

# Interactive Visual Displays for Results Management in Complex Medical Workflows

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Committee: Ben Shneiderman (Chair)

Linda Aldoory (Dean's Representative)

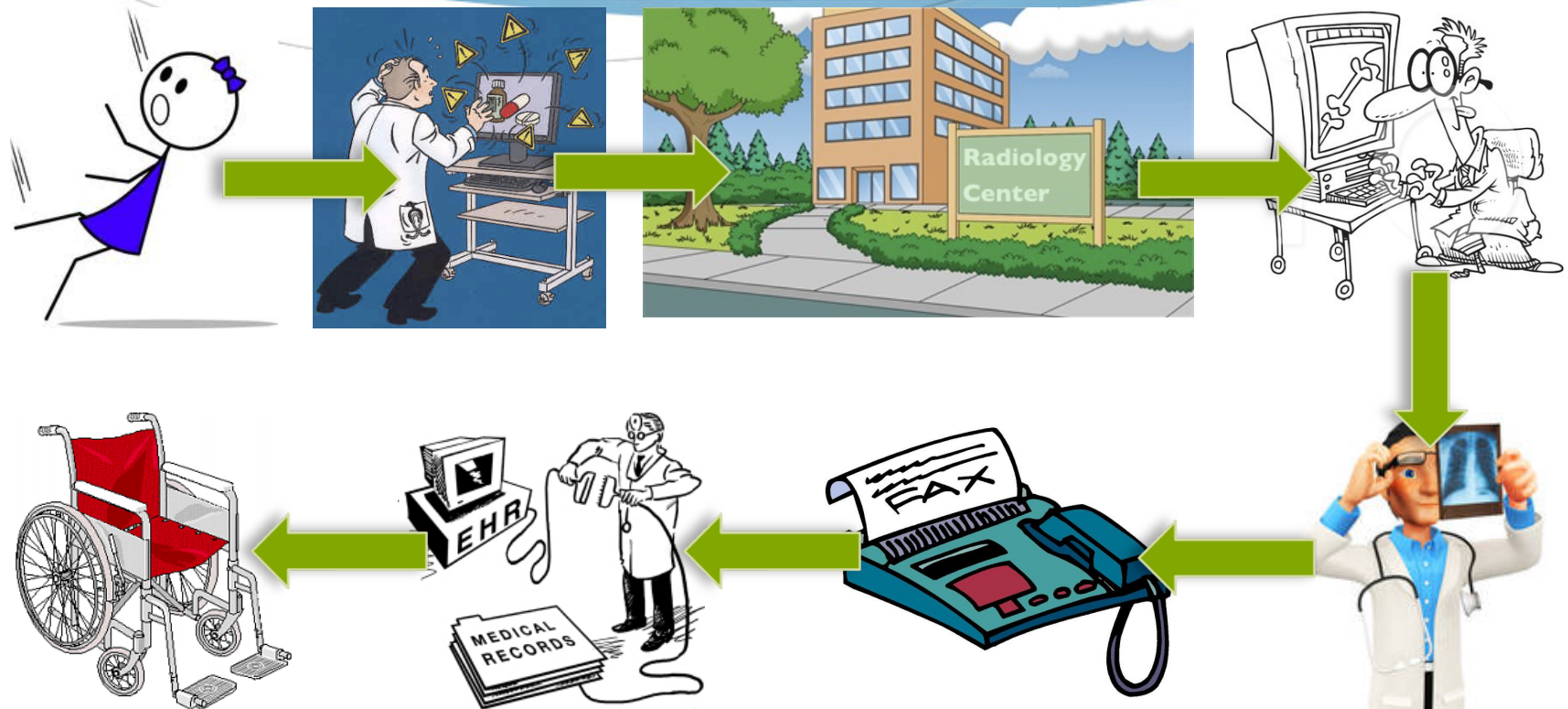
Ben Bederson

Rance Cleaveland

Catherine Plaisant



# A story...



# Missed Results



Hickner, 2008; Phillips, 2004



# Veterans Administration View Alert

The screenshot displays the 'Patient Selection' window for 'Patients (Wednesday Clinic)'. It includes a 'Patient List' section with radio buttons for 'Default: Wednesday Clinic', 'Providers', 'Team/Personal', 'Specialties', 'Clinics', 'Wards', and 'All'. A list of patients is shown, with a callout indicating 'Patient record has pending orders'. The 'Notifications' table below lists alerts with columns for Patient, Location, Urgency, Alert Date/Time, Message, and Forwarded By/When. A callout points to the 'Patient' column, stating 'Arrived results in chronological order'. Another callout points to the 'Message' column, stating 'Too much text'. A third callout points to the 'Forwarded By/When' column, stating 'Empty column'. The bottom of the window features buttons for 'Process Info', 'Process All', 'Process', 'Forward', and 'Remove'.

**Patient Selection**

Patients (Wednesday Clinic)

OK  
Cancel

Save Patient List Settings

**Notifications**

Info	Patient	Location	Urgency	Alert Date/Time	Message	Forwarded By/When
	Patient, Test132		Moderate	01/01/2010@03:14	Scheduled Consult: ORTHOPEDICS	
	Patient, Test164		Moderate	01/01/2010@15:09	Scheduled Consult: NON-INVASIVE ECHO	
	Patient, Test243		Moderate	01/02/2010@02:06	COMPLETED EMERGENCY ROOM NOTE available for ADD'L	
	Patient, Test32		HIGH	01/02/2010@05:35	Medications Nearing expiration	
	Patient, Test17		Moderate	01/02/2010@08:09	Imaging request held: KNEE 3 VIEWS, LEFT	
	Patient, Test267	GM	Moderate	01/03/2010@07:09	Abnormal labs - [TROPONIN I]	
	Patient, Test165		Moderate	01/04/2010@03:23	Abnormal labs - [LIPID PROFILE, COMPREHENSIVE]	
	Patient, Test138		Moderate	01/04/2010@08:46	Abnormal labs - [BASIC METABOLIC PANEL]	
	Patient, Test106		Moderate	01/05/2010@02:06	Labs resulted - [MICROALBUMIN:URINE]	
	Patient, Test286		Moderate	01/05/2010@04:33	COMPLETED PHARMACY PATIENT ENCOUNTER available for	
	Patient, Test362	GM	HIGH	01/05/2010@08:32	Critical lab: CR 2/27 05:00	
	Patient, Test151		Moderate	01/06/2010@07:09	Imaging Results, Critical: SPINE LUMBOSACRAL MIN 2 VI	
	Patient, Test209		Moderate	01/07/2010@05:00	Discontinued consult DERMATOLOGY	
	Patient, Test122	GM	Moderate	01/08/2010@02:08	Comment Added consult PAIN MANAGEMENT	
	Patient, Test305		Moderate	01/08/2010@08:41	Abnl Imaging Results Attn: CT ABDOMEN W&W/O CO	
	Patient, Test132		Moderate	01/08/2010@09:07	Completed Consult NURSING CASE MANAGEMENT	
	Patient, Test57		Moderate	01/08/2010@16:09	Abnl Imaging Results Attn: MAGNETIC IMAGE LUMBAR S	
	Patient, Test160		Moderate	01/09/2010@03:09	UNSIGNED CARE FOLLOW-UP available for SIGNA	

Process Info Process All Process Forward Remove

Patient record has pending orders

Arrived results in chronological order

Too much text

Empty column

# OpenVista Follow-up

Medsphere OpenVista® CIS [FALCON] - Connected as USER,PHYSICIAN (openvista.medsphere.org)

File Edit View Actions Options Tools Help



## PATIENT, LABORATORY

MRN: TST900000104  
Age/Sex: 51 (Male)

Wt: 83.915 kg  
Ht: 177.8 cm  
BMI/BSA: 26.5 (2.04)

## MS 202-1

Provider: USER,PHYSICIAN  
Admit Dx:

Admitted: 9/9/2008 3:53:13 AM  
Acct #:

Postings: A

Alerts:

## Care Team

Admitting MD: None  
Attending MD: USER,PHYSICIAN

New Consult... New Procedure... Edit Note Delete Note

Alerted consults

Date	Title	Record
3/16/2009	ALLERGY Cons	Consult #11
3/18/2009	PHARMACY CONSULT RESULTS	

Consult: ALLERGY Cons 3/16/2009 3:00:35 PM (Completed)

Current Pat. Status: Inpatient  
Ward: MED/SURG

### Order Information

To Service: ALLERGY  
Attention: MANAGER, SYSTEM  
From Service: MED/SURG  
Requesting Provider: MANAGER, SYSTEM  
Service is to be rendered on an INPATIENT basis  
Place: Bedside  
Urgency: Routine  
Orderable Item: ALLERGY  
Consult: Consult Request  
Provisional Diagnosis: Rash (782.1)  
Reason For Request: testing

### Inter-facility Information

This is not an inter-facility consult request.

Status: COMPLETE  
Last Action: COMPLETE/UPDATE

### Facility

Activity	Date/Time/Zone	Responsible Person	Entered By
CPRS RELEASED ORDER	03/16/09 15:00	MANAGER, SYSTEM	MANAGER, SYSTEM
COMPLETE/UPDATE	03/18/09 09:36	LEES, ALLI	LEES, ALLI
Note# 16			

Note: TIME ZONE is local if not indicated

TITLE: PHARMACY CONSULT RESULTS  
DATE OF NOTE: MAR 18, 2009@09:35 ENTRY DATE: MAR 18, 2009@09:36:05  
AUTHOR: LEES, ALLI EXP COSIGNER:  
URGENCY: STATUS: COMPLETED

Go to Orders tab

Patient Summary Problem List Medications **Orders** Clinical Notes Consults/Procedures Discharge Summary Vital Signs Lab Results Chart Inquiries

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Processing Alert: PATIENT, L (P) Completed Consult ALLERGY

Next Renew Forward Remove Stop

# OpenVista Follow-up

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File Edit View Actions Options Tools Help



## PATIENT,LABORATORY

MRN: TST900000104  
Age/Sex: 51 (Male)

Wt: 83.915 kg  
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MS 202-1  
Provider: USER,PHYSICIAN  
Admit Dx:

Admitted: 9/9/2008 3:53:13 AM  
Acct #:

Postings: A

Alerts:

## Care Team

Admitting MD: None  
Attending MD: USER,PHYSICIAN

Active Orders (includes Pending)

View as Tree | Expand Tree | Collapse Tree

Current Orders (Active & Pending)

Expiring Orders

Unsigned Orders

Recently

click Common Orders

Service	Status	Order
Home Med	Active	HOME MEDICATIONS GINSENG CAP/TAB 1 CAP/TAB ORAL EVERY DAY Non-VA medication not recommended by VA provider.
		ONE MARROW BLOCK-TECH TISSUE WC ONCE LB #111
		IB GREEN-SP PLASMA I ONCE LB #105
Lab	Active	GLUCOSE RANDOM GREEN BLOOD LC ONCE LB #104
Lab	Active	SP EOSIN STAIN TISSUE WC ONCE LB #99
Lab	Active	SP H & E STAIN TISSUE WC ONCE LB #93
Imaging - MRI	Active	MRI BRAIN W&W/O CONTRAST
Imaging - Mammography	Active	MAMMOGRAM SCREENING BILAT
Imaging - MRI	Active	MRI ABDOMEN W/O CONTRAST
Consults	Scheduled	ALLERGY Cons Bedside
Consults	Pending	CARDIOLOGY Cons Consultant's Choice

Write Orders

Common Orders

Cardiology Menu

Endocrinology

Gastroenterology

Mental Health Menu

Neurology

OB/GYN

Orthopedics

Pediatric Menu

Pulmonary Menu

Surgery Menu

\*\*\*\*\*

Write Delayed Orders

Patient  
Summary

Problem  
List

Medications

Orders

Clinical  
Notes

Consults/  
Procedures

Discharge  
Summary

Vital  
Signs

Lab  
Results

Chart  
Inquiries

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medsphere

Processing Alert: PATIENT,L (P) Completed Consult ALLERGY

Next

Renew

Forward

Remove

Stop

# OpenVista Follow-up

Medsphere OpenVista® CIS [FALCON] - Connected as USER,PHYSICIAN (openvista.medsphere.org)

File Edit View Actions Options Tools Help

**PATIENT, LABORATORY** Wt: 83.915 kg MS 202-1 Admitted: 9/9/2008 3:53:13 AM Postings: **A** Care Team  
MRN: TST900000104 Ht: 177.8 cm Provider: USER,PHYSICIAN Acct #: Alerts: Admitting MD: None  
Age/Sex: 51 (Male) BMI/BSA: 26.5 (2.04) Admit Dx: Attending MD: USER,PHYSICIAN

Active Orders

Current Order

Expiring Order

Unsigned Order

Recently Expired

Write Orders

Common Orders

Cardiology Menu

Endocrinology

Gastroenterology

Mental Health

Neurology

OB/GYN

Orthopedics

Pediatric Menu

Pulmonary Menu

Surgery Menu

\*\*\*\*\*

Write Orders

Patient Summary

**Common Orders**

CMP STAT	Metformin HCl 500mg Q...	Brain MRI WO Contrast	O2 Protocol
Hepatic Profile in AM	Triazolam 0.5mg at Bedt...	Skull Series 4 Views	Skin & Wound Care
Troponin Q8H X3	ASA EC 81mg Daily	Sinus Series	All Nursing Orders
Search All Labs	Acetaminophen 650mg ...	VQ Scan Lung	
	Search All IVs	Abdominal U/S Complete	
	Search All Meds	Lumbar Spine	
		Cervical Spine 2 views	
		Pelvic U/S Non OB	
		Carotid Duplex Ultrasound	
		Abdomen Upright	
		Abdomen Flat	
		Bone Scan Whole Body	
<b>DIET ORDERS</b>	<b>CONSULTS</b>		
Regular Diet	Medicine	EKG	Allergy Enter/Edit
NPO	Cardiology	Cardiac Cath Implant	
NPO NOW	Pulmonary	ECG Monitor	<b>TEXT ORDERS ONLY</b>
NPO Midnight	Gastroenterology	Echo	Text Orders
Clear Liquids	Hematology	Exercise Tolerance Test	
Enteral Formula	Allergy	PFT	

select Allergy consultation

Back Forward Close

Processing Alert: PATIENT, L (P) Completed Consult ALLERGY




Next Renew Forward Remove Stop

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# OpenVista Follow-up

Medsphere OpenVista® CIS [FALCON] - Connected as USER,PHYSICIAN (openvista.medsphere.org)

File Edit View Actions Options Tools Help

 <b>PATIENT, LABORATORY</b> MRN: TST900000104 Age/Sex: 51 (Male)	Wt: 83.915 kg Ht: 177.8 cm BMI/BSA: 26.5 (2.04)	<b>MS 202-1</b> Provider: USER,PHYSICIAN Admit Dx:	Admitted: 9/9/2008 3:53:13 AM Acct #:	<b>Postings:</b> A <b>Alerts:</b>  	<b>Care Team</b> Admitting MD: None Attending MD: USER,PHYSICIAN
---	---	--	--	--	--

Active Orders | **Common Orders** | View as Tree | Expand Tree | Collapse Tree

Current Order: CMP STAT, Metformin HCl 500mg Q..., Brain MRI WO Contrast, O2 Protocol

Expiring Order: Hepatic Profile in AM, Triazolam 0.5mg a

Unsigned Order: Troponin Q8H X3, ASA EC 81mg Daily

Recently Expired: Search All Labs, Acetaminophen 650, Search All IVs, Search All Meds

Write Orders

Common Orders

Cardiology Menu

Endocrinology

Gastroenterology

Mental Health

Neurology

OB/GYN

Orthopedics

Pediatric Menu

Pulmonary Menu

Surgery Menu

\*\*\*\*\*

Write Orders

Patient Summary

Back Forward

**DIET ORDERS**

- Regular Diet
- NPO
- NPO NOW
- NPO Midnight
- Clear Liquids
- Enteral Formula

**CONSULTS**

- Medicine
- Cardiology
- Pulmonary
- Gastroenterology
- Hematology
- Allergy

Exercise Tolerance Test

PFT

**Order a Consult**

Consult to Service/Specialty: ALLERGY

Patient will be seen as: ☐ Inpatient ☒ Outpatient

Attention:

Place of Consultation: CONSULTANT'S CHOICE

Urgency: ROUTINE

Provisional Diagnosis:  Diagnosis

Reason for Request:

ALLERGY Cons CONSULTANT'S CHOICE

Order

Save As Quick Order

Cancel

Close

Processing Alert: PATIENT, L (P) Completed Consult ALLERGY

Next Renew Forward Remove Stop

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# Contributions

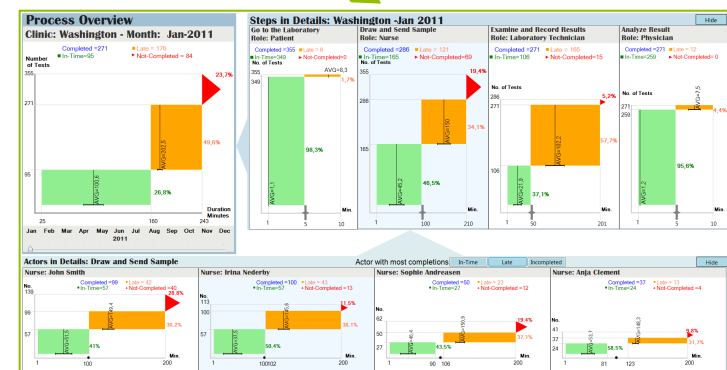
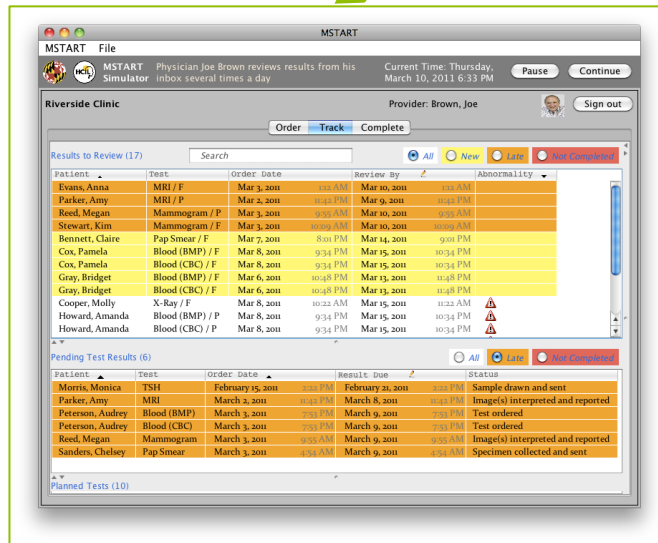
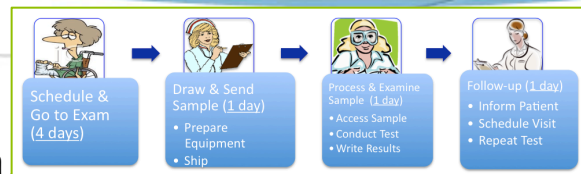
- ① Observations and interviews with clinicians and discussions of findings for results management
- ② Evaluations to quantify the benefits in time-critical applications where distractions undermine users' ability to track and react to orders
- ③ The development of guidelines for interactive rich tables with actions for rapid completion (ARCs)
- ④ The design and user studies of a novel retrospective analysis visualization

# Solution

Physician,  
Resident,  
Assistant

...

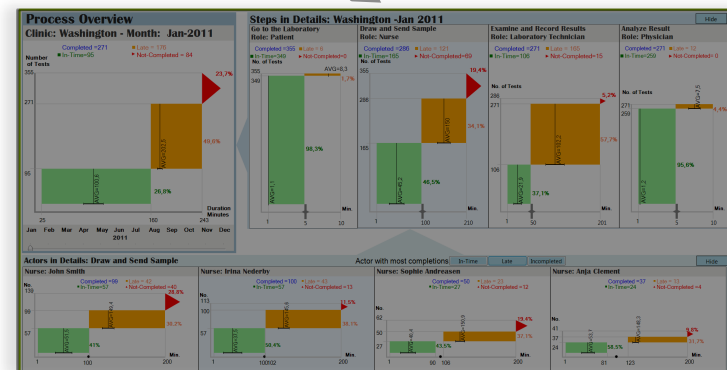
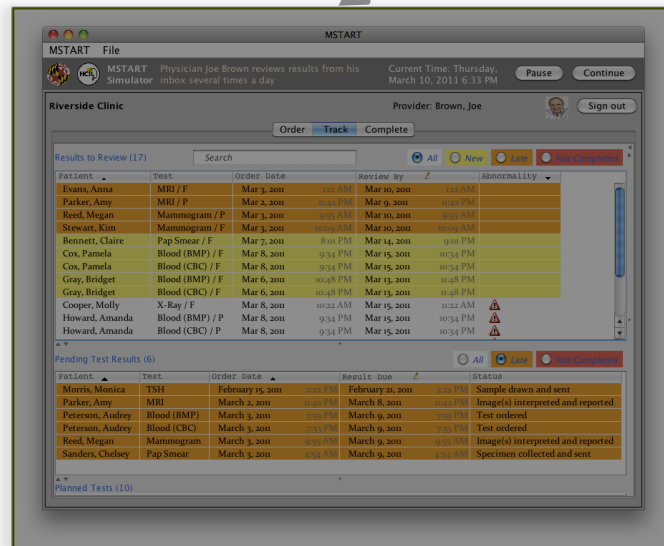
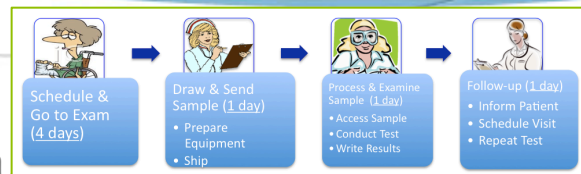
Manager



# Solution

Physician,  
Resident,  
Assistant

Manager

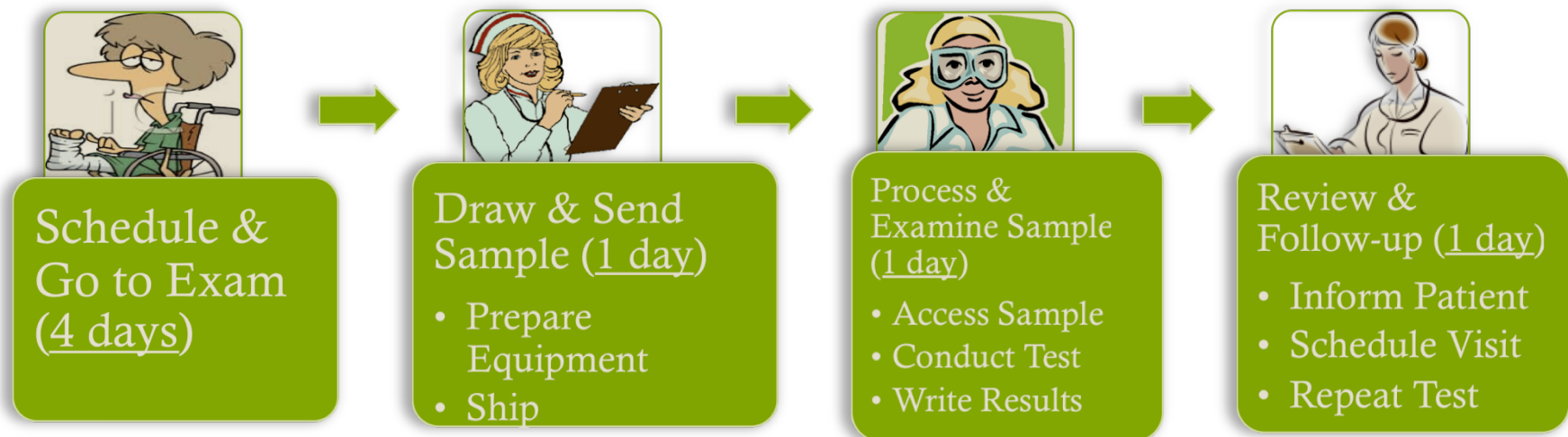


# Requirements Analysis

- ◆ Visits to 7 hospitals & clinics
- ◆ Observations of the medical workflow
- ◆ Electronic Health Record issues reported by clinicians
- ◆ Problems related to results management
- ◆ Design ideas about use cases, tables, delays, actions

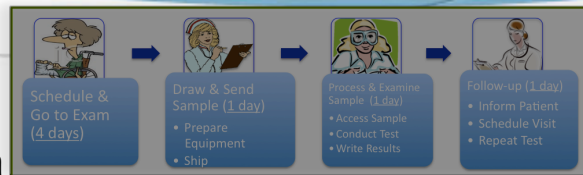


# Results Management Workflow & Actions



◆ [Aalst, 2005; Cass, 2000; Peterson, 1981; White, 2004]

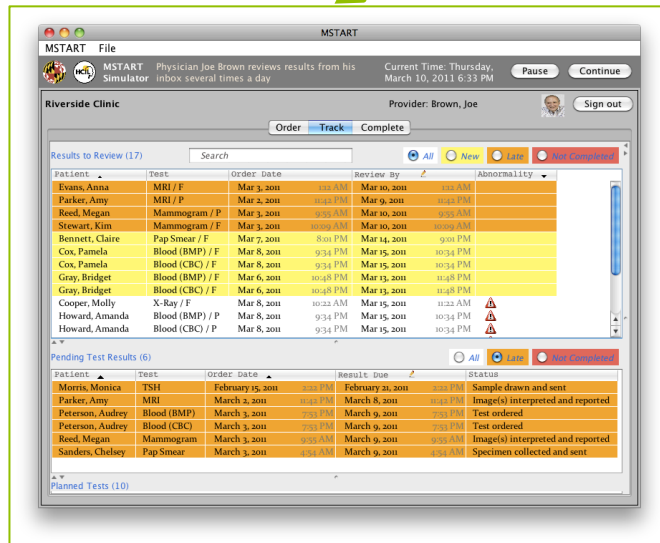
# Solution



Physician,  
Resident,  
Assistant

...

Manager



# Timely Management of Medical Orders: MStart

**MSTART** File

MSTART Simulator Physician Joe Brown reviews results from inbox several times a day

Current Time: Thursday, March 10, 2011 6:33 PM

Pause Continue

Riverside Clinic Provider: Brown, Joe Sign out

Track Complete

Results to Review (17)

Patient	Test	Order Date	Review By	Abnormality
Ans, Anna	M / F	Mar 3, 2011 1:12 AM	Mar 10, 2011 1:12 AM	
Parker, Amy	M / P	Mar 2, 2011 11:42 PM	Mar 9, 2011 11:42 PM	
Reed, Megan	Mammogram / P	Mar 3, 2011 9:55 AM	Mar 10, 2011 9:55 AM	
Stewart, Kim	Mammogram / F	Mar 3, 2011 10:09 AM	Mar 10, 2011 10:09 AM	
Bennett, Maire	Pap Smear / F	Mar 7, 2011 8:01 PM	Mar 14, 2011 9:01 PM	
Cox, Pamela	Blood (BMP) / F	Mar 8, 2011 9:34 PM	Mar 15, 2011 10:34 PM	
Cox, Pamela	Blood (CBC) / F	Mar 8, 2011 9:34 PM	Mar 15, 2011 10:34 PM	
Gray, Bridget	Blood (BMP) / F	Mar 6, 2011 10:48 PM	Mar 13, 2011 11:48 PM	
Gray, Bridget	Blood (CBC) / F	Mar 6, 2011 10:48 PM	Mar 13, 2011 11:48 PM	
Cooper, Molly	X-Ray / F	Mar 8, 2011 10:22 AM	Mar 15, 2011 11:22 AM	⚠
Howard, Amanda	Blood (BMP) / P	Mar 8, 2011 9:34 PM	Mar 15, 2011 10:34 PM	⚠
Howard, Amanda	Blood (CBC) / P	Mar 8, 2011 9:34 PM	Mar 15, 2011 10:34 PM	⚠

Pending Test Results (6)

Patient	Test	Order Date	Result Due	Status
Morris, Monica	TSH	February 15, 2011 2:22 PM	February 21, 2011 2:22 PM	Sample drawn and sent
Parker, Amy	MRI	March 2, 2011 11:42 PM	March 8, 2011 11:42 PM	Image(s) interpreted and reported
Peterson, Audrey	Blood (BMP)	March 3, 2011 7:53 PM	March 9, 2011 7:53 PM	Test ordered
Peterson, Audrey	Blood (CBC)	March 3, 2011 7:53 PM	March 9, 2011 7:53 PM	Test ordered
Reed, Megan	Mammogram	March 3, 2011 9:55 AM	March 9, 2011 9:55 AM	Image(s) interpreted and reported
Sanders, Chelsey	Pap Smear	March 3, 2011 4:54 AM	March 9, 2011 4:54 AM	Specimen collected and sent

Planned Tests (10)

# Timely Management of Medical Results: ARC

MSTART

MSTART File

MSTART Simulator Physician Joe Brown reviews results from his inbox several times a day

Current Time: Thursday, March 10, 2011 6:33 PM

Pause Continue

Riverside Clinic

Provider: Brown, Joe

Sign out

Order Track Complete

Results to Review (17)

Search

All New Late Not Completed

Patient	Test	Order Date	Review By	Abnormality
Evans, Anna	MRI / F	Mar 3, 2011 1:12 AM	Mar 10, 2011 1:12 AM	

NAME: Evans, Anna  
STUDY DATE: 03/09/2011 4:28:29 PM  
COMPARISON: None available  
HISTORY: Pain  
MRI OF THE RIGHT ANKLE (WITHOUT IV CONTRAST)  
FINDINGS:  
The bones demonstrate no fracture or gross marrow abnormality. Articular surfaces are within normal limits.  
The spring ligament complex appears to be intact.  
The tibialis posterior, flexor digitorum, and flexor hallucis longus tendons are intact. The peroneus brevis and longus tendons are intact. The Achilles tendon is intact.  
The tarsal sinus is unremarkable. There are no significant fluid collections to suggest ligamentous injury.  
The remaining muscles and soft tissues are unremarkable.

Ask Nurse to

☐ No Follow-up

☐ Inform Patient (Evans, Anna)

☐ Schedule Visit

Order

☐ Repeat Test

Comments:

Review Later Complete

Patient	Test	Order Date	Result Due	Status
Morris, Monica	TSH	Mar 2, 2011	Mar 8, 2011	Sample drawn and sent
Parker, Amy	MRI	Mar 2, 2011	Mar 8, 2011	Image(s) interpreted and reported
Peterson, Audrey	Blood (BMP)	Mar 3, 2011	Mar 9, 2011	Test ordered
Peterson, Audrey	Blood (CBC)	Mar 3, 2011	Mar 9, 2011	Test ordered
Reed, Megan	Mammogram	Mar 3, 2011	Mar 9, 2011	Image(s) interpreted and reported
Sanders, Chelsey	Pap Smear	Mar 3, 2011	Mar 9, 2011	Specimen collected and sent

Planned Tests (10)



# Evaluations

- ◆ Iterative Design Reviews with Medical Professionals
- ◆ Controlled Experiment for Awareness of Order Timeliness
- ◆ Evaluations of Actions for Rapid Completion

# Iterative Design Reviews with Medical Professionals

- ◆ Participatory design [Greenbaum and Kyng, 1991]
- ◆ Medicine, human-computer interaction, or software engineering
- ◆ 40 or more clinicians
- ◆ 15 presentations + 6 meetings
- ◆ 30 mins to 2 h each
- ◆ Live demonstration or with interactive executable
- ◆ Nov, 2010 – Jun, 2011 & Jan – May, 2012

# Iterative Design Reviews with Medical Professionals

- ◆ Feedback on guidelines and evaluation
- ◆ Suggestions from a graphic designer
- ◆ Refinements to results management workflow
- ◆ Updates to prototype interface and interactions
- ◆ Design of retrospective analysis visualization

# Controlled Experiment for Awareness of Order Timeliness

- Quantify the benefit of
  - showing a list of pending orders
  - prioritizing by lateness information
- Compare 3 versions
  - Time to answer question: what is late/lost?

Riverside Clinic  
Evaluation Setting  
Current Time: Friday, October 26, 2012  
6:10 PM  
Pause Continue  
Provider: Brown, Joe  
Sign out

Order Track Complete  
Search

Results to Review (11)

Patient	Test	Ordered By	Arrival Date	Abnormality
Peterson, Audrey	MRI / F	Brown, Joe (P)	10/26/2012@09:53	Abnormal
Black, Sue	X-Ray / F	Brown, Joe (P)	10/26/2012@12:59	Abnormal
Stewart, Kim	X-Ray / F	Brown, Joe (P)	10/26/2012@17:47	Abnormal
Morris, Monica	X-Ray / F	Brown, Joe (P)	10/26/2012@19:28	Normal
Baker, Isabel	Rapid Strep Test / F	Brown, Joe (P)	10/26/2012@19:38	Normal
Wood, Courtney	MRI / F	Brown, Joe (P)	10/26/2012@19:55	Abnormal
James, Britney	Blood Test (BMP) / F	Brown, Joe (P)	10/26/2012@19:55	Abnormal
Ward, Andrea	Blood Test (CBC) / F	Brown, Joe (P)	10/26/2012@19:56	Abnormal
Ball, Lindsay	Blood Test (CBC) / F	Brown, Joe (P)	10/26/2012@19:59	Abnormal
Smith, Kathy	Blood Test (BMP) / F	Brown, Joe (P)	10/26/2012@19:59	Abnormal
Brooks, Caitlyn	Rapid Strep Test / F	Brown, Joe (P)	10/26/2012@19:54	Normal

Riverside Clinic  
Evaluation Setting  
Current Time: Friday, October 26, 2012  
6:10 PM  
Pause Continue  
Provider: Brown, Joe  
Sign out

Order Track Complete  
Search

Results to Review (11)

Patient	Test	Ordered By	Arrival Date	Abnormality
Green, Robbie	Blood Test (CBC) / F	Brown, Joe (P)	10/26/2012	Normal
Parker, Amy	Rapid Strep Test / F	Brown, Joe (P)	10/26/2012	Abnormal
Wood, Courtney	X-Ray / F	Brown, Joe (P)	10/26/2012	Abnormal
Ball, Lindsay	Rapid Strep Test / F	Brown, Joe (P)	10/26/2012	Normal
Edwards, Rachel	Blood Test (BMP) / F	Brown, Joe (P)	10/26/2012	Abnormal
Smith, Kathy	Blood Test (BMP) / F	Brown, Joe (P)	10/26/2012	Normal
Campbell, Jessica	Blood Test (CBC) / F	Brown, Joe (P)	10/26/2012	Abnormal
Murphy, Sabrina	MRI / F	Brown, Joe (P)	10/26/2012	Abnormal
White, Jane	Blood Test (BMP) / F	Brown, Joe (P)	10/26/2012	Abnormal
Richardson, Allison	Blood Test (CBC) / F	Brown, Joe (P)	10/26/2012	Abnormal
James, Britney	Rapid Strep Test / F	Brown, Joe (P)	10/26/2012	Abnormal

Pending Test Results (9)

Patient	Test	Order Date
Ball, Lindsay	Dietetics	10/24/2012
Cook, Lisa	Dietetics	10/24/2012
Watson, Brooke	Blood Test (CBC)	10/23/2012
Ward, Andrea	Rapid Strep Test	10/23/2012
Parker, Amy	Dietetics	10/23/2012
Richardson, Allison	Rapid Strep Test	10/23/2012
Doe, Jo	Blood Test (BMP)	10/23/2012
Edwards, Rachel	X-Ray	10/23/2012
Edwards, Rachel	Dietetics	10/23/2012

Riverside Clinic  
Evaluation Setting  
Current Time: Friday, October 26, 2012  
6:10 PM  
Pause Continue  
Provider: Brown, Joe  
Sign out

Order Track Complete  
Search

Results to Review (12)

Patient	Test	Order Date	Review By	Abnormality
Kelly, Cecilia	MRI / F	October 23, 2012	October 23, 2012	Abnormal
Evans, Anna	Blood Test (CBC) / F	October 23, 2012	October 24, 2012	Abnormal
Black, Sue	Blood Test (BMP) / F	October 23, 2012	October 24, 2012	Abnormal
Ragan, Emma	Blood Test (BMP) / F	October 23, 2012	October 23, 2012	Abnormal
Baker, Isabel	Blood Test (BMP) / F	October 23, 2012	October 24, 2012	Abnormal
Cooper, Molly	MRI / F	October 23, 2012	October 24, 2012	Abnormal
Collins, Emily	Rapid Strep Test / F	October 24, 2012	October 24, 2012	Abnormal
Campbell, Jessica	Blood Test (CBC) / F	October 24, 2012	October 24, 2012	Abnormal
Richardson, Allison	Rapid Strep Test / F	October 23, 2012	October 23, 2012	Normal
Edwards, Rachel	MRI / F	October 23, 2012	October 24, 2012	Normal
Richardson, Allison	Blood Test (BMP) / F	October 23, 2012	October 23, 2012	Normal
Collins, Emily	Blood Test (BMP) / F	October 23, 2012	October 23, 2012	Normal

Pending Test Results (8)

Patient	Test	Order Date	Status
Bennett, Claire	Blood Test (CBC)	October 23, 2012	Test ordered
Cook, Lisa	X-Ray	October 23, 2012	Test ordered
Sanders, Chelsey	Blood Test (CBC)	October 23, 2012	Test ordered
Ball, Lindsay	Audiometry	October 23, 2012	Test ordered
James, Britney	Audiometry	October 23, 2012	Exam scheduled
Watson, Brooke	Audiometry	October 23, 2012	Exam scheduled
Collins, Emily	Dietetics	October 24, 2012	Test ordered
Phillips, Sarah	Dietetics	October 24, 2012	Exam scheduled



# Provide list of orders

10/22/2012

Bell, Lindsay	Blood Test (CBC)
Brooks, Caitlyn	Rapid Strep Test
Evans, Anna	Blood Test (BMP)
Smith, Kathy	Blood Test (BMP)

10/23/2012

Bailey, Isabel	Dietetics
Bailey, Isabel	Rapid Strep Test
Black, Sue	X-Ray
Brooks, Caitlyn	X-Ray
Doe, Jo	MRI
James, Britney	Blood Test (BMP)
Parker, Amy	Audiometry
Peterson, Audrey	MRI
Richardson, Allison	Dietetics
Stewart, Kim	X-Ray
Ward, Andrea	Blood Test (CBC)
Wood, Courtney	Blood Test (CBC)
Wood, Courtney	MRI

10/24/2012


Bell, Lindsay	Blood Test (BMP)
Brooks, Caitlyn	Audiometry
Morris, Monica	X-Ray

	Expected Duration (Days)	Considered Lost After (Days)
Imaging and Lab Tests	1	4
Blood Tests [BMP or CBC] Rapid Strep Test MRI X-Ray Mammogram		
Consultations	3	16
Dietetics Audiometry		

A distraction task...



# Results only (sorted by time received)

 MSTART Simulator

Evaluation Setting


Current Time: Friday, October 26, 2012 6:10 PM

Pause

Continue

Riverside Clinic

Provider: Brown, Joe



Sign out

Order

Track

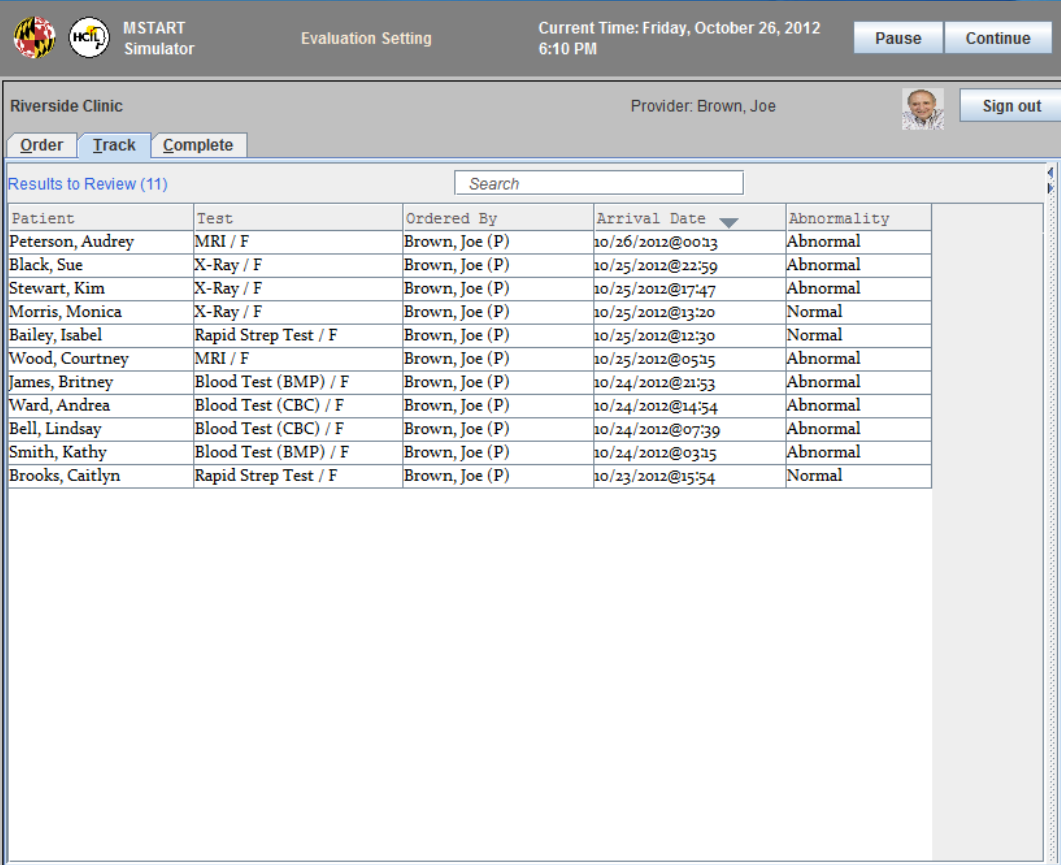
Complete

Results to Review (11)

Search

Patient	Test	Ordered By	Arrival Date	Abnormality
Peterson, Audrey	MRI / F	Brown, Joe (P)	10/26/2012@00:13	Abnormal
Black, Sue	X-Ray / F	Brown, Joe (P)	10/25/2012@22:59	Abnormal
Stewart, Kim	X-Ray / F	Brown, Joe (P)	10/25/2012@17:47	Abnormal
Morris, Monica	X-Ray / F	Brown, Joe (P)	10/25/2012@13:20	Normal
Bailey, Isabel	Rapid Strep Test / F	Brown, Joe (P)	10/25/2012@12:30	Normal
Wood, Courtney	MRI / F	Brown, Joe (P)	10/25/2012@05:35	Abnormal
James, Britney	Blood Test (BMP) / F	Brown, Joe (P)	10/24/2012@21:53	Abnormal
Ward, Andrea	Blood Test (CBC) / F	Brown, Joe (P)	10/24/2012@14:54	Abnormal
Bell, Lindsay	Blood Test (CBC) / F	Brown, Joe (P)	10/24/2012@07:39	Abnormal
Smith, Kathy	Blood Test (BMP) / F	Brown, Joe (P)	10/24/2012@03:35	Abnormal
Brooks, Caitlyn	Rapid Strep Test / F	Brown, Joe (P)	10/23/2012@15:54	Normal

# Results only (sorted by time received)



The screenshot shows the MSTART Simulator interface for Riverside Clinic. The top header includes the MSTART Simulator logo, 'Evaluation Setting', and the current time: Friday, October 26, 2012, 6:10 PM. There are 'Pause' and 'Continue' buttons. Below the header, the clinic name 'Riverside Clinic' and provider 'Brown, Joe' are displayed. A 'Sign out' button is next to the provider's name. The main section is titled 'Results to Review (11)' and contains a table of test results. The table has columns for Patient, Test, Ordered By, Arrival Date, and Abnormality. The results are sorted by arrival date, with the earliest at the bottom and the latest at the top.

Patient	Test	Ordered By	Arrival Date	Abnormality
Peterson, Audrey	MRI / F	Brown, Joe (P)	10/26/2012@00:13	Abnormal
Black, Sue	X-Ray / F	Brown, Joe (P)	10/25/2012@22:59	Abnormal
Stewart, Kim	X-Ray / F	Brown, Joe (P)	10/25/2012@17:47	Abnormal
Morris, Monica	X-Ray / F	Brown, Joe (P)	10/25/2012@13:20	Normal
Bailey, Isabel	Rapid Strep Test / F	Brown, Joe (P)	10/25/2012@12:30	Normal
Wood, Courtney	MRI / F	Brown, Joe (P)	10/25/2012@05:35	Abnormal
James, Britney	Blood Test (BMP) / F	Brown, Joe (P)	10/24/2012@21:53	Abnormal
Ward, Andrea	Blood Test (CBC) / F	Brown, Joe (P)	10/24/2012@14:54	Abnormal
Bell, Lindsay	Blood Test (CBC) / F	Brown, Joe (P)	10/24/2012@07:39	Abnormal
Smith, Kathy	Blood Test (BMP) / F	Brown, Joe (P)	10/24/2012@03:15	Abnormal
Brooks, Caitlyn	Rapid Strep Test / F	Brown, Joe (P)	10/23/2012@15:54	Normal

Which orders are late? Lost?



# Results only (sorted by time received)

(Compare with orders)

10/22/2012


Bell, Lindsay	Blood Test (CBC)
Brooks, Caitlyn	Rapid Strep Test
Evans, Anna	Blood Test (BMP)
Smith, Kathy	Blood Test (BMP)

10/23/2012

Bailey, Isabel	Dietetics
Bailey, Isabel	Rapid Strep Test
Black, Sue	X-Ray
Brooks, Caitlyn	X-Ray
Doe, Jo	MRI
James, Britney	Blood Test (BMP)
Parker, Amy	Audiometry
Peterson, Audrey	MRI
Richardson, Allison	Dietetics
Stewart, Kim	X-Ray
Ward, Andrea	Blood Test (CBC)
Wood, Courtney	Blood Test (CBC)
Wood, Courtney	MRI

10/24/2012

Bell, Lindsay	Blood Test (BMP)
Brooks, Caitlyn	Audiometry
Morris, Monica	X-Ray


MSTART  
Simulator

Evaluation Setting


Current Time: Friday, October 26, 2012  
6:10 PM

Pause

Continue

Riverside Clinic

Provider: Brown, Joe


Sign out

Order Track Complete

Results to Review (11)

Search

Patient	Test	Ordered By	Arrival Date	Abnormality
Peterson, Audrey	MRI / F	Brown, Joe (P)	10/26/2012@00:13	Abnormal
Black, Sue	X-Ray / F	Brown, Joe (P)	10/25/2012@22:59	Abnormal
Stewart, Kim	X-Ray / F	Brown, Joe (P)	10/25/2012@17:47	Abnormal
Morris, Monica	X-Ray / F	Brown, Joe (P)	10/25/2012@13:20	Normal
Bailey, Isabel	Rapid Strep Test / F	Brown, Joe (P)	10/25/2012@12:30	Normal
Wood, Courtney	MRI / F	Brown, Joe (P)	10/25/2012@05:35	Abnormal
James, Britney	Blood Test (BMP) / F	Brown, Joe (P)	10/24/2012@21:53	Abnormal
Ward, Andrea	Blood Test (CBC) / F	Brown, Joe (P)	10/24/2012@14:54	Abnormal
Bell, Lindsay	Blood Test (CBC) / F	Brown, Joe (P)	10/24/2012@07:39	Abnormal
Smith, Kathy	Blood Test (BMP) / F	Brown, Joe (P)	10/24/2012@03:15	Abnormal
Brooks, Caitlyn	Rapid Strep Test / F	Brown, Joe (P)	10/23/2012@15:54	Normal

Which orders are late? Lost?

# Add pending orders

(Compare with orders)

10/22/2012


Bell, Lindsay	Blood Test (CBC)
Brooks, Caitlyn	Rapid Strep Test
Evans, Anna	Blood Test (BMP)
Smith, Kathy	Blood Test (BMP)

10/23/2012

Bailey, Isabel	Dietetics
Bailey, Isabel	Rapid Strep Test
Black, Sue	X-Ray
Brooks, Caitlyn	X-Ray
Doe, Jo	MRI
James, Britney	Blood Test (BMP)
Parker, Amy	Audiometry
Peterson, Audrey	MRI
Richardson, Allison	Dietetics
Stewart, Kim	X-Ray
Ward, Andrea	Blood Test (CBC)
Wood, Courtney	Blood Test (CBC)
Wood, Courtney	MRI

10/24/2012

Bell, Lindsay	Blood Test (BMP)
Brooks, Caitlyn	Audiometry
Morris, Monica	X-Ray


MSTART Simulator

Evaluation Setting


Current Time: Friday, October 26, 2012  
6:10 PM

Pause

Continue

Riverside Clinic

Provider: Brown, Joe


Sign out

Order

Track

Complete

Results to Review (11)

Search

Patient	Test	Ordered By	Arrival Date	Abnormality
Green, Bobbie	Blood Test (CBC) / F	Brown, Joe (P)	10/25/2012	Normal
Parker, Amy	Rapid Strep Test / F	Brown, Joe (P)	10/25/2012	Abnormal
Wood, Courtney	X-Ray / F	Brown, Joe (P)	10/25/2012	Abnormal
Bell, Lindsay	Rapid Strep Test / F	Brown, Joe (P)	10/25/2012	Normal
Edwards, Rachel	Blood Test (BMP) / F	Brown, Joe (P)	10/24/2012	Abnormal
Smith, Kathy	Blood Test (BMP) / F	Brown, Joe (P)	10/24/2012	Normal
Campbell, Jessica	Blood Test (CBC) / F	Brown, Joe (P)	10/24/2012	Abnormal
Murphy, Sabrina	MRI / F	Brown, Joe (P)	10/24/2012	Abnormal
White, Jane	Blood Test (BMP) / F	Brown, Joe (P)	10/24/2012	Abnormal
Richardson, Allison	Blood Test (CBC) / F	Brown, Joe (P)	10/24/2012	Abnormal
James, Britney	Rapid Strep Test / F	Brown, Joe (P)	10/24/2012	Abnormal

Pending Test Results (9)

Patient	Test	Order Date
Bell, Lindsay	Dietetics	10/24/2012
Cook, Lisa	Dietetics	10/24/2012
Watson, Brooke	Blood Test (CBC)	10/23/2012
Ward, Andrea	Rapid Strep Test	10/23/2012
Parker, Amy	Dietetics	10/23/2012
Richardson, Allison	Rapid Strep Test	10/22/2012
Doe, Jo	Blood Test (BMP)	10/22/2012
Edwards, Rachel	X-Ray	10/22/2012
Edwards, Rachel	Dietetics	10/22/2012

Which orders are late? Lost?

# Add pending orders (with lateness information)

(Compare with orders)

10/22/2012


Bell, Lindsay	Blood Test (CBC)
Brooks, Caitlyn	Rapid Strep Test
Evans, Anna	Blood Test (BMP)
Smith, Kathy	Blood Test (BMP)

10/23/2012

Bailey, Isabel	Dietetics
Bailey, Isabel	Rapid Strep Test
Black, Sue	X-Ray
Brooks, Caitlyn	X-Ray
Doe, Jo	MRI
James, Britney	Blood Test (BMP)
Parker, Amy	Audiometry
Peterson, Audrey	MRI
Richardson, Allison	Dietetics
Stewart, Kim	X-Ray
Ward, Andrea	Blood Test (CBC)
Wood, Courtney	Blood Test (CBC)
Wood, Courtney	MRI

10/24/2012

Bell, Lindsay	Blood Test (BMP)
Brooks, Caitlyn	Audiometry
Morris, Monica	X-Ray


MSTART Simulator

Evaluation Setting

Current Time: Friday, October 26, 2012 6:10 PM

Pause Continue

Riverside Clinic

Provider: Brown, Joe

Sign out

Order Track Complete

Results to Review (12)

Search

Patient	Test	Order Date	Review By	Abnormality
Kelly, Cecelia	MRI / F	October 22, 2012	October 23, 2012	Abnormal
Evans, Anna	Blood Test (CBC) / F	October 23, 2012	October 24, 2012	Abnormal
Black, Sue	Blood Test (BMP) / F	October 23, 2012	October 24, 2012	Abnormal
Rogers, Emma	Blood Test (BMP) / F	October 23, 2012	October 23, 2012	Abnormal
Bailey, Isabel	Blood Test (BMP) / F	October 23, 2012	October 24, 2012	Abnormal
Cooper, Molly	MRI / F	October 23, 2012	October 24, 2012	Abnormal
Collins, Emily	Rapid Strep Test / F	October 24, 2012	October 24, 2012	Abnormal
Campbell, Jessica	Blood Test (CBC) / F	October 23, 2012	October 24, 2012	Abnormal
Richardson, Allison	Rapid Strep Test / F	October 22, 2012	October 23, 2012	Normal
Edwards, Rachel	MRI / F	October 23, 2012	October 24, 2012	Normal
Richardson, Allison	Blood Test (BMP) / F	October 22, 2012	October 23, 2012	Normal
Collins, Emily	Blood Test (BMP) / F	October 23, 2012	October 24, 2012	Normal

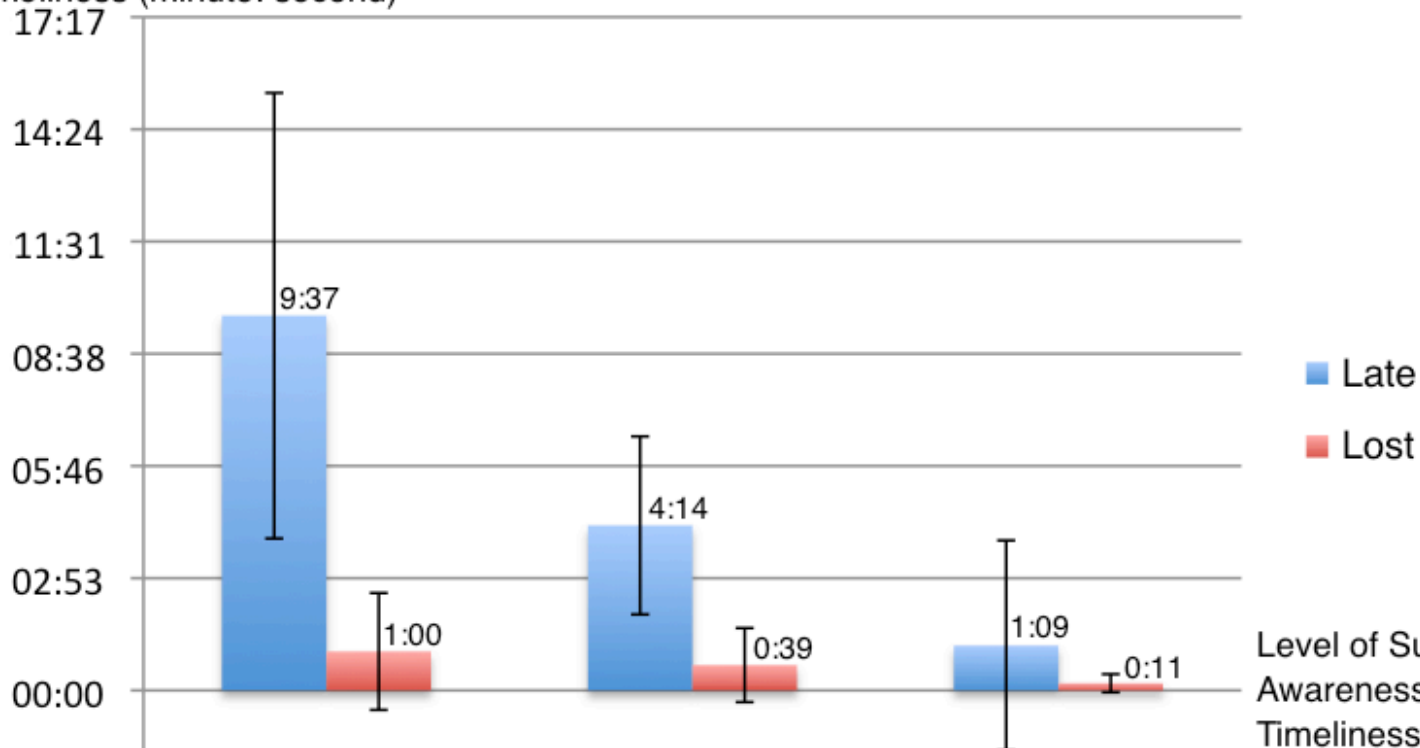
Pending Test Results (8)


All Late Lost

Patient	Test	Order Date	Status
Bennett, Claire	Blood Test (CBC)	October 23, 2012	Test ordered
Cook, Lisa	X-Ray	October 22, 2012	Test ordered
Sanders, Chelsey	Blood Test (CBC)	October 22, 2012	Test ordered
Bell, Lindsay	Audiometry	October 23, 2012	Test ordered
James, Britney	Audiometry	October 22, 2012	Exam scheduled
Watson, Brooke	Audiometry	October 22, 2012	Exam scheduled
Collins, Emily	Dietetics	October 24, 2012	Test ordered
Phillips, Sarah	Dietetics	October 24, 2012	Exam scheduled

Which orders are late? Lost?

Time to correctly mark all order  
timeliness (minute: second)





HIVISTATOR


Simulation

Evaluation Setting


Current Time: Friday, October 20, 2012  
 6:10 PM

Riverside Clinic

Prodr: Brown, Joe



Patients	Test	Ordered By	Arrival Date	Abnormality
Peterson, Audrey	MRU / F	Brown, Joe (P)	10/26/201200:00:33	Abnormal
Black, Sue	N-Ray / F	Brown, Joe (P)	10/25/201208:10:59	Abnormal
Stewart, Kim	N-Ray / F	Brown, Joe (P)	10/25/201207:47:47	Abnormal
Morris, Monica	N-Ray / F	Brown, Joe (P)	10/25/201208:00:30	Normal
Bailey, Isabel	Rapid Strip Test / F	Brown, Joe (P)	10/25/201208:32:20	Normal
Wood, Courtney	MRU / F	Brown, Joe (P)	10/25/201208:05:35	Abnormal
Leite, Brittany	Blood Test (BAP) / F	Brown, Joe (P)	10/25/201208:13:54	Abnormal
Wind, Andrea	Blood Test (CBC) / F	Brown, Joe (P)	10/24/201208:13:34	Abnormal
Bell, Lindsay	Blood Test (CBC) / F	Brown, Joe (P)	10/24/201207:39:39	Abnormal
Smith, Kathy	Blood Test (BAP) / F	Brown, Joe (P)	10/24/201207:37:35	Abnormal
Brooks, Caitlyn	Rapid Strip Test / F	Brown, Joe (P)	10/23/201208:15:24	Normal



ESTIMATE

Generator

Evolution Setting

Current Time: Friday, October 26, 2012 4:10 PM

Passes

Sign on

Overview Clinic

Provider: Brown, Joe



Results to Review (11)

Search

Patient	Test	Ordered By	Arrival Date	Abnormality
Green, Bobbie	Blood Test (CBC) / F	Brown, Joe (F)	10/23/2012	Normal
Prokes, Amy	Rapid Strep / F	Brown, Joe (F)	10/25/2012	Abnormal
Wood, Courtney	X-Ray / F	Brown, Joe (F)	10/23/2012	Normal
Hall, Lindsay	Rapid Strep / F	Brown, Joe (F)	10/23/2012	Normal
Edwards, Rachel	Blood Test (BMP) / F	Brown, Joe (F)	10/24/2012	Abnormal
Sutton, Kaitly	Blood Test (BMP) / F	Brown, Joe (F)	10/24/2012	Normal
Campbell, James	Blood Test (BMP) / F	Brown, Joe (F)	10/24/2012	Abnormal
Whitney, Sabrina	MBI / F	Brown, Joe (F)	10/24/2012	Normal
White, Jesse	Blood Test (BMP) / F	Brown, Joe (F)	10/24/2012	Abnormal
Richardson, Allison	Blood Test (CBC) / F	Brown, Joe (F)	10/24/2012	Abnormal
Jones, Britney	Rapid Strep / F	Brown, Joe (F)	10/24/2012	Abnormal

Showing Test Results (0)

Patient	Test	Order Date
Hall, Lindsay	Dietetics	10/24/2012
Cook, Lisa	Dietetics	10/24/2012
Warden, Brooke	Blood Test (CBC)	10/23/2012
Vand, Andrea	Rapid Strep Test	10/23/2012
Wacker, Amy	Dietetics	10/23/2012
Richardson, Allison	Rapid Strep Test	10/23/2012
Choe, Jo	Blood Test (BMP)	10/23/2012
Edwards, Rachel	X-Ray	10/23/2012
Edwards, Rachel	Dietetics	10/23/2012



MILESTONE

Simulation
Simulation

Evaluation Settings
Current Time: Friday, October 26, 2012 6:50 PM
Pause
Continue

Overview Clinic
Provider: Brown, J.
Sign Out

Order
Track
Complete

Results to Review (12)

Patient	Test	Order Date	Review By	Abnormality
Kelly, Cecelia	MBP / F	October 24, 2012	October 23, 2012	Abnormal
Bliss, Anna	Blood Test (CBC) / F	October 24, 2012	October 24, 2012	Abnormal
Black, Sue	Blood Test (BMP) / F	October 24, 2012	October 24, 2012	Abnormal
Ragers, Emma	Blood Test (BMP) / F	October 24, 2012	October 23, 2012	Abnormal
Baker, Isabel	Blood Test (BMP) / F	October 24, 2012	October 24, 2012	Abnormal
Cooper, Kelly	MBP / F	October 24, 2012	October 24, 2012	Abnormal
Reed, Emily	Blood Test (CBC) / F	October 24, 2012	October 24, 2012	Abnormal
Campbell, Jesse	Blood Test (CBC) / F	October 24, 2012	October 24, 2012	Abnormal
Richardson, Allison	Rapid Strep / F	October 24, 2012	October 23, 2012	Normal
Smith, Rachel	MBP / F	October 24, 2012	October 23, 2012	Normal
Richardson, Allison	Blood Test (BMP) / F	October 24, 2012	October 23, 2012	Normal
Collins, Emily	Blood Test (BMP) / F	October 24, 2012	October 24, 2012	Normal

Showing Test Results (8)
▲
▼
Print

Patient	Test	Order Date	Review
Benjamin, Cassie	Blood Test (CBC)	October 24, 2012	Test ordered
Cook, Lisa	X-Ray	October 22, 2012	Test ordered
Stanton, Chelsey	Blood Test (CBC)	October 22, 2012	Test ordered
Leib, Lilydell	Audiometry	October 24, 2012	Test ordered
Jones, Britney	Audiometry	October 24, 2012	Exam scheduled
Watson, Brooke	Audiometry	October 24, 2012	Exam scheduled
Collins, Emily	Diastasis	October 24, 2012	Test ordered
Phillips, Sarah	Diastasis	October 24, 2012	Exam scheduled





# Predictive Model for Results Management

- ◆ Goals, Operators, Methods, and Selection rules (GOMS) [Card, 1983]
- ◆ Time to compare names  $\approx 0.5$  sec
- ◆  $2 < \text{time to look up a date} \leq 2.5$
- ◆  $3 \leq \text{time to compare dates} \leq 3.5$

# Evaluations of Actions for Rapid Completion

- ◆ Evaluating Time to Execute Actions
- ◆ Evaluating the Number of Steps

# Conventional Follow-up

Act on Result of MRI

Patient: Evans, Anna

Ordered By: Brown, Joe

**NAME:** Evans, Anna  
**STUDY DATE:** 03/09/2011 4:28:29 PM  
**COMPARISON:** None available  
**HISTORY:** Pain  
**MRI OF THE RIGHT ANKLE (WITHOUT IV CONTRAST)**  
**FINDINGS:**  
The bones demonstrate no fracture or gross marrow abnormality. Articular surfaces are within normal limits.  
The spring ligament complex appears to be intact.  
The tibialis posterior, flexor digitorum, and flexor hallucis longus tendons are intact. The peroneus brevis and longus tendons are intact. The Achilles tendon is intact.  
The tarsal sinus is unremarkable. There are no significant fluid collections to suggest ligamentous injury.  
The remaining muscles and soft tissues are unremarkable.

☐ No Follow-up  
**Ask Nurse to**  
☐ Inform Patient (Evans, Anna)  
☐ Schedule Visit 1 months  
**Order**  
☐ Repeat Test 1 months  
**New Test**  
**Medication**  
**Consultation**  
**See History**  
**Comments:**  
**Review Later** **Complete**

**Edit New Test**  
**Edit Medication**  
**Edit Consultation**

Patient	Test	Order Date	Result Due	Status
Morris, Monica	TSH	Mar 2, 2011	Mar 8, 2011	Sample drawn and sent
Parker, Amy	MRI	Mar 2, 2011	Mar 8, 2011	Image(s) interpreted and reported
Peterson, Audrey	Blood (BMP)	Mar 3, 2011	Mar 9, 2011	Test ordered
Peterson, Audrey	Blood (CBC)	Mar 3, 2011	Mar 9, 2011	Test ordered
Reed, Megan	Mammogram	Mar 3, 2011	Mar 9, 2011	Image(s) interpreted and reported
Sanders, Chelsey	Pap Smear	Mar 3, 2011	Mar 9, 2011	Specimen collected and sent

Planned Tests (10)

# Evaluating Time to Execute Actions★

Action	Conventional	ARC	ARC w/ Keyboard
Review Later	30s	28s (7%)	26s (13%)
Inform Patient + Confirm	44s	39s (11%)	29s (34%)
Inform Patient + Repeat Test (1 mo) + Confirm	51s	42s (18%)	34s (33%)
Inform Patient + Schedule Visit (1 w) + Confirm	1m 8s	51s (25%)	41s (40%)
No Follow-up (Other) + Confirm	1m 2s	53s (15%)	49s (21%)

★Measured Difference: 10 orders w/o distraction

# Evaluating the Number of Steps

Action	OpenVista	Allscripts	ARC
Inform Patient	-	6	3 (50%)
Confirm	-	5	2 (60%)
No Follow-up	-	4	4 (0%)
Repeat Test	17	-	5 (71%)
Schedule Visit	12	-	5 (58%)



# Design Guidelines

- ◆ Results management design guidelines (8)
- ◆ Table design guidelines (65)
- ◆ Actions for rapid completion design guidelines (17)

# Results Management Design Guidelines

- ◆ Show pending orders
- ◆ Prioritize by late/lost status
- ◆ Embed actions when appropriate
- ◆ Provide retrospective analysis

# Table Design Guidelines

Notifications						
Info	Patient	Location	Urgency	Alert Date/Time	Message	Forwarded By/When
	Patient, Test132		Moderate	01/01/2010@03:14	Scheduled Consult: ORTHOPEDICS	
	Patient, Test164		Moderate	01/01/2010@15:09	Scheduled Consult: NON-INVASIVE ECHO	
	Patient, Test243		Moderate	01/02/2010@02:06	COMPLETED EMERGENCY ROOM NOTE available for ADD'L	
	Patient, Test32		HIGH	01/02/2010@05:35	Medications Nearing expiration	
	Patient, Test17		Moderate	01/02/2010@08:09	Imaging request held: KNEE 3 VIEWS, LEFT	
	Patient, Test267	GM	Moderate	01/03/2010@07:09	Abnormal labs - [TROPONIN I]	
	Patient, Test165		Moderate	01/04/2010@03:23	Abnormal labs - [LIPID PROFILE, COMPREHENSIVE]	
	Patient, Test138		Moderate	01/04/2010@08:46	Abnormal labs - [BASIC METABOLIC PANEL]	
	Patient, Test106		Moderate	01/05/2010@02:06	Labs resulted - [MICROALBUMIN;URINE]	
	Patient, Test286		Moderate	01/05/2010@04:33	COMPLETED PHARMACY PATIENT ENCOUNTER available for	
	Patient, Test362	GM	HIGH	01/05/2010@08:32	Critical lab: CR 2.3 05/27 05:00	
	Patient, Test151		Moderate	01/06/2010@07:09	Imaging Results, Non Critical: SPINE LUMBOSACRAL MIN 2 VI	
	Patient, Test209		Moderate	01/07/2010@05:00	Discontinued consult DERMATOLOGY	
	Patient, Test122	GM	Moderate	01/08/2010@02:08	Comment Added to Consult PAIN MANAGEMENT	
	Patient, Test305		HIGH	01/08/2010@08:41	Abnl Imaging Reslt; Needs Attn: CT ABDOMEN W&W/O CO	
	Patient, Test132		Moderate	01/08/2010@09:07	Completed Consult NURSING CASE MANAGEMENT	
	Patient, Test57		Moderate	01/08/2010@16:09	Abnl Imaging Reslt; Needs Attn: MAGNETIC IMAGE LUMBAR S	
	Patient, Test160		Moderate	01/09/2010@03:09	UNSIGNED PRIMARY CARE FOLLOW-UP available for SIGNA	

# Table Design Guidelines

- Sorting, icons, colors, columns, labels, filters, layout

All

New

Late

Patient ▲	Test	Order Date		Review By 📅		Abnormality ▼
Evans, Anna	MRI / F	Mar 3, 2011	1:12 AM	Mar 10, 2011	1:12 AM	
Parker, Amy	MRI / P	Mar 2, 2011	11:42 PM	Mar 9, 2011	11:42 PM	
Reed, Megan	Mammogram / P	Mar 3, 2011	9:55 AM	Mar 10, 2011	9:55 AM	
Stewart, Kim	Mammogram / F	Mar 3, 2011	10:09 AM	Mar 10, 2011	10:09 AM	
Cooper, Molly	X-Ray / F	Mar 8, 2011	10:22 AM	Mar 15, 2011	11:22 AM	⚠
Howard, Amanda	Blood (BMP) / P	Mar 8, 2011	9:34 PM	Mar 15, 2011	10:34 PM	⚠

[Few, 2004; MSCUI, 2008; Tullis, 2004]

# Actions for Rapid Completion Design Guidelines

☒ All
 ☐ New
 ☐ Late

Patient	Test	Order Date	Review By	Abnormality
Evans, Anna	MRI / F	Mar 3, 2011 1:12 AM	Mar 10, 2011 1:12 AM	
Parker, Amy	MRI / P	Mar 2, 2011 11:42 PM	Mar 9, 2011 11:42 PM	
Reed, Megan	Mammogram / P	Mar 3, 2011 9:55 AM	Mar 10, 2011 9:55 AM	
Stewart, Kim	Mammogram / F	Mar 3, 2011 10:09 AM	Mar 10, 2011 10:09 AM	
Cooper, Molly				
Howard, Ama				

☐ No Follow-up

#### Ask Nurse to

☐ Inform Patient (Stewart, Kim)

☐ Schedule Visit  ☐ days ☐ weeks ☒ months ☐ years

#### Order

☐ Repeat Test  ☐ days ☐ weeks ☒ months ☐ years

Comments:

?

Review Later

Complete

Procedure reported

Film screen mammography, both breasts.

Reason for procedure

Screening

Findings

Comparison was made to exam from 11/14/2001. The breasts are heterogeneously dense. This may lower the sensitivity of mammography. No significant masses, calcifications, or other abnormalities are present. There is no significant change from the prior exam.

Impressions

BI-RADS® Category 1: Negative. Recommend normal interval follow-up in 12 months

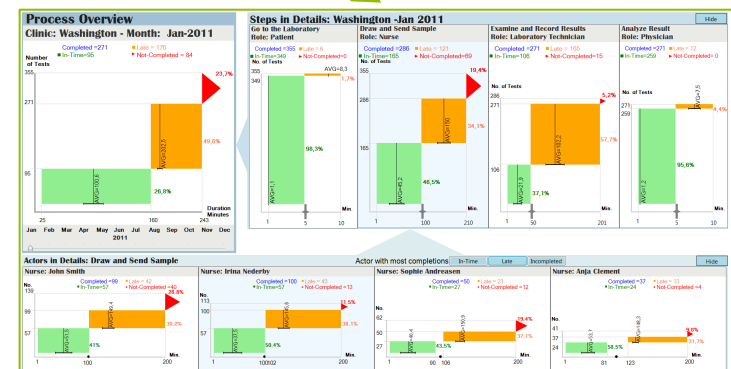
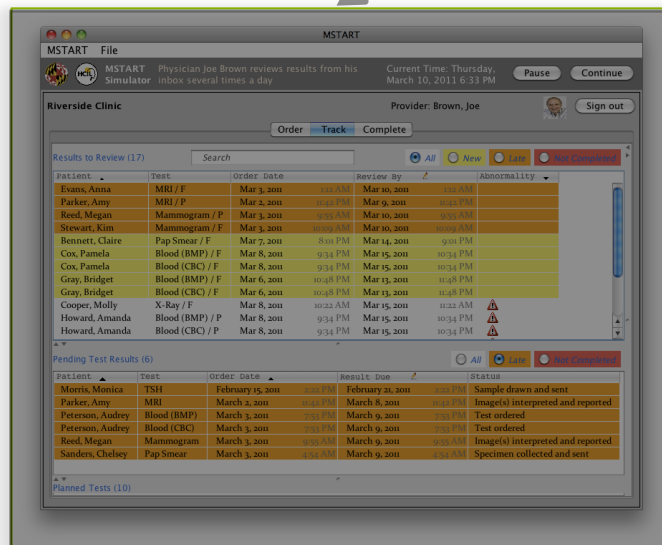


# Solution

Physician,  
Resident,  
Assistant

...

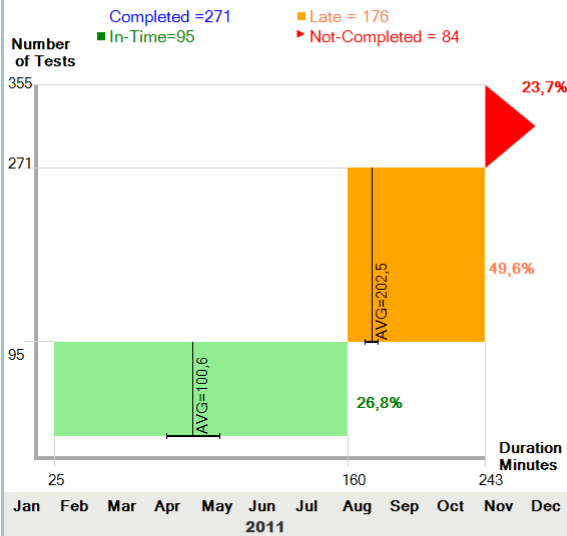
Manager



# Retrospective Analysis of Medical Orders: MSProVis

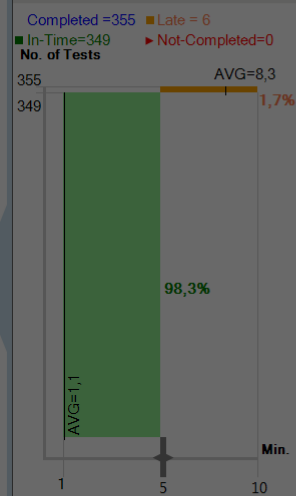
## Process Overview

Clinic: Washington - Month: Jan-2011

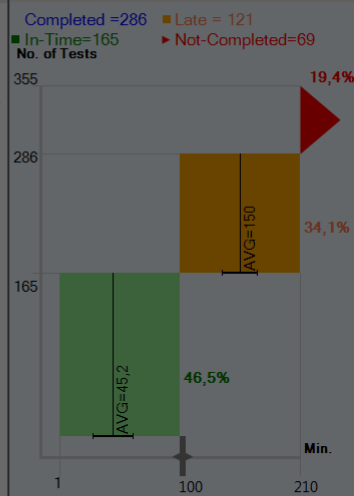


## Steps in Details: Washington - Jan 2011

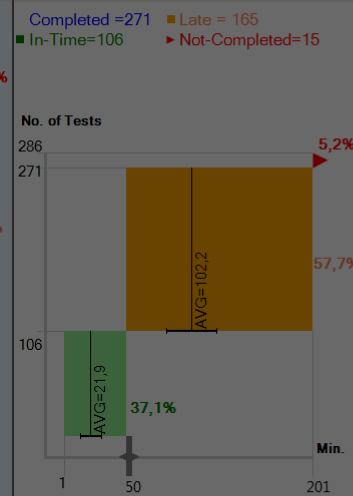
Go to the Laboratory  
Role: Patient



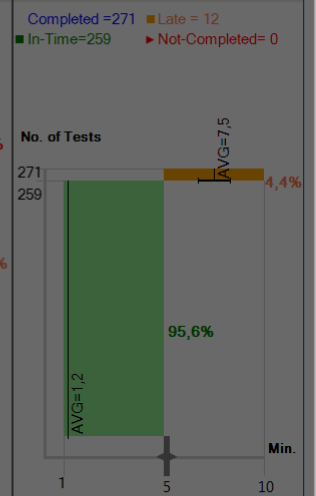
Draw and Send Sample  
Role: Nurse



Examine and Record Results  
Role: Laboratory Technician

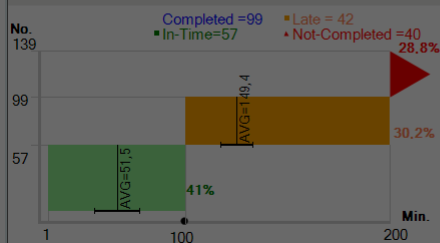


Analyze Result  
Role: Physician

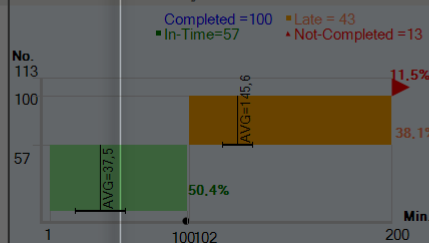


## Actors in Details: Draw and Send Sample

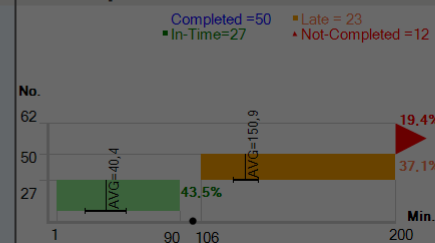
Nurse: John Smith



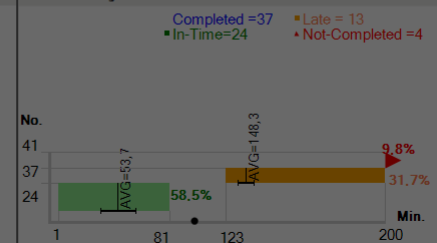
Nurse: Irina Nederby



Nurse: Sophie Andreasen



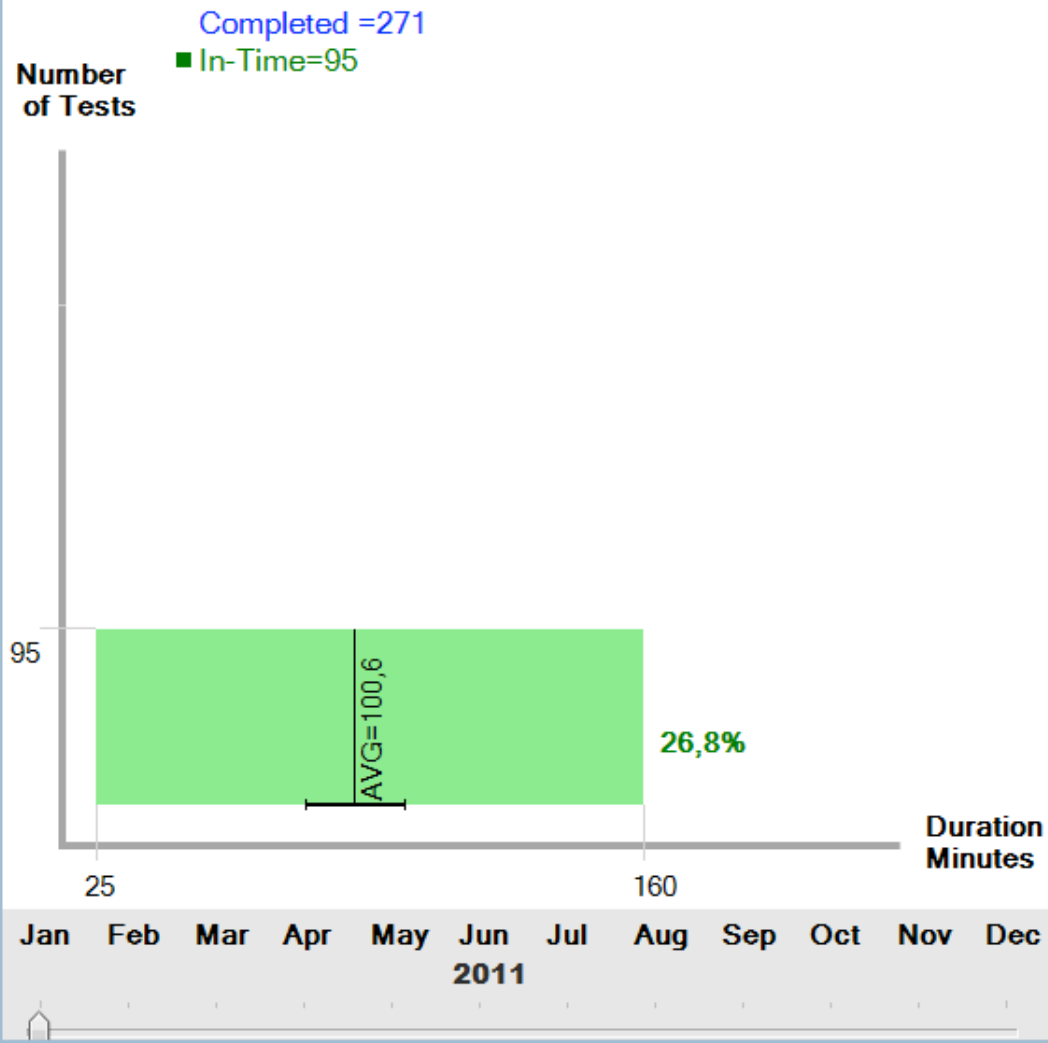
Nurse: Anja Clement



# Process Completion Diagram (PCD)

## Process Overview

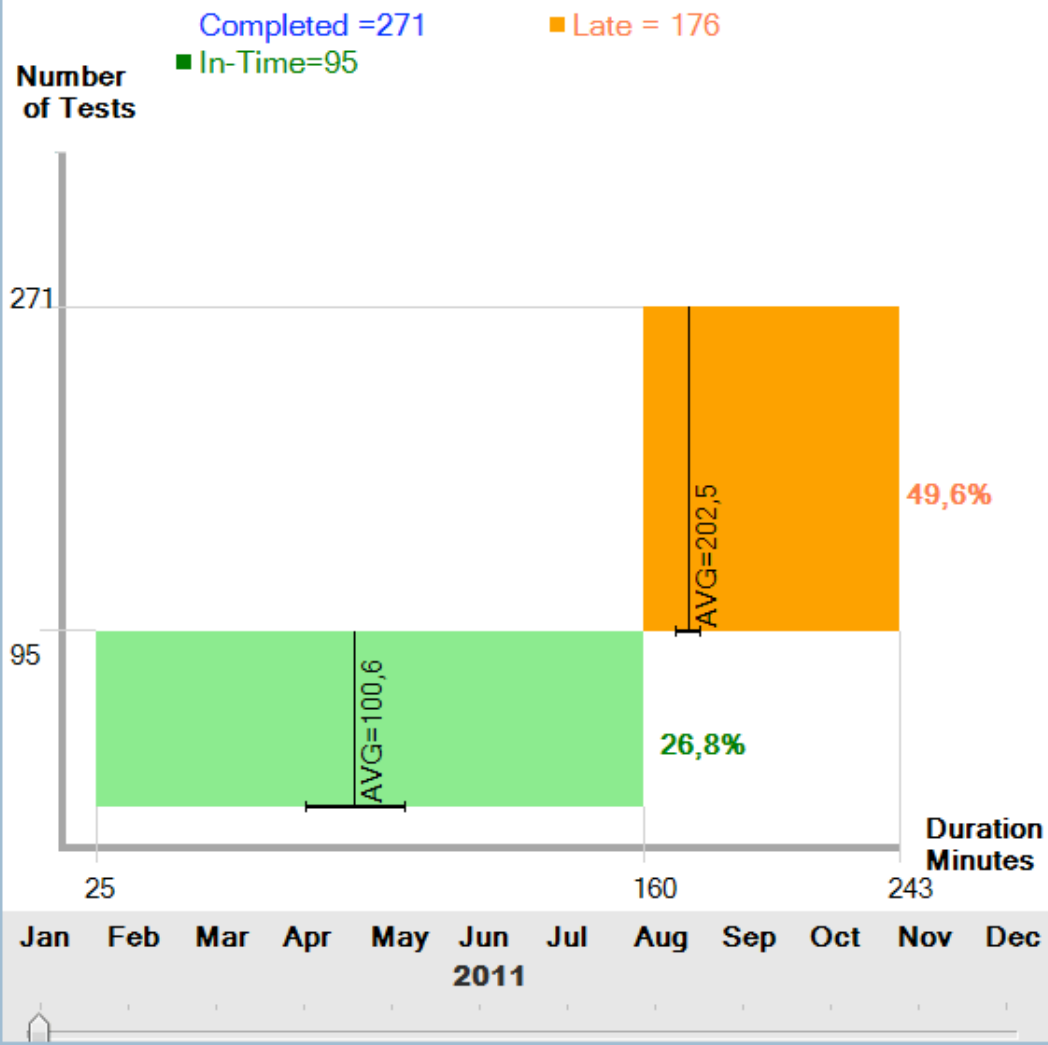
Clinic: Washington - Month: Jan-2011



# Process Completion Diagram (PCD)

## Process Overview

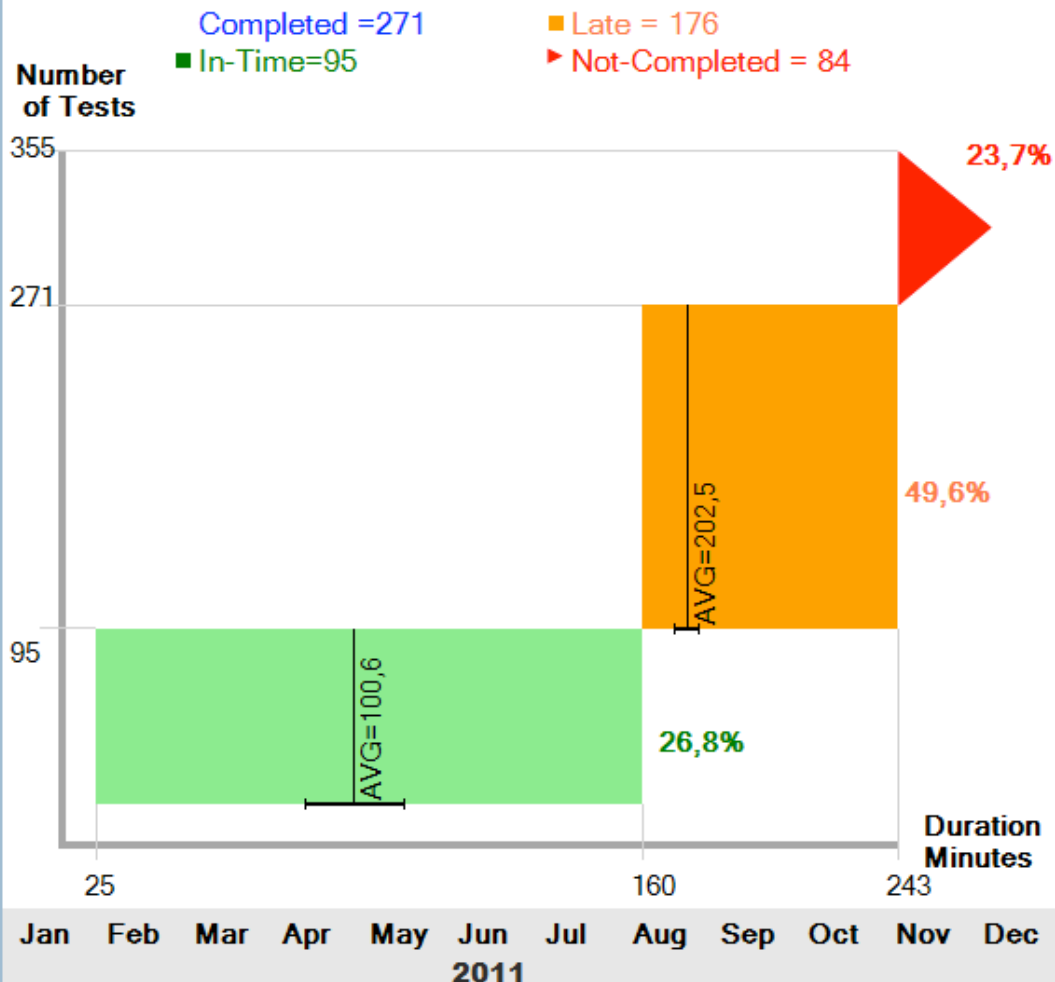
Clinic: Washington - Month: Jan-2011



# Process Completion Diagram (PCD)

## Process Overview

Clinic: Washington - Month: Jan-2011

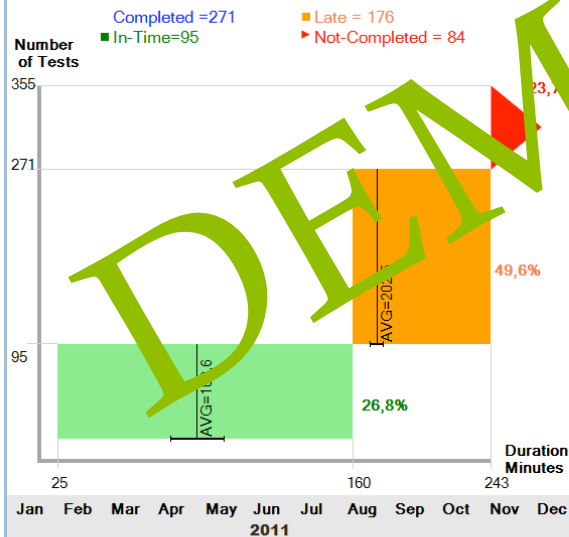




# Multi-Step Process Visualization

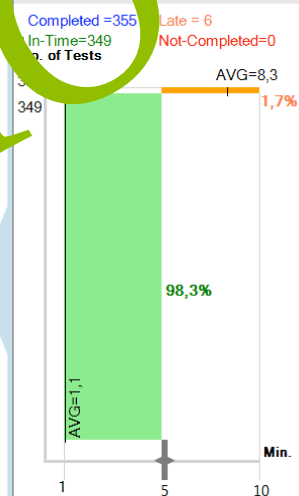
## Process Overview

Clinic: Washington - Month: Jan-2011

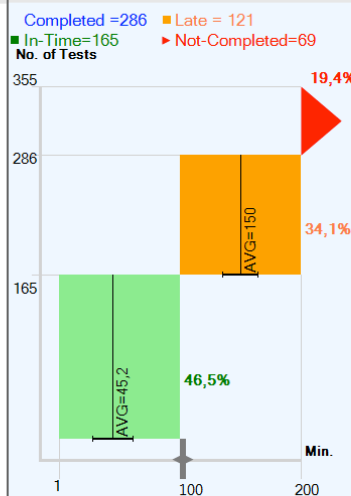


## Step Details: Washington - Jan 2011

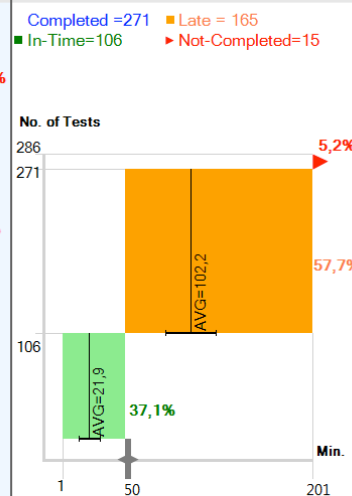
Go to the Laboratory  
Role: Patient



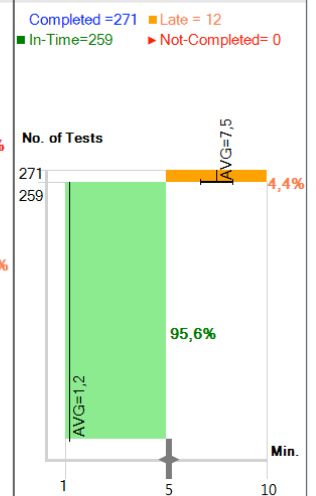
Draw and Send Sample  
Role: Nurse



Examine and Record Results  
Role: Laboratory Technician



Analyze Result  
Role: Physician

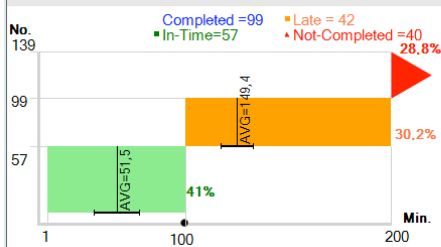


## Actors in Details: Draw and Send Sample

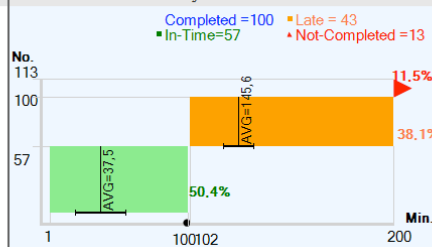
Actor with most completions

In-Time Late Incompleted

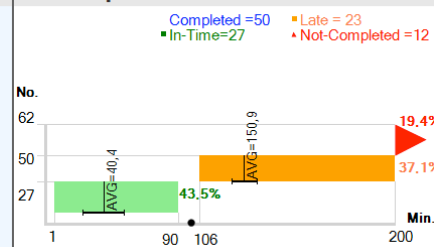
Nurse: John Smith



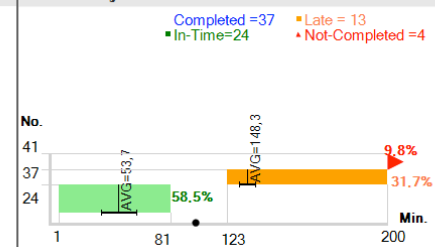
Nurse: Irina Nederby



Nurse: Sophie Andreasen



Nurse: Anja Clement

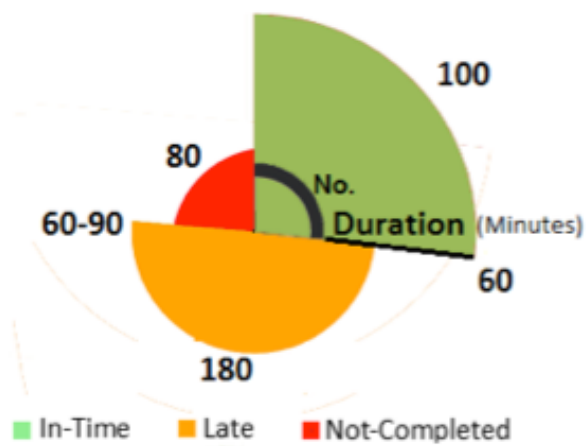
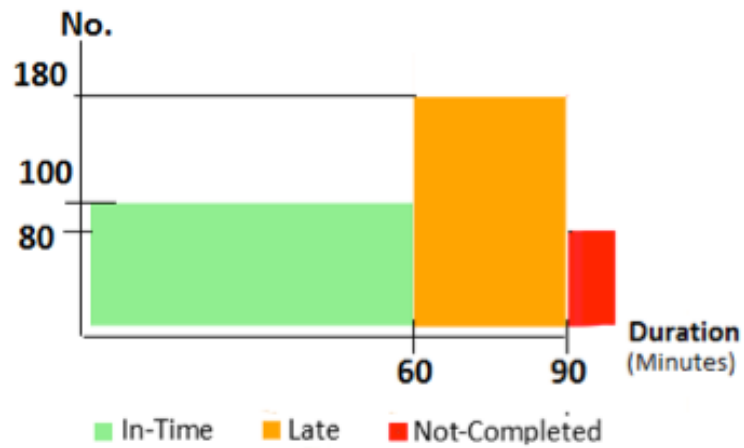


# Evaluation

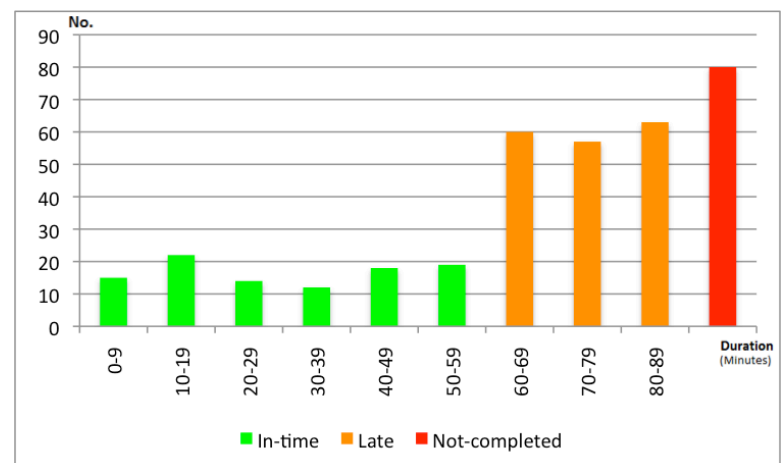
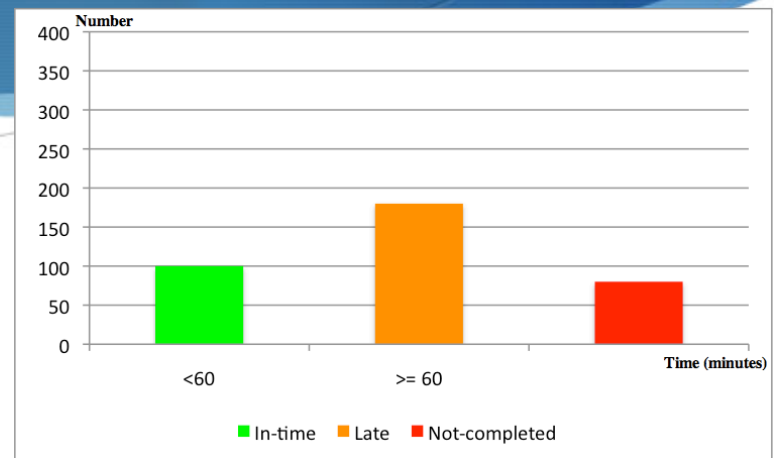
- ◆ Usability studies
  - ◆ Studies with 5 novices
  - ◆ Studies with 2 physicians
- ◆ Surveys

# Surveys

## Survey 1



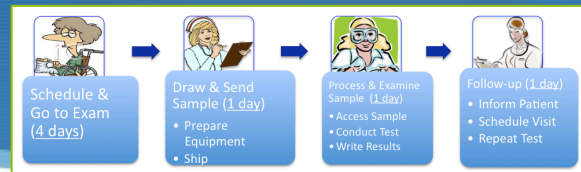
## Survey 2



# Conclusion

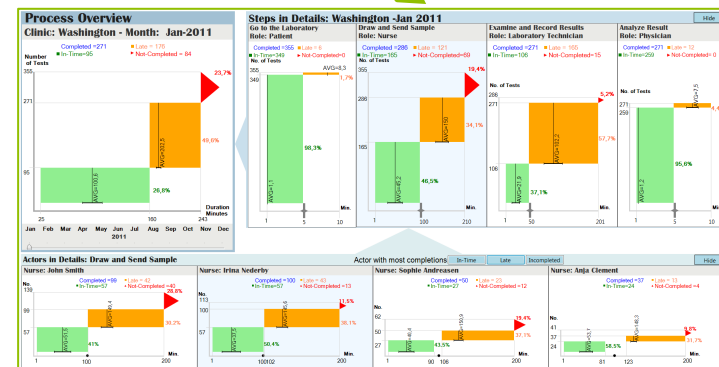
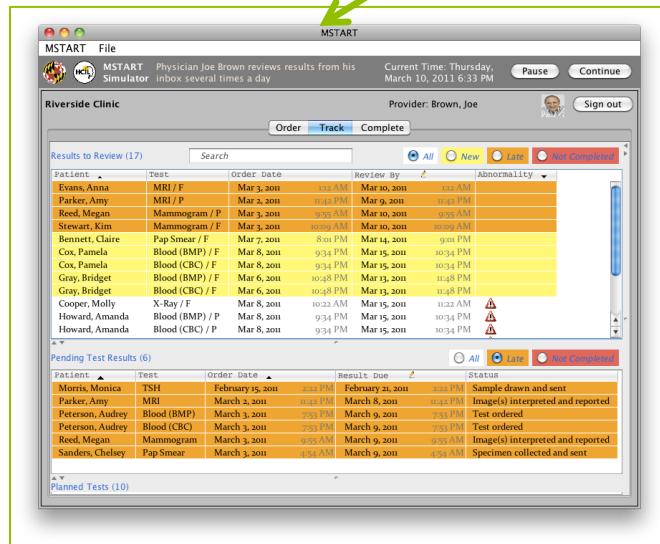
- ① Observations and interviews with clinicians and discussions of findings for results management
- ② Evaluations to quantify the benefits in time-critical applications where distractions undermine users' ability to track and react to orders
- ③ The development of guidelines for interactive rich tables with actions for rapid completion
- ④ The design and user studies of a novel retrospective analysis visualization

# Conclusion



Provider,  
Resident,  
Assistant

Manager



**SHARPC**  
NCCD