Imaging Guidelines in Trauma: Help or Hindrance?

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What Are They?
ACCF/AHA Guideline

2010 ACCF/AHA/AATS/ACR/ASA/SCA/SCAI/SIR/STS/SVM Guidelines for the Diagnosis and Management of Patients With Thoracic Aortic Disease


Endorsed by the North American Society for Cardiovascular Imaging

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Adult Head Trauma

Using the Canadian CT Head Rule (CCHR):

**Inclusion Criteria** for use in patients with:
- Blunt trauma to the head resulting in one or more of the following:
  - Witnessed loss of consciousness or
  - Definite amnesia or
  - Witnessed disorientation (no matter how brief, as reported by the patient or witness)
- Initial emergency department GCS score of 13, 14 or 15 as determined by the treating physician
- Injury within the previous 24 hours

**Exclusion Criteria** for patients who have clinical evidence/history of blunt head trauma, do not use CCHR if any of the following apply:
- Emergency department GCS score less than 13
- An obvious penetrating skull injury or obvious depressed skull fracture
- Unstable vital signs associated with major trauma
- Focal neurological deficit
- Seizure prior to assessment in ED
- Bleeding disorder or use of oral anticoagulants

**High risk (for neurosurgical intervention)**
- Any of the following:
  - GCS score <15 at 2h after injury
  - Suspected open or depressed skull fracture
  - Any sign of basal skull fracture (haemotympanum, ‘raoon’ eyes, cerebrospinal fluid otorrhea/rhinorrhoea, Battle’s sign)
  - Vomiting ≥ two episodes
  - Age ≥ 65 years

**Imaging Recommended**
CT should be performed due to the higher likelihood of clinically important

**Canadian C-Spine Rule**

**Inclusion Criteria:**
- Adults (defined as >16 years of age); AND
- Acute trauma to the head or neck; AND
- Stable (i.e. normal vital signs as per Revised Trauma Score); AND
- Alert (GCS = 15); AND
- Injury within previous 48 hours; AND EITHER
  - Neck pain; OR
  - No neck pain but meet the following criteria:
    - Visible injury above the clavicles; AND
    - Non-ambulatory; AND
    - Dangerous mechanism of injury

**Exclusion Criteria:**
- Trivial injuries (e.g. Simple facial lacerations) and did not fulfill the “at risk” inclusion criteria;
- Penetrating trauma;
- Presented with acute paralysis;
- Known vertebral disease (e.g. ankylosing spondylitis, rheumatoid arthritis, spinal stenosis, or previous cervical surgery) as determined by the examining physician;
- Returned to ED for reassessment of same injury;
- Pregnancy.

**YES to ANY**
- 1. Any high-risk factor that mandates radiography?
- Age ≥ 65

**NO to ANY**
Exclude
CONSENSUS!
Consensus

“To me, consensus seems to be the process of abandoning all beliefs, principles, values and policies. So it is something in which no one believes and to which no one objects.”

Margaret Thatcher
Physician Autonomy

“To many, physician autonomy means physicians should have complete freedom to provide treatments for patients according to their best judgment.”

Physician Autonomy and Health Care Reform
Ezekiel J. Emanuel, MD, PhD; Steven D. Pearson, MD, MSc
To Err Is Human
Building a Safer Health Care System

- 1999 Report on Patient Safety from the Institute of Medicine, USA

- Patient Deaths due to Preventable Medical Errors
  - Estimated 44,000 – 98,000 per year
    - Motor vehicle accidents (43,000)
    - Breast cancer (42,000)
To Err Is Human

- Direct and Indirect Costs - US
  - $17-29 billion for preventable adverse events
  - 2% of total national health care expenditure
  - Medication error alone:
    - $5000/admission on average
    - $2.1 million/year for a 700 bed hospital

- New Zealand:
  - 13% of all hospital admissions associated with an adverse event
  - 15% of these result in permanent disability or death
  - Substantial cost: average of 9 extra hospital days/event

What are we doing wrong?

Unexplainable variation in practice

Over Use

Under Use

Misuse

Of tests, procedures, and medication
We do not consistently apply the science we know
“Miracle on the Hudson”

- January 15, 2009, 3 minutes after take off from LaGuardia Airport in New York City, a US Air Airbus A320 struck a flock of geese and lost power to both engines.
- Judging that he didn’t have time to safely return to LaGuardia or land at another nearby airport, Captain Sullenberger decided to crash land the plane in the Hudson River.
- First time a major aircraft had crash landed in the water in 45 years.
- All passengers and crew survived – 155 people.
- One serious casualty: one woman broke both legs.
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Executive Safety/Reliability Management Professional

Bottom-line driven manager supported by progressively responsible experience across 40+ years in the aviation industry. Possess in-depth understanding of aviation operations acquired through real-world flight experience, professional training and leadership roles with one of world’s leading airlines. History of achievement in safety, innovation, crew training, operational improvement, cost savings, productivity improvement and customer service; proven ability to maximize crew performance and flight safety. Combine strong industry knowledge and business leadership skills to consistently manage complex scheduling, lead high-performance, motivated teams and implement efficient processes that ensure smooth operations and quality customer service. Strong communicator, effective negotiator and motivational team builder; able to effectively communicate needs and merge disparate teams in the support of market objectives. Respected for wide range of industry knowledge, solid sense of integrity and demonstrated passion for industry as a whole as evidenced by lifelong career of flying.
Risk comparison

- Serious injury after crash landing in an airplane on the Hudson River: $\frac{1}{155} = 0.6\%$
- Permanent disability or death due to avoidable medical error: $13\% \times 15\% = 2.0\%$
Trauma Statistics

- Commonest cause of death under age 45
- 36 life years lost per trauma death
- For every trauma death, 2 will have serious permanent disability
- Increased morbidity and mortality after hours – weekend effect
  - Not seen in established trauma centers
- Better outcomes if high volume (>400/year)
  - Auckland City Hospital: about 300/year

Trauma: Who Cares? A report of the National Confidential Enquiry into Patient Outcome and Death (2007)
Day of Hospital Admission of 3883 Major Trauma Patients

(a)

Time of Hospital Admission of 3883 Major Trauma Patients

(b)
Attributes of a Trauma Center

**Surgery**
- 24/7 Consultant led trauma team

**Radiology**
- 24/7 staffing (resident radiologist, MRT)
- CT scanner in ED

**Interventional Radiology**
- 24/7, within 30-60 minutes
- 47% increase in mortality for each hour of delay in hemodynamically unstable patients

**Standardized protocols**

**Focus on audit and education, continuous improvement**
Does Organizing Trauma Care Make a Difference?

- Trauma: Who Cares? A report of the National Confidential Enquiry into Patient Outcome and Death (2007)
  - Deficiencies, unexplainable variation in trauma care
  - In hospital mortality 20% higher than in US
  - 3 times more likely to die if major trauma compared to Australia

- 30% decrease in mortality in first 48 hours if patient transferred to trauma center vs non trauma center first

- NHS Restructured Trauma Care in 2012
  - 37 additional survivors over expected in first 6 months after London Trauma Network established
How do we organize trauma imaging in Auckland?
Who should get CT?

Mechanism is not specific for presence of injury

Anatomic/physiologic parameters alone not sensitive

>1 million US trauma patients
- anatomic and physiological parameters
  only have a sensitivity of 56% for
detecting patients with an ISS >15

Combination of criteria: physiological, anatomical, and mechanism of injury to identify severely injured patients with occult or compensated injuries.

Multiregional CT Decision Aid For Adult Blunt Trauma

Middlemore Hospital
Auckland
 Courtesy E. Perry
Trauma CT at ADHB

- Decision for CT - team ED/trauma/radiology
- Trauma patients prioritised to come to CT as soon as team is ready
Multiregional Whole Body Scan

- CT head/C spine, no IV contrast
  - Radiologist review, +/- CTA neck
  - Vascular injury underdiagnosed, cause of preventable stroke
- Protocol
  - CTAC  CTA Carotids Trauma  50mls Omni 350 + 50mls Saline
  - Arterial High Energy Transfer Mechanism trauma from Resus with:
    - Clinical: Acute infarction brain, CHI consistent with DAI and GCS <6
    - Radiology: Skull Base fracture, LeFortII, III or mandible #, C1-3 fracture, Vertebral body fracture, Facet subluxation/dislocation
  - Review of CT Head and C Spine first.
CT Protocols at ADHB

- CT Chest, Abdomen, Pelvis
  - Arterial Chest Abdomen, PV Abdo Pelvis
  - Arterial phase to detect active extravasation or pseudoaneurysm in solid organs
  - Add Arterial pelvis if unstable pelvic fracture
Reformats for Trauma

- Head - axial soft tissue and bone
- C-spine - axial, coronal, sag bone, axial soft tissue
- Chest abdomen pelvis - axial, coronal, sagittal soft tissue and bone, axial lung

Reporting

- Verbal report of major findings at time of scan
- Registrars given a ‘list’ of critical findings to assess

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<td>(see comment box below)</td>
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<tr>
<td>Major Pelvic Fracture</td>
<td>Yes</td>
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Reporting

Written report within 60 minutes with phone call if significant change from verbal report
When Things Go Wrong
A Near Miss

19 year old fell off his bike,
left flank pain, amnesia
CT: Head
Abdomen and Pelvis

Protocol:
APT
Abd/pel Trauma
100 ml Omni 300
No Oral
PV, +/- arterial
Trauma
Trauma Follow up/ Liver Laceration FU
Non Operative Management

6 hours later:
Emergent Splenectomy

What went wrong?
Review of events

- Report: splenic injury with active bleeding and blood in pelvis; verbal report to ED at time of scan, emergent surgical opinion advised.

- Surgical team discussed with Interventional Radiology; intervention not undertaken at that time.

- Patient observed for 6 hours in high dependency unit, became hemodynamically unstable and referred to IR, diverted to theatre due to instability for open splenectomy.
To Err Is Human

- Diagnostic
  - Error or delay in diagnosis
    - No
  - Failure to employ indicated tests
    - Yes
  - Use of outmoded tests or therapy
    - Yes
  - Failure to act on results of monitoring or testing
    - Yes
Do We Need to Develop A Guideline?

Name, Blame, Shame doesn’t work they say....
What Did We Do?

- Multidisciplinary Group to Discuss Case
  - Senior Trauma Surgeon, Trauma Fellow
  - Two Interventional Radiologists
  - Diagnostic Radiologist

- Reviewed the Literature

- Hashed out a pathway/guideline for splenic trauma

- Communicated with team members, educated team members, disseminated information

- Audit
Blunt Splenic Trauma Guidelines

- Imaging will be performed as detailed below* on blunt trauma patients who do not have immediate indications for theatre i.e. peritonitis, hypotension.
- Evidence of splenic trauma with contrast extravasation, false aneurysm, and/or arteriovenous fistula will proceed directly to angiography from emergency department. This will be organised by phone call from the most senior surgical registrar available to the interventional consultant.
- Any grade 3+ splenic injury without the above findings will prompt a phone call from the surgical consultant to the interventional consultant. If the surgical consultant is not available within 20 minutes to make this call, the most senior surgical fellow/registrar will initiate the communication.
- Factors that may prompt angiography in the absence of contrast extravasation, false aneurysm, and/or arteriovenous fistula include but are not limited to:
  - Significant hemoperitoneum
  - Clinical findings concerning for impending instability
    - Hemoglobin drop
    - Tachycardia
    - Hypotension
    - Fluid requirement >1L or blood product requirement
  - Patients who are higher risk for complications from hypotension and/or laparotomy
    - TBI
    - Elderly/comorbid
- If it is decided that the patient not require immediate angiography, a plan will be put in place to allow for prompt reconsideration should the patient’s condition change. Ideally the patient will be admitted to a monitored setting i.e. HDU.

*Imaging (pertains only to those patients who do not require a chest CT; these patients will continue as before)
- Dual phase abdominal CT (arterial upper abdomen, portal venous abdomen and pelvis):
  - Resus patients coming through as a trauma call
  - Non resus patients with positive FAST
- Dual phase abdominal CT including pelvis (arterial abdomen and pelvis, portal venous abdomen and pelvis):
  - Patients with unstable pelvic fractures.
- Single phase abdominal CT (portal venous phase abdomen and pelvis):
  - All other trauma patients.

CT: Who and How

Angio: All patients with contrast extravasation, pseudoaneurysm, or a/v fistula

Consultant Discussion:
Any grade 3+ injury without extrav/psa/fistula

Table 1

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<th>AAST Splenic Injury Grading Scale</th>
<th>Acute</th>
<th>Chronic</th>
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<tr>
<td>Grade 1</td>
<td>1-2cm</td>
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<tr>
<td>Grade 2</td>
<td>2-4cm</td>
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<tr>
<td>Grade 3</td>
<td>4-6cm</td>
<td>4-6cm</td>
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<tr>
<td>Grade 4</td>
<td>&gt;6cm</td>
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Legend:
- Grade 1: Small, non-bleeding aneurysm or pseudoaneurysm
- Grade 2: Medium-sized, non-bleeding aneurysm or pseudoaneurysm
- Grade 3: Large aneurysm or pseudoaneurysm
- Grade 4: Massive aneurysm or pseudoaneurysm

Notes:
- Acute: Spontaneous rupture
- Chronic: Late complication

*Imaging performed when indicated*
Isn’t this just part of our job?
“The minutes and first hours after an accident are not the time to be working out care from first principles. We miss the obvious under pressure; we cannot hope to make consistently inspired diagnoses. It is not the time to be negotiating a hierarchy, debating priorities and searching shelves and drawers for equipment. We need a well worked out process based on getting most things right and very few things wrong.”

Guidelines

Help

Supported by evidence
Developed by knowledge teams
Temporary, teams are set and when developed by, and when
Cumbersome and interfere
Modified appropriately for local environment
Reviewed and changed as needed to continuously improve care
Systems-based practice
Thank you very much!
References


Trauma: Who Cares? A report of the National Confidential Enquiry into Patient Outcome and Death (2007)
