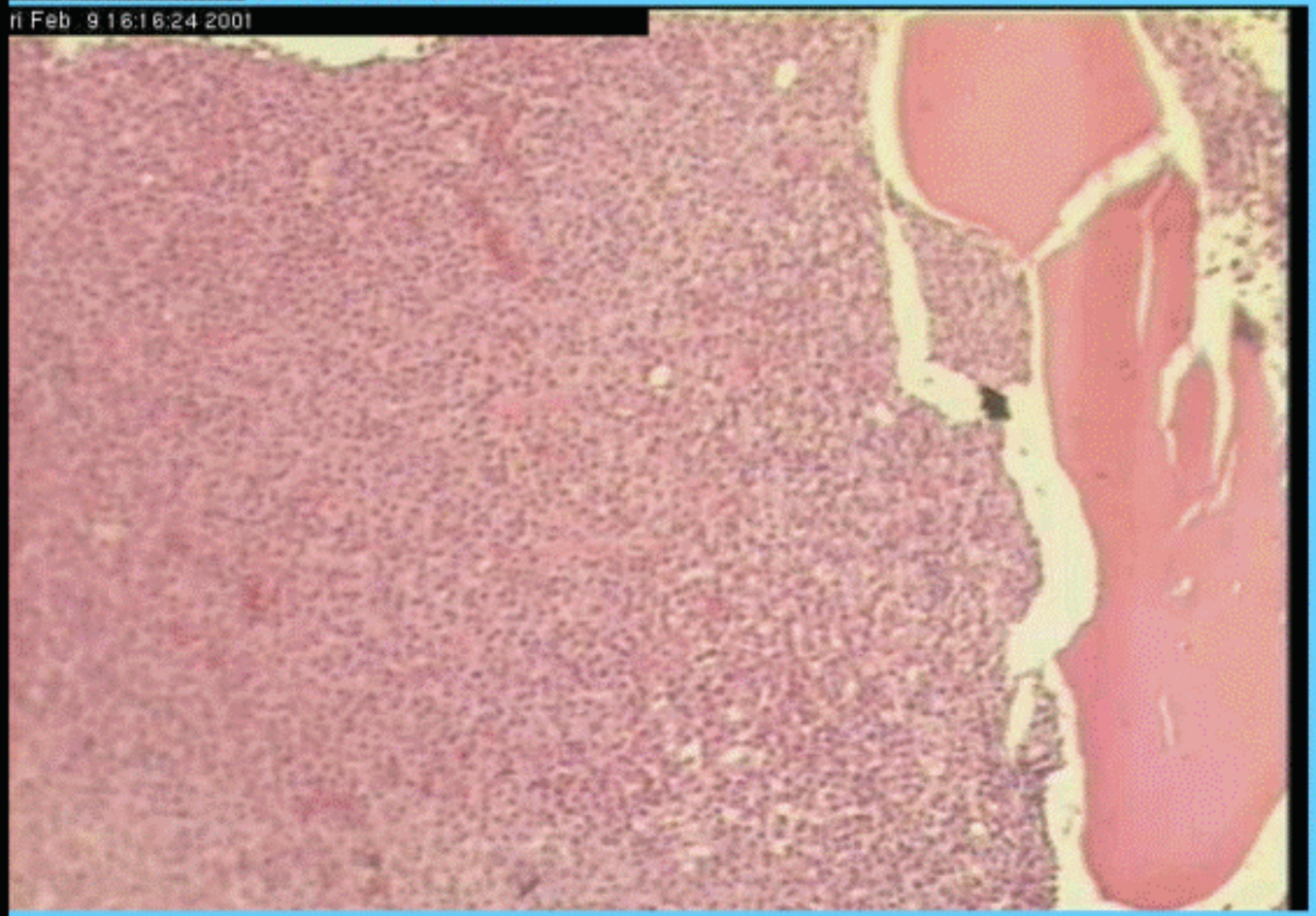
Does not work with Internet Explorer use Netscape.

Click any small image to enlarge

HELP

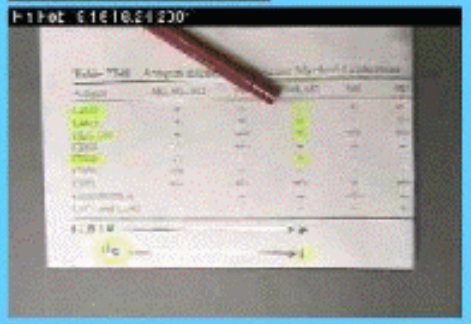
BJ Signout ScopeCam Save the image into database

ri Feb 9 16:16:24 2001



MSB Conf PeopleCam

LBJ Signout GrossCam



LBJ Signout PeopleCam

378K read (at 47.3K/sec)

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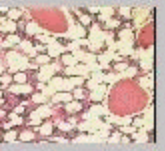
Bookmarks Location: http://hawk.uth.tmc.edu/CPCases/CPCaseInputLBJ.asp What's Rela

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

se Number: 0018

age File Name: PathImage/0018.jpg

gnosis: AML, hypocellular bone marrow

OMED Code:

ditional Data: 68 y/o male with AML. Bone marroe cellulariry was 25%.

senter(s): Andy Nguyen

nference Date: 12/7/2000

Submit Data

Reset Input Data

Document: Done

Browsing all the Archived CP Cases

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

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

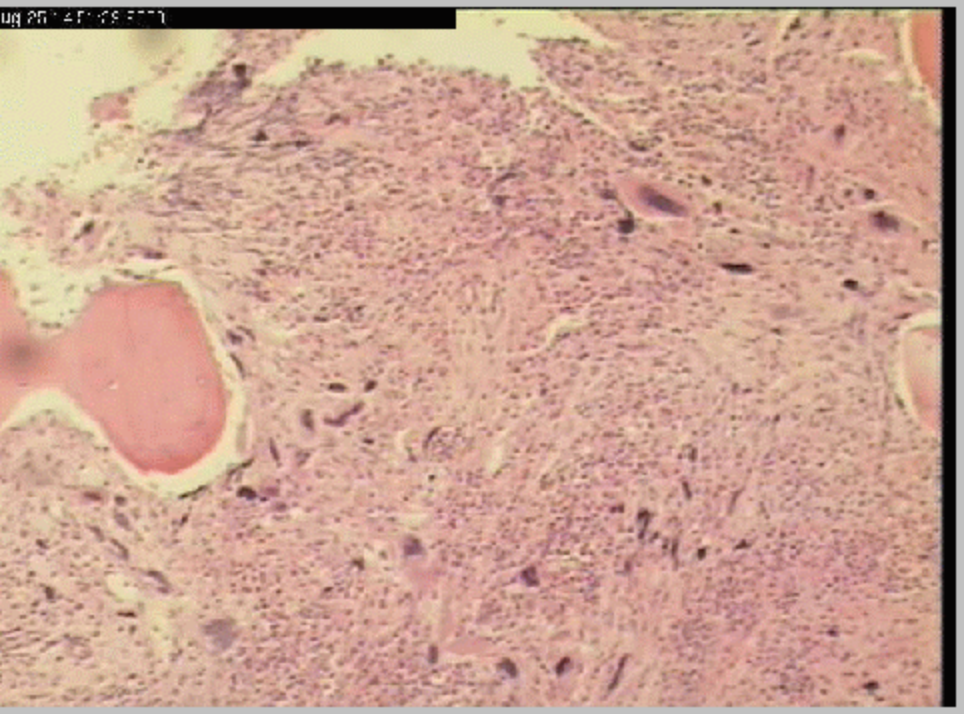
agnosis: **Idiopathic myelofibrosis**

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

OMED Code: **M49000**

hor: **Andy Nguyen**

e: **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

P Cases: Find Cases with a given Diagnosis

e following matches were found:

view full image, put cursor on thumb-nail image, click the right mouse button and choose View Image)

se Number: **4074**

age Location: **PathImage/4074.jpg**

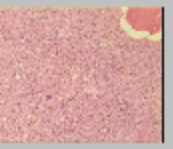
agnosis: **Hodgkin's Lymphoma**

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

OMED Code:

esenter(s): **Deepali Gupta**

nference Date: **9/19/2000**



se Number: **2070**

age Location: **PathImage/2070-1.jpg**

agnosis: **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.
- Nguyen, A.N.D., Milam J.D., Johnson K.A., Banez E.I.: A Relational Database for Diagnosis of Hematopoietic Neoplasms Using Immunophenotyping by Flow Cytometry. American J Clinical Pathology. 2000; 113:95-106.

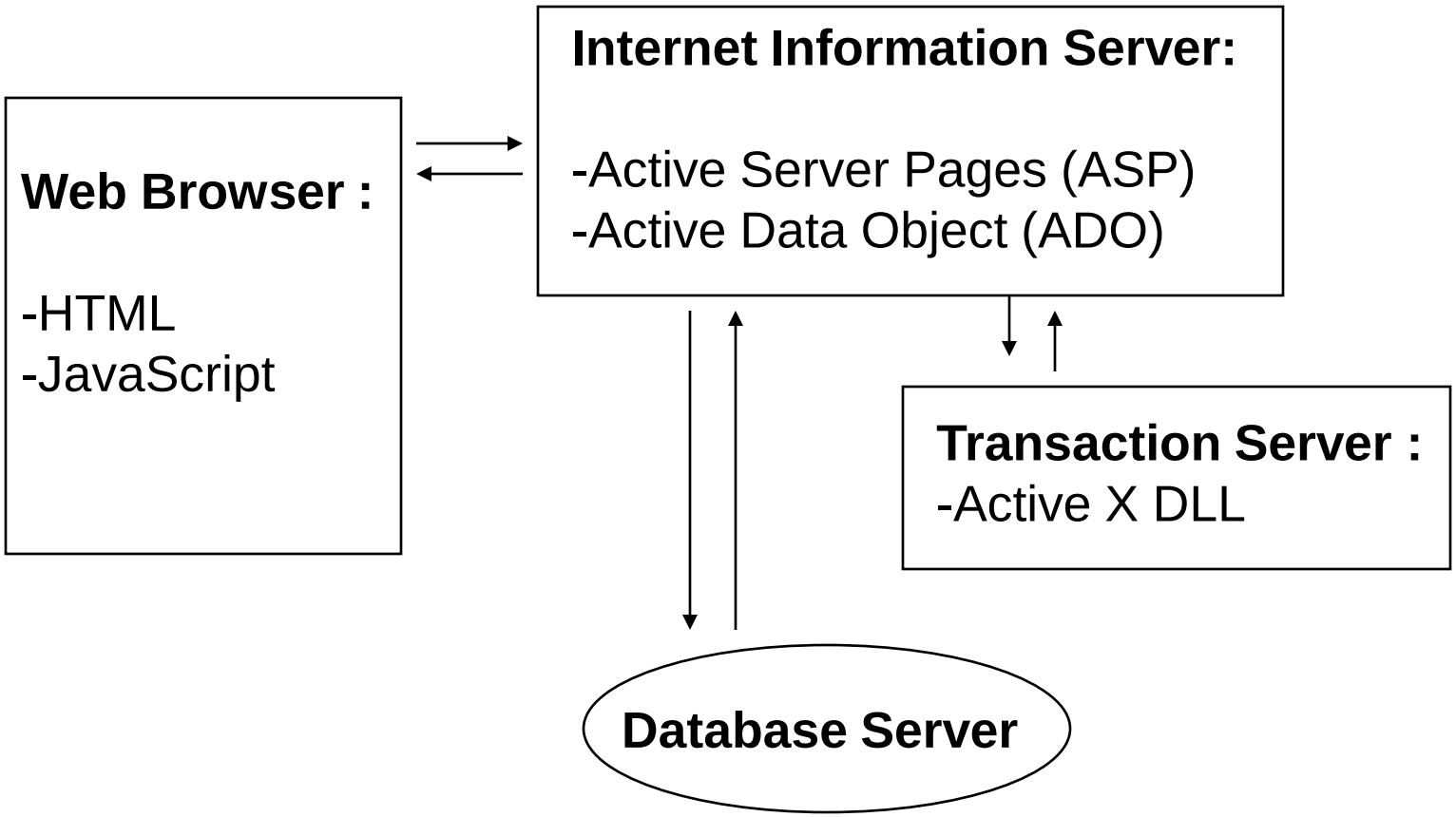
Introduction

- 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)



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

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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**

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:	+		

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

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

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.

CD MARKER DX Home Page

CD MARKER DX: Archived Cases

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

Case Number	CD1	CD2	CD3	CD4	CD5	CD7	CD8	CD10	CD11b	CD11c	CD13	CD14	CD15	CD16	CD19	CD20	CD21
1			-	-	+	-	-	-		-		-		-	+	+	
11			-	-	-	-	-	-		-		-		-	+	+	
20			-	-	+	-	-	-		-		-		-	+	+	
30			-	-	+	-	-	-		+		-		-	+	+	
31			-	-	-	-	-	-		+		-		-	+	+	
48			-	-	+	-	-	-		+		-		-	+	+	
50			-	-	+	-	-	-		+		-		-	+	+	
52			-		+	-						-			+	+	
53			-		+	-						-			+	+	
54			-		+	-						-			+	+	
63			-		+	-						-			+	+	
64			-		+	-									+	+	

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	C
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	12	0	7	0	0	0	0

CD MARKER DX Home Page

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/