Clinical Decision Support Systems

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Clinical Decision Support Systems CDSS

- CDSS opportunities and challenges
- Uses of CDSS today
- Uses of CDSS tomorrow
  - Radiology

Reasoning with Clinical Knowledge

AKA

Evidence-based DS

Knowledge-based DS

Expert-based DS

Rule-based DS

Knowledge Representation

Typically constructed using knowledge rules

Clinical Decision Support Systems

Strong versus Weak AI

- Examples
  - Strong
    - Independent Automaton
  - Weak
    - Calculator
    - Cognitive Prosthesis
- Healthcare DS does not need strong AI to aid many of its data rich challenges

Clinical Decision Support Systems
Opportunities

- Improved patient safety
- Improved quality of care
- Improved efficiency

Clinical Decision Support Systems
Challenges

- Knowledge Management
- Dependence on an EMR for data
- Poor ergonomics
- Failure to fit naturally into routine care
- General reluctance of healthcare workers

CDSS Today

- **Reminders and Alerts**
  - Immunizations, EMR monitoring
- **Diagnostic Assistance**
  - Waveform analysis
  - DxPlain, Illiad, HELP
- **Therapy critiquing and planning**
- **Prescribing decision support systems**
  - D-D interactions, dosage errors, EMR contraindications
- **Information retrieval**
  - 'Agents' providing user preferences filtered information
- **Image recognition and interpretation**
  - CAD – breast and lung CA screening
- **Practice Guidelines**
  - American College of Radiology - Appropriateness Criteria

Radiology Decision Support Systems

Manual System Limitations

- The current knowledge unmanageable
- The knowledge transfer is inaccurate
- Feedback is anecdotal
- No systems to monitor effectiveness
- Result……
  - High variability in human decision making
- And……
  - It's all getting worse

ACR Appropriateness Criteria™

Intended to guide radiologists, radiation oncologists, and referring physicians in making *initial* decisions about diagnostic imaging and therapeutic techniques.

Criteria Development

Based on principles developed by Institute of Medicine (IOM) and used by Agency for Health Care Research and Quality (AHRQ)

Expert Organ System Panels

- Cardiovascular
- Gastrointestinal
- Urologic
- Musculoskeletal
- Woman's Imaging
- Thoracic
- Neurological
- Pediatric
- Women's Imaging

Expert Panel Composition

- Chaired by acknowledged expert
- About a dozen members
- Broad representation
  - Geographic
  - All imaging modalities
  - Academic/community practices
  - Participation from non-radiologic specialty societies

Criteria Development

- Review scientific literature
- Data insufficient for meta-analysis
- Consensus techniques complementing scientific data
  - modified Delphi methodology

SAMPLE EVIDENCE TABLE

Pretreatment Staging of Clinically Localized Prostate Cancer

Reference	Type of Study	Number of Patients	Study Problem (Purpose of Study)	Study Results	Strength of Recommendations
Partin AW, Kattan MW, Subong EN, et al. Combination of prostate-specific antigen, clinical stage, and Gleason score to predict pathological stage of localized prostate cancer: a multi-institutional update. JAMA 1997; 277(18):1445-1451.	3a	4133	Developed multi-institutional model to predict pathology shape of prostate cancer.	Nomograms developed. Valid and useful.	A-
D'Amico AV. Combined modality staging for localized adenocarcinoma of the prostate. Oncology (Huntingt) 2001; 15(8):1049-1059.	7		To identify pre-treatment risk factors.	Useful risk factor analysis.	A-
Platt JF, Bree RL, Schwab RE. The accuracy of CT in the staging of carcinoma of the prostate. AJR 1987; 149(2):315-318.	3b	32	How accurate is CT in staging prostate cancer? (local extension and nodal detection).	67% overall accuracy; 67% retrospect accuracy; needs more work!	E

ACR Appropriateness CriteriaÔ

Tabulation Form

UROLOGIC IMAGING

Clinical Condition: Pretreatment Staging of Clinically Localized Prostate Cancer | **Tabulation Voting Round 2**

Variant 2: PSA > 10 ng/ml; and < 20, and/or Gleason Score 7.

EXAMINATION	RATING TABULATION	CONSENSUS	COMMENTS
MRI +/- MRSI	1: 0, 2: 0, 3: 0, 4: 0, 5: 1, 6: 2, 7: 1, 8: 2, 9: 0		
Radionuclide bone scan	1: 0, 2: 0, 3: 0, 4: 0, 5: 0, 6: 0, 7: 2, 8: 3, 9: 1		
CT of pelvis/abdomen	1: 0, 2: 0, 3: 0, 4: 1, 5: 1, 6: 1, 7: 3, 8: 0, 9: 0		
ProstaScint radio-immunodetection	1: 0, 2: 1, 3: 0, 4: 0, 5: 2, 6: 2, 7: 1, 8: 0, 9: 0		
Transrectal Sonography (TRUS)		Probably Not Indicated	

SCALE

1-2 Not Indicated
3-4 Probably Not Indicated
5-6 Probably Indicated
7-8 Indicated
9 Necessary

SAMPLE TOPIC TABLE

Condition: Pretreatment Staging of Clinically Localized Prostate Cancer

Variant 2: PSA > 10 ng/ml; and < 20, and/or Gleason Score 7.

Radiologic Exam Procedure	Appropriateness Rating	Comments
Radionuclide bone scan	8	
Computed tomography of pelvis/abdomen (CT)	8	
MRI +/- MRSI	6	Not yet widely available. Spectroscopy technique is still evolving. Requires experienced observer.
ProstaScint radio-immunodetection	4	Not yet widely available. Requires skill in interpreting SPECT. Relative expensive.
Transrectal sonography (TRUS)	4	

SCALE

1-2 Not Indicated

3-4 Probably Not Indicated

5-6 Probably Indicated

7-8 Indicated

9 Necessary

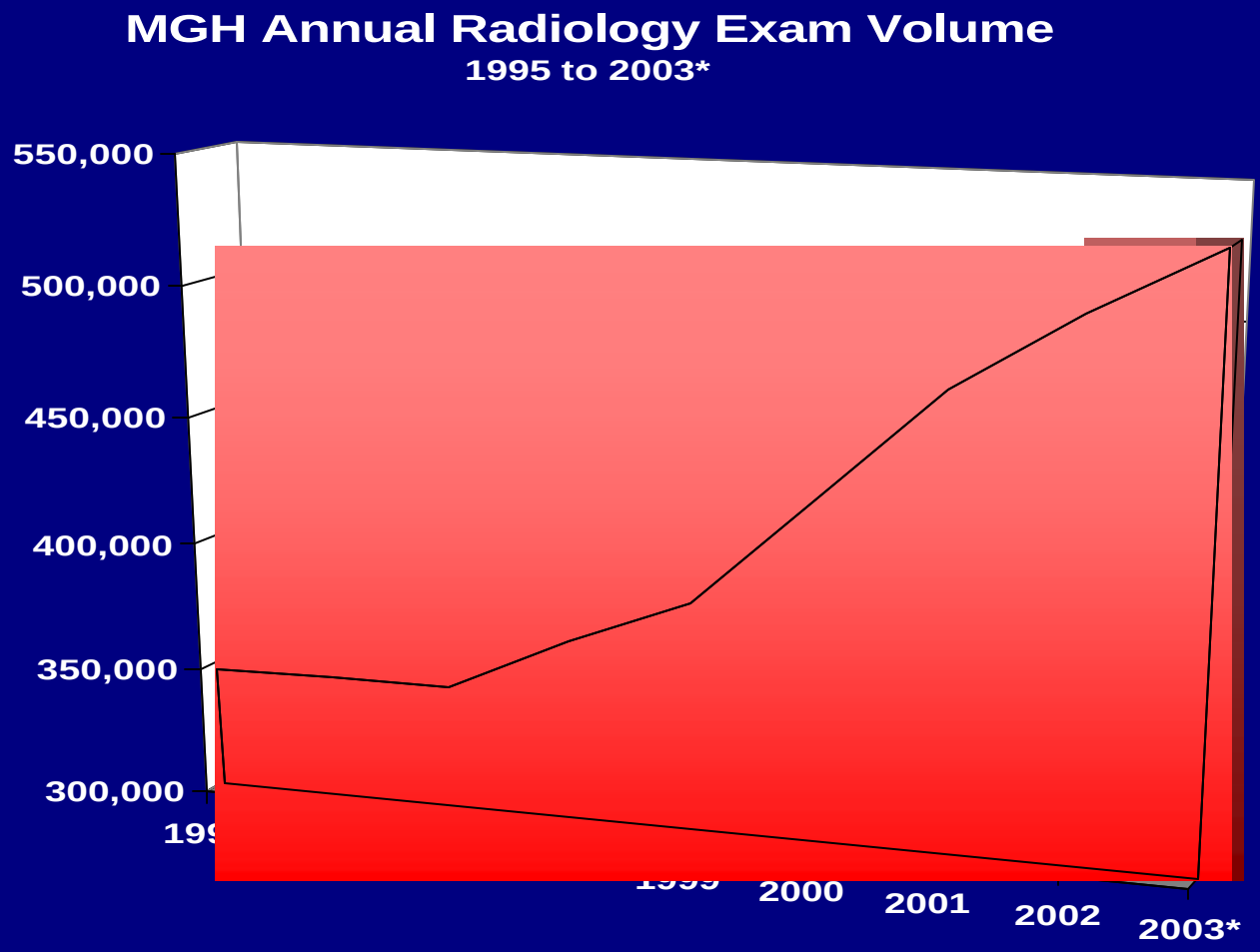
ACR-AC Future Plans

- Ongoing updates to criteria and modalities
- Expanding beyond 1,000 clinical conditions
- Current system paper based
- Web service application is currently underway

Radiology Decision Support Systems MGH Goals

- Provide ordering physician decisions support
- Provide radiologist decision support
- Monitor the effect on utilization and quality

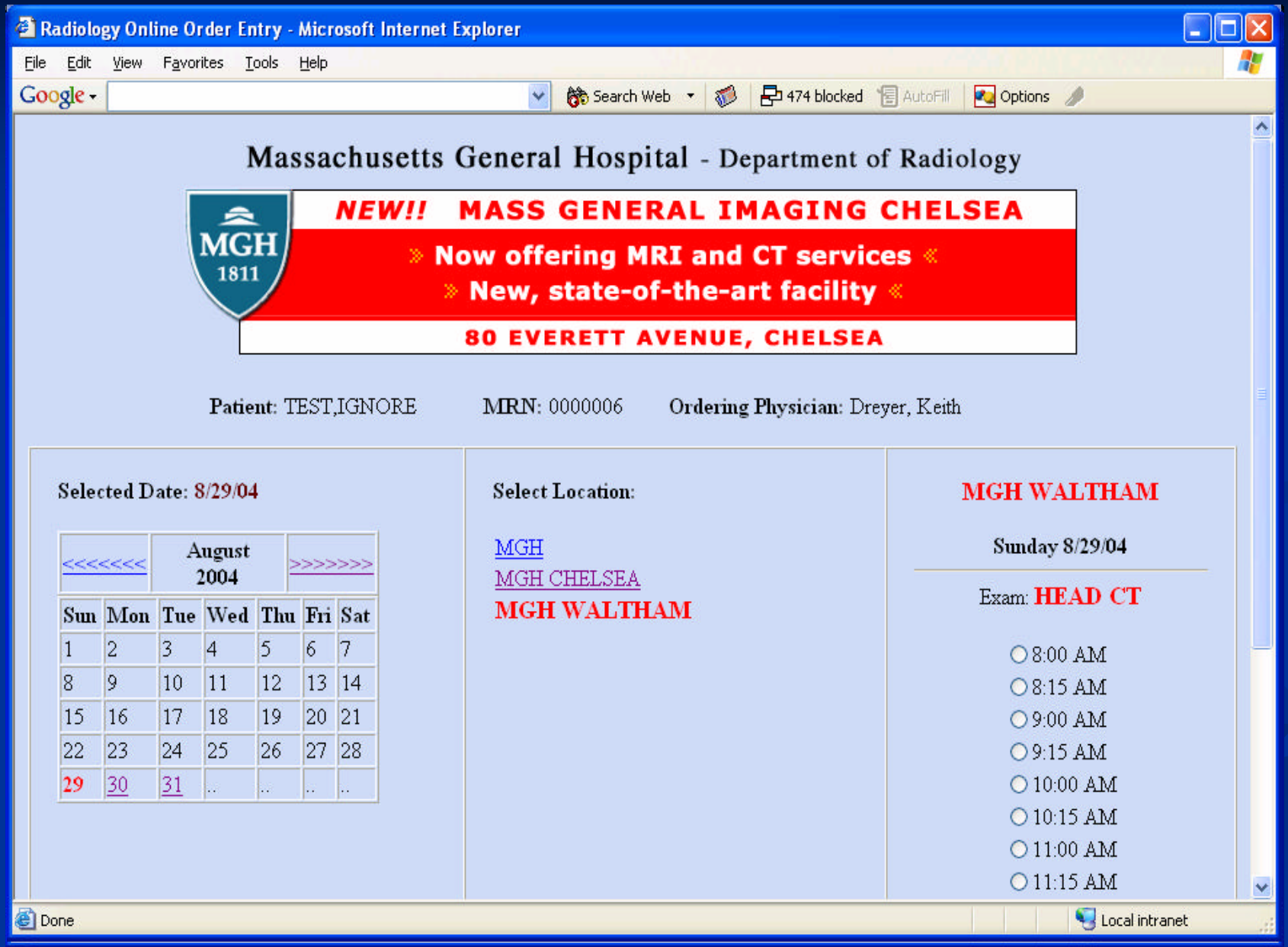
Motivation


MGH Annual Radiology Exam Volume
1995 to 2003*
550,000
500,000
450,000
400,000
350,000
300,000
2000
2001
2002
2003*

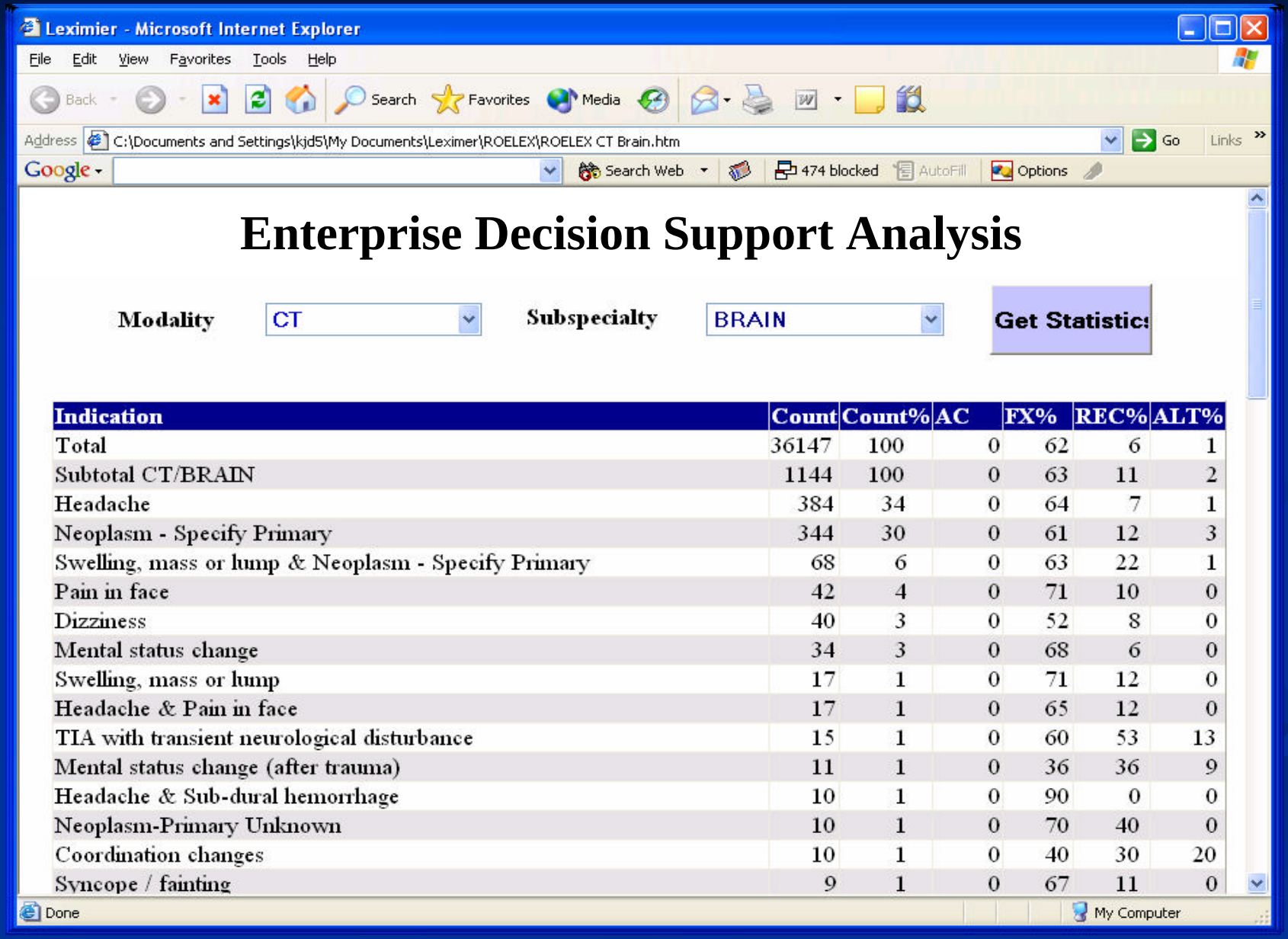
Radiology Ordering Decision Support

- Contraindication Screening
- Protocol Information
- Duplicate Examination Notification
- ACR Appropriateness Criteria Framework
- Simple Color Coded Results
- Imaging Alternatives
- Integration with various CPOE systems

Ordering Physician RDSS



RDSS Rule and Compliance Validation



Enterprise Decision Support Analysis

Modality CT **Subspecialty** BRAIN **Get Statistics**

Indication	Count	Count%	AC	FX%	REC%	ALT%
Total	36147	100	0	62	6	1
Subtotal CT/BRAIN	1144	100	0	63	11	2
Headache	384	34	0	64	7	1
Neoplasm - Specify Primary	344	30	0	61	12	3
Swelling, mass or lump & Neoplasm - Specify Primary	68	6	0	63	22	1
Pain in face	42	4	0	71	10	0
Dizziness	40	3	0	52	8	0
Mental status change	34	3	0	68	6	0
Swelling, mass or lump	17	1	0	71	12	0
Headache & Pain in face	17	1	0	65	12	0
TIA with transient neurological disturbance	15	1	0	60	53	13
Mental status change (after trauma)	11	1	0	36	36	9
Headache & Sub-dural hemorrhage	10	1	0	90	0	0
Neoplasm-Primary Unknown	10	1	0	70	40	0
Coordination changes	10	1	0	40	30	20
Syncope / fainting	9	1	0	67	11	0

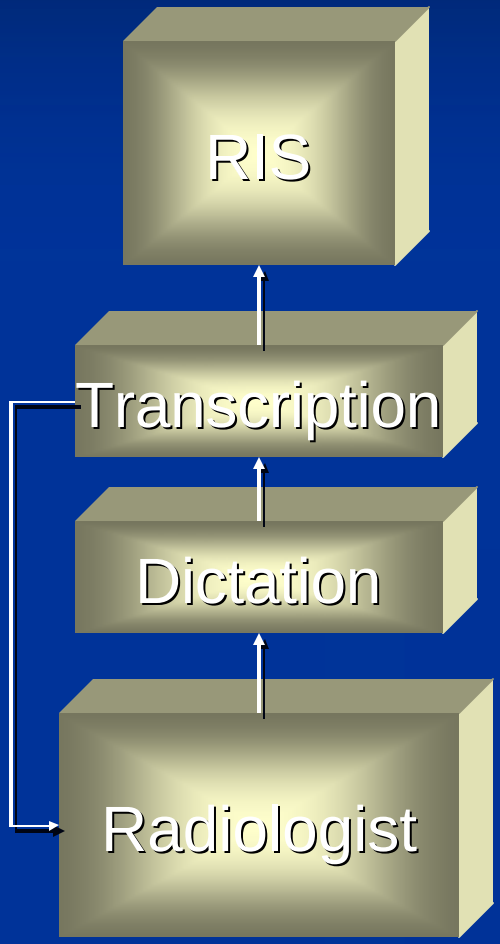
RDSS Statistics

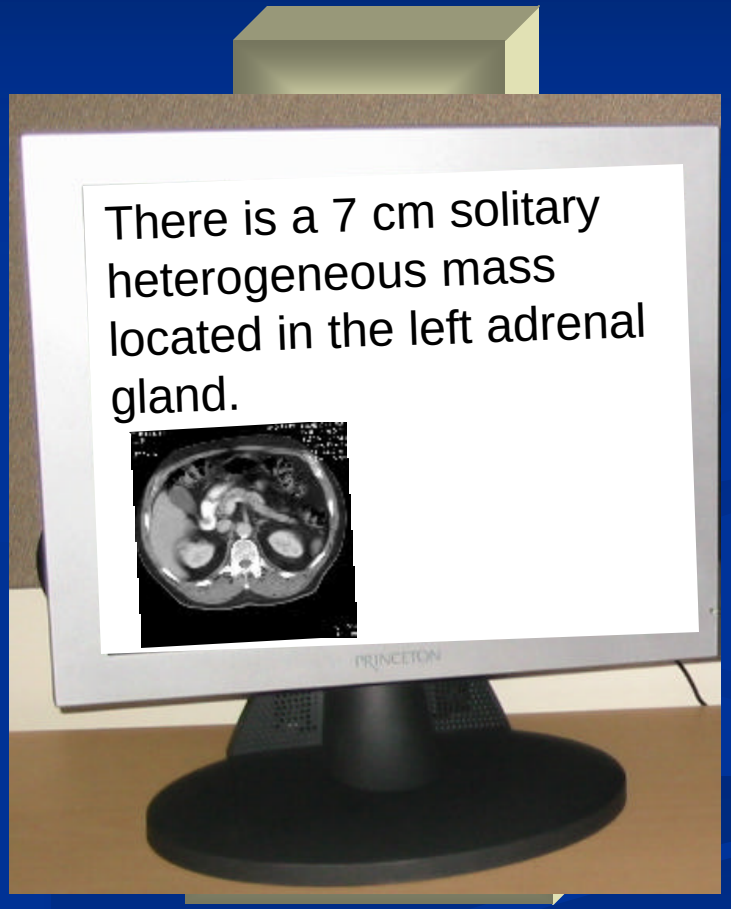
- Operational November, 2004
- Over 3,000 Ordering Physicians
- Over 50,000 exams ordered
- Over 20% of orders modified by DS guidelines

Radiologist Decisions Support

- Anatomy Atlas
- Differential Diagnosis
- Disease References
- External Information Sources
- Recommendation Protocols
- Personal Reference Notes
- Critical Alerts
- Integrated with Voice Recognition

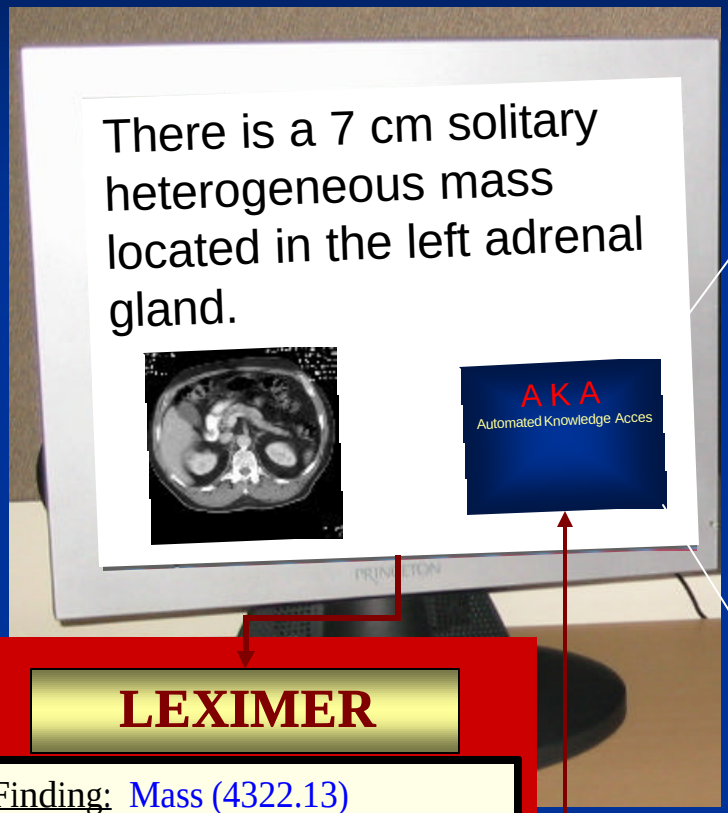
Speech Recognition





Radiologist Decision Support

~ Cognitive Prosthesis ~



LEXIMER

Finding: Mass (4322.13)
Location: Adrenal Gland (R43.8)
Side: Left (R42.1)
Features: Heterogenous (R343.9)
Size: 7 cm (302.1 -7)

MEDICAL KNOWLEDGE

Pheochromocytoma

1. Imaging Characteristics
2. Pathophysiology
3. Associated Disease States
4. Protocols
5. Recommendations
6. Special Considerations

Critical Alerts

- **Notification of Critical Findings and Recommendations**

This study is reviewed with Dr Smith. Standard protocol was used to obtain an MRI of the brain with MRA of the circle of Willis and DWI imaging.

Dizziness and recurrent syncope. Please evaluate the posterior circulation. Comparison is to a CT of the head performed 3 September 99. Comparison is also to a CT performed the day after the MRI on 5 September 1909. Bilateral subdural hemorrhages are present. The right sided subdural hemorrhage appears improved when compared to the prior CT. It has a component extending further posteriorly than appreciated on the CT, appearing to involve the occipital lobe on the right side. The left subdural hemorrhage is worse than it appeared on the initial CT. There is extensive subarachnoid hemorrhage better appreciated on MRI than on CT.

There is no evidence of tentorial subdural hematoma. The subsequent CT did show such a bleed, this must have occurred in the interval between studies. DWI imaging of the brain parenchyma is normal in appearance. There is no evidence of acute infarction. The circle of Willis was imaged with particular attention to the posterior circulation. The right vertebral artery appears prominent. The procedure circulation appears entirely normal. Because imaging was centered on the procedure circulation, the MCA's are not completely evaluated. The ventricular system and CSF spaces do not show evidence of abnormal dilation. The visualized extracranial structures are normal in appearance.

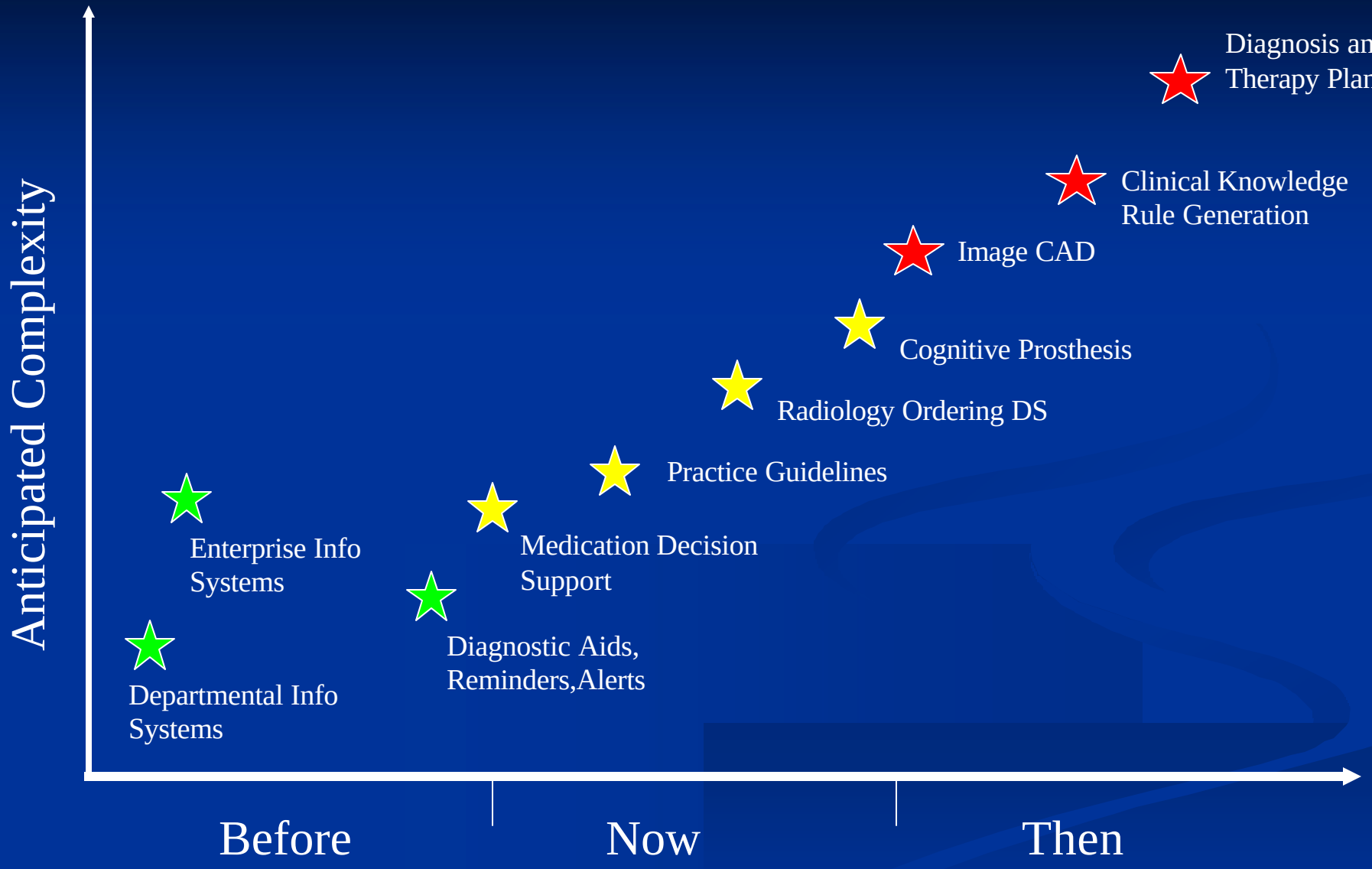
Impression. No evidence of acute infarction on diffusion weighted imaging. Bilateral subdural hemorrhages with subarachnoid hemorrhage. The posterior circulation appears entirely normal. A follow up MRI of the brain is recommended within 7 days to assess progression of hemorrhage.

Subarachnoid Hemorrhage

Brain MRI within 7 Days

- **Notification of Reports not Visualized or Acted Upon**

Summary Timeline



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