



Positioning the Laboratory to Integrate Clinical Care: New Approaches to Interactive Test Ordering and Reporting

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Before creating a solution, you should
first identify the problem you are solving

Axiom #1

The Book of Medical Knowledge & Future Horizons of Medical Care

- Future of medicine centered on synthesizing and coalescing information
 - For individuals across multiple episodes of care
 - For groups of individuals to understand risk and determine efficacy of intervention
- This knowledge will be used to create “individualized” prevention and treatment plans
- This knowledge will be used to evaluate the competence of individual care providers

The Book of Medical Knowledge & Laboratory Services

- Pathology & Laboratory Services are a primary engine for creating medical knowledge
 - Over 50% of MR information from Lab Medicine
- Pathology & Laboratory Services are an important frontier for “individualized” patient care:
 - Genetic risk profiling
 - Patient-specific cancer treatments (mSMART)
- The variety, complexity, and “information density” laboratory tests is rapidly expanding

Laboratory Physicians, Medical Care, and Information Delivery

- The central role of the lab in creating knowledge creates unique opportunities for Lab Professionals
- To take advantage, Lab Professionals must be active participants in patient care
- To take advantage Lab Professionals must help identify current challenges in medical care
- Lab Professionals must participate in design of the tools which deliver the care we provide
 - Increased opportunity for unnecessary testing
 - Increased need for contextual result interpretation



If the solution is more complicated than the problem, then you are probably not solving the problem you think you are.

Axiom #2

The Position of the Lab in Clinical Care

Why aren't we at the table?

- Facilitating Over-Utilization:
 - “The Doctor knows (or should know) what they want”
- Driving Over-Utilization:
 - Volume-driven sales and marketing approaches
- Adding to the cost of care
 - Hidden cost: positive result for an unneeded test
 - Fragmented reports not calling out significant findings
- These issues ALL decrease the perceived and actual value of our specialty

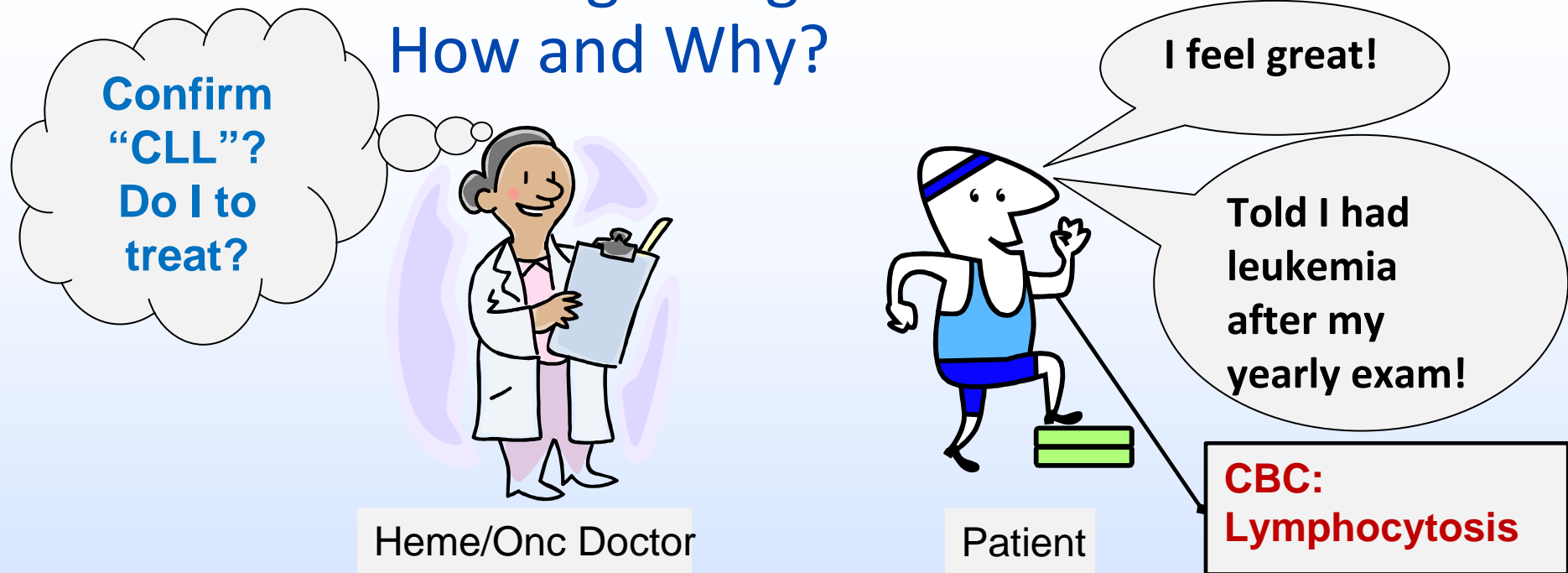
Positioning of the Lab: Moving Forward

- Need to be proactive in guiding test ordering
 - Simplify offerings around clinical questions
 - Algorithmic approach co-created with clinicians
- Need to assimilate inter-related results into a single report
- Need to provide meaning to groups of individual results rather than just interpretation of the data
- Need to create systems that holds, links, collates, and integrates orders and results

Positioning Lab to Add Value

- Must understand the context in which tests are ordered
- Must be cognizant of how the information is being used in patient care
- Must understand changing cultural paradigms for how information is accessed and delivered

The Beginning: Test Orders How and Why?



- Doctor examines patient and reviews preliminary data
- Makes presumptive diagnosis based on data
- Orders additional studies to confirm diagnosis and generate prognostic data

Current Approach – 4 Tests, 4 Results

Billing Events

Leukemia/Lymphoma
Immunophenotyping by
Flow Cytometry

Test
Order



Diagnosis:
It is CLL OR
It is NOT CLL

Chronic Lymphocytic
Leukemia (CLL), FISH

Test
Order



If CLL
Tests help
determine
prognosis

Immunoglobulin Heavy
Chain Gene Mutation Status

Test
Order



If NOT CLL
Tests
provide
little value
and may
confuse
clinician

ZAP-70, Chronic
Lymphocytic Leukemia
(CLL) Prognosis

Test
Order



Current Approach – 4 Tests, 4 Results

October 13

MAYO CLINIC
Laboratory Service Report 1-800-533-1710

Patient Name: TEST IMPLEMENTATION TESTING
Specimen ID: 10132010 08:06
Collected: 10/13/2010 13:42
Printed: 10/13/2010 13:42

Ordering Phys: BENSON
Account Information: C799996-CLAP ROCHA
300 SUPERIOR DRIVE
ROCHESTER, MN 55901

Test: FISH
Specimen ID: 743524
Reason for Referral: CLL

Test Results:

Test	Flag	Results	Unit	Reference Value	Perform Site*
CLL, FISH		Blood		REPORTED 10/13/2010 13:46	MCR
Specimen ID		743524		10 Oct 2010 13:29	MCR
Reason for Referral		CLL			MCR

FISH probes and locus (200 nuclei/500 nuclei per probe set)

Probe	Result (%)	95% normal cutoff
6q	60%	<5.0
11q	100%	<5.0
12	100%	<5.0
13q	100%	<5.0
17p	100%	<5.0
t(11;14)	100%	<5.0
14q32	100%	<5.0
17p	100%	<5.0
t(11;14)	100%	<5.0
14q32	100%	<5.0

Interpretation: This test was developed and its performance characteristics determined by Laboratory Medicine and Pathology, Mayo Clinic, Rochester, MN. It has not been cleared or approved by the U.S. Food and Drug Administration. This FISH test does not rule out other chromosome abnormalities.

Reviewed and approved by: Heather Owen, Released: 10/13/2010

October 16

MAYO CLINIC
Hematopathology Report
Mayo Medical Laboratories - External Consultation
Mayo Clinic - Rochester
200 1st Street SW
Rochester, MN 55905

Client Number: 00000000000000000000
Patient Name: 00000000000000000000
Date of Birth: 00/00/0000
Gender: F

Accession #: BR09-33784
Procedure Date: 10/14/2009
Received Date: 10/15/2009
Report Signed: 10/16/2009 12:18

Order Number: 00000000000000000000
Referring Physician: ATTN: Referral Testing
Nebraska Lab, Inc.
5440 South Street
Suite 100
Lincoln, NE 68506
(402) 484-5462
Fax Phone: 402-484-5463

Final Diagnosis: Peripheral blood, flow cytometric immunophenotyping: The lambda light chain-restricted B-cells are negative for ZAP70 (6%).

Comment: Negative ZAP70 expression (less than 20% of B-cells) has been associated with a better outcome in patients with B-cell chronic lymphocytic leukemia (CLL). Its role in other B-cell disorders has not been clarified and cannot be assumed to add any additional clinical or diagnostic value in non-CLL patients.

Procedure: Flow cytometric immunophenotyping was performed with antibodies directed against CD3, surface kappa and lambda immunoglobulin light chains, and ZAP70.

Interpreted by: William G. Morice II, M.D.
Report electronically signed by: William G. Morice II, M.D., Ph.D.
Transcribed by: 10/16/2009 08:36:42

Material Received: 2 acid tubes peripheral blood for flow cytometry

Specimen Description: A: Peripheral Blood

Analyte Specific Reagent: ZAP70 immunophenotyping test was developed and its performance characteristics determined by Laboratory Medicine and Pathology, Mayo Clinic. This test has not been cleared or approved by the U.S. Food and Drug Administration.

October 13

MAYO CLINIC
Cytogenetics Laboratory
Mayo Medical Laboratories, 200 First Street SW, Rochester, Minnesota 55905

Name: Test, Implementation Testing
DOB: 05/23/1955
Collected Date: 10/13/2010
Ref'd Date: 10/13/2010
Specimen: Blood
Requested By: DXAMP
Location: Rochester, MN

Reason for Referral: CLL, FISH

Method: FISH probes and locus (200 nuclei/500 nuclei per probe set)

Probe	Result (%)	95% normal cutoff
6q	60%	<5.0
11q	100%	<5.0
12	100%	<5.0
13q	100%	<5.0
17p	100%	<5.0
t(11;14)	100%	<5.0
14q32	100%	<5.0
17p	100%	<5.0
t(11;14)	100%	<5.0
14q32	100%	<5.0

Interpretation: This test was developed and its performance characteristics determined by Laboratory Medicine and Pathology, Mayo Clinic, Rochester, MN. It has not been cleared or approved by the U.S. Food and Drug Administration. This FISH test does not rule out other chromosome abnormalities.

Reviewed and approved by: Heather Owen, Released: 10/13/2010

October 22

MAYO CLINIC
Laboratory Service Report 1-800-533-1710

Patient Name: TESTING 83727
Specimen ID: 10132010 06:00
Collected: 10/22/2009 06:00
Printed: 10/22/2009 11:14

Ordering Phys: BENSON
Account Information: C799996-STUSTEST
300 FIRST STREET SW
ROCHESTER, MN 55901

Test: FISH
Specimen ID: 743524
Reason for Referral: CLL

Test Results:

Test	Flag	Results	Unit	Reference Value	Perform Site*
CLL, FISH		Blood		REPORTED 10/22/2009 10:46	MCR
Specimen ID		743524		10 Oct 2010 13:29	MCR
Reason for Referral		CLL			MCR

FISH probes and locus (200 nuclei/500 nuclei per probe set)

Probe	Result (%)	95% normal cutoff
6q	60%	<5.0
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13q	100%	<5.0
17p	100%	<5.0
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Interpretation: This test was developed and its performance characteristics determined by Laboratory Medicine and Pathology, Mayo Clinic, Rochester, MN. It has not been cleared or approved by the U.S. Food and Drug Administration. This FISH test does not rule out other chromosome abnormalities.

Reviewed and approved by: Heather Owen, Released: 10/22/2009 10:46



That doesn't
really help ...



What Should Happen

Scenario #1

Leukemia/Lymphoma
Immunophenotyping by
Flow Cytometry



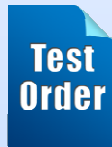
Result – Not CLL



**Billing
Event**

Cancelled

Chronic Lymphocytic
Leukemia (CLL), FISH



Immunoglobulin Heavy
Chain Gene Mutation
Status



ZAP-70, Chronic
Lymphocytic Leukemia
(CLL) Prognosis



What Should Happen

Scenario #2

Leukemia/Lymphoma
Immunophenotyping by
Flow Cytometry



Result – CLL Confirmed
Prognosis – Standard Risk



Billing
Event

~~Defining~~ Confirmed

Chronic Lymphocytic
Leukemia (CLL), FISH



Immunoglobulin Heavy
Chain Gene Mutation
Status



ZAP-70, Chronic
Lymphocytic Leukemia
(CLL) Prognosis



Billing
Events



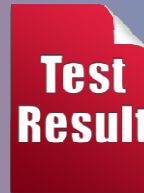
Integrated Report

Integrated Report

The Integrated Report uses results A – D and combines them into a single fully integrated report.



Cell Kinetics



Cell Kinetics



Molecular Hematopathology



Cytogenetics



Integrated Report

Integrated Report E
+++++

Result A
=====

Result B
=====

Result C
=====

Result D
=====

The Integrated Report

MAYO Clinic

Bone Marrow Morphology Analysis

Patient Name: **TEST, TEST**
 Birth Date: 4/7/1993 8:00:00 AM Age: 17 Y Gender: Female
 Referring Physician: **test test**
 Tel: 0000000000 Fax: 0000000000
 Collection Date: 04/21/2010

Order #: **100000198**
 Client Specimen #: **CLTEST**
 Client Lab ID: **TEST CLINIC**SCC USE**
 Client Hospital ID: **TEST CLINIC**SCC USE**
 Specimen(s) Received: 2 Block, Wet tissue, 1 Slide, Smear

Treating Physician: **Laura Test**
 Tel: 1111112222 Fax:
 Received Date: 04/21/2010

Case #: **P-10-198**

Clinical Data
 Patient has a history of Acute Leukemia.

Body Site
 Bone, Left Iliac
 Bone, Left Iliac
 Bone, Left Posterior Iliac

Diagnosis
 Hypercellular marrow 85% with maturing trilineage hematopoiesis.

Reviewing Pathologist: 0000000000

Giemsa


Iron


Peroxidase


Bone Marrow Differential Count
 Differential/Aspirate (200 cells counted)

Cell/Signal Type	Cell/Signal Count	Cell/Signal Normal Range	Cell/Signal Type	Cell/Signal Count	Cell/Signal Normal Range
PRONORMOBLASTS	6	0-2	ERYTHROID SERIES	20	15-25
PLASMA CELLS	10	0-1	MYELOBLASTS	0	0-3
PROMYELOCYTES	0	2-8	MYELOCYTES	30	10-13
METAMYELOCYTES	22	10-15	NEUTROPHILS/BANDS	5	25-40

MAYO Clinic

Surgical Pathology Report
ICC Analysis

Patient Name: **TEST, TEST**
 Birth Date: 4/7/1993 8:00:00 AM Age: 17 Y Gender: Female
 Referring Physician: **test test**
 Tel: 0000000000 Fax: 0000000000
 Collection Date: 04/21/2010

Order #: **100000200**
 Client Specimen #: **CLTEST**
 Client Lab ID: **TEST CLINIC**SCC USE**
 Client Hospital ID: **TEST CLINIC**SCC USE**
 Specimen(s) Received: 1 Block, Paraffin

Treating Physician: **Laura Test**
 Tel: 1111112222 Fax:
 Received Date: 04/21/2010

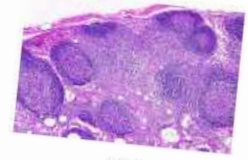
Case #: **P-10-200**

Clinical Data
 Patient has a history of migraine headaches.

Body Site
 Lymph Node

Interpretation
 Stage IV neuroblastoma. This interpretation is based on histological features seen in an excised lymph node mass.

Comment
 This analysis is an adjunct to the evaluation of the referring physician and does not represent a final diagnosis.

H&E


Marker
 NB84s

Marker Comment
 Neuroblastoma

Result
 Positive-Cytotrophoblast/Villi stroma

Electronically Signed By
LAURA DE LA MIRANDA SCC
 Employee

Date
 4/22/2010 9:05 AM

This test was developed and its performance characteristics have been determined by Mayo Clinic. It has not been cleared or approved by the FDA. The FDA has determined that such clearance or approval is not necessary. The laboratory is regulated under the Clinical Laboratory Improvement Amendments of 1988 (CLIA) as qualified to perform high complexity clinical testing.

Integrated Test Ordering and Reporting

- Is this the end or the beginning?
- How do you integrate information that is not there?

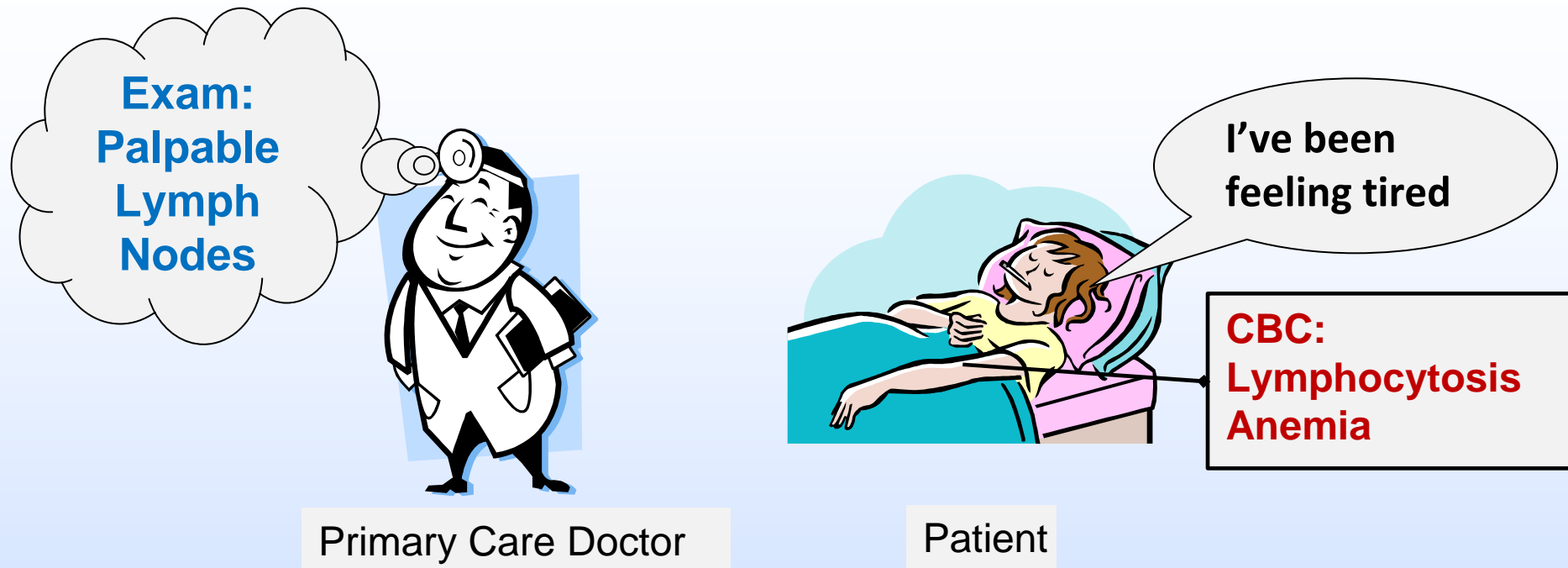
SHREK, ONIONS, and Consultative Laboratory Medicine



Consultative Laboratory Practice: Different Layers

- TECHNICAL: Request for assistance in creating data or verifying methods of data creation
- INTERPRETIVE: Request for assistance in interpreting data to generate an individual result
- INTEGRATIVE: Request to assist in reviewing and collating group of individual results
- SUPPORTIVE: Request for assistance in using knowledge to guide the selection of individual tests to appropriately answer clinical questions

The Beginning: How are Orders Created?



- Doctor examines patient and reviews preliminary data
- Creates differential diagnosis (List) based on data
- Orders additional studies to narrow list into specific diagnosis

Differential Diagnosis & Test Ordering

Differential Diagnosis

- Viral Infection (80%)
- Autoimmune Disease (5%)
- Lymphocytic Leukemia (5%)
- Immunodeficiency (5%)
- Something else (5%)

Ordered Tests

- Viral Serologies
- Autoimmune Serologies
- Leukemia Flow Cytometry
- Immune Function Tests
- Round 2

Integrated Report



Cell Kinetics



Integrated Report

How can we integrate what does not exist and should?



Cell Kinetics



Molecular Hematopathology



Cytogenetics

Integrated Report

Integrated Report ?
+++++

Result A CLL
=====

CLL Prog Result ?
=====

CLL Prog Result ?
=====

CLL Prog Result ?
=====

CD5 Positive B-CLPD
N=175 of 252 cases (69%)

Prototypic CLL
Pattern, n=97

92 cases CLL/SLL
5 cases non-CLL/SLL
or MCL

¹Sensitivity=82%

¹Specificity=96%

Prototypic MCL
Pattern, n=25

22 cases MCL
3 cases non-CLL/SLL
or MCL

²Sensitivity=56%

²Specificity=99%

CD5+ Non-Specific
Pattern, n=27

11 cases CLL/SLL
13 cases MCL
3 cases non-CLL/SLL
or MCL

³Pos Pred Value= 88%

CD5 Partial
Pattern, n=28

8 cases CLL/SLL
4 cases MCL
16 cases non-CLL/SLL
or MCL

³Pos Pred Value=42%

¹For CLL/SLL

²For MCL

³Positive Predictive Value For a Diagnosis of CLL/SLL **OR** MCL

Current Approach – 1 Test, Now What?

Clinician

Is it CLL?

Now what?

?

Pathologist

Maybe

CLL FISH
Zap 70
CD49D
CD52
Point Mutation



Why was I called
out from a
patient visit?

The Lab called?
What did they
say?

That doesn't
really help
either...



Testing Recommendation Question

New Notification

Category: Messages

Subcategories: important








Audience: Pathologist

Case number: MGS-13-0000009 TEST, TEST MRN: MRN0008925 DOB:1990/04/11

Subject: Testing Recommendation Question

Attachments

Attach file

B *I* U ^A _A A ab       

Patient has tested negative for Lynch and FAP. What additional testing is recommended?

Notification/Conversation Thread

New Notification

Sender	Subject	Sent
Group: Order#:MGS130000009 (3)		
AUTO	Report has been released	05/24/2013 12:44
DAKIL	Testing Recommendation Question	06/17/2013 21:40
JOHND	Re:Testing Recommendation Question	06/17/2013 21:52

Subject: Re:Testing Recommendation Question

From: JOHND 06/17/2013 21:52

Audience: Requesting Doctor

Not Reviewed

Importance: IMPORTANT

Test HCCP, Hereditary Colon Cancer Multi-Gene Panel is useful for providing a comprehensive evaluation for hereditary colon cancer in patients with a personal or family history suggestive of a hereditary colorectal cancer syndrome. To order go to: [link](#)

Patient has tested negative for Lynch and FAP. What additional testing is recommended?

Patient: [MRN0008925](#)

Billing#: [BILL0007016](#)

Order#: [MGS130000009](#)

[View patient history](#)

Reviewed

Reply

MAYO
CLINIC

Provider Orders HCCP and Submits Billing Information

SoftGENE portal Home LIS News About Welcome, DAKIL! You're logged to WESTC. Sign Out

Simple Search New Requisition

New Open Requisition Label Requisition Report Check Med Nec Refresh Edit Save Template: TESTADDON Apply Template

SCC Diagnostic Laboratory Soft Computer

SCC SoftComputer
Diagnostic Laboratory
5400 Tech Data Drive
Clearwater, Florida 33760
USA

Patient Information

Order#: MSG-13-09 Sex: Female DOB: 04/11/1990
MRN: MRN0008925 First Name: TEST Last Name: TEST

Billing Information

Patient Subtype: ☒ Inpatient ☒ Outpatient ☐ Non-Hospital patient
Patient Status: Outpatient Hospital Discharge Date:
Insurance: MCR
Insurance Name:
Policy/Cert#: Group ID:
Zip Code: City:
State: Address2:

Insured information

First Name: Last Name:
Middle Name: Phone:
Relation to insured: ☒ Self ☐ Spouse ☐ Child ☐ Other ☐ Unknown

TEST SELECTION

☒ Next-Generation Sequencing
☒ HCCP

☒ PCR Assays
CHRMOS
CHRLIM
CHRCVSDIR

☒ Chromosomal Analysis
CHITO
CBAND

☒ FISH Panels
ADENOVIMESO
AFAFP
AFP4

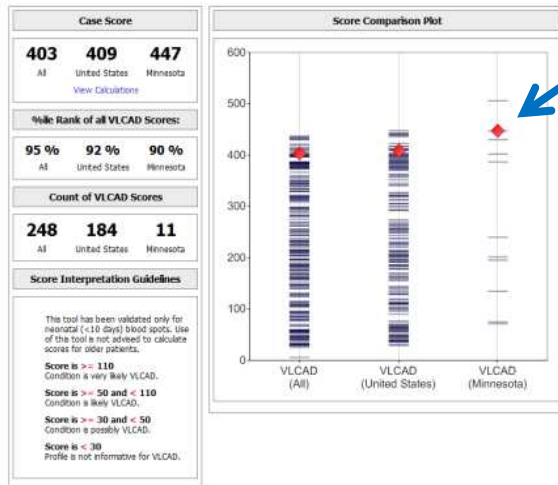
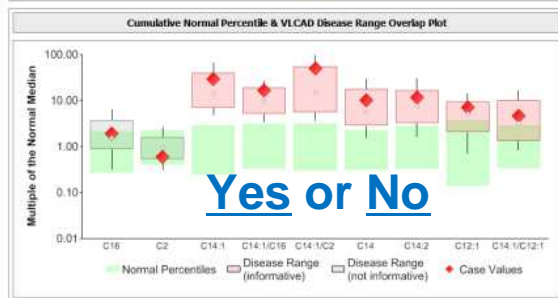
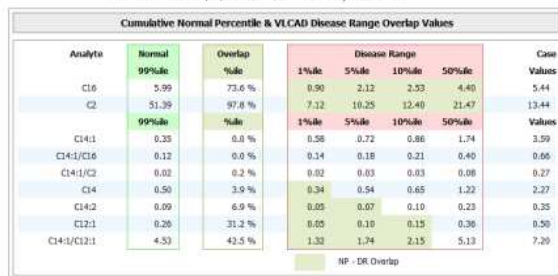
☒ Other AML-Related FISH Probes
ALEUKS
BCELLPREP

☒ Individual FISH Probes
BIHCP7B
BLADVPROS
BLBMS
BMM
BMIMTCLLOT
BMIMTCORE
CBAND
CARCMELA

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Mayo Clinic Integration of Laboratory Information : Collaborative Laboratory Integrated Reports (CLIR)

- A Mayo-led, worldwide collaborative project to improve the post-analytical interpretation of mass spec. newborn screening results (134 results per patient)
- Based on multivariate pattern recognition software that generates post-analytical interpretive tools



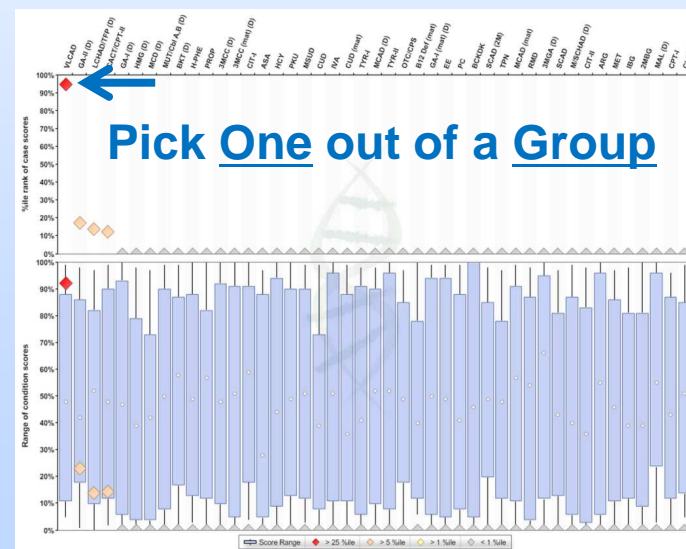
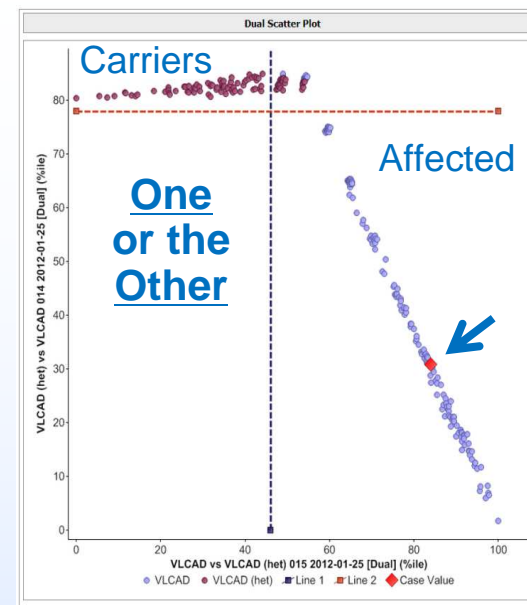
CLIR Tools

2012-2013 (YTD) UTILIZATION

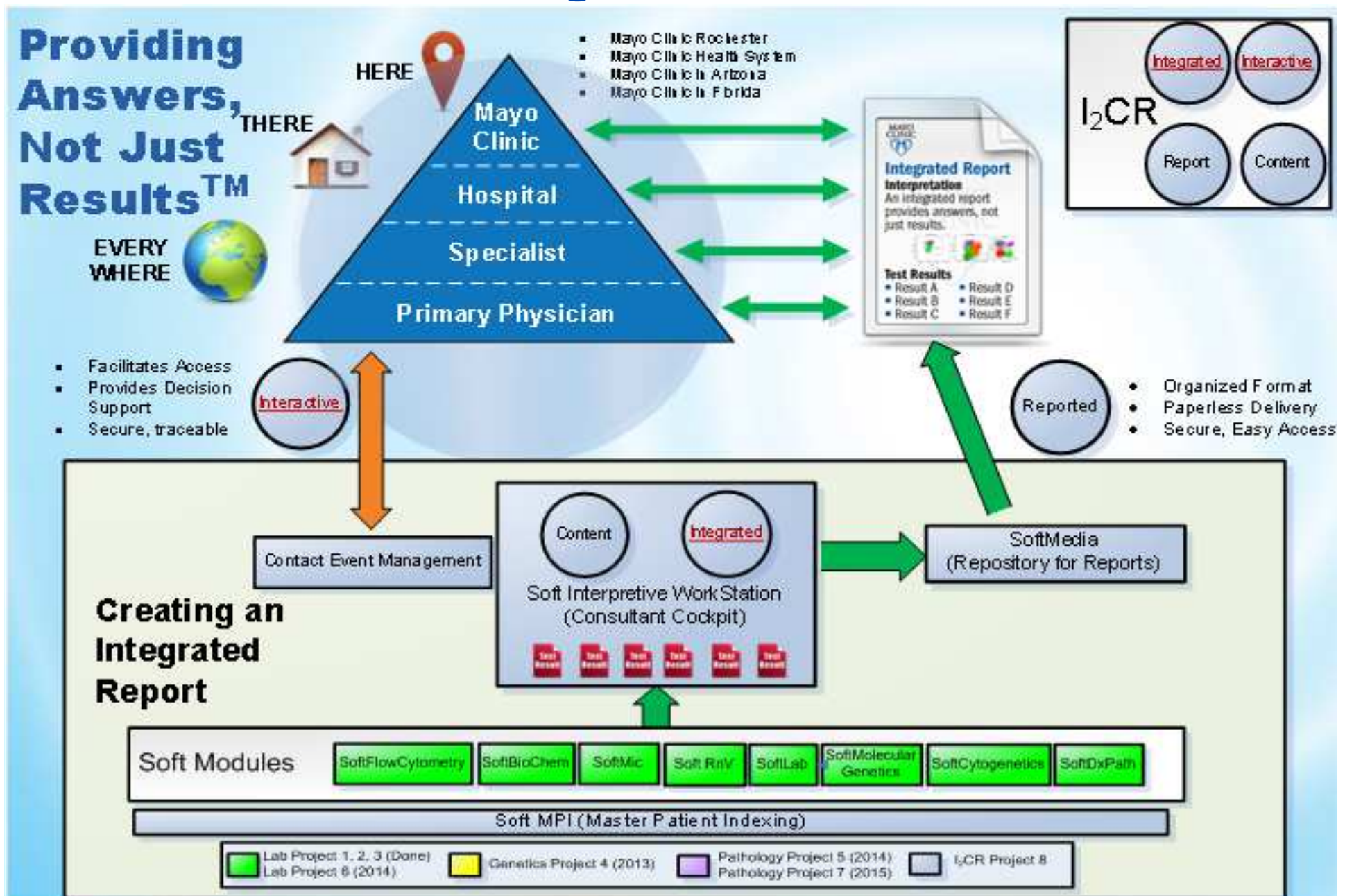
195 sites
52 countries
>58 million
calculated scores

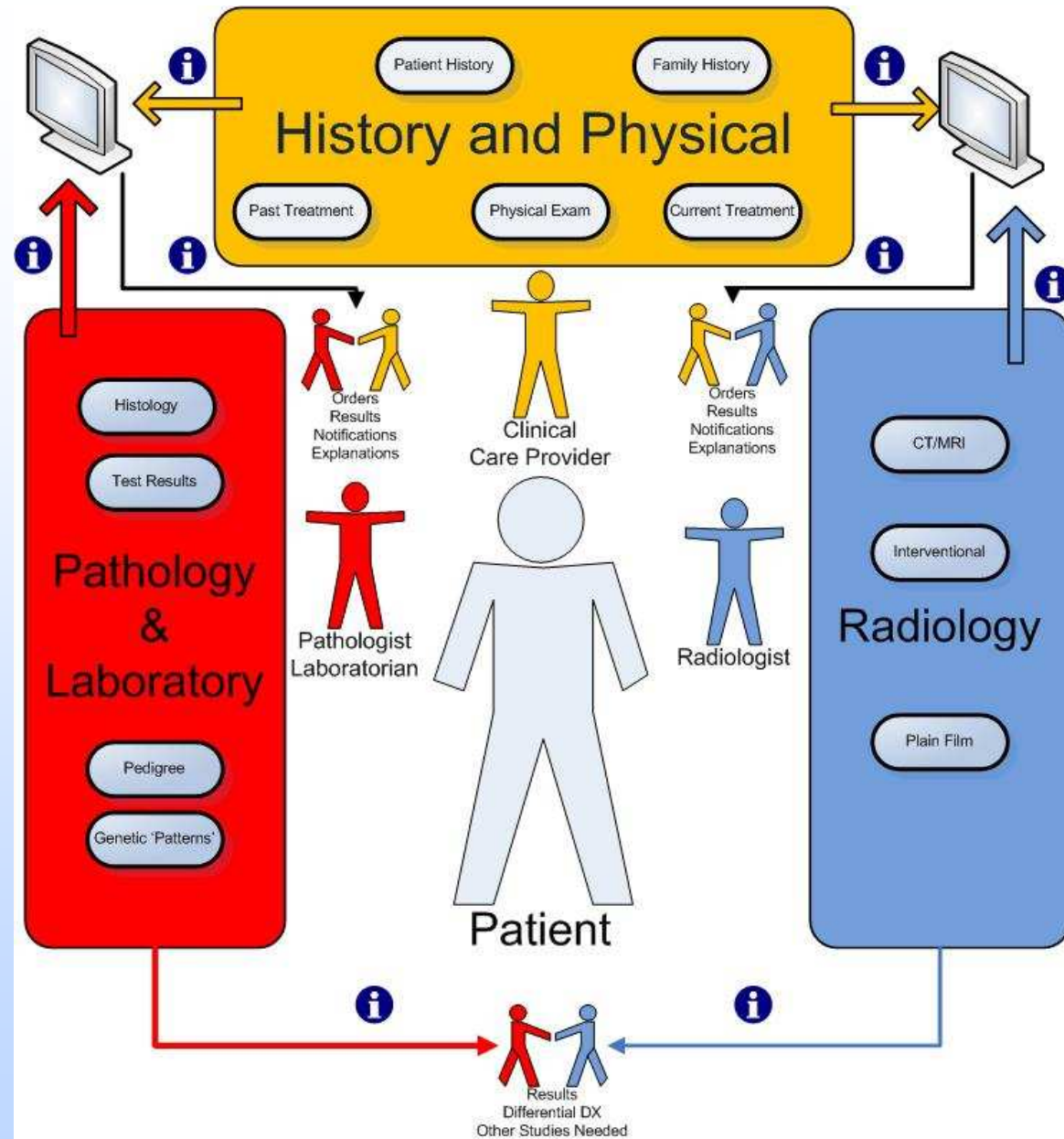
McHugh DMS et al. (2011)
Clinical validation of cutoff
target ranges in newborn
screening of metabolic
disorders by tandem mass
spectrometry: A worldwide
collaborative project. Genet
Med 13:230-254.

Marquardt G et al. (2012)
Enhanced interpretation of
newborn screening results
without analyte cutoff
values. Genet Med,
14:648-654.



Building Tools to Add Value





Cervical Cancer Prevention: Do we need to think of a different system?

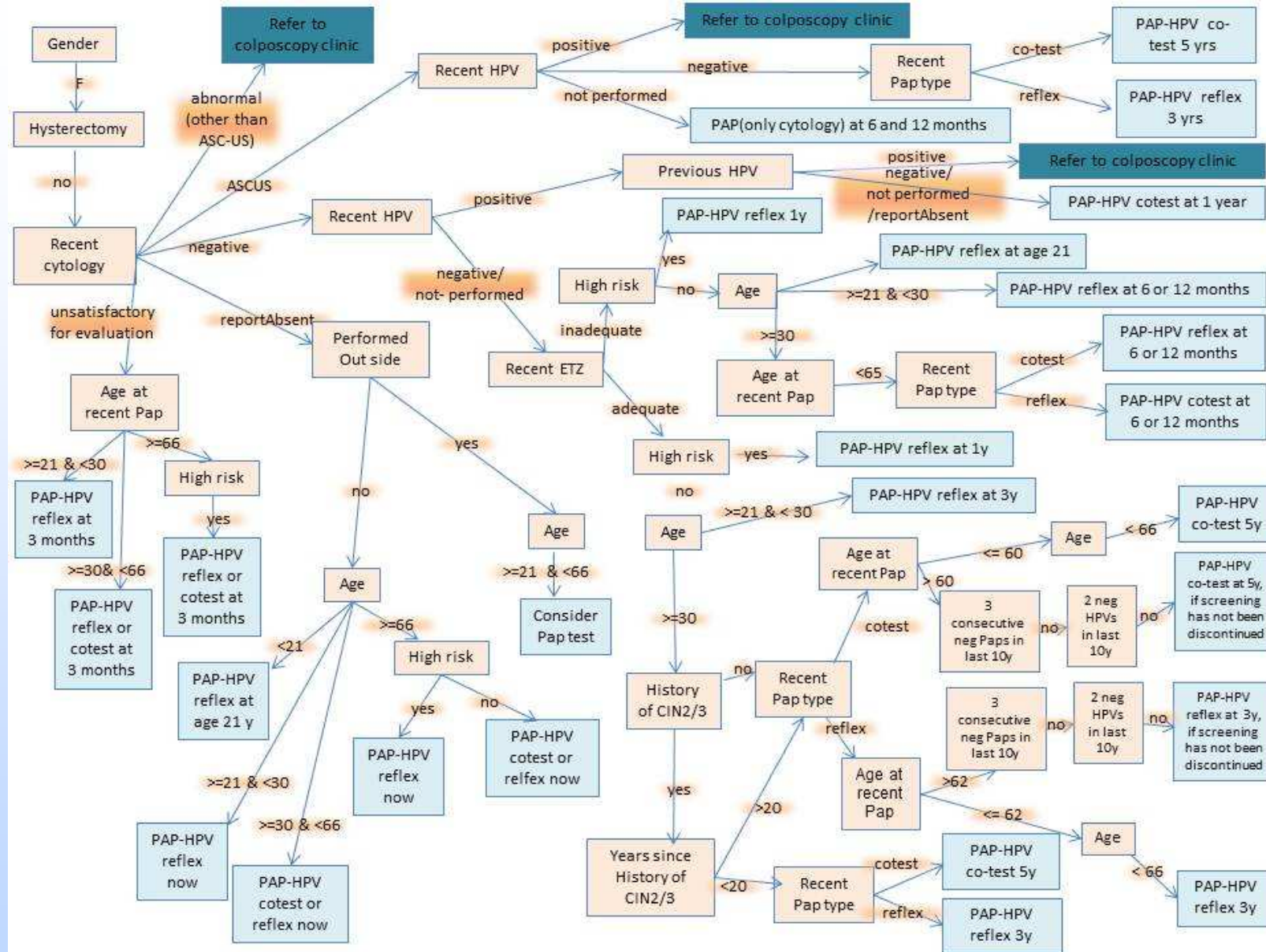
Problem: Although cervical cancer is highly preventable, it still continues to be a leading cause of death.

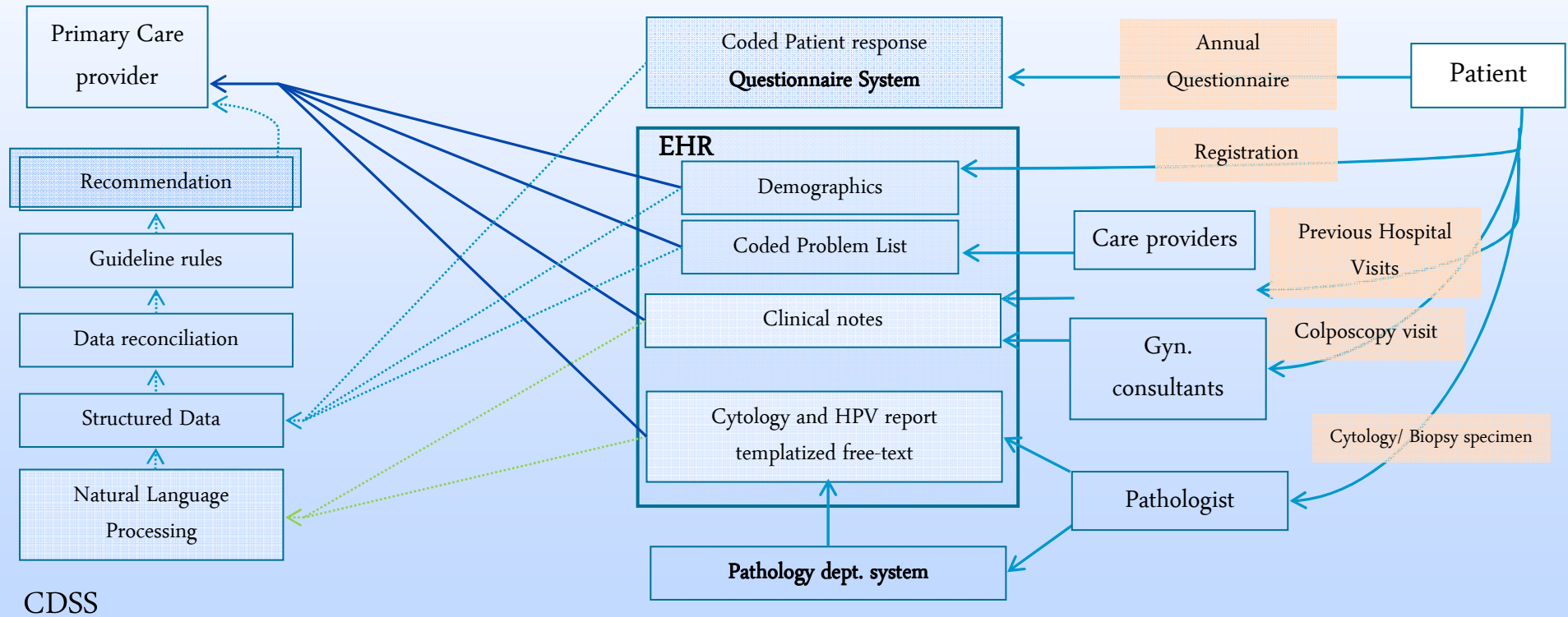
More than half of the women diagnosed with cervical cancer were found to have inadequate screening

*Guidelines for cervical cancer are **complex** and not easily recalled by health providers.*

Solution: Clinical Decision Support Service incorporated into pathology report, to remind optimal care.

Decision logic for Pap derived from the care process model





New generation PAP Reporting Using CDSS

Service Description	Date/Time	Status	Subtype	Dept	Fac
General Pathology Report	23-May-2012 10:56	Final	PATHGE		MCR

Pathology Recommendations
refer to colposcopy clinic and decide on restarting screening Refer to colposcopy clinic, as last PAP report (17-Jul-2009) indicated cytology:abnormal(other than ASCUS). If co...

- 25 Users, 175 cases, 87% accuracy
- All errors corrected after ID'ing rule deficiencies
 - *J Am Med Inform Assoc* 2013;**20**:749-757

Positioning the Laboratory to Add Value: Who Benefits (ROI)?

- #1: The Patient
 - Increased accuracy
 - Fewer office visits, get diagnosis more quickly
- Clinical Care Provider: Clearer understanding of tests ordered, results, meaning for patient
- Laboratory
 - Increased value of service provided
 - Decreased number of non-reimbursed tests
- Healthcare System
 - Optimized utilization eliminates waste
 - Potential to broadly integrate patient information



Thank You to:
Dr. Piero Rinaldo, CLIR
Dr. Rajiv Chaudry, CDSS
Dr. Matthew Howard
The Organizers
And Audience!

Questions?