What, Where, and When—Radiologic Imaging for Internal Medicine Physicians

Bilal Tahir, MD
Indiana University School of Medicine
Department of Radiology & Imaging Sciences

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No Disclosures
Radiologic management
  - Adrenal nodules
  - Thyroid nodules
  - Adnexal cystic lesions

Ordering dilemmas
  - CT IV contrast and renal insufficiency
  - Anti-platelet / Anti-coagulants, labs and non-vacular invasive radiology procedures
  - Oral contrast ---- yes or no?
Newer technology and applications
  - US liver elastography
    - Background
    - Clinical value
    - Reporting
Adrenal Nodules
6% of CTs (10% in > 70-years age) show adrenal incidentaloma (AI)
3-5% of AI are hormonally active
78% of AI are likely to be adenomas
  70% of AI are lipid rich

Likelihood of Solitary AI to be Malignant

- Retrospective review of 1639 patients with suspected carcinoma of unknown primary
  - 95 (5.8%) had adrenal gland involvement at presentation
  - Only 4 (0.2%) had isolated adrenal met (all > 6 cm size)

- Retrospective review of 973 patients (not known to have malignancy) with 1049 AI on CT
  - 1-year imaging follow up or 2-yer clinical follow-up on all
  - No adrenal malignancies seen

- Bottom line: < 4 cm nodule without known cancer or other metastatic lesions has very small (< 0.2%) likelihood of malignancy

American College of Radiology (ACR) Guidelines for AI

Incidental, Asymptomatic Adrenal Mass (≥1 cm) Detected on any CT or MR exam

Diagnostic Benign Imaging Features
- Myelolipoma, No enhancement,
- Ca = Benign, no F/U,
- ≤10 HU or ↑ signal on CS-MR
- = Benign adenoma, no F/U

Indeterminate Imaging Features

≥1-<4 cm

≥4 cm

No Cancer Hx:
- Consider resection

+ Cancer Hx:
- Consider Bx or PET-CT

Prior imaging

Stable ≥1 year

New or enlarging

Benign, no F/U

No Cancer Hx:
- Consider F/U adrenal CT or resection

+ Cancer Hx:
- Consider Bx or PET-CT

No Prior Imaging, No Cancer Hx

≥2 cm, <4 cm

Adrenal CT

1-2 cm, Probably benign
- Consider 12 month F/U adrenal CT

Reduced dose NCCT ≤10 HU
- = benign adenoma, no F/U

NCCT >10 HU

Adrenal CT washout

No enhancement (<10 HU) = cyst or hemorrhage

APW/RPW ≥60/40%

Benign, no F/U

APW/RPW <60/40%

Benign adenoma, no F/U

Imaging F/U, Bx, PET-CT, or resection depending on clinical scenario
- Left AI with high density (41 HU on Pre). No known cancer.
- Should have had follow-up CT or MRI.
- Instead had biopsy which was not indicated without h/o cancer.

CT 4 years later shows no change in size.

- Bladder cancer and bone met
- 5 cm left adrenal nodule.
- Likelihood of met is high.
- Should have had PET-CT or biopsy
- Instead had non-indicated triple-phase CT with showed indeterminate washout.
Thyroïde nodules
Introduction

- 50-70% of asymptomatic adults have thyroid nodules
- 5-10% malignant
- 70-80% of thyroid cancer in women and 45% in men do not change survival

Why Standardized Reporting

- > 50% of thyroid US at our practice from primary care
- Internal audit ⇒ 43-74% discrepancy in IU radiology consecutive thyroid US reports for
  - Timing of follow up
  - Biopsy vs. follow up
- Review of 100 consecutive US reports showed 57 did not specifically mention ATA findings
Classification Systems for Thyroid Nodules

- ACR TI-RADS White Paper: 2017
- American Thyroid Association: 2015
- Korean Society of Thyroid Radiology: 2011
- American Association of Clinical Endocrinologists + European Thyroid Association: 2010
- Society of Radiologists in US (SRU): 2005
### Table 6. Sonographic Patterns, Estimated Risk of Malignancy, and Fine-Needle Aspiration Guidance for Thyroid Nodules

<table>
<thead>
<tr>
<th>Sonographic pattern</th>
<th>US features</th>
<th>Estimated risk of malignancy, %</th>
<th>FNA size cutoff (largest dimension)</th>
</tr>
</thead>
<tbody>
<tr>
<td>High suspicion</td>
<td>Solid hypoechoic nodule or solid hypoechoic component of a partially cystic nodule with one or more of the following features: irregular margins (infiltrative, microlobulated), microcalcifications, taller than wide shape, rim calcifications with small extrusive soft tissue component, evidence of ETE</td>
<td>&gt;70–90^a^</td>
<td>Recommend FNA at ≥1 cm</td>
</tr>
<tr>
<td>Intermediate suspicion</td>
<td>Hypoechoic solid nodule with smooth margins without microcalcifications, ETE, or taller than wide shape</td>
<td>10–20</td>
<td>Recommend FNA at ≥1 cm</td>
</tr>
<tr>
<td>Low suspicion</td>
<td>Isoechoic or hyperechoic solid nodule, or partially cystic nodule with eccentric solid areas, without microcalcification, irregular margin or ETE, or taller than wide shape</td>
<td>5–10</td>
<td>Recommend FNA at ≥1.5 cm</td>
</tr>
<tr>
<td>Very low suspicion</td>
<td>Spongiform or partially cystic nodules without any of the sonographic features described in low, intermediate, or high suspicion patterns</td>
<td>&lt;3</td>
<td>Consider FNA at ≥2 cm. Observation without FNA is also a reasonable option</td>
</tr>
<tr>
<td>Benign</td>
<td>Purely cystic nodules (no solid component)</td>
<td>&lt;1</td>
<td>No biopsy^b^</td>
</tr>
</tbody>
</table>

^a^US-guided FNA is recommended for cervical lymph nodes that are sonographically suspicious for thyroid cancer (see Table 7).

^b^The estimate is derived from high volume centers, the overall risk of malignancy may be lower given the interobserver variability in sonography.

^c^Aspiration of the cyst may be considered for symptomatic or cosmetic drainage.

^d^ETE, extrathyroidal extension.

ATA Pattern Approach

- **High Suspicion (70-90%)**
  - Microcalcifications
  - Hypoechoic nodule
  - Irregular margins

- **Intermediate Suspicion (10-20%)**
  - Hypoechoic solid regular margin

- **Low Suspicion (5-10%)**
  - Hyperechoic solid regular margin
  -Isoechoic solid regular margin

- **Very Low Suspicion (<3%)**
  - Spongiform

- **Benign (<1%)**
  - Cyst

- **Risk of Malignancy**
ACR TI-RADS

**COMPOSITION (Choose 1)**
- Cystic or almost completely cystic: 0 points
- Spongiform: 0 points
- Mixed cystic and solid: 1 point
- Solid or almost completely solid: 2 points

**ECHOGENICITY (Choose 1)**
- Anechoic: 0 points
- Hypoechoic or isoechoic: 1 point
- Hyperechoic: 2 points
- Very hypoechoic: 3 points

**SHAPE (Choose 1)**
- Widener-than-tall: 0 points
- Taller-than-wide: 3 points

**MARGIN (Choose 1)**
- Smooth: 0 points
- Ill-defined: 0 points
- Lobulated or irregular: 2 points
- Extra-thyroidal extension: 3 points

**ECHOCENTIC FOCI (Choose All That Apply)**
- None or large comet-tail artifacts: 0 points
- Micronodules: 1 point
- Calcifications: 2 points
- Punctate echogenic foci: 3 points

Add Points From All Categories to Determine TI-RADS Level

- 0 Points
- TR1 Benign: No FNA
- 2 Points
- TR2 Not Suspicious: No FNA
- 3 Points
- TR3 Mildly Suspicious: FNA if ≤ 2.5 cm, Follow if ≤ 1.5 cm
- 4 to 6 Points
- TR4 Moderately Suspicious: FNA if ≤ 1.5 cm, Follow if ≤ 1 cm
- 7 Points or More
- TR5 Highly Suspicious: FNA if ≤ 1 cm, Follow if ≤ 0.5 cm

**COMPOSITION**
- Spongiform: Composed predominantly (>80%) of small cystic spaces. Do not add further points for other categories.
- Mixed cystic and solid: Assign points for predominant solid component. Assign 2 points if composition cannot be determined because of calcification.

**ECHOGENICITY**
- Anechoic: Applies to cystic or almost completely cystic nodules.
- Hypoechoic/isoechoic/hyperechoic: Compared to adjacent parenchyma.
- Very hypoechoic: More hypoechoic than strap muscles.
- Assign 1 point if echogenicity cannot be determined.

**SHAPE**
- Taller-than-wide: Should be assessed on a transverse image with measurements parallel to sound beam for height and perpendicular to sound beam for width. This can usually be assessed by visual inspection.

**MARGIN**
- Lobulated: Promotions into adjacent tissue.
- Irregular: Jagged, spiculated, or sharp angles.
- Extra-thyroidal extension: Obvious invasion = malignancy.
- Assign 0 points if margin cannot be determined.

**ECHOCENTIC FOCI**
- Large comet-tail artifacts, V-shaped, >1 mm in cystic components.
- Micronodules: Cause acoustic shadowing.
- Calcifications: Complete or incomplete along margin.
- Punctate echogenic foci: May have small comet-tail artifacts.

Refer to discussion of papillary microcalcifications for 6-9 mm TR6 nodules.

TI-RADS 1

- 0 points
- Benign
- No FNA

- Cystic
- Anechoic
- Wider than tall
- Smooth margins
- No calcifications
TI-RADS 2

- 2 points
- Not suspicious
- No FNA

- Mixed cystic solid - 1 point
- Isoechoic - 1 point
- Wider than tall
- Smooth margins
- No calcifications
TI-RADS 3

- 3 points
- Mildly suspicious
- FNA ≥ 2.5 cm
  Follow ≥ 1.5 cm

Solid - 2 point
Isoechoic to hyperechoic - 1 point
Wider than tall
Smooth margins
No calcifications
TI-RADS 4

- 4-6 points
- Moderately suspicious
- FNA ≥ 1.5 cm
  Follow ≥ 1.0 cm

- Solid - 2 point
- Hypoechoic - 2 point
- Wider than tall
- Smooth margins
- No calcifications
TI-RADS 5

≥ 7 points

Highly suspicious

FNA ≥ 1.0cm
Follow ≥ 0.5 cm

- Solid - 2 point
- Isoechoic - 1 point
- Taller than wide - 3 points
- Smooth margins?
- Punctate echogenic foci - 3 points
Increased risk of papillary microcarcinoma

No deaths in such cancers in 1235 Japanese cohort \(^1\)

Progression more likely in \(< 40 \text{ years} \text{ cf } > 60 \text{ years}\)
  - Increased growth (6\% vs 2\%)
  - New lymph node mets (5\% vs 0.4\%)
  - ? Consider biopsy in younger patient

Must report location of lesion – abuts trachea, close to TE groove (site of recurrent laryng. nerve)

\(^1\) Ito Y, Miyaucht al. Patient age is significantly related to progression of papillary microcarcinoma of thyroid under observation. Thyroid 2014;24:27–34.
No comparison studies of ACR TIRADs and 2015 ATA guidelines
- Studies have compared older ATA and SRU or Korean / other TI-RADS

TIRADs initially time consuming to learn
- Easier to incorporate into voice dictation
- ATA doesn’t classify 3.8% of nodules – 18% of these were malignant

Timing of Follow Up

- No definite literature
- TR 5 – scan annually for up to 5 years
- TR 4 – may be same
- TR 3 – 1, 3 and 5 years: Stop at 5 years if no growth
- Growth = 20% increase in 2 nodule dimensions (minimum 2 mm increase)
- No rules if lesion increases in size but remains below biopsy threshold
What to Biopsy

- No need to biopsy > 2 nodules
- Biopsy the two highest ranked nodules – not necessarily the largest
Simple Ovarian Cyst

- Malignancy Risk < 1% for < 10 cm
- Rounded
- Smooth thin wall
- Anechoic
- No mural nodule
- No septa
- No internal color flow

When a rare large (> 7 cm) simple cyst is found to be malignant – usually inadequate US assessment of cyst ⇒ MRI
Hemorrhagic Cyst

- Hemorrhage in corpus luteal or functional cyst
- Appearance depends on acuteness
  - Solid areas
  - Often posterior through transmission
  - Variable wall thickness +/- irregular
  - No internal flow
- Resolve in 6 weeks
  - Endometrioma do not resolve in 6 weeks
Endometrioma

- Homogeneous low-level echoes
- Ground-glass appearance
- Atypical findings in 15% (worry about cancer)
  - Mural irregularities (avascular, adherent clot)
  - Internal flow
Endometrioma (MRI)

- High on T1w and fat-sat
- Low on T2w - “T2 shading”
- Fluid-blood level
- Ring of dark hemosiderin
Mature Cystic Teratoma (Dermoid)

- Diagnosis on US may be difficult
- Three main signs
  1. Hyperechoic foci + acoustic attenuation due to hair, sebum, Ca²⁺
  2. Thin echogenic lines due to hair ("mesh" sign)
  3. Fluid-fluid level (sebum-cyst fluid)
- 0.1-2% ⇒ squamous cancer
  - > 10 cm
  - > 50 years of age
  - Solid center with flow

EV probe compression
Hyperechoic fat (sebum)-fluid level

Dermoid: Hyperechoic with acoustic attenuation

Hyperechoic Rokitansky nodule

Hyperechoic Rokitansky nodule with acoustic attenuation and fat-fluid level

Thin echogenic lines due to hair ("mesh" sign)
Hydrosalpinx

- Tubular in two planes
- Incomplete septa
- Endosalpingeal folds
- Tapering end onto uterus
- Absent peristalsis
- Blood flow in walls
- Pressure with transducer may separate cyst from ovary
Endosalpingeal folds - short linear projections
“Beads on string” sign

Incomplete septa but not tubular
This was ovarian cystadenofibroma
SRU Guidelines for Premenopausal Women

- Simple or hemorrhagic cysts < 3 cm
  - No follow-up and, perhaps no need to report on
- Simple or hemorrhagic cysts 3-5cm
  - No follow-up but mention in report
- Simple cysts 5 - 7 cm
  - Annual US follow up to ensure lesion stability
- Hemorrhagic cysts 5-7 cm
  - 6–12-week follow-up US to ensure resolution
- Simple cysts > 7 cm
  - Further imaging (e.g., MRI) or surgery
SRU Guidelines in Post Menopausal Women

- Simple cysts < 1 cm
  - No follow-up and may be omitted from report
- Simple cysts 1 – 7 cm mention on report
  - Annual US
  - After 2 years or if size ↓ ⇒ longer interval follow up
- Simple cysts > 7 cm – as in premenopausal women
- For 1-5 years post menopause ovulation may occur
  - Hemorrhagic cysts need 6-12 week follow up
- Hemorrhagic cyst > 5 year post menopause
  - Concern for cancer
SRU Guidelines for Pre- or Postmenopausal Women

- Classic endometrioma
  - 6–12-week follow-up US examination to ensure stability
  - If not removed – annual follow up with US
- Classic dermoid
  - No additional imaging for confirmation
  - Annual follow up
- Classic hydrosalpinx
  - No additional imaging or follow-up
  - Treatment based in age and symptoms
- Para-ovarian cyst
  - Same criteria as simple ovarian cysts
SRU Guidelines for Indeterminate Cysts

- **Features**
  - Thin septa
  - Solid nodule without flow
  - Irregular wall
- **If premenopausal**
  - 6-12 week US follow up
  - If persistent $\Rightarrow$ MRI: if still indeterminate $\Rightarrow$ Sx
- **If postmenopausal**
  - Sx (not: indeterminate $+$ $> 10$ cm $\Rightarrow$ 13% cancer risk)

IV Contrast for CT
CT with IV Contrast

- Metastatic cancer work-up / follow-up
- Trauma (head & C/T/L-spine without)
- Abdominal / pelvic / chest pain, weight loss, infection, inflammatory processes, most other indications
- For arterial stenosis, CTA
- Some indications require multiple post contrast phases (HCC screening → triple phase, pancreatic → dual phase)
Chronic Renal Insufficiency & CT IV contrast

- On hemodialysis --- full IV contrast dose
- For GFR > 45, full IV contrast dose
- For GFR of 31-45 and not on hemodialysis, IV hydration (250 mL NS prior and 250 mL after), decrease IV contrast dose by 20-25%
- For GFR of 30 or less and not on hemodialysis, no IV contrast
Oral Contrast for CT
Oral Contrast

- Gastrografin --- if pt < 150 lbs, recent GI surgery/enteric leak
- Water --- pancreatic protocol
- Volumen --- enterography
Anti-platelet / Anti-coagulants, labs & invasive radiology procedures

- Non-vascular invasive radiology procedures
  - High risk
  - Moderate risk
  - Low risk

- Recommendations on
  - anti-coagulants
  - anti-platelet agents
  - labs
<table>
<thead>
<tr>
<th>Procedures with low risk of bleeding, easily detectable and controllable</th>
<th>Procedures with moderate risk of bleeding, difficult to detect or control</th>
<th>Procedures with high risk of bleeding, difficult to detect or control</th>
</tr>
</thead>
<tbody>
<tr>
<td>Paracentesis** or thoracentesis</td>
<td>Superficial biopsy (thyroid, lymph node, breast)</td>
<td>Kidney or splenic parenchymal biopsy</td>
</tr>
<tr>
<td>Superficial aspiration or drainage</td>
<td>Drainage catheter exchange</td>
<td>Retroperitoneal Biopsy</td>
</tr>
<tr>
<td></td>
<td>Joint injection or arthrogram***</td>
<td>Bone Biopsy, not complex, easily compressible</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Lung FNA Biopsy</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Lung Core Biopsy</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Bone Biopsy, difficult to compress, vertebral Body</td>
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<tr>
<td></td>
<td></td>
<td>Liver biopsy†</td>
</tr>
</tbody>
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<table>
<thead>
<tr>
<th>Recommended Labs</th>
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</tr>
</thead>
<tbody>
<tr>
<td>INR, recommended for history of warfarin use or liver disease</td>
<td>Platelet Count, recommended for established thrombocytopenia</td>
<td>INR, recommended</td>
</tr>
<tr>
<td>Platelet Count, recommended for established thrombocytopenia</td>
<td>Hb/Hct, not routinely recommended</td>
<td>Platelet Count, recommended</td>
</tr>
<tr>
<td>Hb/Hct, not routinely recommended</td>
<td>aPTT, not routinely recommended</td>
<td>aPTT, not routinely recommended</td>
</tr>
<tr>
<td>aPTT, not routinely recommended</td>
<td>(observe UFH hold time)</td>
<td>(observe UFH hold time)</td>
</tr>
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<table>
<thead>
<tr>
<th>Lab Thresholds/Management</th>
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</tr>
</thead>
<tbody>
<tr>
<td>INR &gt; 2.0, Consider PCC, FFP, and/or Vitamin K</td>
<td>INR &gt; 2.0, Consider PCC, FFP, and/or Vitamin K</td>
<td>INR &gt; 1.5†, Consider PCC, FFP, and/or Vitamin K</td>
</tr>
<tr>
<td>Platelets &lt; 25-50,000, consider transfusion**</td>
<td>Platelets &lt; 25-50,000, consider transfusion**</td>
<td>Platelets &lt; 25-50,000, consider transfusion**</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Common Anticoagulant Hold Times (Labs affected)</th>
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</tr>
</thead>
<tbody>
<tr>
<td>Warfarin- Hold 5 days (INR), may bridge UFH (IV)-Hold 1 hour (aPTT)</td>
<td>Warfarin- Hold 5 days (INR), may bridge UFH (IV)-Hold 4 hours (aPTT)</td>
<td>Warfarin- Hold 5 days (INR), may bridge UFH (IV)-Hold 4 days (aPTT)</td>
</tr>
<tr>
<td>UFH (SQ)-Hold 4 hours (aPTT)</td>
<td>UFH (SQ)-Hold 4 hours (aPTT)</td>
<td>UFH (SQ)-Hold 6-8 hours (aPTT)</td>
</tr>
<tr>
<td>LMWH (30-40mg)-No hold (none)</td>
<td>LMWH (30-40mg)-Hold 12 hours (none)</td>
<td>LMWH (30-40mg)-Hold 12-24 hours (none)</td>
</tr>
<tr>
<td>LMWH (60-100mg)-Hold 12 hours (none)</td>
<td>LMWH (60-100mg)-Hold 24 hours (none)</td>
<td>LMWH (60-100mg)-Hold 24 hours (none)</td>
</tr>
<tr>
<td>Pradaxa*/Xarelto/Eliquis/Atrixia*- Hold 24 hours (none)</td>
<td>Pradaxa*/Xarelto/Eliquis/Atrixia*- Hold 48 hours (none)</td>
<td>Pradaxa*/Eliquis- Hold 72 hours (none)</td>
</tr>
<tr>
<td></td>
<td>Atrixia*- Hold 36 hours (none)</td>
<td>Xarelto/Atrixia*- Hold 48 hours (none)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Common Antiplatelet Hold Times</th>
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</tr>
</thead>
<tbody>
<tr>
<td>ASA (low dose)- No hold</td>
<td>ASA (low dose)- No hold</td>
<td>ASA (low dose)- 2-7 days†††</td>
</tr>
<tr>
<td>ASA (high dose)- No hold</td>
<td>ASA (high dose)- Hold 5 days†††</td>
<td>ASA (high dose)- Hold 5-7 days†††</td>
</tr>
<tr>
<td>Plavix/Effient/Ticlid- No hold*</td>
<td>Plavix/Effient/Ticlid- Hold 5 days</td>
<td>Plavix/Effient/Ticlid- Hold 5 days</td>
</tr>
<tr>
<td>NSAIDS- No hold</td>
<td>NSAIDS- No hold</td>
<td>NSAIDS- Hold 10 days</td>
</tr>
</tbody>
</table>
Newer Technology & Applications
Elastography

- Measure of tissue “stiffness”
- Methods:
  - Strain (“Transient”)
  - Shear Wave (Using an Acoustic Radiation Force Impulse ARFI)
    - Point (focal region of interest)
    - 2-Dimensional (larger ROI)
  - MR Elastography
Strain Elastography ("Transient," 1st generation, based on tissue deformation resulting from manual pressure)
Shear Wave Elastography (based on resultant shear wave velocity resulting from an ARFI “Push Pulse”)

Push Pulse enters

ROI placed

Detection pulses

Transverse (Shear) Waves produced

Velocity in stiffer tissue faster than soft
Why use elastography?

- 1. Focal liver lesions (under research)
- 2. Diffuse, chronic liver disease
The main indication for liver elastography is fibrosis staging of chronic liver disease
Diffuse Liver Disease

- Tissue stiffness is a surrogate marker of fibrosis.
- Fibrosis is the deposition of collagen and extracellular matrix in response to chronic injury.
Diffuse Liver Disease

- Etiologies: HBV, HCV, alcohol abuse, NAFLD, autoimmunity, cholestasis (PBC), deposition (iron or copper).
- Liver biopsy is the “imperfect” gold standard:
  - Invasive
  - Minimal amount of tissue sampled
  - Potential serious complications (2-3% require hospitalization)
Liver biopsy is the “imperfect” gold standard:
- Invasive
- Minimal amount of tissue sampled
- Potential serious complications (2-3% require hospitalization)
Liver Biopsy: Fibrosis staging by METAVIR criteria/scoring

- **F0 (no fibrosis)**
- **F1 (mild)**
  - Fibrous portal expansion
- **F2 (moderate)**
  - Bridging fibrosis
- **F3 (severe)**
  - Intralobular degeneration
- **F4 (cirrhosis)**
  - Lobule
  - Central area
  - Hepatocytes
  - Portal area
Disease progression is marked by increased tissue stiffness and therefore higher shear wave velocity.
Threshold Values in Hepatitis C based on public literature for the manufacturer of Philips ElastPQ

**METAVIR Stage**

<table>
<thead>
<tr>
<th>US Shear wave</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>F₀/F₁</strong></td>
</tr>
<tr>
<td><strong>F₂</strong></td>
</tr>
<tr>
<td><strong>F₃</strong></td>
</tr>
<tr>
<td><strong>F₄</strong></td>
</tr>
</tbody>
</table>
How do the modalities compare?

- All modalities’ measurements of liver stiffness strongly correlate with the histologic degree of fibrosis.
MR most closely correlates to adequate liver biopsy, plus has the benefits of sampling the entire liver, evaluating distribution of disease, and measurements are less variable and less patient-dependent.
How do the modalities compare?

- US-based modalities are inexpensive and fast (MR is expensive and time-consuming).
- **Transient Elastography** is used at the point of care by clinicians with dedicated machines.
- The device produces stiffness measurements without images.
Shear Wave Elastography is performed under real-time US imaging as an add-on to compatible US machines, which allows sampling of areas chosen by the technologist.

- SWE is slightly more accurate than TE, but less than MRI
- Point SWE (pSWE) may be less variable than 2D SWE.
2D SWE provides real-time color-coding based on stiffness values.
Newer technology, less researched
How can liver elastography benefit patients?

- Identify patients with NO or MINIMAL fibrosis (Metavir Fo and F1) to avoid biopsy.
How can liver elastography benefit patients?

- Identify patients with NO or MINIMAL fibrosis (Metavir F0 and F1) to avoid biopsy.
- Identify patients with SEVERE fibrosis and CIRRHOSIS (F3 and F4) to prompt further evaluation (blood tests, biopsy, MRI, regular screening).
How can liver elastography benefit patients?

- Identify patients with NO or MINIMAL fibrosis (Metavir F0 and F1) to avoid biopsy.
- Identify patients with SEVERE fibrosis and CIRRHOSIS (F3 and F4) to encourage further evaluation.
- Evaluate progression of disease and response to therapy.
Regarding Technique:

- The goal is to achieve reproducibility in serial measurements
- So tracking more specific details is required
Reporting Components Specific to Liver Elastography

- Regarding Technique:
  - Ultrasound machine make, model, software, and device-specific identifier
  - Transducer used
  - Patient positioning
    - Supine, Left Lateral Decubitus, Other
    - Right arm extended above head
**Reporting Components Specific to Liver Elastography**

- Regarding Findings:
  - Potential Limitations
  - Median of 10 measurements
  - IQR/median ratio
  - METAVIR-equivalent
Regarding Findings:

- **Potential Limitations**
  - Obesity
  - Ascites
  - Non-standard positioning
  - Non-fasting
  - Co-morbid condition
  - Abnormal breathing
Regarding Findings:
- Potential Limitations
- **Median of 10 measurements**
  - In meters/second or kilopascal (kPa)
- **IQR/median ratio**
  - Adequate ratio is <30% (0.3)
Regarding Findings:

- Potential Limitations
- Median of 10 measurements
- IQR/median ratio
- **METAVIR-equivalent**
  - <1.22 m/s \(\rightarrow\) \(\text{F0/F1}\)
  - \(\geq 1.22\) m/s \(\rightarrow\) \(\text{F2}\)
  - \(\geq 1.49\) m/s \(\rightarrow\) \(\text{F3}\)
  - \(\geq 2.21\) m/s \(\rightarrow\) \(\text{F4}\)
Regarding Interpretation of Results:
- Due to significant overlap between stages of fibrosis the consensus panel recommends separating patients into 3 groups based on two threshold values that reflect the likelihood of having clinically significant fibrosis.
Consensus Threshold Values

- Low risk: <1.37 m/sec (<5.7 kPa)
- Moderate risk
- High risk: >2.2 m/sec (>15 kPa)
Consensus threshold values establish clinically-oriented priority levels to help guide follow-up and screening

- **1. Low risk for clinically significant fibrosis (F0/F1)**
  - No follow-up required.
- **2. Moderate risk (F2/F3)**
  - Additional testing is appropriate (depending on etiology)
- **3. High risk (some F3/F4)**
  - Follow-up is advised (consider blood tests, biopsy, MRI, regular screening)
References (Elastography)


Feel free to email with questions: btahir@iupui.edu