



Evidence Based Trauma Radiology

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Disclosure:

Book Royalties, Springer-Verlag

Evidence Based Imaging: Optimizing Imaging for Patient Care

Evidence Based Imaging in Pediatrics: Optimizing Imaging for Patient Care



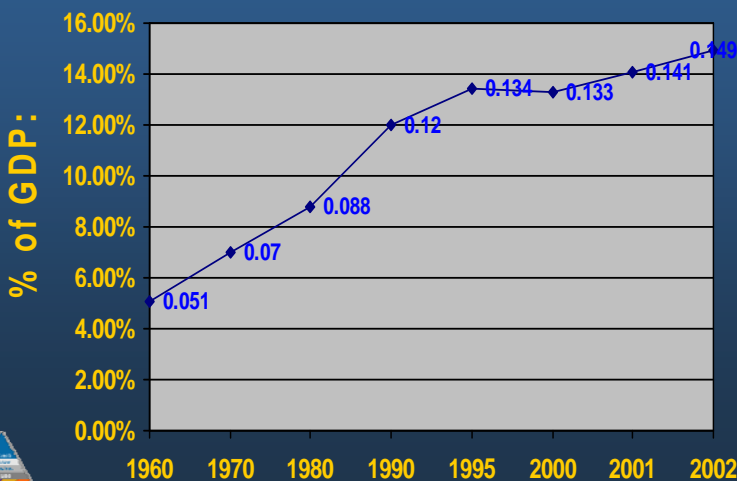
Quality in Medicine

- IOM 1999 report:
 - “To err is human: Building a safer health system”
- Preventable deaths
 - 44,000 to 98,000 in medical centers/year in US
- Research
 - Omission, commission, communication



Rising Healthcare Costs

Health Care as % Gross Domestic Product (GDP)



What We Get for All Those Dollars

- U.S. over 17% of GDP for health care is:
 - 2X developed country avg. of 8.3%
 - 50% higher than #2 Switzerland
- WHO report, 2003 – U.S.:
 - Has the 37th best health care in the world
 - Ranks 47th in life expectancy
 - Ranks 42nd in infant mortality
 - Worse than all Nordic countries



Healthcare Expenditures

| | % GDP 2003 | Five year increase (%) | Per capita (\$) | Life expectancy |
|---------|------------|------------------------|-----------------|-----------------|
| Norway | 10.3 | 10 | 5000 | 80 |
| Sweden | 9.4 | 12 | 3100 | 81 |
| Finland | 7.4 | 7 | 2300 | 79 |
| Denmark | 9.0 | 6 | 3800 | 78 |
| Iceland | 10.5 | 12 | 3500 | 81 |
| US | 15.2 | 16 | 5700 | 78 |



Current State

- Cottage industry
 - Prior to industrial revolution
 - Individual artisans
 - Customized care
 - **Fragmented**
 - **Only 50% evidence supported care**
 - **20% of provided care unnecessary**



Swensen, NEJM 2010



Growth in Imaging Procedures



Radiation

- CT now largest source of medical radiation
 - CT most rapidly rising
- Over 50% variation in imaging rates in US regions
- Increasing awareness and scrutiny
- Emergency radiology perceived as a major source of overutilization



Parker, AJR 2008



Objectives

- Introduce Evidence Based Imaging
- Apply EBI to trauma radiology
 - Who should undergo imaging?
 - Clinical prediction rules
 - How should we image?
- Future of EBI



Evidence Based Medicine

- McMaster/Oxford mid-1990s
- Medical decision making based on “integration of best research evidence with clinical expertise and patient values”

Sackett, et al. Evidence-Based Medicine 2000



Evidence Based Medicine

- **Ask**- answerable question
- **Search**- relevant literature
- **Appraise**- literature critically
- **Summarize**- evidence
- **Apply**- evidence to guide action



Ask

- “Is head CT useful in trauma patients?”



PICO

- Patient
- Intervention
- Comparison
- Outcome



Ask

- “Is head CT useful in trauma patients?”
- In young neurologically intact trauma victims, is unenhanced head CT superior to clinical exam for the detection of surgically important intracranial injury?



Search

- Comprehensive
- Unbiased
- Search is “subject recruitment”
- PubMed
- Embase
- Medical librarian



Appraise

- Critical assessment
- Predefined criteria
 - STARD
 - QUADAS
- New skill set
 - Limited experience in training
- Determine included papers



Summarize

- Meta-analysis
 - Requires multiple similar high quality studies
- Formal pooling of results
- Summary of differences



Apply

- Institute evidence based best practices



Evidence Based Medicine v. Eminence Based Medicine

- Systematic
- Critical
- Transparent



Challenges with EBM

- Too little evidence
 - 10-40% of medicine is backed by “evidence”
 - John Snow
 - cholera



Challenges with EBM

- Too little evidence
 - 10-40% of medicine is backed by “evidence”
 - John Snow and cholera
- Too much evidence
 - Over 100 radiology journals
 - Radiology- 877,103 articles*



*April 26, 2010



Challenges with EBM

- Too little evidence
 - 10-40% of medicine is backed by “evidence”
 - John Snow and cholera, 1854
- Too much evidence
 - Over 100 radiology journals
 - Radiology- 877,103 articles
- Dissemination
 - Attention of provider
 - Disinformation
 - Provider resistance



EBI Options

- Bottom-up
 - Individually review literature
 - relevance
 - quality
 - timeliness
 - Disadvantages
 - effort
 - expertise



EBI Options

- Top-down
 - Published EBI reviews
 - fast and easy
 - EBM/I expertise
 - Disadvantage
 - trust



Evidence Based Medicine

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Imaging is Different

- Effect of imaging on outcome
- Testing v. Treatment
 - Imaging is information
 - Use diagnosis to guide action
- Challenges in measuring imaging effectiveness
 - Effect of imaging is mediated (confounded) by treatment
 - RCTs of imaging outcomes rare



Imaging “Outcomes”

- Accuracy (sensitivity/specificity)
- Medical decision making
 - Before/after
- Diagnostic yield
 - Imaging unnecessary
- Clinical Prediction Rules



Clinical Prediction Rule

- Decision making tool
 - Multiple factors
 - Define who should be imaged
- Validated
 - Shown to work
 - Multiple populations



Clinical Prediction Rule



Clinical guideline
Evidence based summary
Appropriateness criteria
Best practice
Meta-Analysis
Utilization guideline
Benchmark
Clinical decision tool
Consensus opinion
White paper



Clinical Prediction Rule



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VALIDATED



Strength of Evidence

- Clinical Prediction Rules
- Evidence Based Guidelines
 - Formal evidence synthesis
- Panel recommendations
 - Experts, literature review
- Opinion



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Clinical Prediction Rules

- Ottawa ankle rules
 - Ottawa Foot Rule, Ottawa Knee Rule
- Cervical spine
 - NEXUS, Canadian C-Spine rules
- Head CT
 - New Orleans, Canadian Head CT, CHIP
 - CHALICE, CATCH
- Thoracolumbar spine



Ottawa Ankle Rule



Ottawa Ankle Rules

- Unable to bear weight
- Tenderness at posterior edge or inferior tip of lateral malleolus
- Tenderness at medial malleolus



Stiell, JAMA, 1993; 269: 1127-1132



Ottawa Ankle Rule

- Developed and validated in Ottawa
- Subsequent validation in US, Germany, Asia
- Sensitivity 100%
- Decrease imaging by 34%
 - Site specific
- May be less successful with triage nurses



Ottawa Ankle Rule

- Ottawa Foot Rule
- Ottawa Knee Rule



Cervical Spine Imaging

- NEXUS
 - Validated in 21 US medical centers
 - Based on actual practice
 - Sensitivity 100%
 - Limited ability to decrease imaging
- Canadian Cervical Spine Rule
 - Develop and validate in multi-institution study
 - Sensitivity 100%



NEXUS

- Image if:
 - Tenderness at posterior midline of c-spine
 - Focal neurological deficit
 - Abnormal level of alertness
 - Evidence of intoxication
 - Clinically apparent pain that might distract patient from pain of cervical spine injury



New Orleans Criteria (NOC)

Haydel et al. N Engl J Med 2001

- Clinical findings absent in patients without intracranial injury
- 100% Sensitive
- 22% Reduction in head CTs
- Validated in Holland

(Smits et al. *JAMA* Sept. 2005)



New Orleans Criteria

CT required if: >3 years old, with minor head injury, GCS 15, and 1 of the following:

1. Headache
2. Vomiting
3. Age >60 years
4. Drug or alcohol intoxication
5. Short term memory deficits
6. Visible trauma above the clavicles
7. Seizure (after the head injury)



Canadian Head CT Rule

- High risk factors (100% sensitive)
 - GCS <15 within 2 hours
 - Suspected open skull fracture
 - Sign of basal skull fracture
 - Vomiting at least 2 times
 - Age >65



Stiell, IG 2001 Lancet



CT in Head Injury Patients (CHIP)

- Includes subjects with or without LOC
- For neurosurgical intervention
 - 100% sensitive
 - 30% specific
- 3364 patients
- Netherlands
- Likely cost-effective



Smits, M 2007 Ann Int Med



CHIP

- Major Criteria (any 1)
 - Pedestrian or bike struck by car
 - Ejected from vehicle
 - Vomiting
 - Amnesia > 4hr
 - Clinical signs skull fx
 - GCS < 15
 - Anticoagulants
 - Seizure
 - Age > 60
- Minor criteria (any 2)
 - Fall
 - Anterograde amnesia
 - Skull contusion
 - LOC
 - GCS deterioration of 1 point
 - Age 40-60



CHALICE

- Children's **H**ead injury **A**lgorithm for the prediction of **I**mportant **C**linical **E**vents
- 10 hospitals in England
- Developed on 22,772 children
 - 281 abnormal head CT
 - Sensitivity of 98%
- Not yet validated
- History, exam, mechanism



CATCH

- Not Validated
- High risk factors
 - GCS<15 at 2 hours
 - Suspect open skull fracture
 - Worsening headache
 - Irritability
- Sensitivity 100%
- Specificity 30%



Osmond, MH 2010 CMAJ



Thoracolumbar Spine

- Limited evidence
- Validated clinical prediction rule
 - 2404 subjects
 - Sensitivity 100%
 - Specificity 4%
- Limited effect on utilization



Holmes, J Emerg Med 2003



Holmes Criteria

- Thoracolumbar spine pain
- Thoracolumbar midline spine tenderness
- Decreased level of consciousness
- Abnormal peripheral nerve examination
- Distracting injury
- Intoxication



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 - **How should we image?**
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How Should We Image?

- Competing modalities
- Comparison of accuracy
 - Assume all other factors equal
- Cost-effectiveness analysis
 - More assumptions



Comparison of Accuracy

- Blunt cerebrovascular injury
 - DSA-reference standard
 - CTA-high sensitivity and specificity
 - Imperfect
 - Confounding factors
 - Time, contrast, cost, radiation
- Accuracy insufficient



CT v. Radiography for Cervical Spine Trauma

- CT cost-effective if fracture risk >4%
- Why?
 - Frequency of inadequate radiographs
 - Extreme cost of missed fracture
 - small percentage develop paralysis
 - Higher cost of radiography in high-risk
 - Higher radiation exposure from CT



Blackmore, et al, *Radiology* 1999;212:117-125
Blackmore, et al, *Radiology* 2001;220:581-588



Harborview Cervical Spine CT Criteria

- Focal neurological deficit
- Severe head injury
 - skull fracture
 - intracranial hemorrhage
 - unconscious
- High energy mechanism
 - MVC speed > 35mph
 - auto vs. pedestrian
- Head CT



Hanson, et al, *AJR* 2000;174:713-718



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Future

- Increased resources for practitioners
- Dilution of “Evidence”
- Increased emphasis on top-down EBI for payment decisions
- More appropriate use of healthcare resources



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Resources

- Top down EBI
 - Books, websites, journals
 - Societies/organizations
 - NORDTER
 - Governmental programs
 - Awareness



NORDTER

- Validation of clinical pathways
- Experience with Evidence based Pathways
 - Cervical spine imaging
 - Cerebrovascular injury
- Implement and test
 - Are correct patients being imaged with appropriate modality?
 - Do clinical pathways work?



Head CT Guidelines

- Dutch Guidelines 2001
- World Federation of Neurosurgical Societies (WFNS) 2001
- European Federation of Neurological Societies (EFNS) 2002
- National Institute for Clinical Excellence (NICE) 2001
- Scottish Intercollegiate Guidelines Network (SIGN) 2000
- Scandinavian 2000



Smits, M 2007 Radiology



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Dilution

- Marketing of “Evidence-Based”
 - Sell product or viewpoint
- Quality of EBI is variable
 - Advertising
 - Appropriateness Criteria
- Trust/understand methods



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Washington State Health Technology Assessment Program

- Improve healthcare through EBM
 - Payment decisions (20% of population)
- Perform formal tech assessments
 - Outside consultant
- Healthcare Technology Clinical Committee (3/2007)
 - Coverage decisions
- Tests/ procedures



Washington HTAP

- Upright MRI for back pain
- Pediatric bariatric surgery
- Lumbar fusion surgery for back pain
- Discography for diagnosis
- CT colonography screening
- Drug eluting coronary stents
- Knee arthroscopy for osteoarthritis



Clinical Decision Support

- Computer interface with required indications for imaging studies
- Denial if not listed indication
- Effective
- Intrusive
- Generally limited to outpatient (not emergency)



Evidence Based Imaging

MRI Back Exam

Exam Requested* mr spine mr spine w/ w/o contrast mr spine w/ w/o contrast

Current Weight* # Bx kg Max Table Weight 200 kg/441 lbs

ICD9 Code(s)

Indications (select all that apply)!*

- Motor deficit (781.09)
 - Involuntarily pain despite 6 weeks of appropriate therapy (appropriate therapy is defined as 2 weeks of NSAIDs AND advice to stay active AND documentation of lack of improvement)
- Document in relevant history field and apply appropriate ICD 9 code
- Strong suspicion of systemic disease
 - Document in relevant history field and apply appropriate ICD 9 code
- Neurologic Classification(435.9)
 - Cauda Equina(344.60)
 - Upper motor neuron findings with myelopathy codes
 - Unspecified Region (722.70)
 - Cervical (722.71)
 - Thoracic (722.72)
 - Lumbar (722.73)
- Significant trauma or fall
 - Document in relevant history field and apply appropriate ICD 9 code
- Consult has been performed by physical medicine.

NOTE: A spine MRI will likely not be helpful for the patient with back or neck pain if none of these indications are present. The spine clinic physician on call will provide help by phone and offer a same day visit to assist in care of the patient. Text page (spine clinic page number) on V-Net and enter the following message: "Dr. --- wishes to speak with you about a patient with neck/back pain in whom an MRI is not indicated. Please call (pager number of ordering provider)."

Additional Information (Rule Out, History, Symptoms)

Is this patient uncomfortable in enclosed spaces? No Yes, Uncomfortable, but can tolerate exam Yes, Oral medication provided and ride home confirmed Yes, Moderate sedation required

Able to lie on back for 30 min? Yes No, can not lie on back. Oral medication provided and ride home confirmed No, can not lie on back. Moderate sedation required.

Previous metal worker? No Yes

MRI Migraine Exam

Exam Requested*

Current Weight* # Bx kg Max Table Weight 200 kg/441 lbs

ICD9 Code(s)

Indications (select all that apply)!

- Abnormal neurologic exam.
- Localizing symptoms (e.g. diplopia or paresthesia)
- Other risk factors such as cancer or immune deficiency
- Atypical headache with red flags:
 - Headaches beginning after the age of 50 years
 - Fever
 - Aggravated with valsalva
 - Progressive pattern
 - Concerns of increased intracranial pressure (e.g. N/V, ataxia, somnolence)
- Consult has been performed by neurology.

NOTE: A brain MRI will likely not be helpful for the patient with migraine pain if none of these indications are present. The doctor head of neurology will provide help by phone to assist in care of the patient (the oncall neurologist will be available as a back up in his absence.) Text page Dr. Elliot at 604-234-0044 and enter the following message: "Dr. --- wishes to speak with you about a patient with migraine pain in whom an MRI is not indicated. Please call... (pager number of ordering provider)."

Must Be Indicated: if no indications present, a Migraine consult call is recommended.

Additional Information (Rule Out, History, Symptoms)

Is this patient uncomfortable in enclosed spaces? No Yes, Uncomfortable, but can tolerate exam Yes, Oral medication provided and ride home confirmed Yes, Moderate sedation required

Able to lie on back for 30 min? Yes No, can not lie on back. Oral medication provided and ride home confirmed No, can not lie on back. Moderate sedation required.

Previous metal worker? No Yes

Pacemaker or defibrillator? No Yes

Aneurysm Clip? No Yes

Cochlear Implant? No Yes



Clinical Decision Support

- Restrict imaging systematically
 - Good-eliminate unnecessary imaging
 - Bad-block effective imaging
 - Criteria may or may not be evidence based
- Wide adoption in US within 3 years
 - Driven by payers, health plans, American College of Radiology



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Appropriate Imaging

- Focus on quality not cost
- Radiologist involvement
 - Define quality
- Patient first
 - Cannot be self-serving in defining appropriate
- Collaborative



Future of EBI

- More research/evidence
- Define value of radiology
- Financial pressures will outweigh physician preferences



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