Radiology Protocol Tool Recorder (RAPTOR)

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Objectives

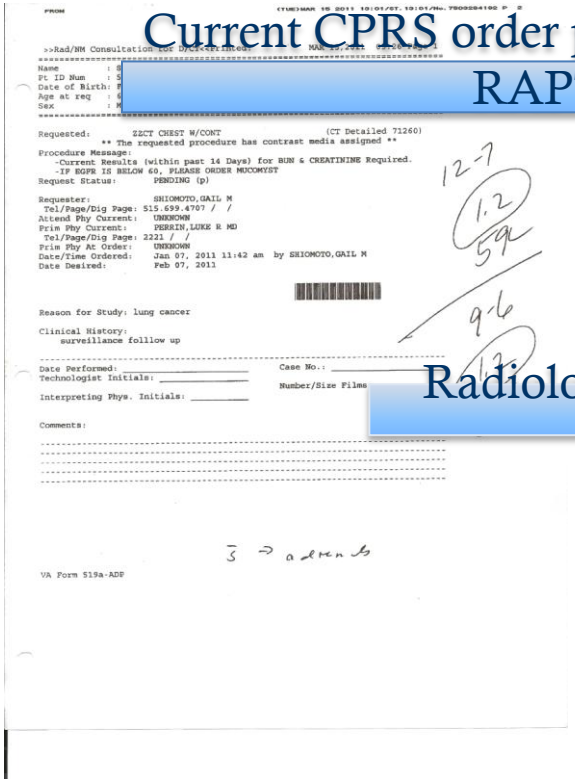
- Convert paper based Radiology Protocol process to a web based tool
- Make rapid, informed protocol decisions and actions
- Maximize Radiologist advanced imaging protocoling effectiveness while improving productivity

Benefits

- Improve clinical decisions and patient care
- Replace inefficient paper – based processes
  - No lost paperwork
  - No duplication of paperwork (and effort)
  - No vague documentation of responsibility
- Improve radiologist & department efficiency
- Benefit medical appropriateness
- Benefit patient safety
- Audit patient consent

RAPTOR - the Electronic 519 Form … and more

Current Paper 519 Form



Requested: 2ZCT CHEST W/CONT (CT Detailed 71260)
** The requested procedure has contrast media assigned **
Procedure Message:
-Current Results (within past 14 Days) for BUN & CREATININE Required.
-IF EGFR IS BELOW 60, PLEASE ORDER MUCOMYST
Request Status: PENDING (p)

Requester: SHIOMOTO,GAIL M
Tel/Page/Dig Page: 515.699.4707 / /
Attend Phy Current: UNKNOWN
Prim Phy Current: PERRIN,LUKE R MD
Tel/Page/Dig Page: 2221 / /
Prim Phy At Order: UNKNOWN
Date/Time Ordered: Jan 07, 2011 11:42 am by SHIOMOTO,GAIL M
Date Desired: Feb 07, 2011

Reason for Study: lung cancer

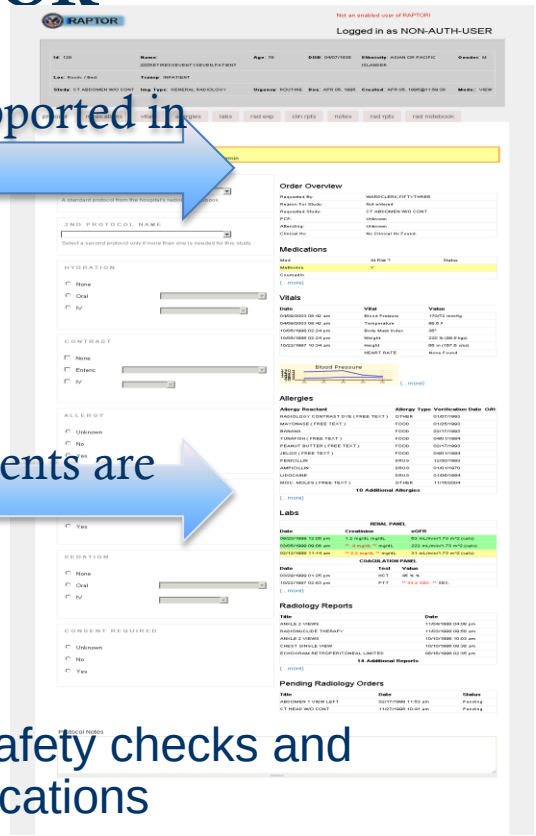
Clinical History:
surveillance folllow up

Date Performed:
Technologist Initials:
Interpreting Phys. Initials:
Case No.:
Number/Size Films

Comments:

VA Form 519a-ADP

RAPTOR

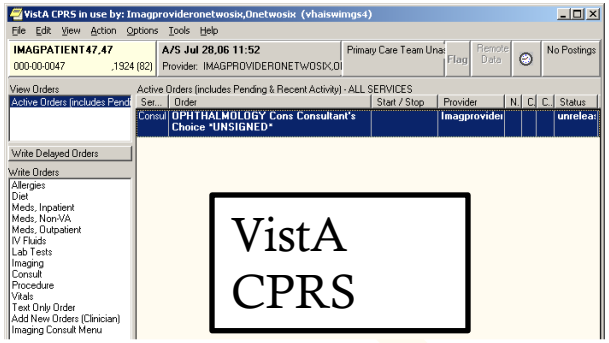


Current CPRS order protocol workflow supported in RAPTOR web form

Radiologist and Tech's comments are captured

Additional patient safety checks and contraindications

Current Workflow from Order to Schedule



Clinician

- Places Imaging Request in CPRS

Manual Processes (performed by either Front Desk, Scheduler or Technician)

- Print VistA CPRS Imaging Order
- Orders are manually sorted by Modality/specialty for workload distribution
- Additional significant clinical information may be collected and included with Protocol Packet
- Delivers Protocol Packet to Radiology Area by Modality/specialty

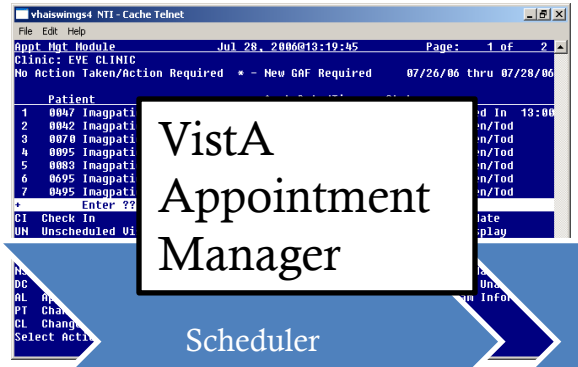
Radiologist

- Review Protocol Packet Information
- Additional clinical information may be collected and reviewed
- Prior Studies and Reports through PACS
- Lab information through VistA
- May call Clinician to discuss order
- Handwritten Protocol on coversheet with radiologist's signature or initial

Manual Processes (performed by either Front Desk, Scheduler or Technician)

- Picks up Protocol information from radiology area
- Protocol coversheet may be scanned
- Procedure is Scheduled in VistA Radiology
- Appointment Information is manually entered into VistA Appointment Manager

Current Protocol Workflow from Schedule to Report



Scheduler

- Patient is scheduled & contacted regarding appointment
- Procedure prep (Q&A)

Technician

- Scheduled exams are Registered. This generates an exam accession # and corresponding printed bar code card
- Reviews Modality Worklist
- Brings Patient to Modality
- Performs Protocol as specified by radiologist
- May call Radiologist to discuss protocol instructions
- May scan protocol sheet and Q&A into patient record
- Exam Case Edited and Completed

Radiologist

- Reviews Reading Worklist
- Refers to clinical symptoms & original protocol
- May call technician to discuss image

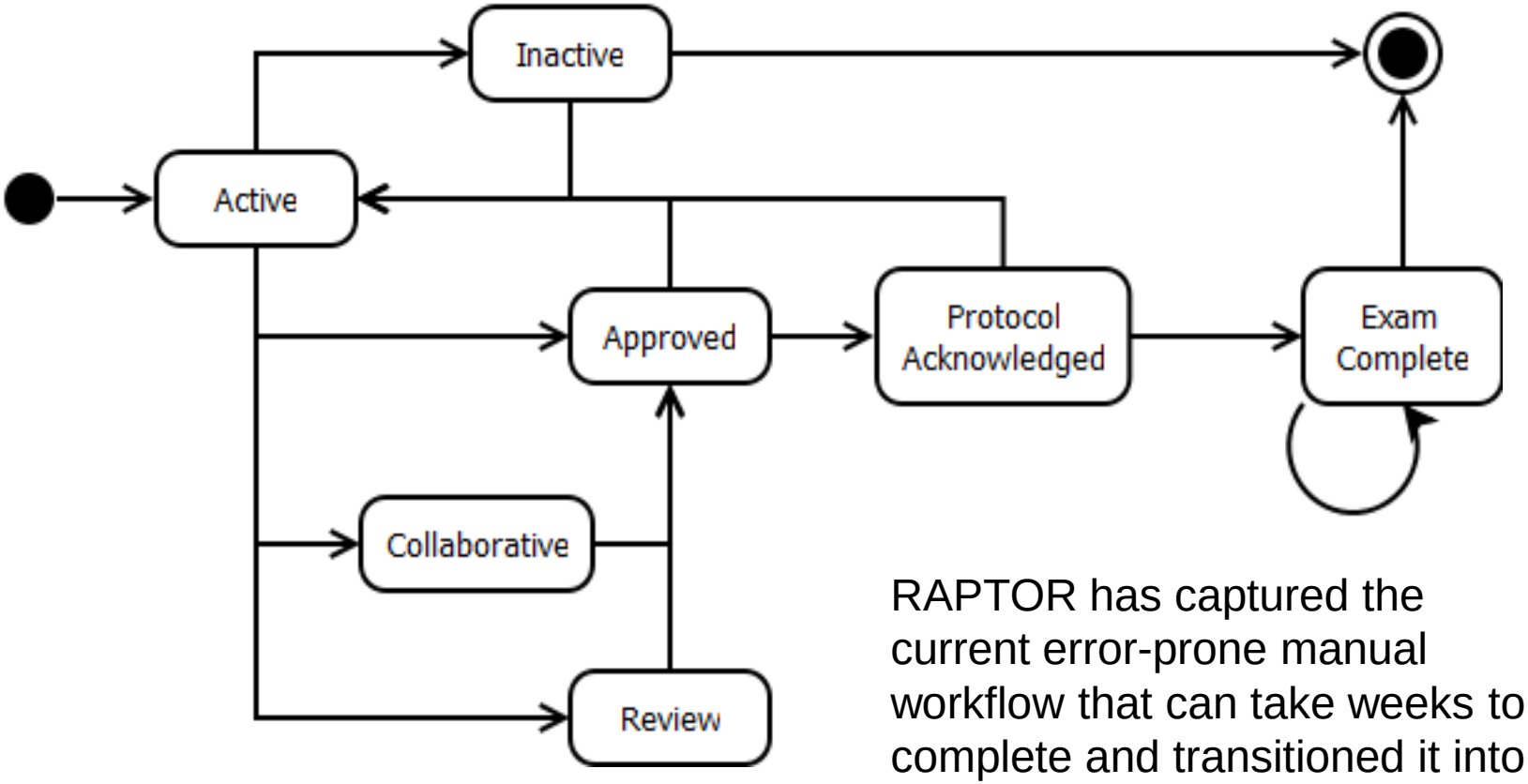
Reviews and reads Image at PACS Workstation

- Dictates Report
- May call Clinician to discuss Report
- Must call Clinician to discuss critical result.

Clinician

- Reviews Report with Patient

RAPTOR State Diagram



RAPTOR has captured the current error-prone manual workflow that can take weeks to complete and transitioned it into an electronic process that can be completed in minutes.

RAPTOR Workflow (Diagnostic)

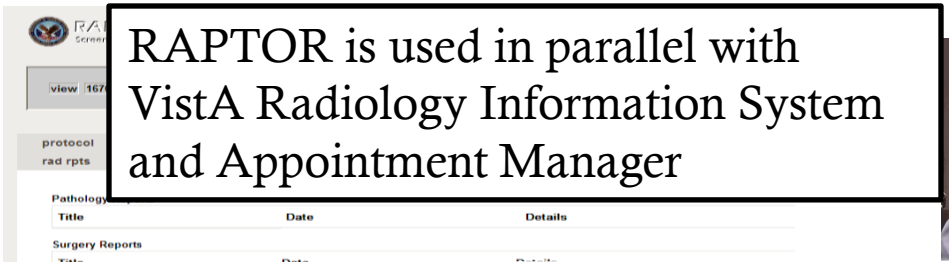
- Web Services automatically pulls Imaging Request and Patient Information into Medical Domain Web Services

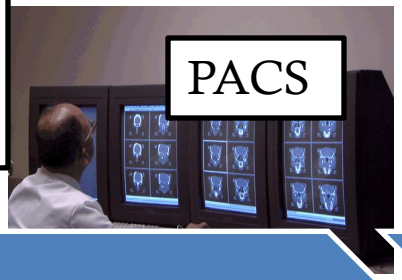
- RAPTOR creates prioritized and specialized sorted protocol worklist
- Expert Logic warns for contrast drug interaction or lapsed lab result

- Reviews and confirms clinical information through RAPTOR
- May utilize web viewer to review prior Studies and Reports
- May utilize secure messaging to discuss order
- Protocol confirmed with Digital Signature

RAPTOR Workflow (Examination &Interpretive)

RAPTOR is used in parallel with VistA Radiology Information System and Appointment Manager





Scheduler

- Order in RIS is assigned
- Patient is contacted and scheduled
- Procedure prep (Q&A)
- May utilize secure messaging to communicate

Technologist

- Scheduled exams are Registered. This generates an exam accession # and corresponding bar code
- Reviews Modality Worklist
- Brings Patient to Modality
- Performs Protocol as specified by radiologist
- May contact Radiologist thorough secure messaging to discuss protocol instructions
- Exam Case Edited and completed

Radiologist

- Reviews Reading Worklist
- Refers to clinical symptoms & original protocol
- Reviews and reads Image at PACS Workstation
- Dictates Report
- May contact Clinician through secure messaging to discuss non-critical Report Diagnosis
- May contact technician through secure messaging to discuss image

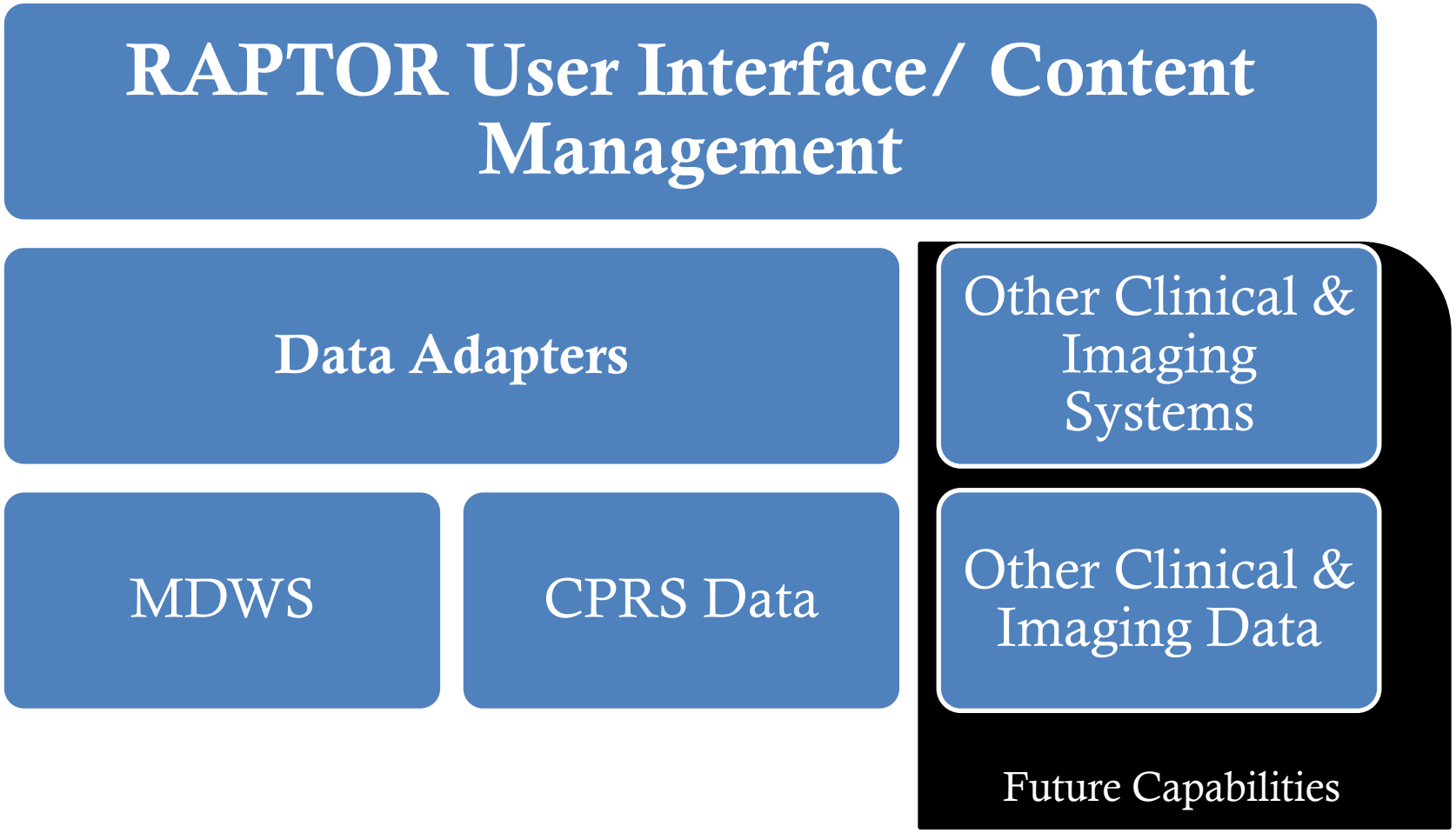
Clinician

- Reports are sent and can be viewed through VistA
- Reviews Report with Patient

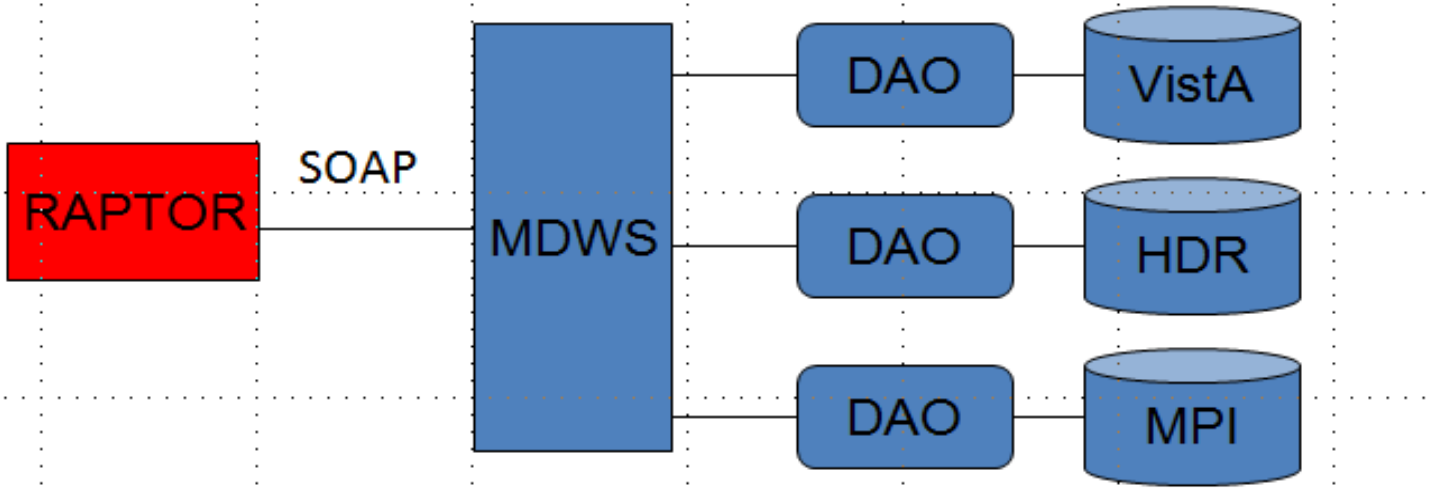
Web Development Strategy

- Open Source, Open Standards, Application Development and Environment
  - Mature open source tools and solutions
  - High functionality in a short time
  - Zero licensing costs
  - Low administration burden
  - Strategy fits with Industry Advisory Council (IAC) VistA Modernization Report

RAPTOR Architecture



RAPTOR communicates with VistA through MDWS



- MDWS is a suite of SOA middle-tier web services.
- MDWS virtualizes VistA RPCs as a web service.
- RAPTOR uses Simple Object Access Protocol (SOAP), the standardized protocol to communicate with MDWS

RAPTOR – Features

- Tracks entire Protocol Workflow
  - Who did what, when
- Ability to detect "at-risk" drug interaction
- Contraindications are acknowledged
- Monitor radiation dose history
- RAPTOR can be used throughout the workflow: protocol, examination and interpretation phases
- Protocol Library maintained

Protocol Worklist

RAPTOR
Screen Concepts

Logged in as Dr. John Alcmaeon

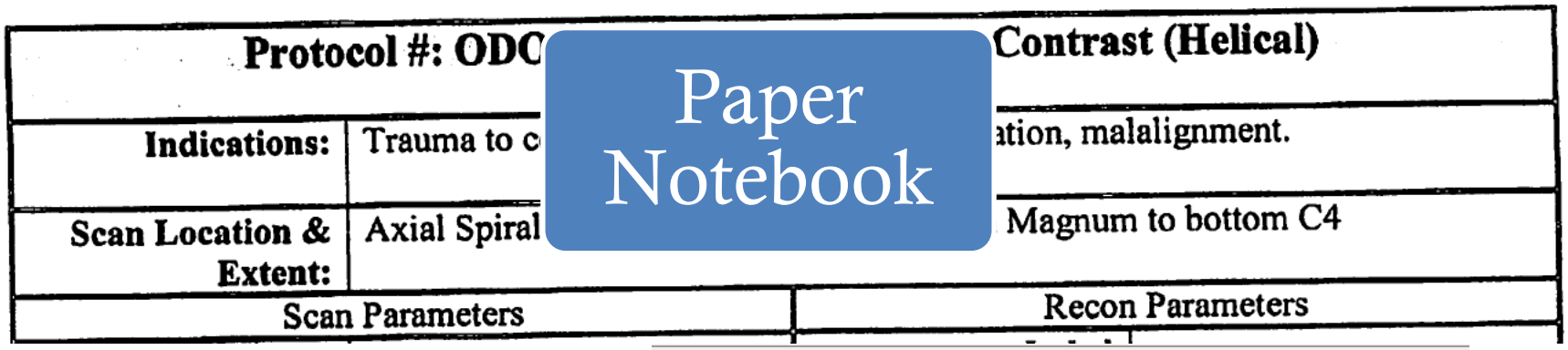
Assignment Filter: Standard filtering

Action	Patient	Date Desired	Date Ordered	Study	Urgency	Transport	Patient Category/ Location	Anatomy/ Imaging Subspecialty	Workflow Status	Assignment
edit view ☐	Vore, Carne	2011-08-05	2011-08-01	CT LUMBAR SPINE Non-Contrast (Helical)	STAT	Transport	In	Neck	Active	open
edit view ☐	Early, Bird	2011-08-07	2011-08-01	CT HEAD PERFUSION with Contrast	Routine	Transport	In	Foramen magnum to Vertex	Active	open
edit view ☐	Early, Late	2011-08-08	2011-08-01	CT HEAD STEREOTACTIC THALAMOTOMY Non-Contrast (Helical)	Routine	Walk	In	Bottom of Sella	Active	John Alcmaeon
edit view ☐	Bird, Feather	2011-08-08	2011-08-01	CT HEAD Non-Contrast (Axial)	Routine	Walk	Out	Vertex	Active	John Alcmaeon

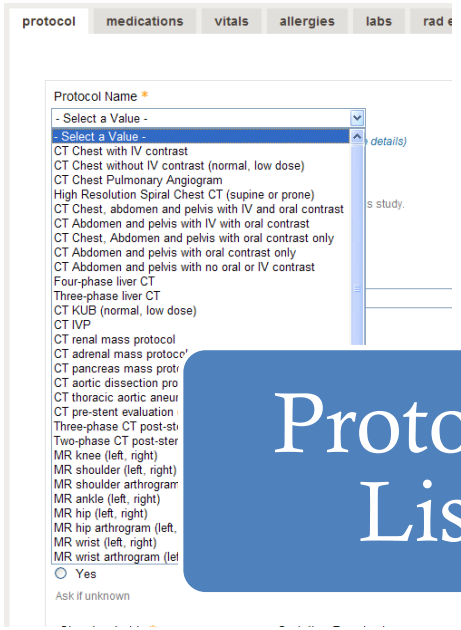
A stack of papers is now replaced by a prioritized protocol worklist. Each study is weighted by a series of configurable attributes, such as urgency, date, and specialty.

Edit Top Work Order | Refresh Worklist

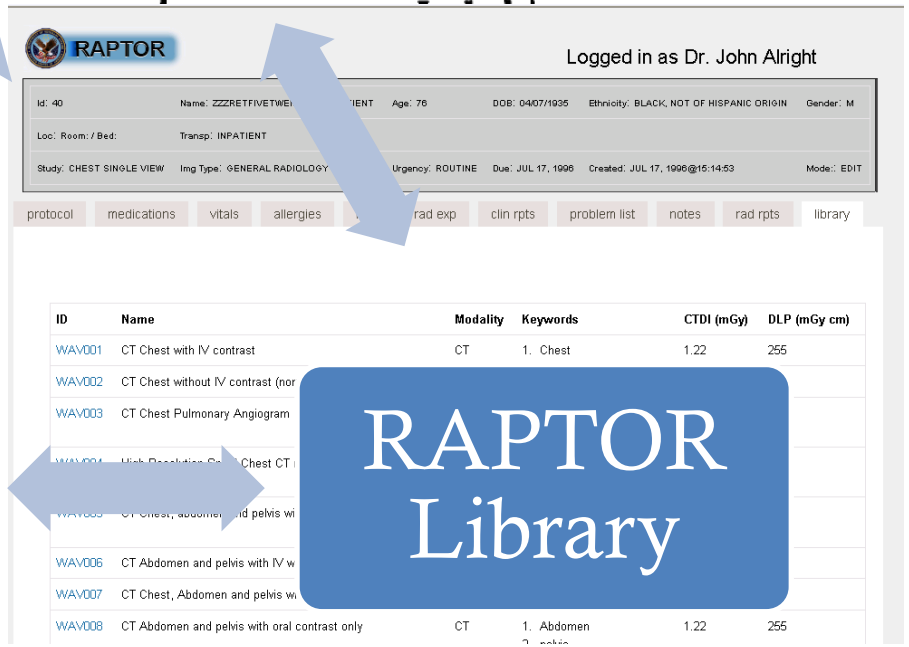
Converting the PaperNotebook into an Electronic Library



Paper Notebook



Protocol List



RAPTOR Library

The Protocol Library

protocol | medications | vitals | allergies | labs | dose hx | clin rpts | problem list | notes | rad rpts | library

ID	Name	Keywords	CTDIvol (mGy)		DLP (mGy cm)		Radiotracer Dose (mCi) +/-10%		Est. Eff. Dose (mSv)
			Configured Estimate	Actual Average	Configured Estimate	Actual Average	Configured Estimate	Actual Average	
RPID18	CT Chest with IV contrast	1. Chest			484	484			
RPID16	CT Chest without IV contrast (normal, low dose)	1. Chest			390	390			

- RAPTOR uses the paper notebook to build an electronic library with important protocol attributes such as RadLex Procedure ID, estimated dose, moving average of actual values and estimate effective dose
- Actual procedure notebook PDF can be linked

RAPTOR workflow

Protocol

- Active order is assigned then selected.
- Hydration, contrast, informed consent & sedation based on case.
- Radiologist, Resident or Technologist reviews and approves the protocol.

Examination

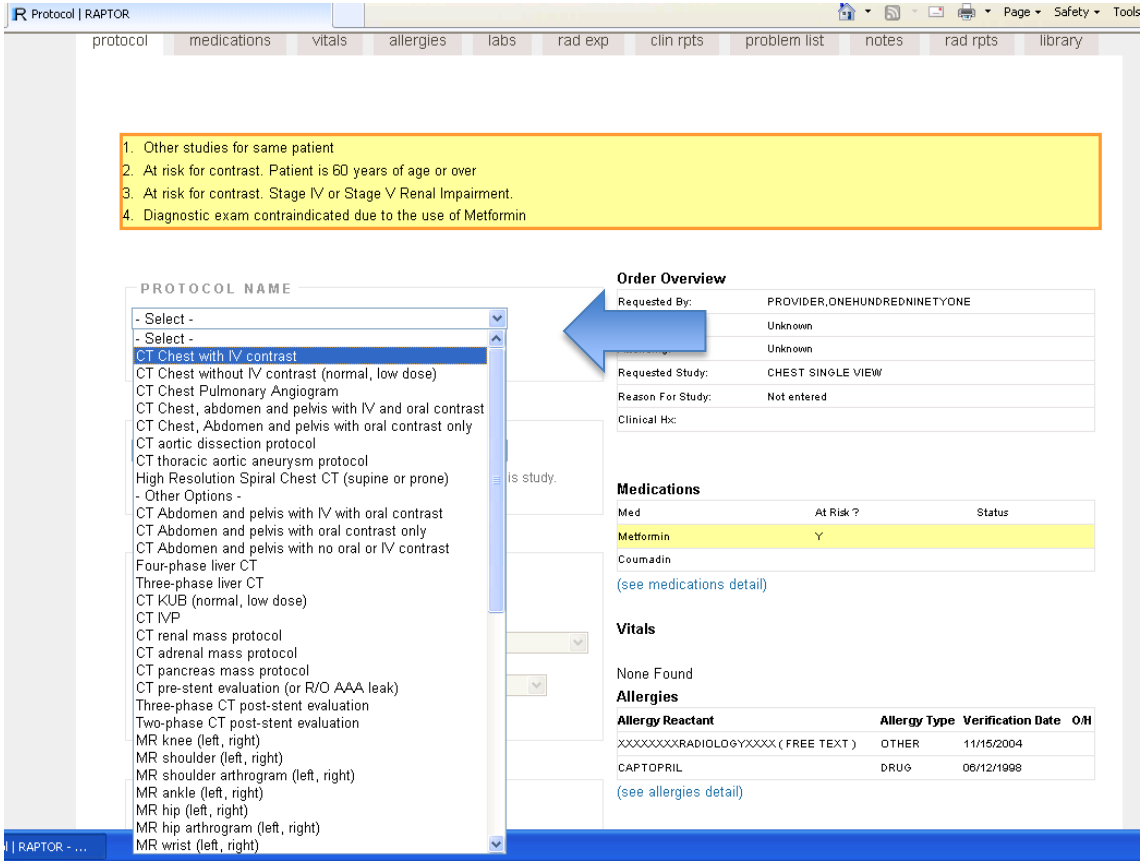
- Technologist acknowledges protocol.
- Actual hydration, contrast & sedation and radiation are noted.
- Exam is completed.

Interpretive

- Radiologist reviews actual vs. planned.
- Post-examination observations are noted.
- Quality Control is noted for completed exams.

RAPTOR suggests Protocol

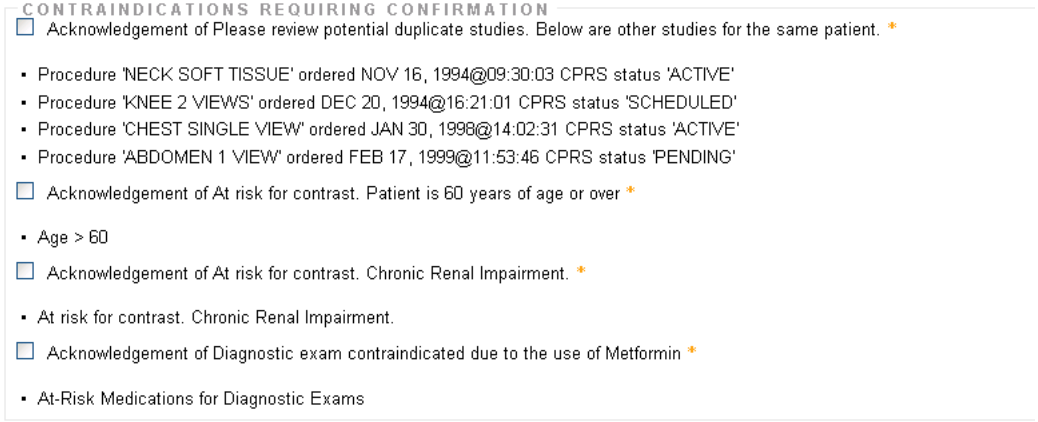
RAPTOR suggests a proper protocol based on order and configurable weighted keywords. The user is free is choose one or more protocols.



Configurable Contraindications

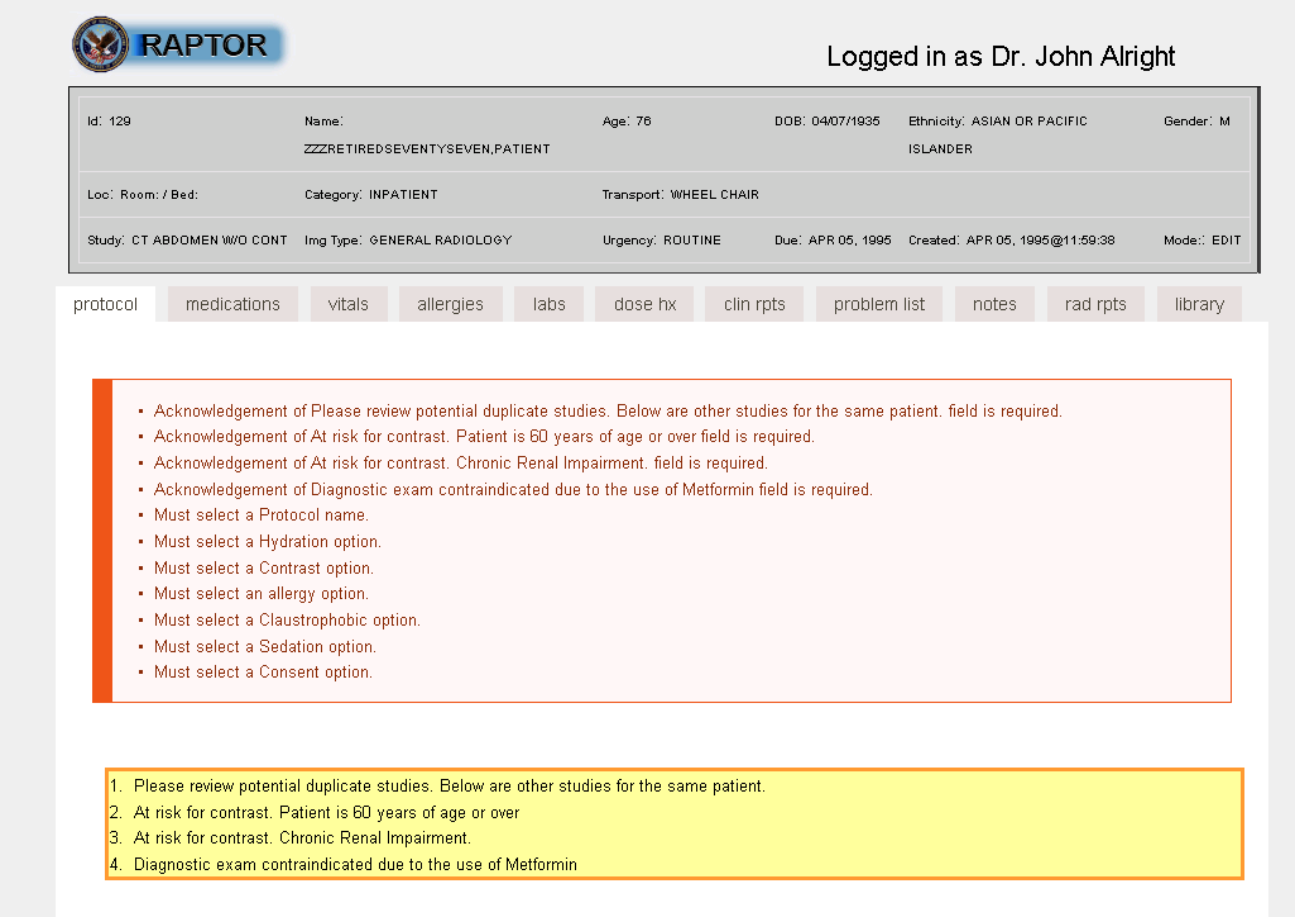
- RAPTOR provides a list of configurable contraindications when it detects potential duplicate studies, chronic renal impairment, an "at-risk" patient or drug interaction.

1. Please review potential duplicate studies. Below are other studies for the same patient.
2. At risk for contrast. Patient is 60 years of age or over
3. At risk for contrast. Chronic Renal Impairment.
4. Diagnostic exam contraindicated due to the use of Metformin

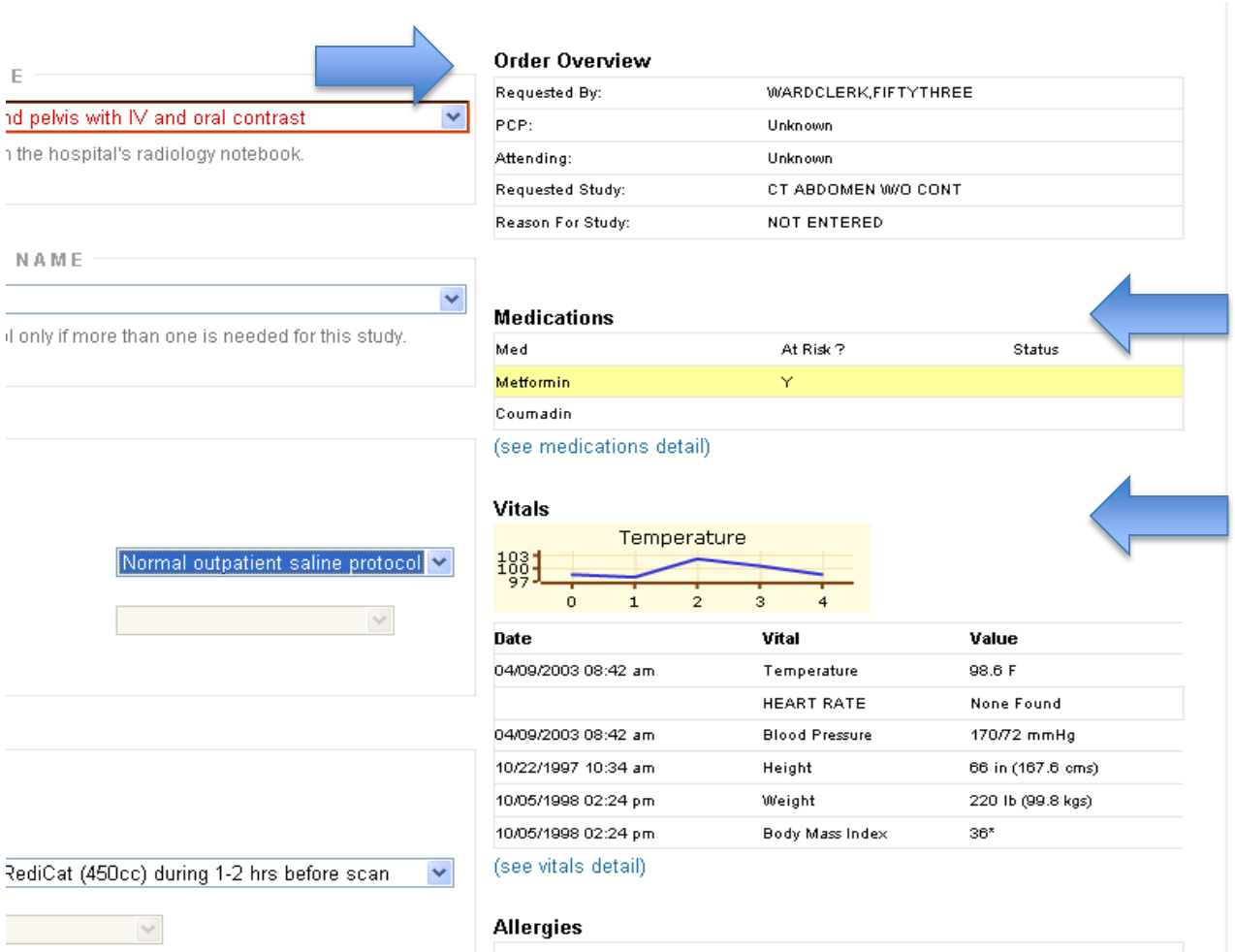


RAPTOR notifications

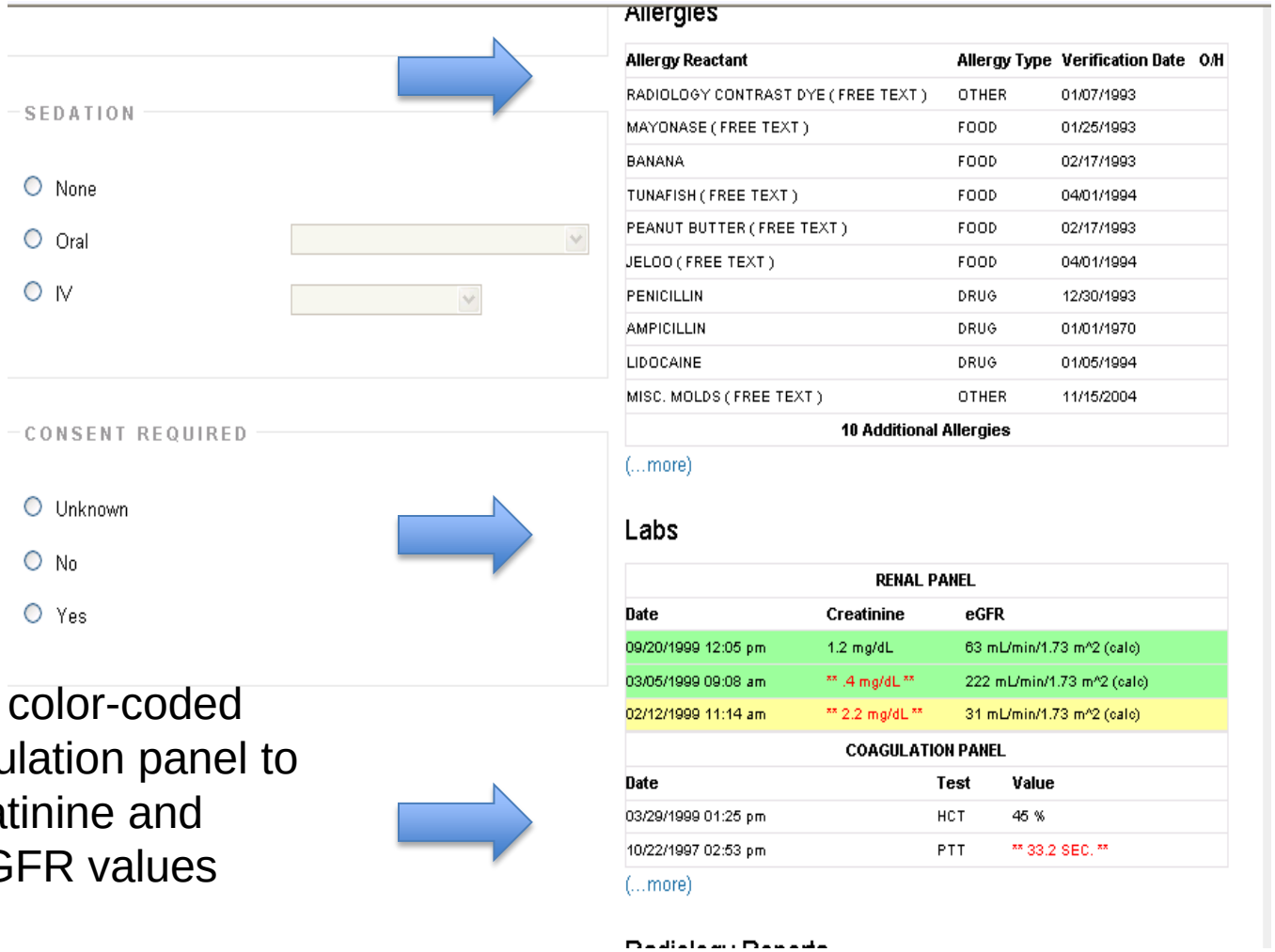
RAPTOR provides notification when a contraindication is not acknowledged or when an option is overlooked



Orders Overview s & Medications & Vitals Thumbnails



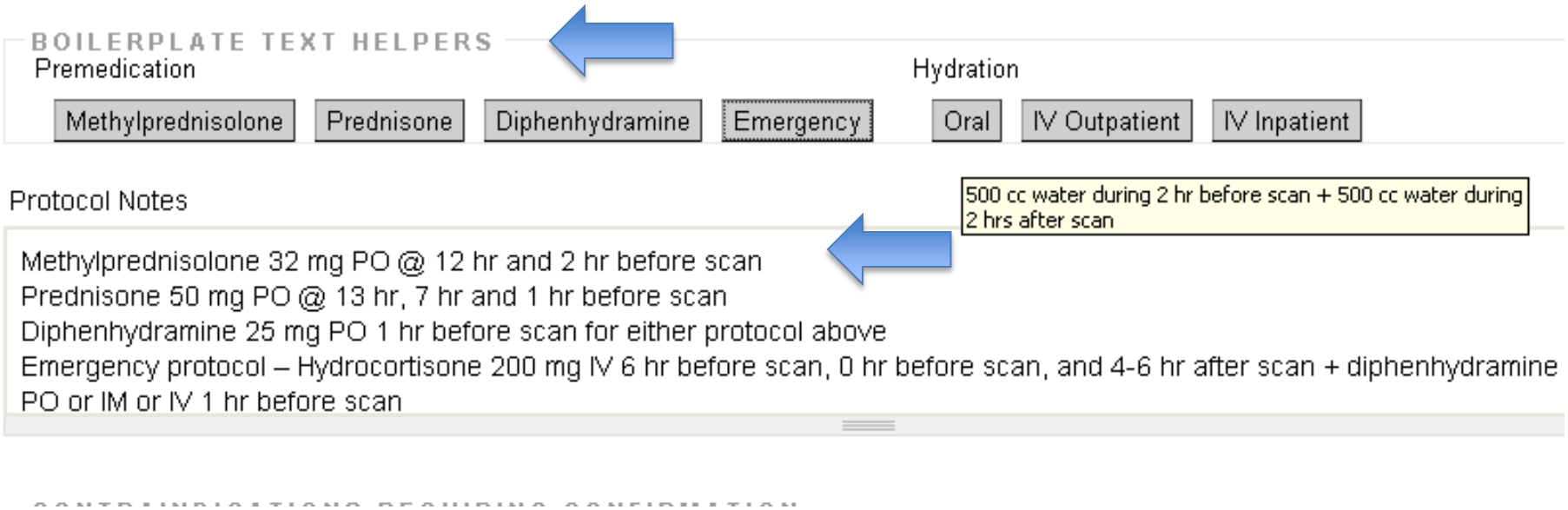
Overview provides allergies & labs "thumbnails"



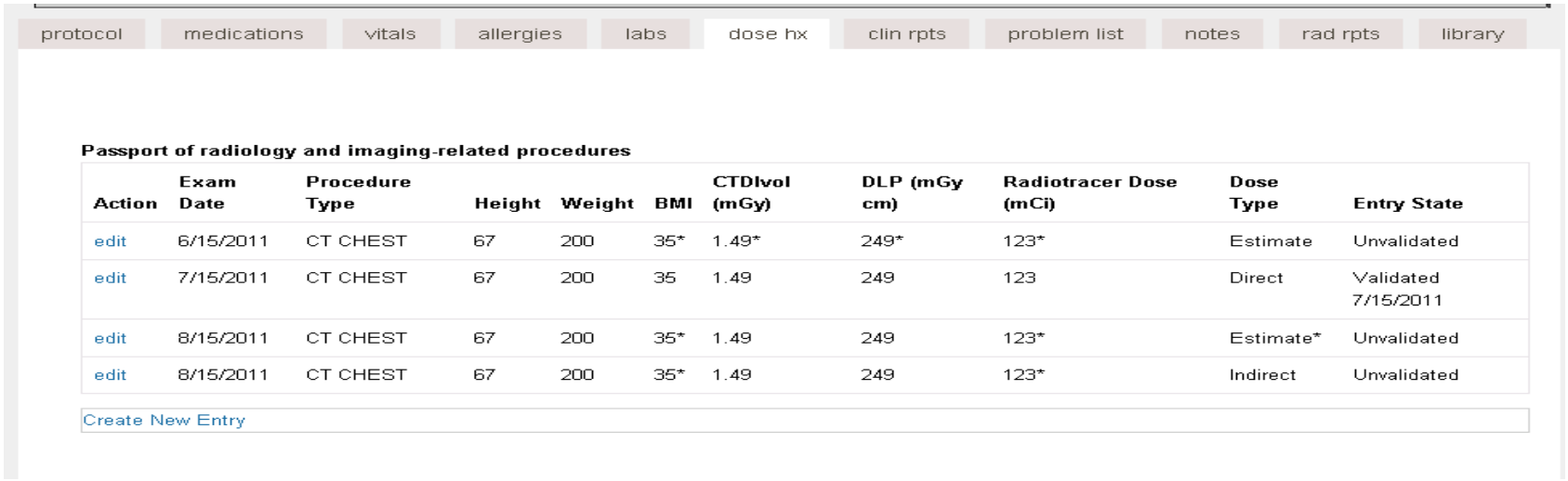
Configurable color-coded renal & coagulation panel to highlight creatinine and calculated eGFR values

Protocol Notes – boilerplate text helpers

- To assist with efficiency, RAPTOR provides configurable text templates to assist with common note writing



Radiation Dose Recording


protocol | medications | vitals | allergies | labs | dose hx | clin rpts | problem list | notes | rad rpts | library

Passport of radiology and imaging-related procedures

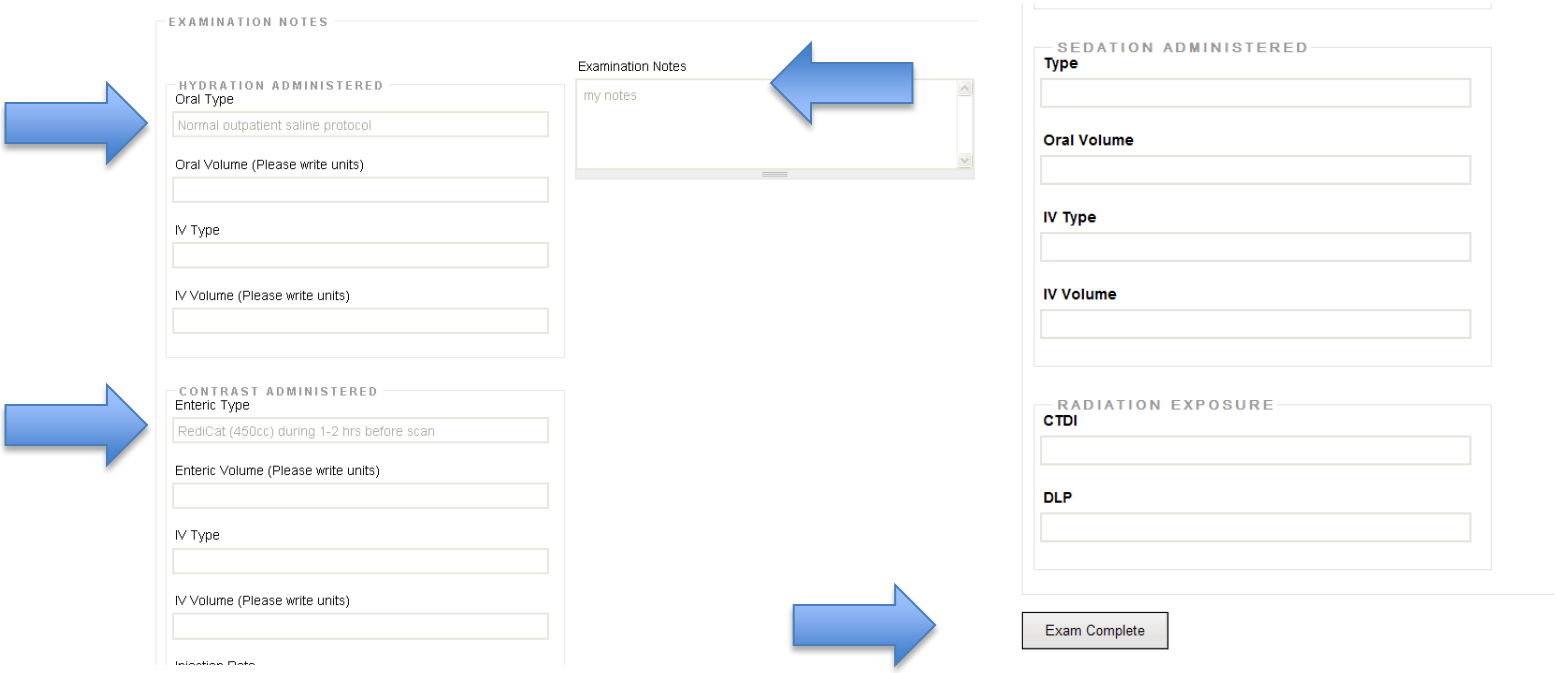
Action	Exam Date	Procedure Type	Height	Weight	BMI	CTDIvol (mGy)	DLP (mGy cm)	Radiotracer Dose (mCi)	Dose Type	Entry State
edit	6/15/2011	CT CHEST	67	200	35*	1.49*	249*	123*	Estimate	Unvalidated
edit	7/15/2011	CT CHEST	67	200	35	1.49	249	123	Direct	Validated 7/15/2011
edit	8/15/2011	CT CHEST	67	200	35*	1.49	249	123*	Estimate*	Unvalidated
edit	8/15/2011	CT CHEST	67	200	35*	1.49	249	123*	Indirect	Unvalidated

Create New Entry

- RAPTOR provides three methods (estimated, direct and indirect) to collect data so that long term dose and risk can be recorded
- Actual modality data can be entered into post-procedure note or into the dose history tab. Historical procedures can be included.
- RAPTOR provides procedure library of configurable dose values and calculates moving average for possible reduction

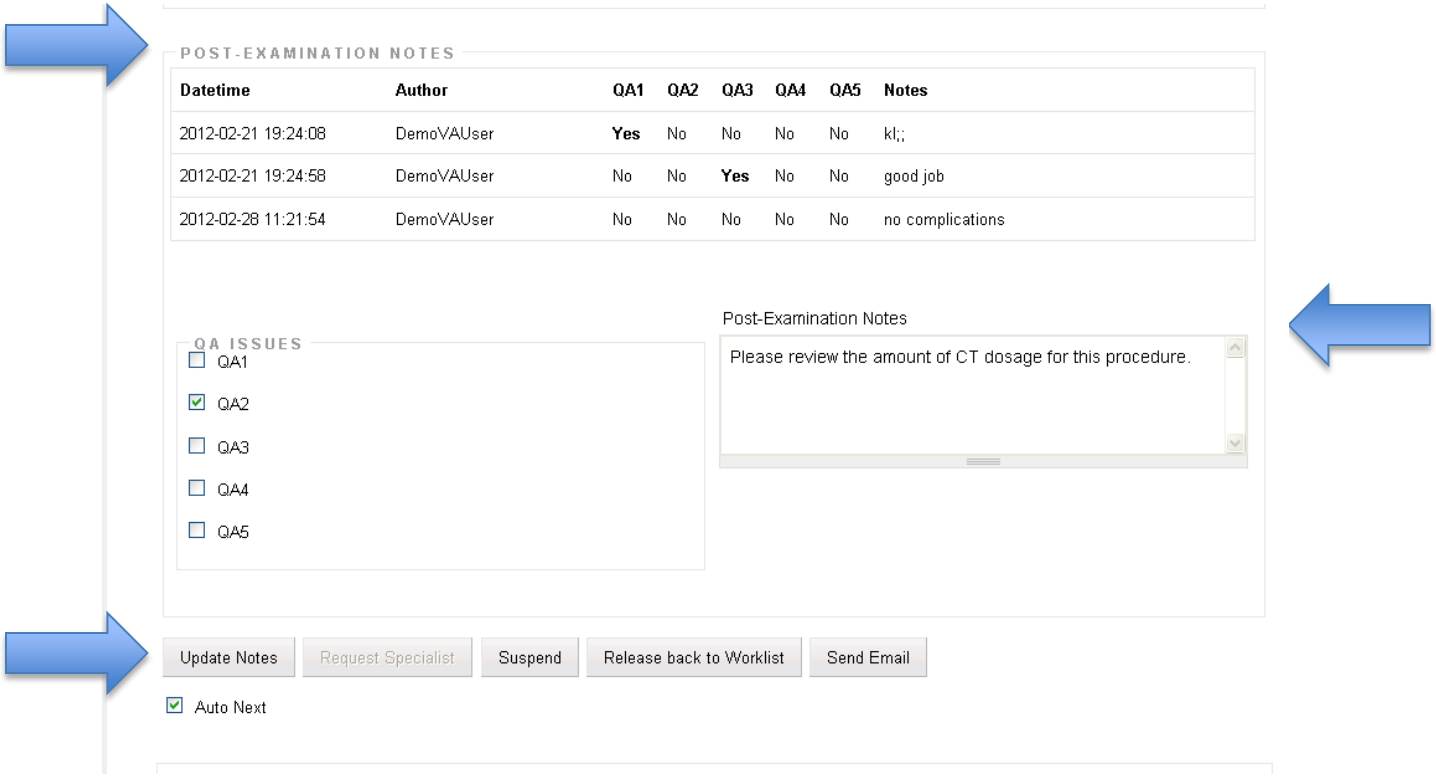
Examination Notes

- To assist with quality transition between protocol and examination, RAPTOR provides clear reporting between what was planned and actual procedure

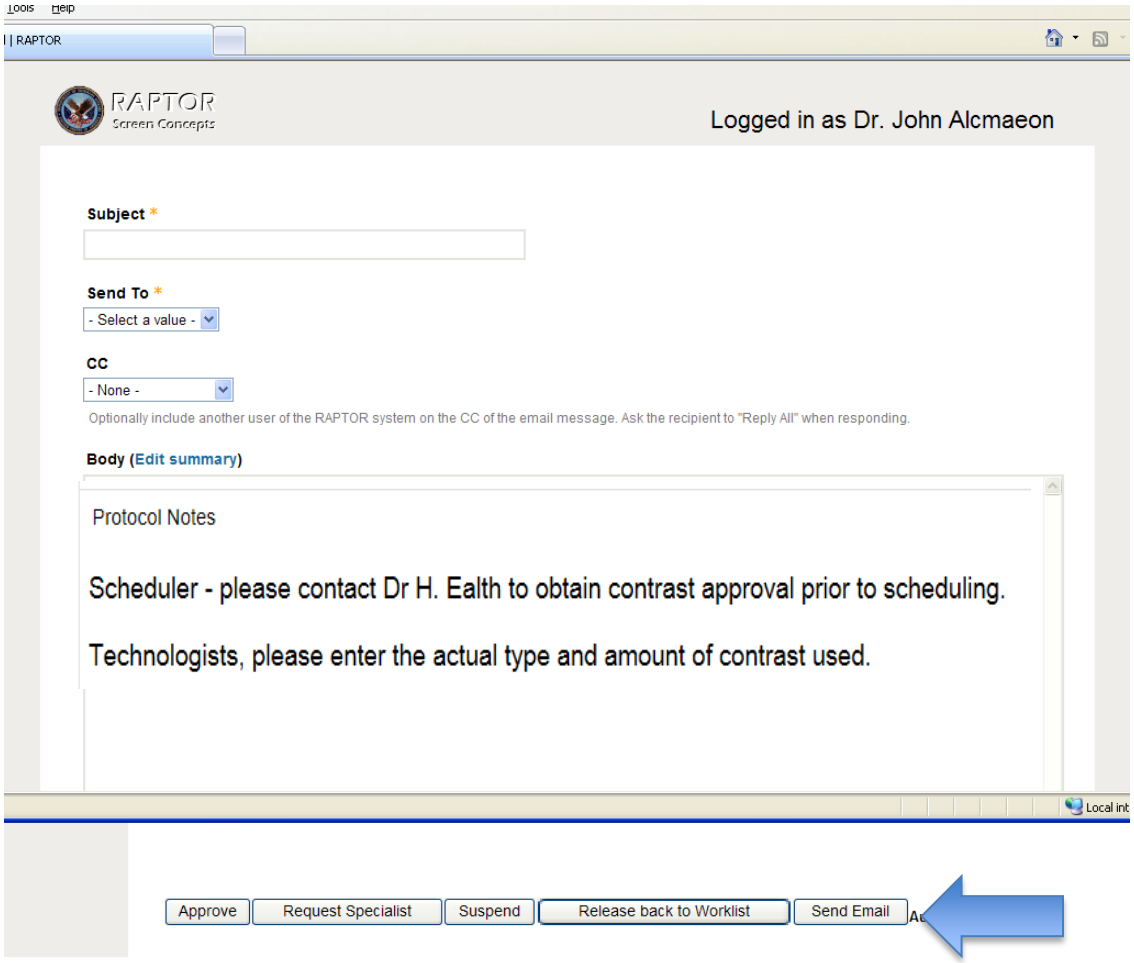


Post-Examination

- To assist with quality assurance between examination and interpretation, RAPTOR provides post-examination notes

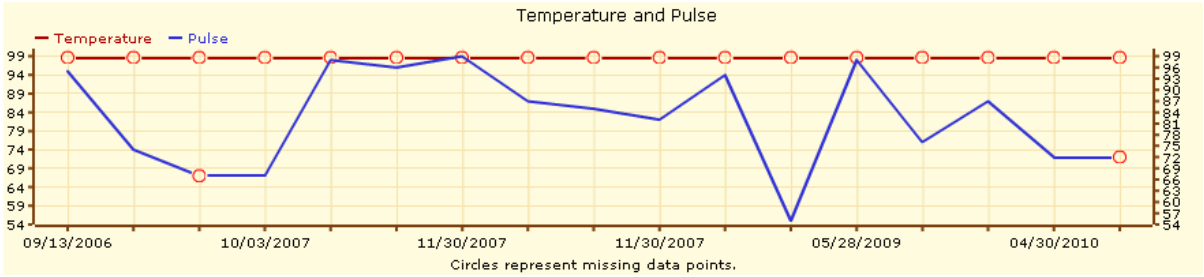


Secure Messaging



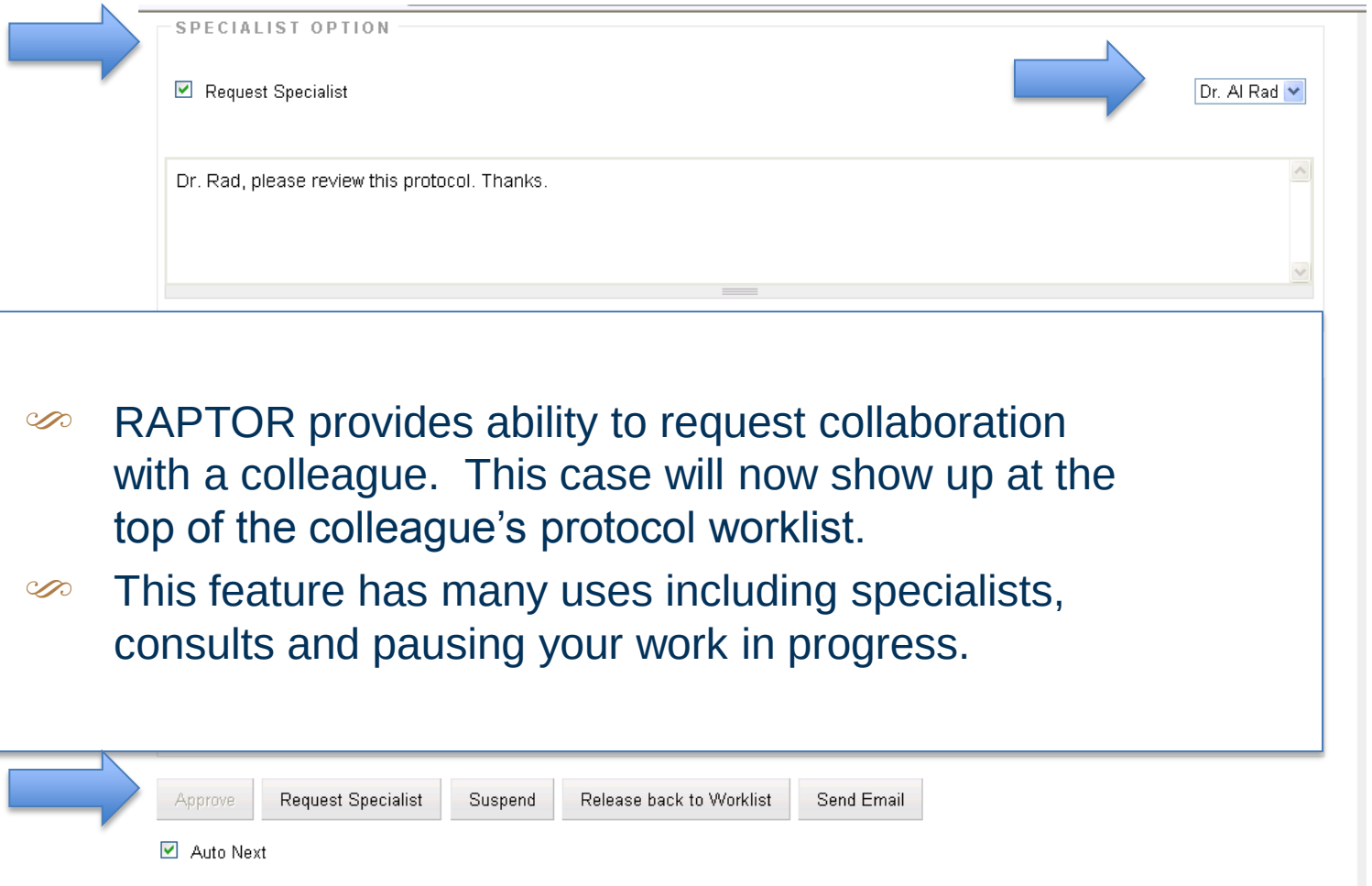
Vitals charting & tables

protocol | vitals | allergies | labs | rad exp | clin rpts | problem list | notes | rad rpts | library



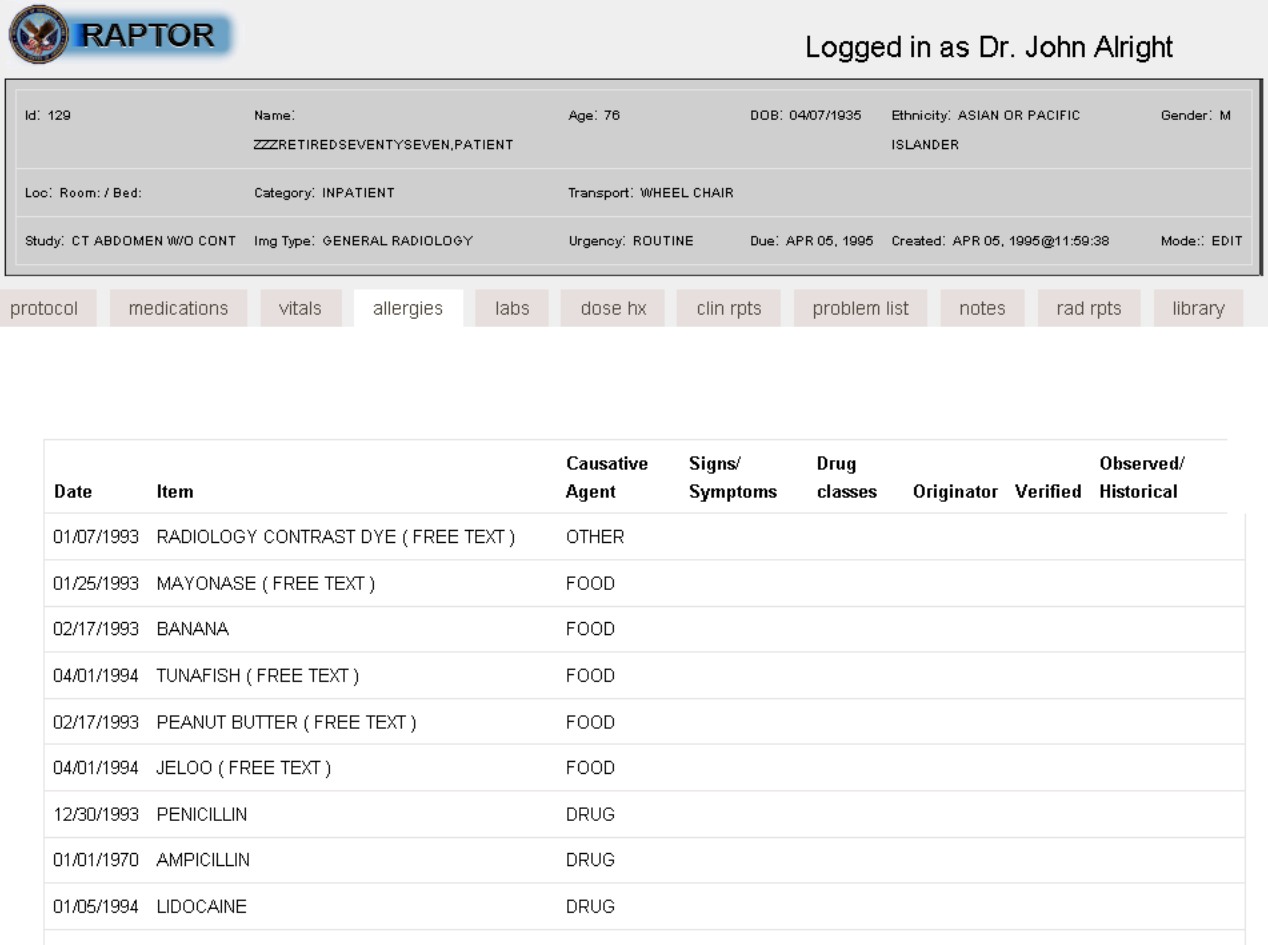
Date Taken	Temp	Height	Weight	BMI	Blood Pressure	Pulse	Resp	Pain	C/G	Pox	CVP	Blood Glucos
04/30/2010 11:00 am			166 lb (75.3 kg)	29*								
04/30/2010 06:30 am					123/78 mmHg	72 /min						
01/05/2010 10:00 am			176.6 lb (80.1 kg)	31*	156/89 mmHg	87 /min						
06/22/2009 11:00 am			170.2 lb (77.2 kg)	30*	139/67 mmHg	76 /min						
05/28/2009 11:00 am			168.2 lb (76.3 kg)	30*	143/72 mmHg	98 /min						
04/21/2009 09:00 am			162 lb (73.5 kg)	29*	98/65 mmHg	55 /min						
05/06/2008 02:00 pm			160.9 lb (73 kg)	29*	175/82 mmHg	94 /min						

Collaboration Request



- RAPTOR provides ability to request collaboration with a colleague. This case will now show up at the top of the colleague's protocol worklist.
- This feature has many uses including specialists, consults and pausing your work in progress.

Allergies



RAPTOR

Logged in as Dr. John Alright

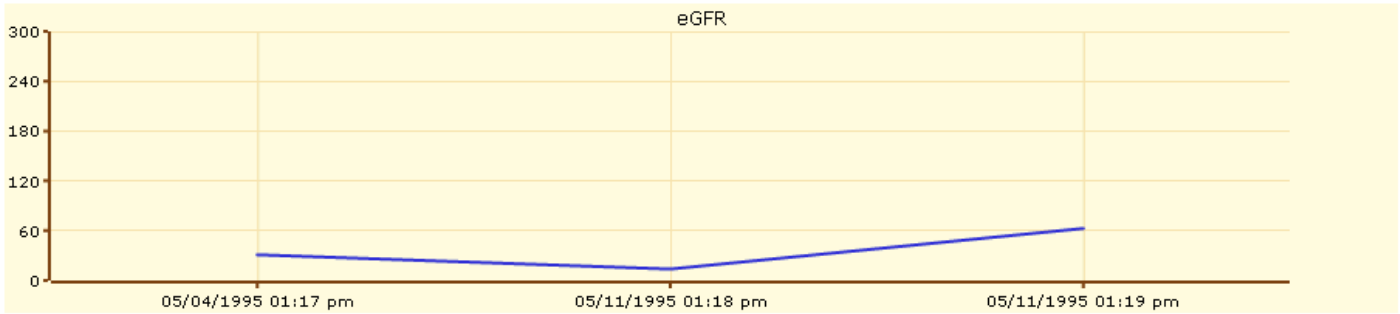
Id: 129	Name: ZZZRETIREDSEVENTYSEVEN,PATIENT	Age: 76	DOB: 04/07/1935	Ethnicity: ASIAN OR PACIFIC ISLANDER	Gender: M
Loc: Room: / Bed:	Category: INPATIENT	Transport: WHEEL CHAIR			
Study: CT ABDOMEN W/O CONT	Img Type: GENERAL RADIOLOGY	Urgency: ROUTINE	Due: APR 05, 1995	Created: APR 05, 1995@11:59:38	Mode:: EDIT

protocol | medications | vitals | allergies | labs | dose hx | clin rpts | problem list | notes | rad rpts | library

Date	Item	Causative Agent	Signs/ Symptoms	Drug classes	Originator	Verified	Observed/ Historical
01/07/1993	RADIOLOGY CONTRAST DYE (FREE TEXT)	OTHER					
01/25/1993	MAYONASE (FREE TEXT)	FOOD					
02/17/1993	BANANA	FOOD					
04/01/1994	TUNAFISH (FREE TEXT)	FOOD					
02/17/1993	PEANUT BUTTER (FREE TEXT)	FOOD					
04/01/1994	JELOO (FREE TEXT)	FOOD					
12/30/1993	PENICILLIN	DRUG					
01/01/1970	AMPICILLIN	DRUG					
01/05/1994	LIDOCAINE	DRUG					

Labs graphing and table

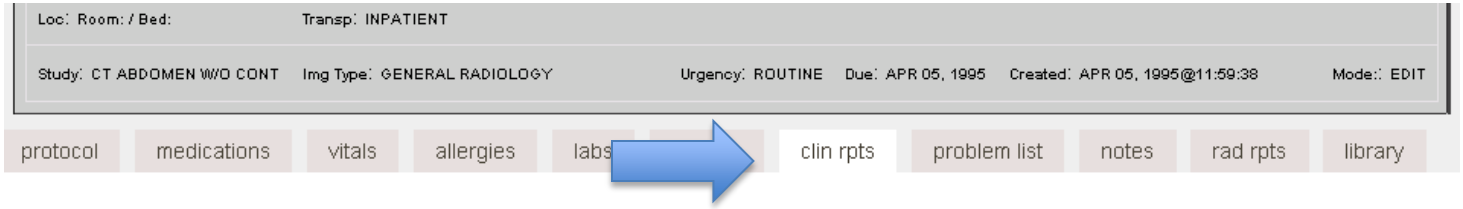
protocol | medications | vitals | labs | rad exp | clin rpts | problem list | notes | rad rpts | library



Patient has a diagnostic exam. Displaying 3 most recent Creatinine and eGFR values.

Date	Creatinine	eGFR	Ref
05/11/1995 01:19 pm	1.2 mg/dL	63 mL/min/1.73 m^2 **(calc)**	.9 - 1.4
05/11/1995 01:18 pm	** 4.5 mg/dL **	14 mL/min/1.73 m^2 **(calc)**	.9 - 1.4
05/04/1995 01:17 pm	** 2.2 mg/dL **	31 mL/min/1.73 m^2 **(calc)**	.9 - 1.4

Clinical Report



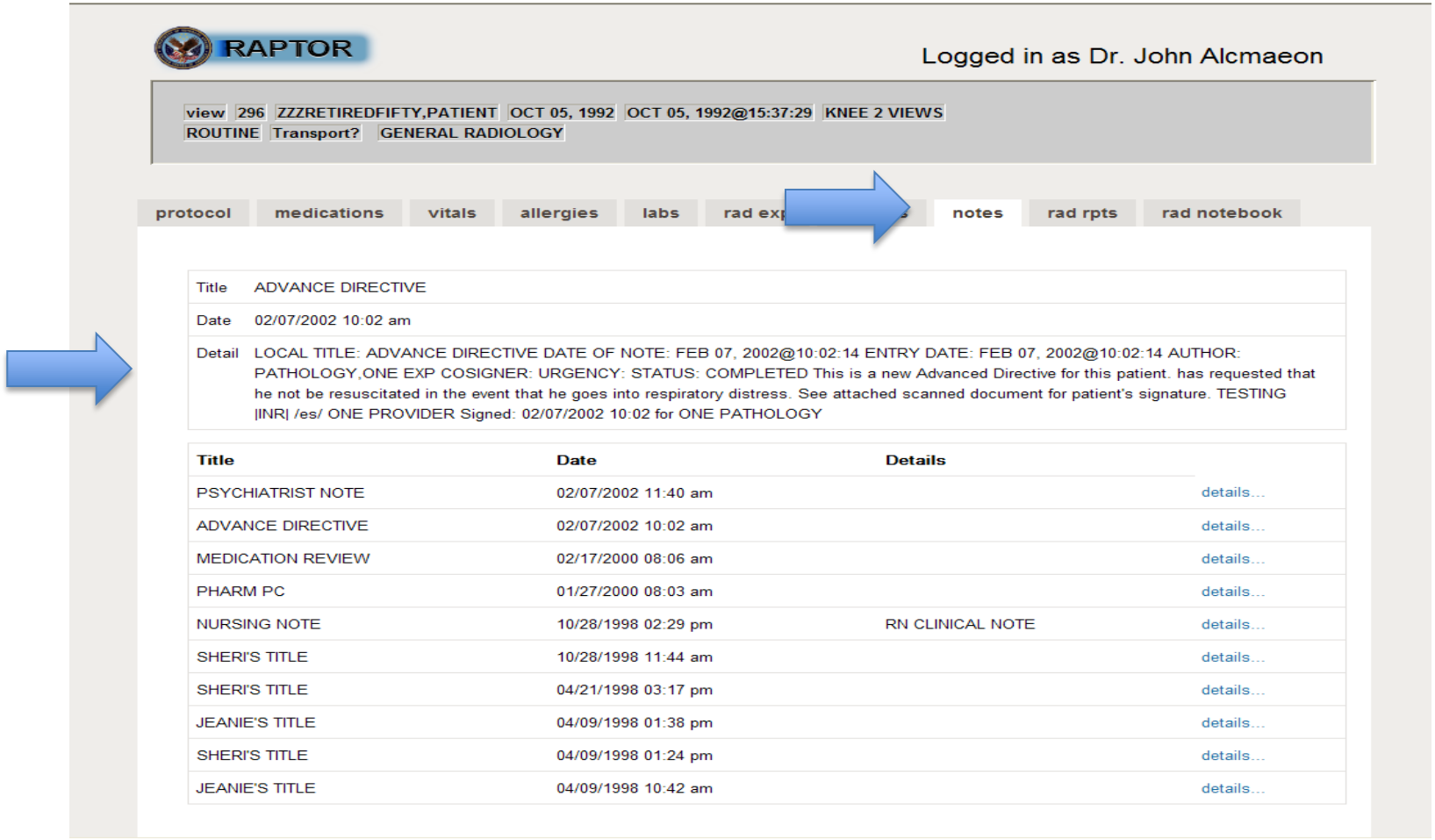
Pathology Reports

Title	Date	Details
Cytopathology Report	04/13/1995 12:00 am	details...

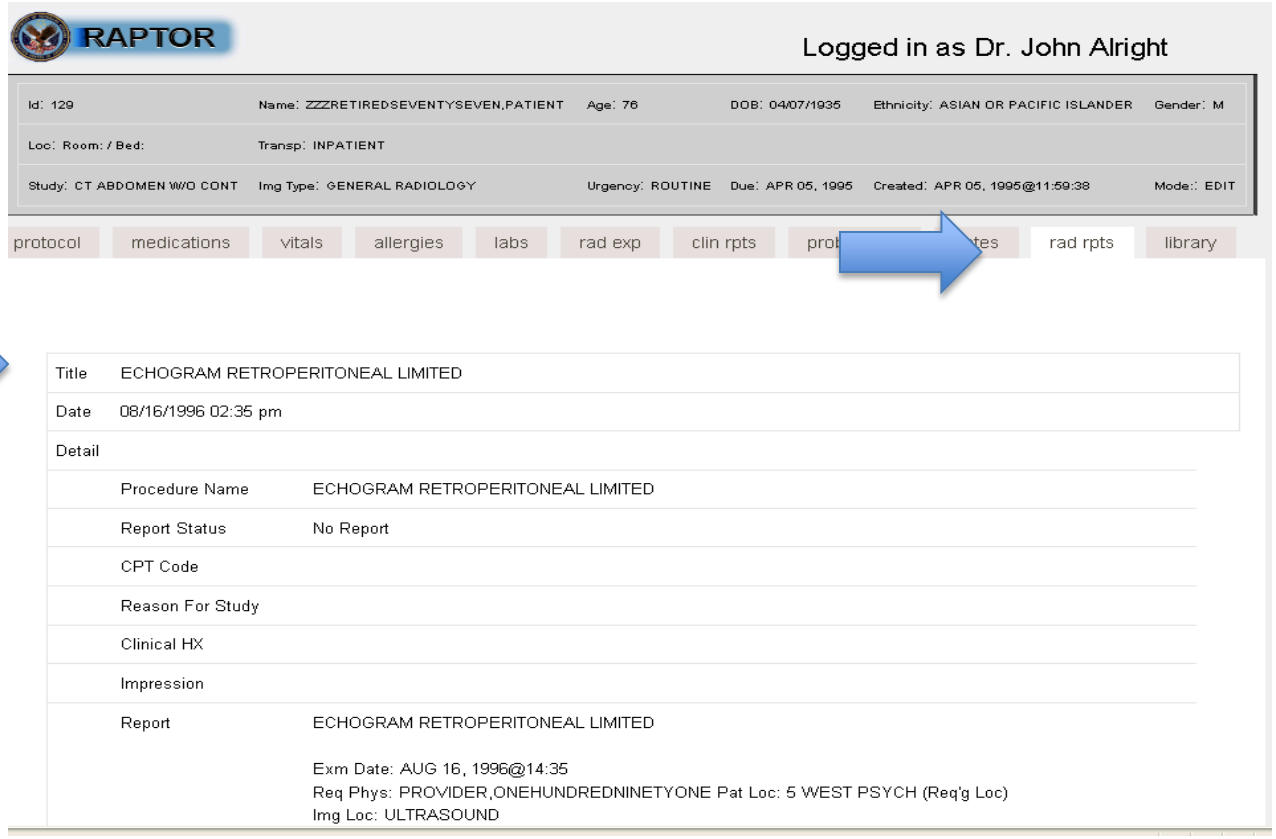
Surgery Reports

Title	Date	Details
CHOLECYSTECTOMY	01/01/1970 12:00 am	details...
INGROWN TOENAIL	01/01/1970 12:00 am	details...
BONE MARROE ASP/BIOPSY (Non-OR)	01/01/1970 12:00 am	details...
CHOLECYSTECTOMY	01/01/1970 12:00 am	details...
APPENDECTOMY	01/01/1970 12:00 am	details...
BILATERAL VASECTOMY	01/01/1970 12:00 am	details...
HANG NAIL REMOVAL RIGHT THUMB	01/01/1970 12:00 am	details...

Clinical Notes



Radiology Reports



Expected Results

- Radiologist acceptance
- VA PSHCS acceptance
- Improved quality
- Improved safety of patient care
- Improved efficiency of advanced diagnostic imaging (CT, MRI, Nuclear Medicine) utilization
- Productivity gains by Radiologists & Radiology departments