

Thyroid Nodules and Ultrasound

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No Financial Disclosures

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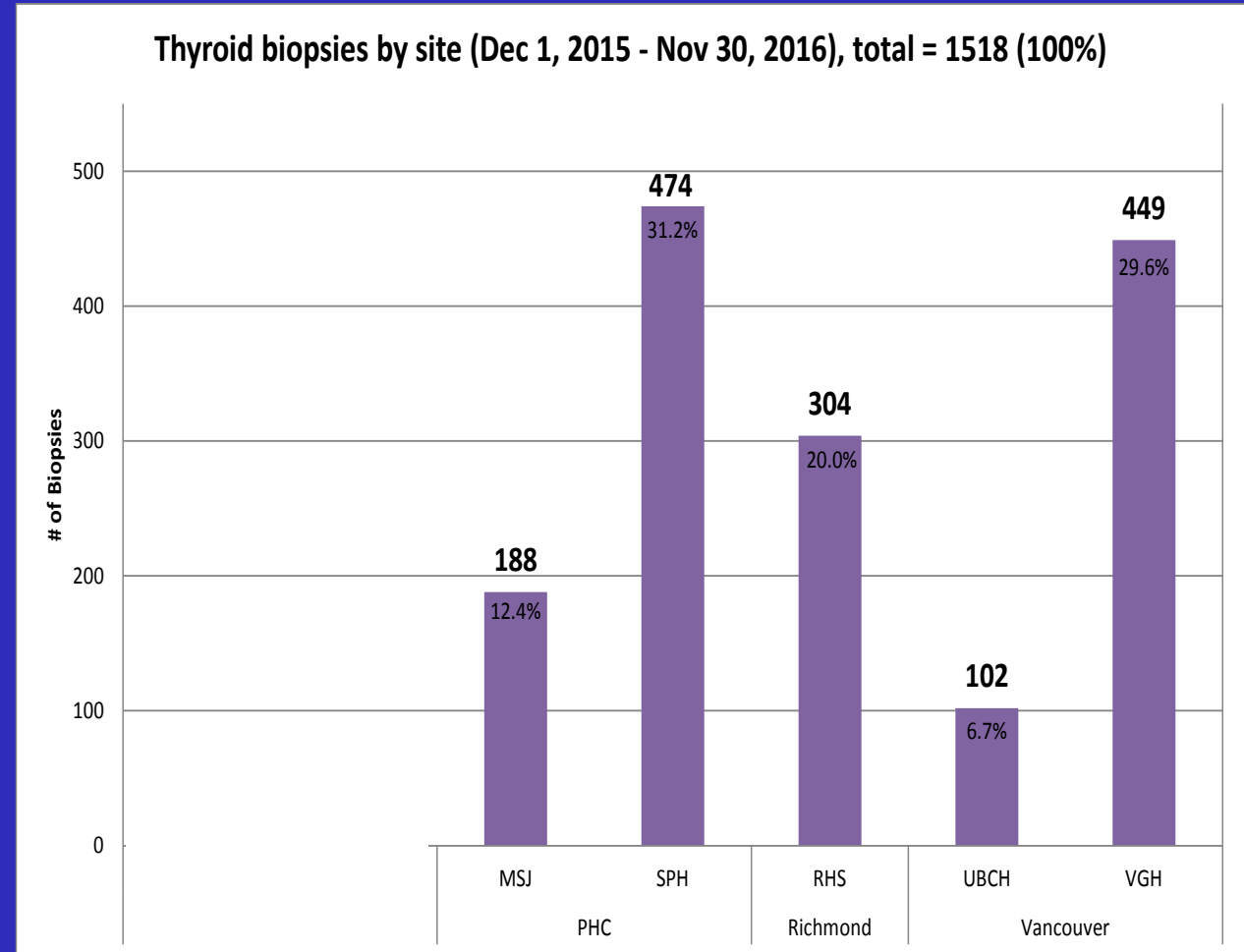
Acknowledgements

Ed Peremaki (SPH)
Emily Pang (VGH)



SPH Radiology

- Large volume
 - 1278 US
 - 540 bxt



OUTLINE PRESENTATION

- Background
- Cases
- What are we currently using (and why)
- ACR TI-RADS system
- Discussion

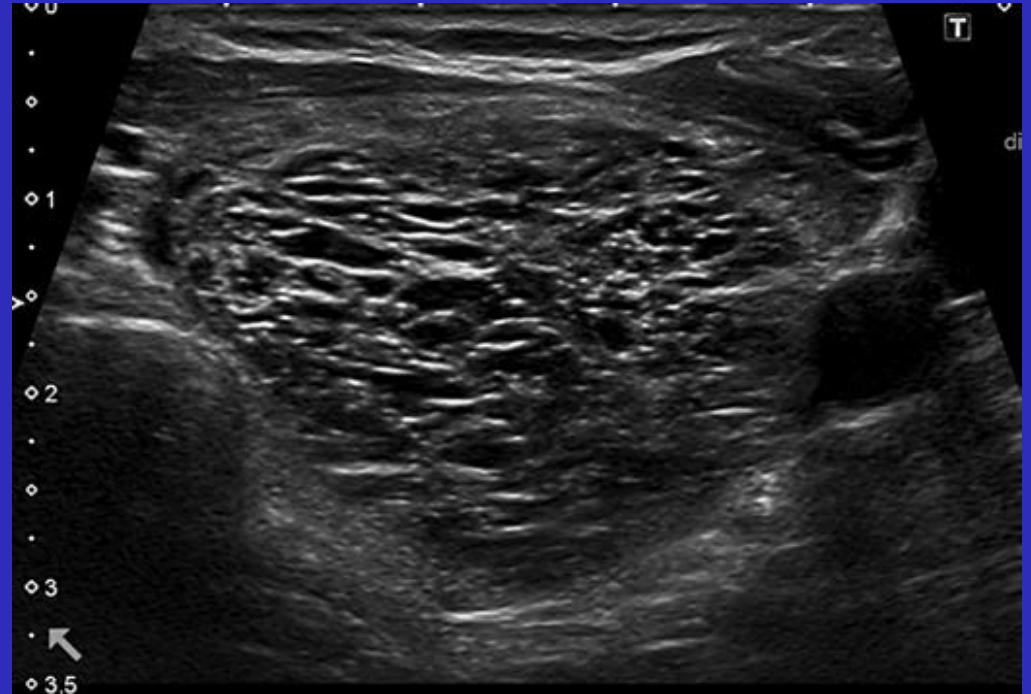
Case 1

- 52 female
- Incidental on Carotid US
- Size 1.2 (AP) x 0.9 (TR) x 1.3 (CC)
- Management?



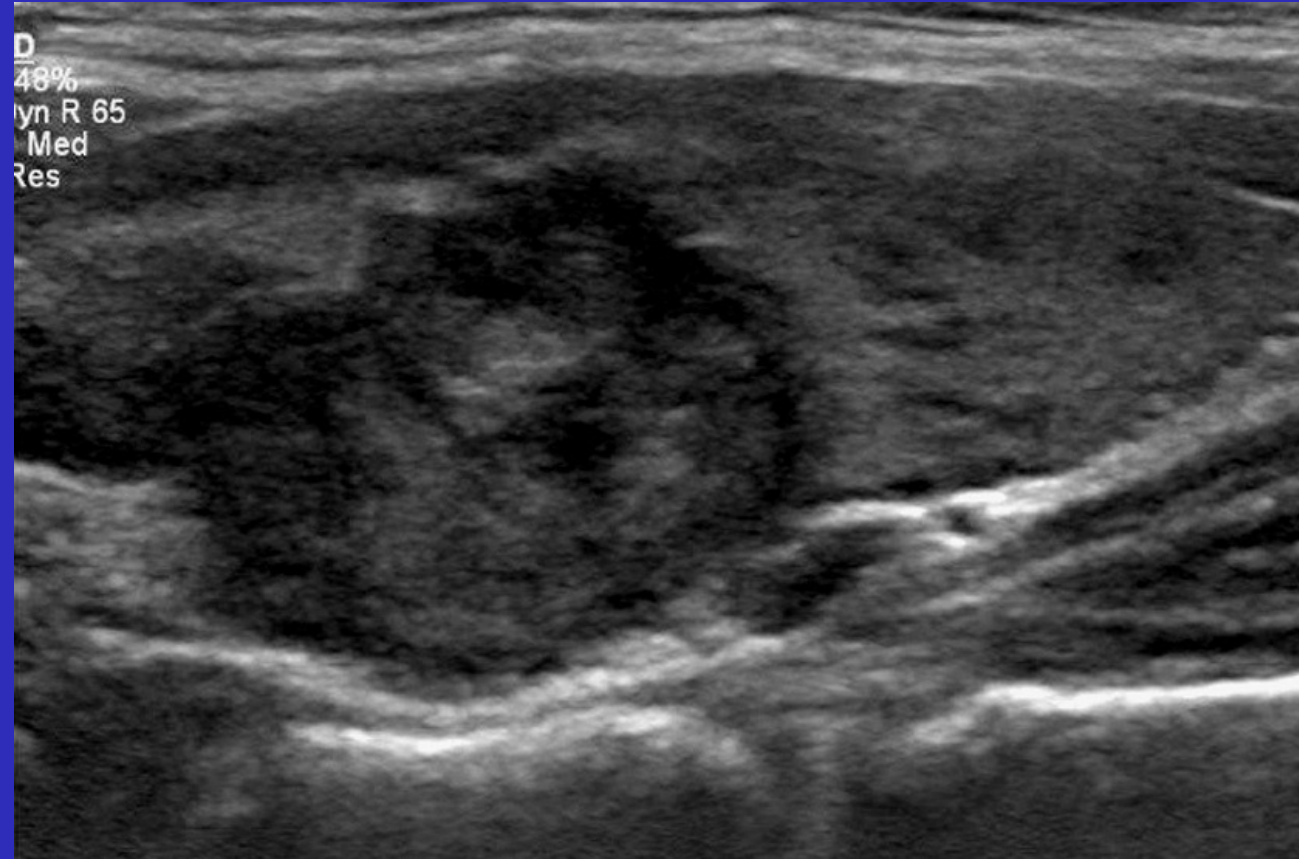
Case 2

- Size 2.0 (AP) x 1.6 (TR) x 1.7 (CC)
- 43 female
- 5mm growth 1 year
- Biopsy?



Case 3

- Size 1.2 (AP) x 1.6 (TR) x 1.8 (CC)
- Male 55
- Incidental on CT Chest
- Recent biopsy "inadequate"
- Management?

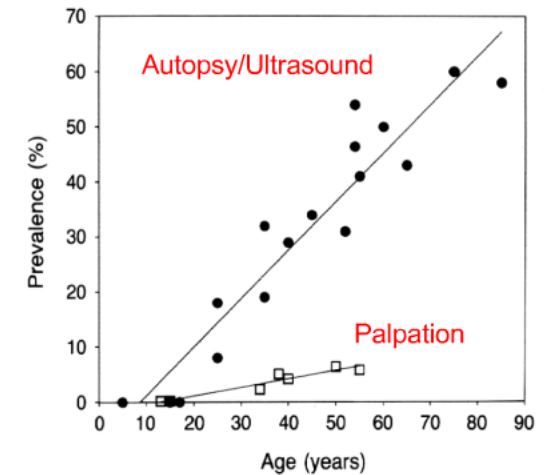


INTRODUCTION

- Thyroid nodules are very common
- Estimated prevalence 4-68%

Epidemiology – thyroid nodules

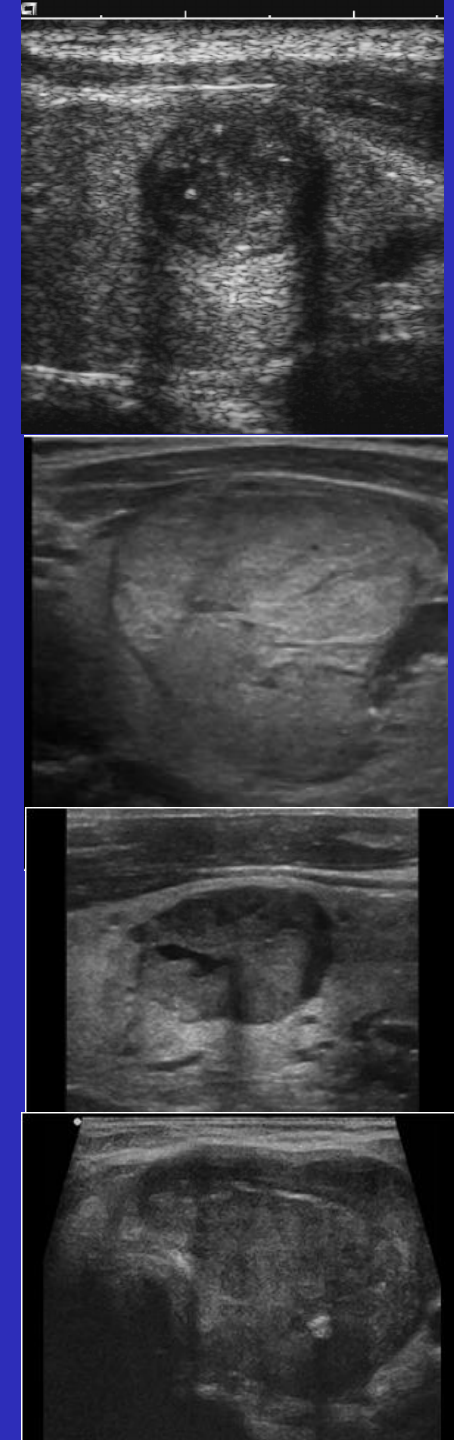
- Common disorder
- More frequent in women
- Increase in frequency with age
- More common in areas of low iodine intake



Guth S. Very high prevalence of thyroid nodules detected by high frequency (13 MHz) ultrasound examination. Eur J Clin Investig

INTRODUCTION

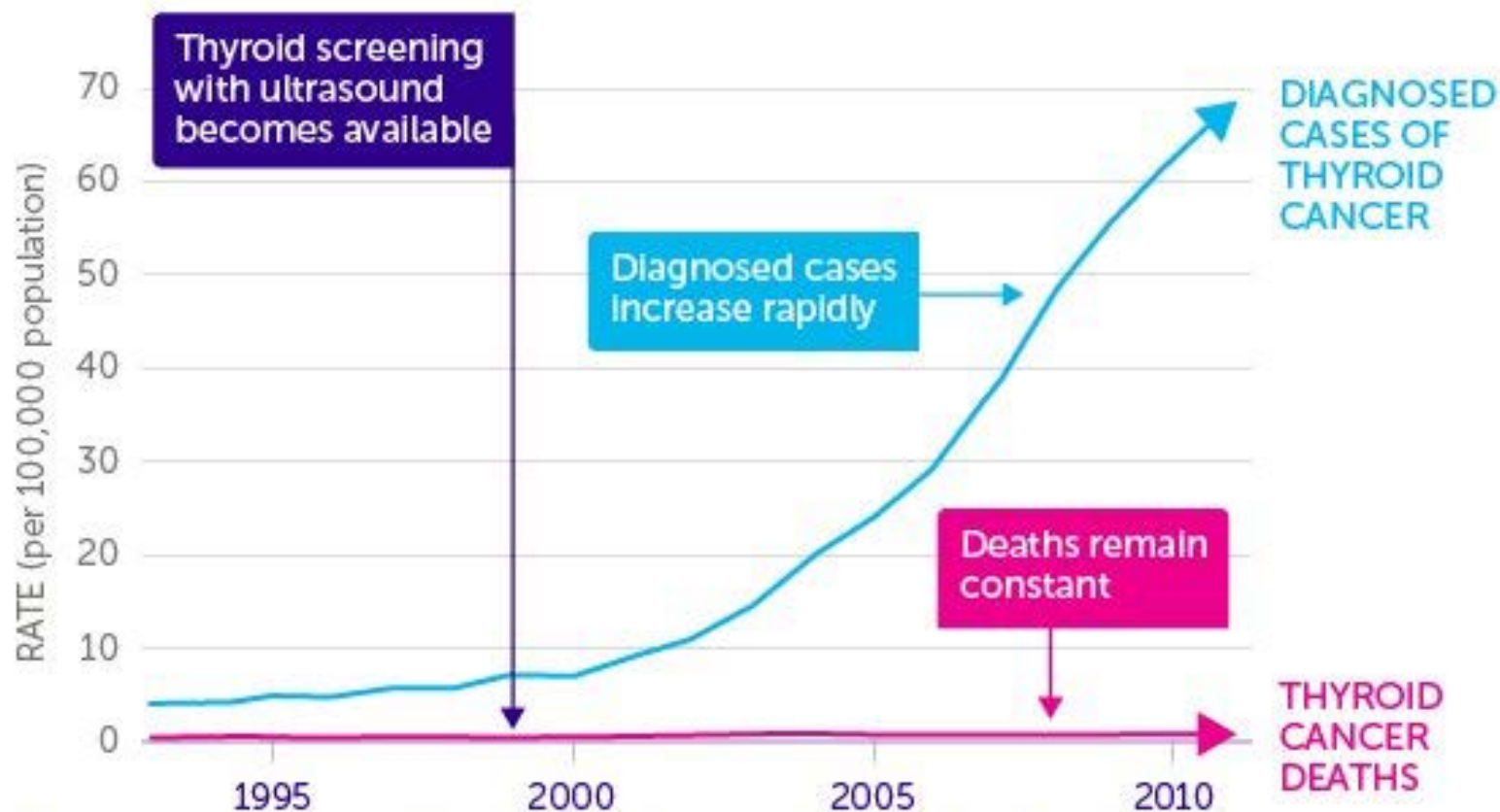
- About 5-10% malignant
- Differentiated
 - Papillary 80%
 - Follicular 10%
- Poorly differentiated carcinoma
 - Medullary 5%
 - Anaplastic 2%



INTRODUCTION

- Incidence Thyroid ca dramatically increased past 30 years
- Increased use Ultrasound and incidentally detected on other modalities
- Mortality Thyroid ca remained relatively stable

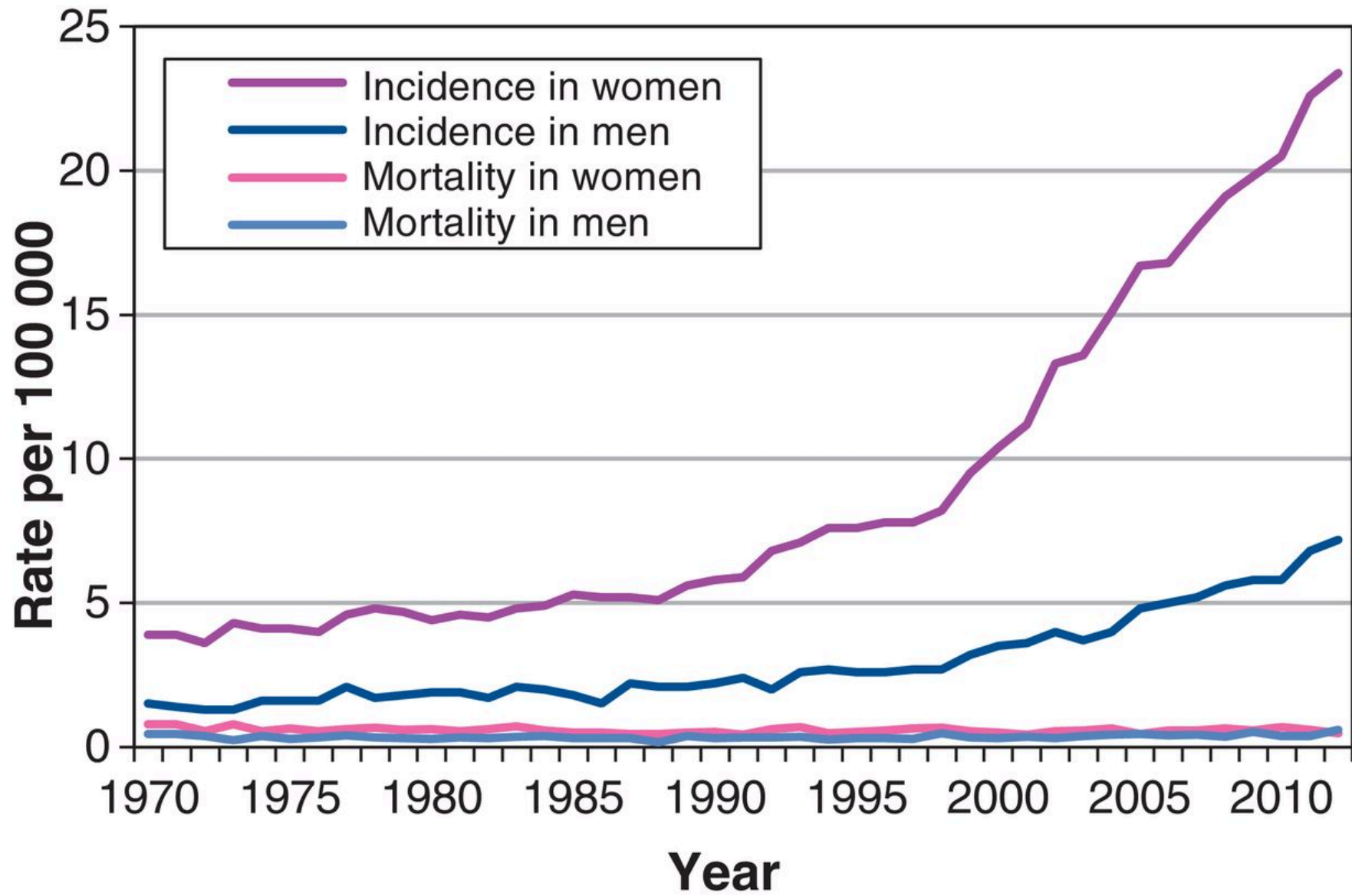
THYROID CANCER SCREENING IN SOUTH KOREA



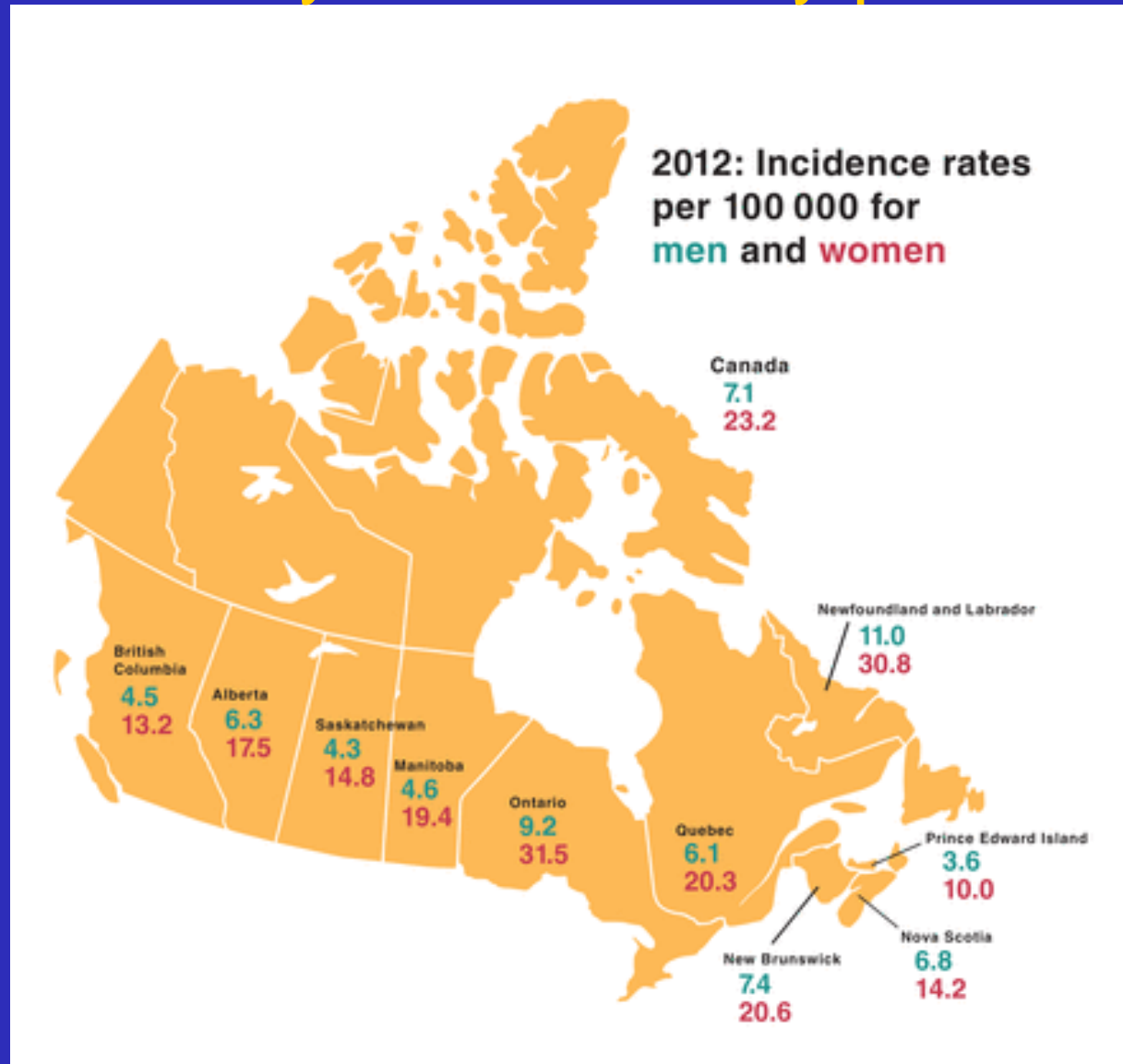
Source: Incidence data from the Cancer Incidence Database, Korean Central Cancer Registry. Mortality data from the Cause of Death Database, Statistics Korea. All data age-adjusted to the South Korean standard population. Adapted from graph in Ahn et al. Korea's thyroid-cancer "epidemic"—Screening and overdiagnosis. *NEJM* 2014; 371 (19).

LET'S BEAT CANCER SOONER
cruk.org





Incidence rates for thyroid cancer by province



New Number of New Thyroid Ca Diagnosed in 2015 in BC



Age at Diagnosis	Males	Females	Total
0-19	0	10	10
20-39	35	80	110
40-59	40	135	180
60-79	35	80	110
80+	5	20	25
Total	115	320	435

BC

Number of Thyroid Cancer Deaths in 2015

Age at Death	Males	Females	Total
0-19	0	0	0
20-39	0	0	0
40-59	0	0	5
60-79	10	5	15
80+	0	10	10
Total	15	15	30

Estimated New Thyroid Cancer Diagnoses in 2018

Health Authority	Age at Diagnosis					Total*
	0-19	20-39	40-59	60-79	80+	
Interior	0	15	35	30	5	80
Fraser	0	55	95	60	15	220
Coastal	0	40	60	35	5	150
Island	0	20	35	30	5	90
Northern	0	10	20	10	0	40
BC	5	140	235	165	35	580

Estimated Thyroid Cancer Deaths 2018

Health Authority	Age at Diagnosis					Total*
	0-19	20-39	40-59	60-79	80+	
Interior	0	0	0	0	0	5
Fraser	0	0	0	10	0	10
Coastal	0	0	0	0	0	5
Island	0	0	0	0	0	5
Northern	0	0	0	0	0	0
BC	0	0	0	20	10	30

“We believe the time has come to address the problem of papillary thyroid cancer overdiagnosis and overtreatment.”

Davies L. Current thyroid cancer trends in the United States. JAMA Otolaryngol Head Neck Surg. 2014

The problem is particularly acute for women, who have lower autopsy prevalence of thyroid cancer than men but higher cancer detection rates by a 3:1 ratio.

Davies L. Current thyroid cancer trends in the United States. JAMA Otolaryngol Head Neck Surg. 2014

Thyroid Nodules: Is It Time to Turn Off the US Machines?¹



John J. Cronan, MD

The authors of the article “Benign” into the US and endocrinology worlds.

Radiology: June 2008

Addressing overdiagnosis and overtreatment in cancer: a prescription for change

We propose the term Indolent Lesion of Epithelial origin, or IDLE, for those lesions currently labelled as cancers

Esserman LJ et al. Addressing overdiagnosis and overtreatment in cancer: a prescription for change. Lancet Oncol. 2014 May;15(6)

75% of Canadians diagnosed with thyroid cancer don't need aggressive treatment, new study suggests



Overdiagnosis likely due to improvements in imaging technology and overtesting, say researchers

Tricia Lo - CBC News - Posted: Aug 14, 2017 3:37 PM MT | Last Updated: August 21, 2017



INTRODUCTION

Need a “reliable, non-invasive method to identify which nodules warrant FNA on the basis of a reasonable likelihood of biologically significant malignancy”

Tessler FN et al. J Am Coll Radiol. 2017 May;14(5):587-595

INTRODUCTION

many professional societies have developed ultrasound-based risk stratification systems to identify nodules that warrant biopsy or follow-up

US-based risk stratification systems

- ACR TI-RADS Thyroid Imaging Reporting and Data System
- ATA
- K- Tirads
- BTA
- National Comprehensive Cancer Network (NCCN)
- AACE/ACE/AME
- F-Tirads
- SRU Ultrasound "U" classification
- McGill Thyroid Nodule Score (MTNS)

US-based risk stratification systems

- Qualitative: How the nodule looks like (ATA)
- Quantitative scoring system: (TI-RADS)

High
Suspicion
>70-90%



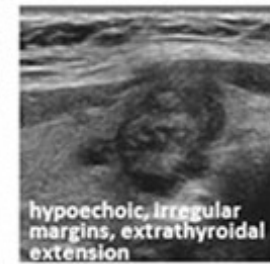
microcalcifications
hypoechoic nodule
irregular margin



hypoechoic
irregular margins



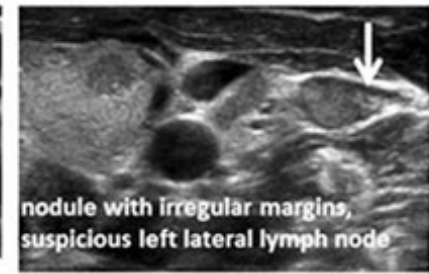
hypoechoic
taller than wide



hypoechoic, irregular
margins, extrathyroidal
extension



hypoechoic,
interrupted rim calcification
with soft tissue extrusion



nodule with irregular margins,
suspicious left lateral lymph node

Intermediate
Suspicion
10-20%



hypoechoic solid regular margin

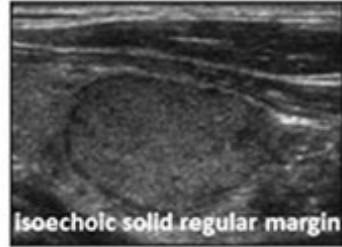


hypoechoic solid
regular margin

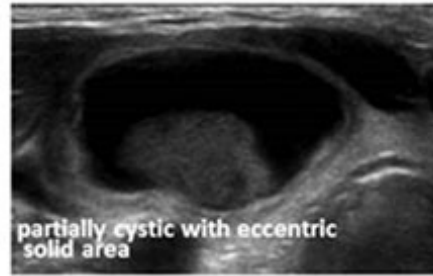
Low
Suspicion
5-10%



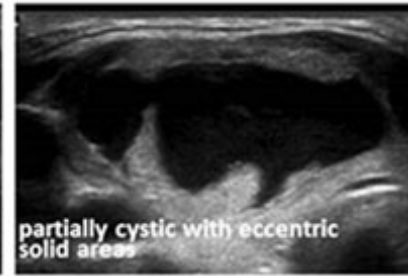
hyperechoic solid regular margin



isoechoic solid regular margin



partially cystic with eccentric
solid area



partially cystic with eccentric
solid areas

Very low
Suspicion
<3%



spongiform

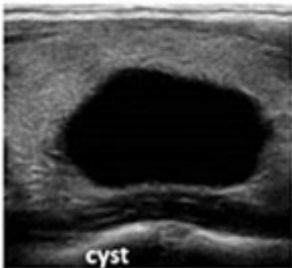


partially cystic no suspicious
features

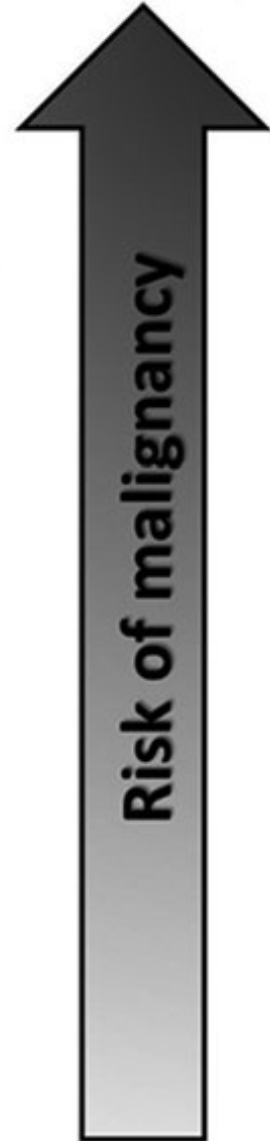


partially cystic no suspicious features

Benign
<1%

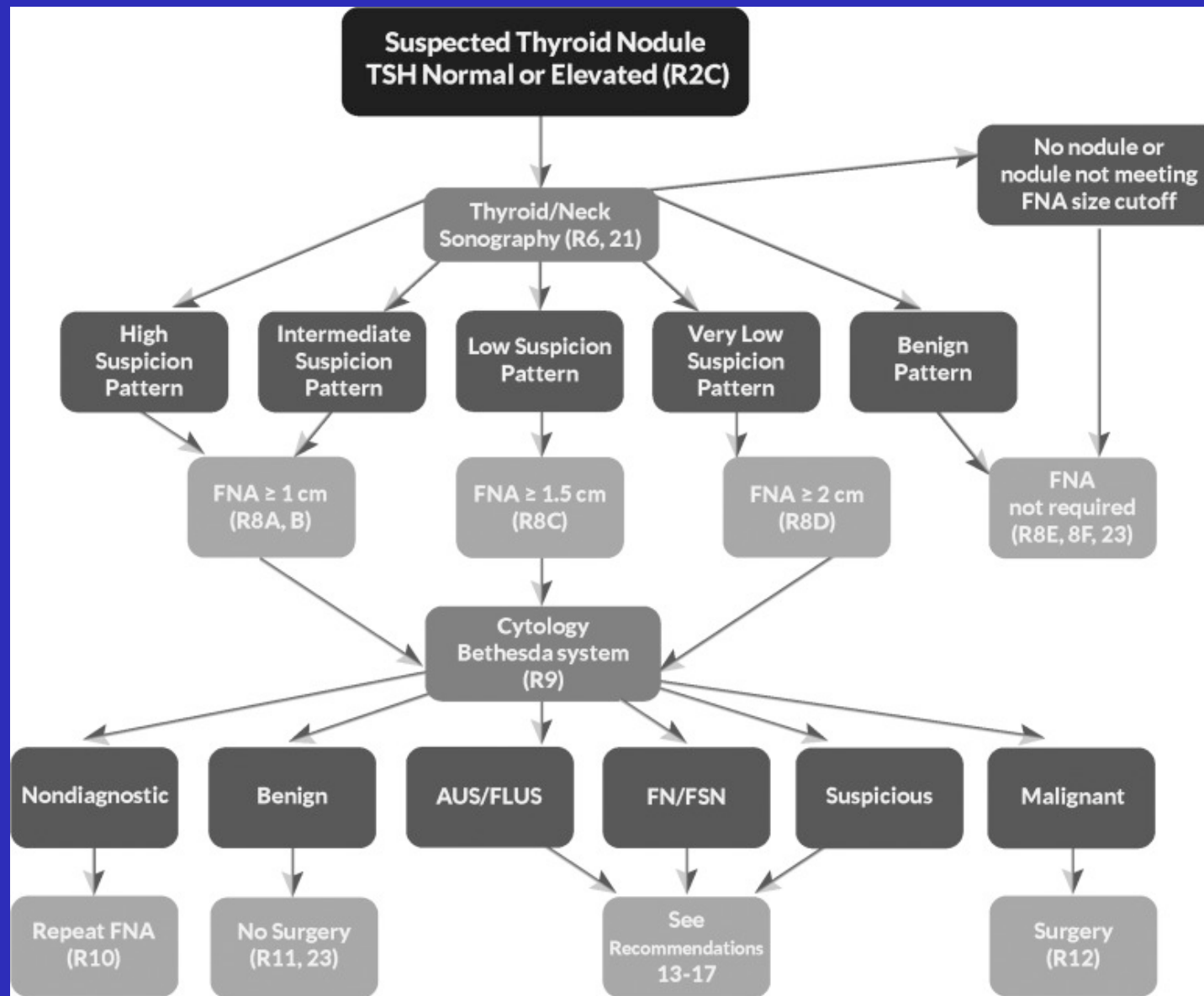


cyst



Risk of malignancy

ATA 2015



2015 American Thyroid Association Management Guidelines

Diagnostic performance?

US-based risk stratification systems

Comparison between the TIRADS and the 2014 ATA Guidelines.

- Both TIRADS and the ATA guidelines provide effective malignancy risk stratification for thyroid nodules

Reducing the number of unnecessary thyroid biopsies while improving diagnostic accuracy: towards the "right" TIRADS

- Wide variety in their ability to reduce the number of unnecessary thyroid nodule FNAs.
- The ACR TIRADS outperformed the others, classifying over half the biopsies as unnecessary

Diagnostic Performance of Seven Society Guidelines Applied to 2000 Thyroid Nodules

	Sensitivity %	Specificity %	PPV %	NPV %	Acc %
ACR	74.7	67.3	40.2	90.1	69.0
ATA	87.6	33.2	28.3	91.6	46.0
AACE/ACE/AME	80.4	58.0	36.0	91.0	63.1
NCCN	92.5	30.2	28.0	93.2	44.4
FSE	72.7	62.4	36.2	88.6	64.7
SRU	70.9	41.5	26.3	82.9	48.2
KTA	94.5	26.4	27.4	94.2	41.9

so far, no consensus on a single system has emer



St Paul's Hospital

SPH

- Large volume requests. Risk factors? Urgency?
- Previous imaging often not available or inadequate
- Recommendations for biopsy vs follow-up often inconsistent

- Clinicians are often frustrated by inconsistent biopsy recommendations
- Or don't get a nodule biopsied to their liking

SPH Examples

- Multinodular goiter. “Please Bxt all nodules >1 cm”
- Repeated request for clearly benign nodules
- Biopsy request in patients with other serious health conditions (Mets, ICU)

Goal SPH

- Too many guidelines. Can we pick 1?
- We should use descriptive terminology that everyone understands
- Clear guideline so our referring clinicians understand our position
- Clinicians on board

OPTIONS TO CONSIDER SPH

- Adopt TI-RADS? ATA?
- one of the Other?
- Only go for size and growth
- Keep doing whatever we prefer to do as individuals

SPH

- Discussions and a vote
- ACR TI-RADS
- Now followed by VGH, UBC, Richmond

TIRADS

2017: ACR Thyroid Imaging, Reporting and
Data System TI-RADS

Proposed by the American College of Radiology in
2017

TI-RADS

- 1. Standardization of US Vocabulary and Reporting**
- 2. Management guidelines based on risk stratification**

TI-RADS

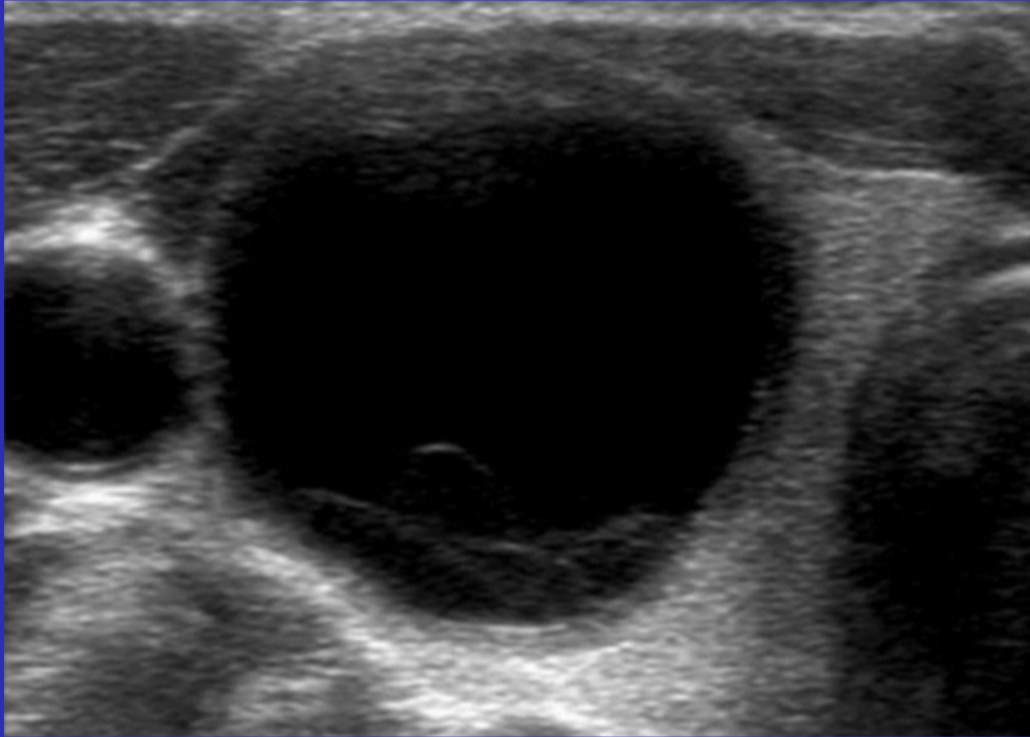
What's New?

- Architecture determines management
- 5 categories different morphologic features
- Points are assigned to each
- Final score (1-5) to stratify risk
- Higher size threshold for FNA and follow-up
- Able to classify all nodules, unlike ATA criteria

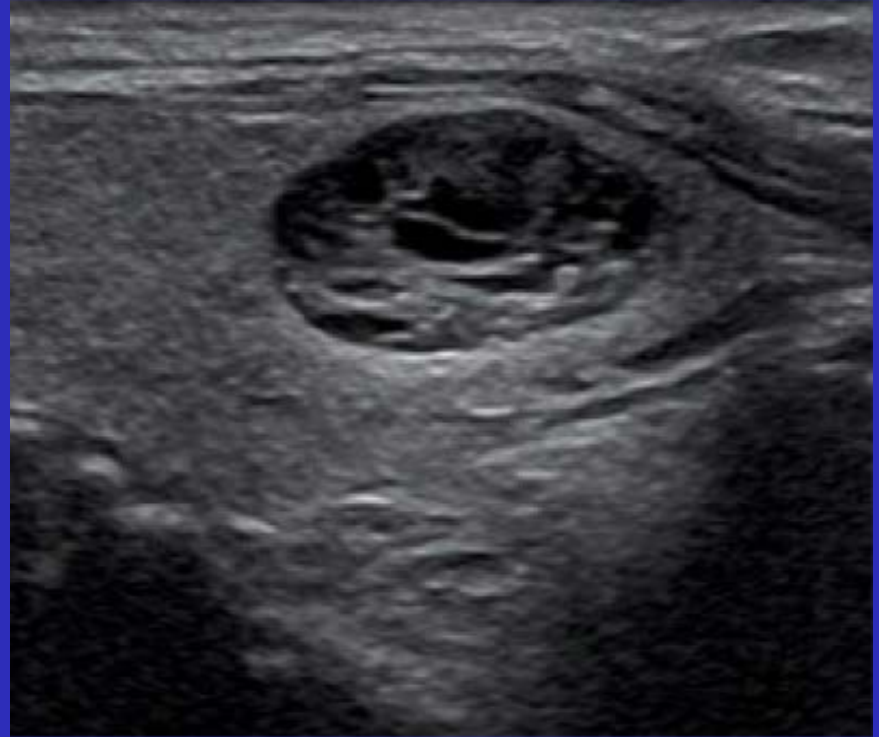
ACR TI-RADS FEATURE CATEGORIES

1. Composition
2. Echogenicity
3. Shape
4. Margin
5. Echogenic Foci

1. COMPOSITION



Cystic or almost entirely cystic (0 points)



Spongiform (0 points)
– no further points are added

1. COMPOSITION

Mixed cystic and solid (1 point)



- More suspicious features of solid components: eccentric, acute angles, punctate echogenic foci, lobulation, hypoechoic
- Exclude echogenic debris: mobile, avascular
- Assign remaining points based on solid component

1. COMPOSITION

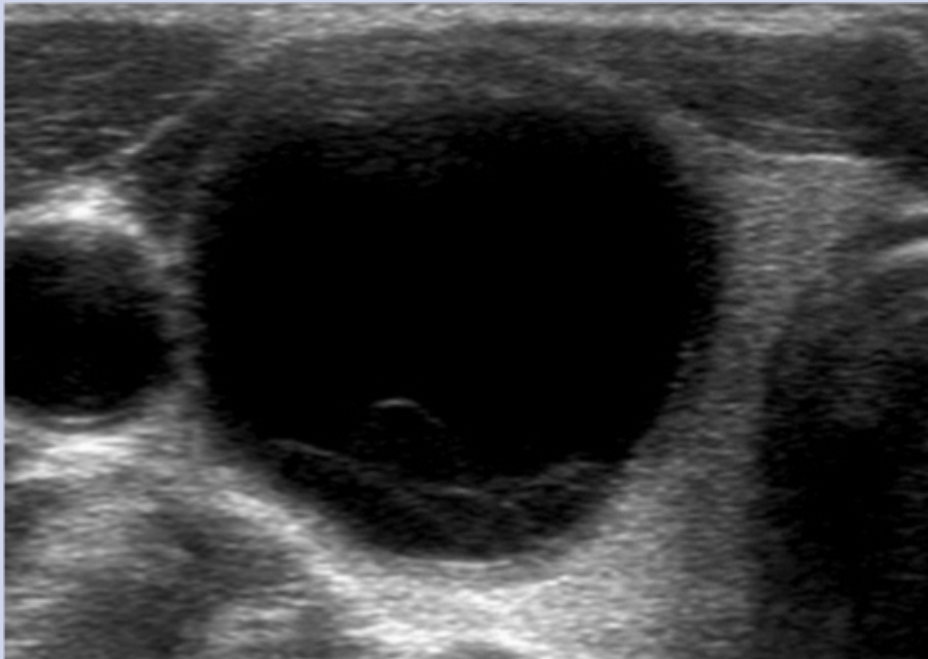
Solid or almost completely solid (2 points)



- Assign 2 points if unable to determine because of calcification (assume solid)

2. ECHOGENICITY

Anechoic (0 points)



- I.e. cystic or almost completely cystic

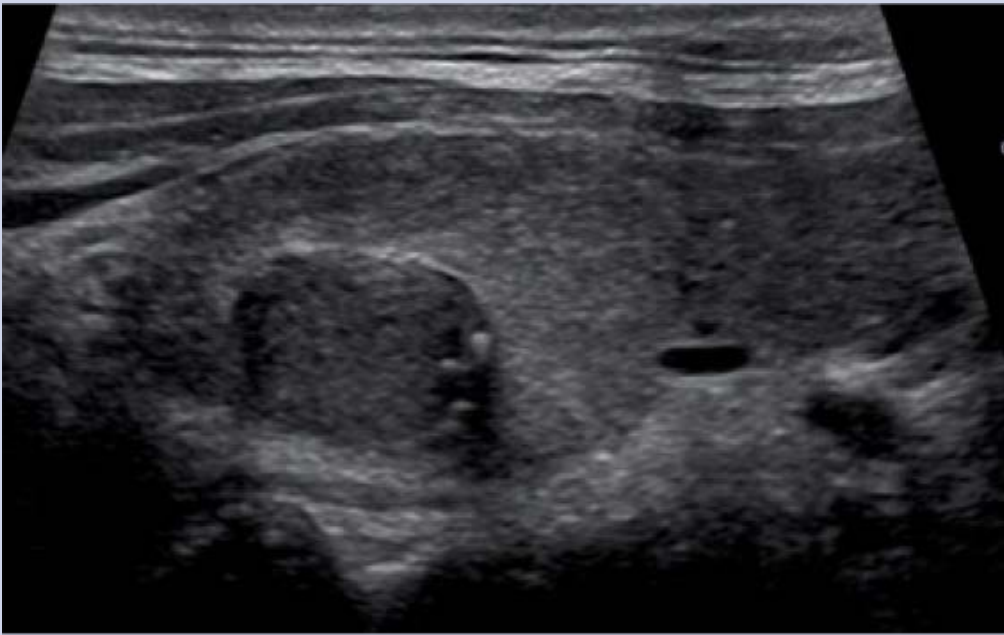
Hyperechoic or isoechoic (1 points)



- Compared to adjacent thyroid parenchyma
- 1 point if unable to determine due to calcification

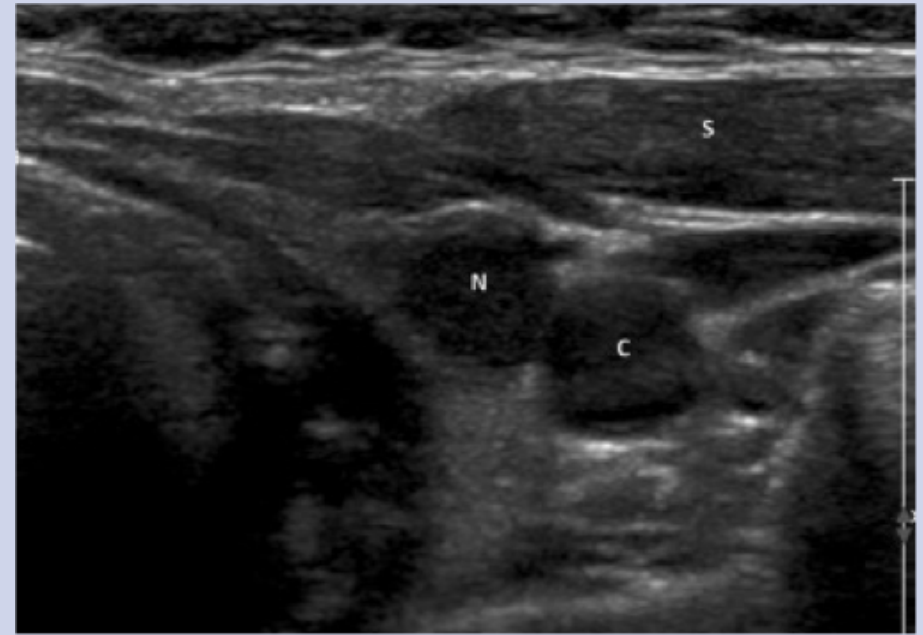
2. ECHOGENICITY

Hypoechoic (2 points)



- Relative to thyroid parenchyma

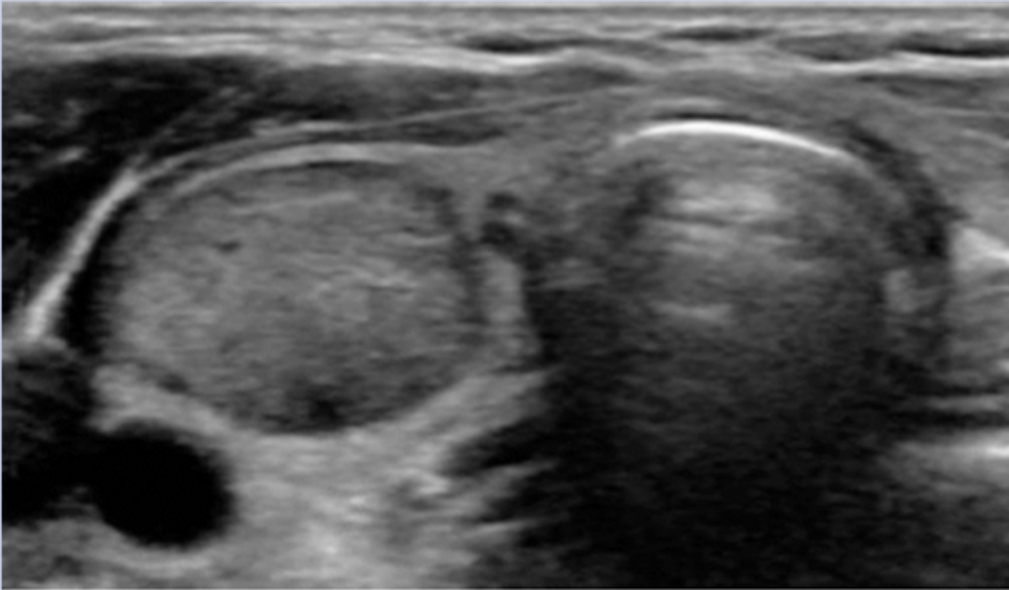
Very hypoechoic (3 points)



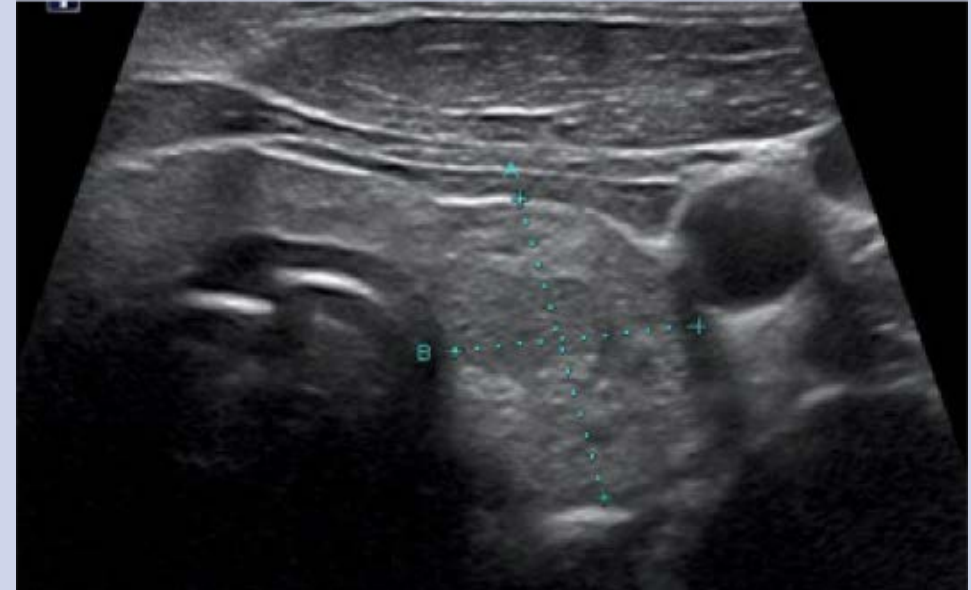
- Relative to neck strap muscles

3. SHAPE

Wider than tall (0 points)



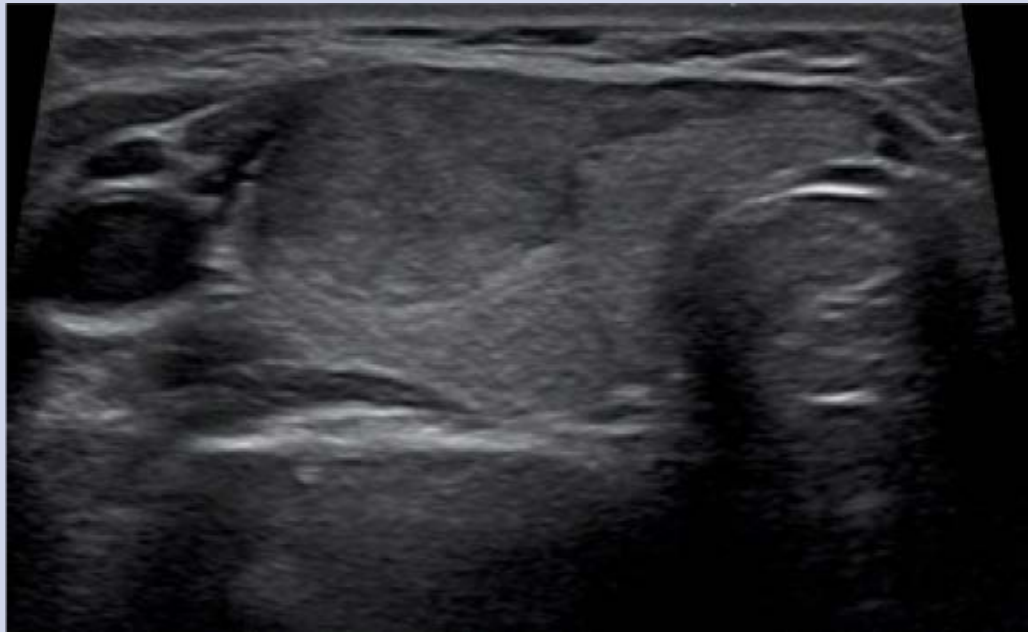
Taller than wide (3 points)



- As determined in the transverse plane, compare dimensions parallel and perpendicular to ultrasound beam (can usually be visually determined)
- Insensitive but specific indicator of malignancy

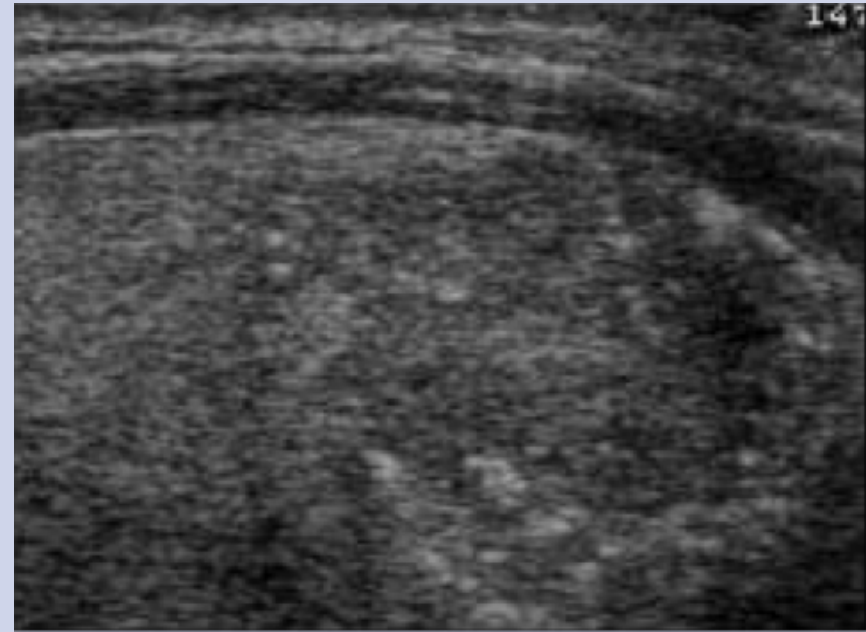
4. MARGINS

Smooth (0 points)



- Uninterrupted, well-defined curvilinear edge
- Spherical or elliptical

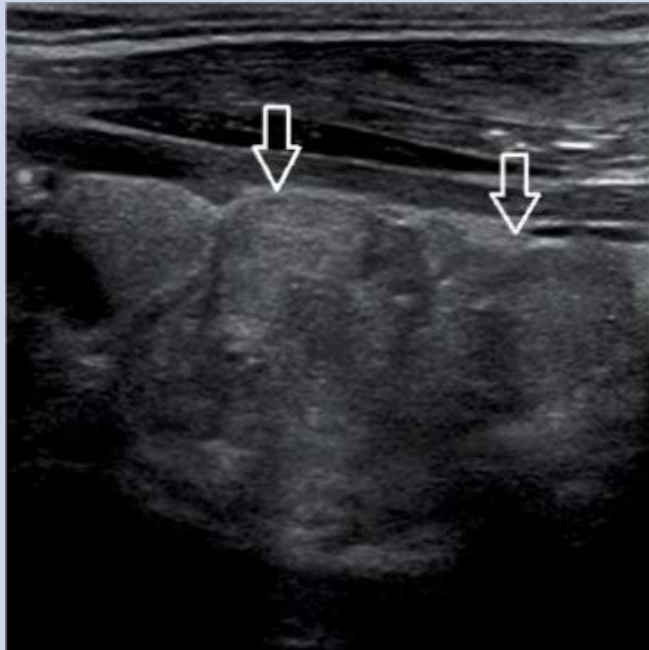
Ill-defined (0 points)



- Unable to define margins

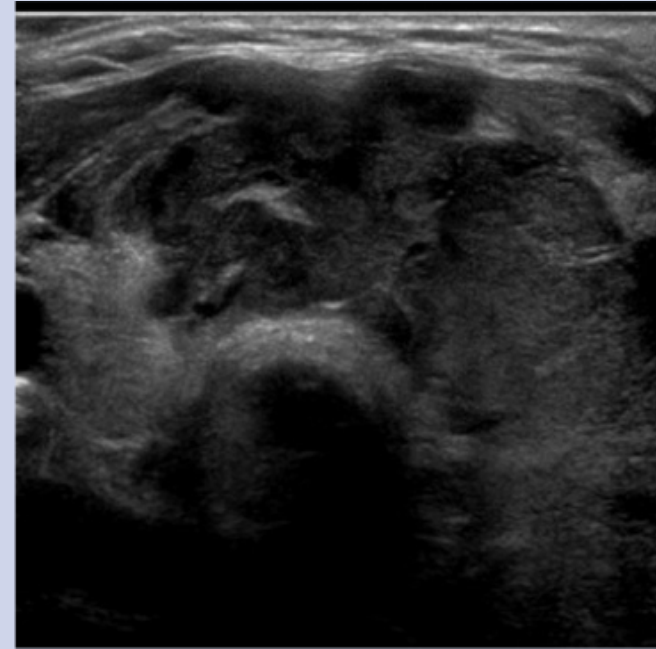
4. MARGINS

Lobulated or irregular (2 points)



- Lobulated: protrusions into adjacent tissue
- Irregular: jagged, spiculated, or sharp margins

Extra-thyroidal extension (3 points)



- Nodule extends through thyroid border
- Use caution when reporting minimal ETE, especially of the nodule otherwise appears benign

5. ECHOGENIC FOCI

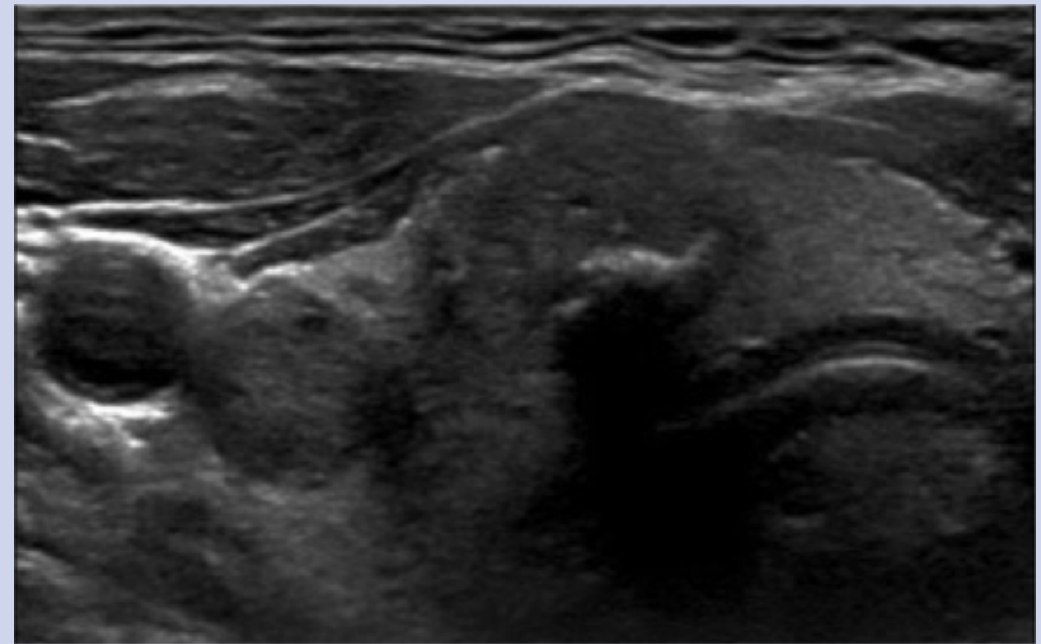
Add all points in this category

None or large comet tail artifact (0 pts)



- Large comet tail – indicating colloid
- V-shaped, >1 mm, in cystic components

Macrocalcifications (1 point)



- Coarse echogenic foci with acoustic shadowing

5. ECHOGENIC FOCI

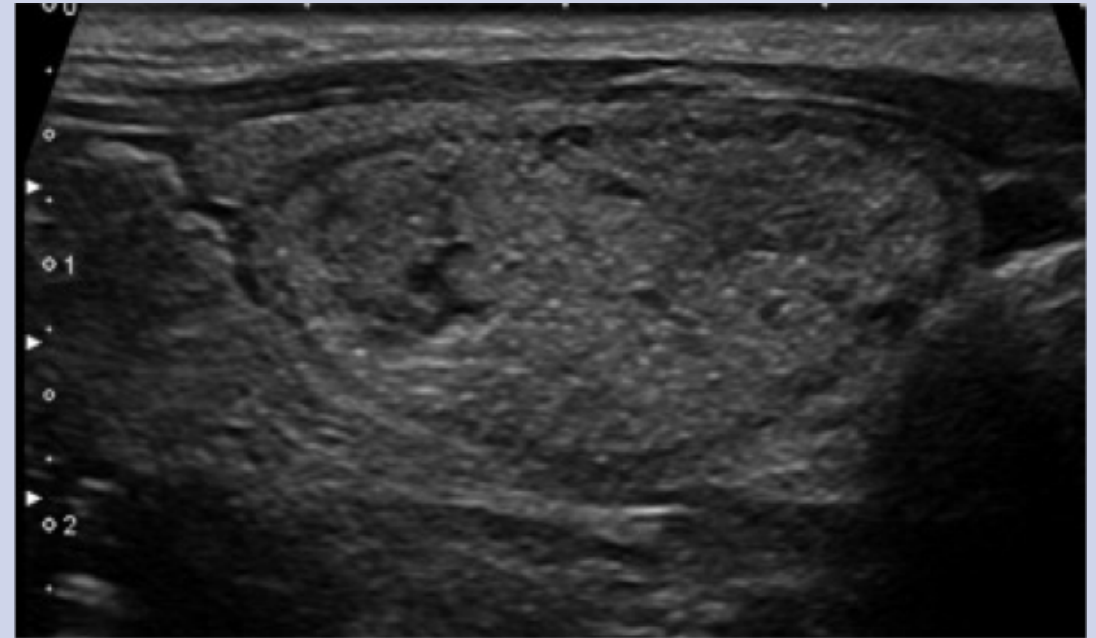
Add all points in this category

Peripheral (rim) calcifications (2 points)

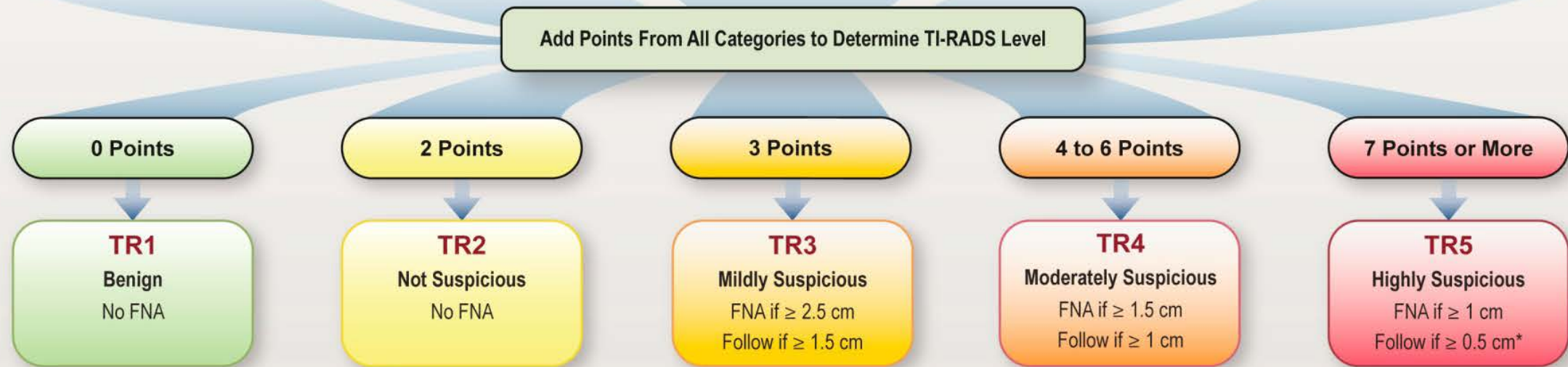


- Complete or incomplete along margin

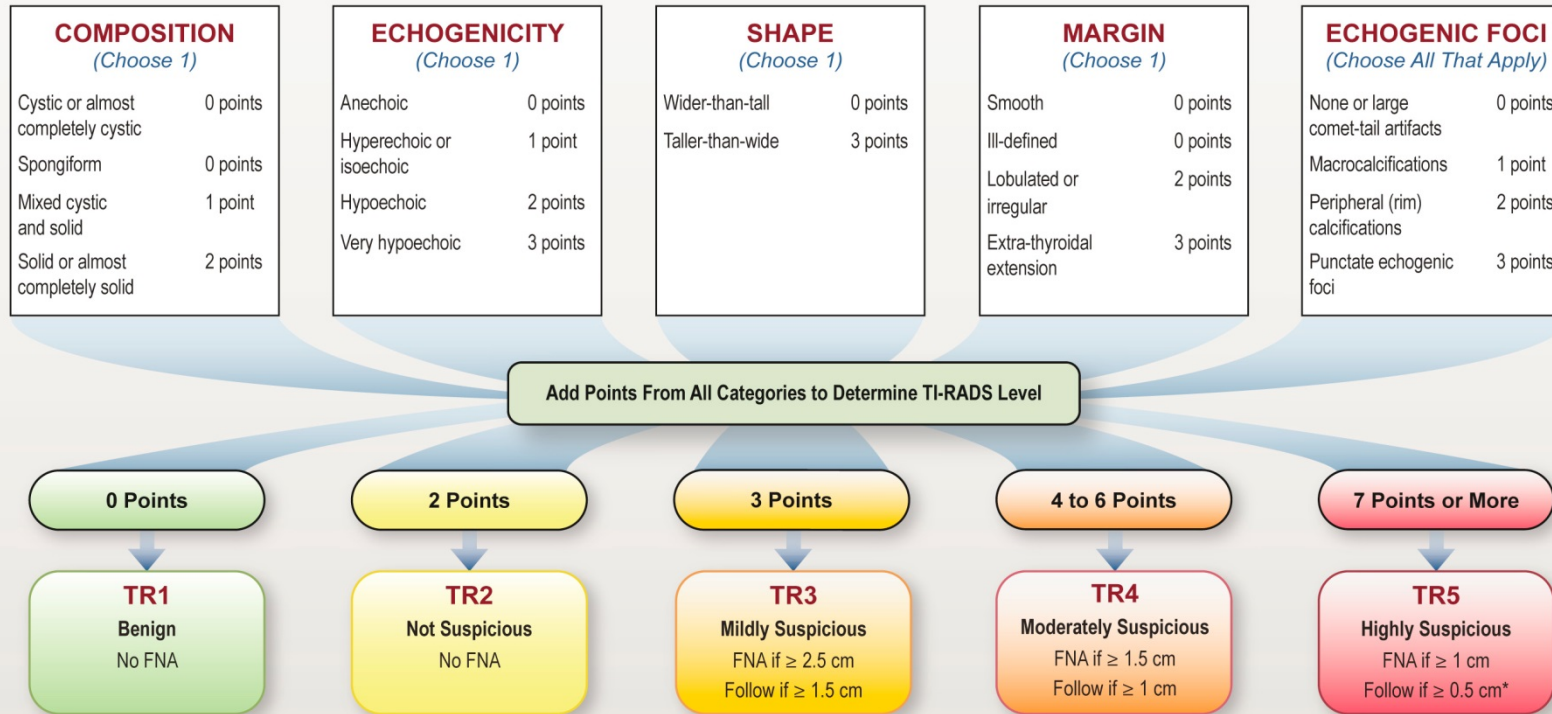
Punctate echogenic foci (3 points)



- Non-shadowing, may have small comet tail artifacts



ACR TI-RADS



COMPOSITION	ECHOGENICITY	SHAPE	MARGIN	ECHOGENIC FOCI
<p><i>Spongiform</i>: Composed predominantly (>50%) of small cystic spaces. Do not add further points for other categories.</p> <p><i>Mixed cystic and solid</i>: Assign points for predominant solid component.</p> <p>Assign 2 points if composition cannot be determined because of calcification.</p>	<p><i>Anechoic</i>: Applies to cystic or almost completely cystic nodules.</p> <p><i>Hyperechoic/isoechoic/hypoechoic</i>: Compared to adjacent parenchyma.</p> <p><i>Very hypoechoic</i>: More hypoechoic than strap muscles.</p> <p>Assign 1 point if echogenicity cannot be determined.</p>	<p><i>Taller-than-wide</i>: Should be assessed on a transverse image with measurements parallel to sound beam for height and perpendicular to sound beam for width.</p> <p>This can usually be assessed by visual inspection.</p>	<p><i>Lobulated</i>: Protrusions into adjacent tissue.</p> <p><i>Irregular</i>: Jagged, spiculated, or sharp angles.</p> <p><i>Extrathyroidal extension</i>: Obvious invasion = malignancy.</p> <p>Assign 0 points if margin cannot be determined.</p>	<p><i>Large comet-tail artifacts</i>: V-shaped, >1 mm, in cystic components.</p> <p><i>Macrocalcifications</i>: Cause acoustic shadowing.</p> <p><i>Peripheral</i>: Complete or incomplete along margin.</p> <p><i>Punctate echogenic foci</i>: May have small comet-tail artifacts.</p>

*Refer to discussion of papillary microcarcinomas for 5-9 mm TR5 nodules.

TECH SHEET

SONOGRAPHER WORKSHEET

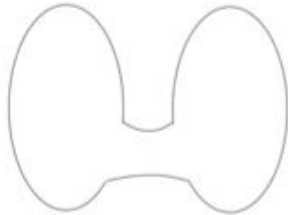
THYROID

This is NOT a diagnosis by a medical practitioner
Please refer to the radiologist's report for final results

Patient label

ECHOTEXTURE NORMAL COARSE DARK BRIGHT VASCULAR

RIGHT	ISTHMUS	LEFT
cm	cm	cm



	Cystic Spongiform Mixed Solid	Anechoic Hypoechoic Darker than muscle	Wider Taller	Smooth margins Ill-defined Lobulated / Irreg. "Outside" thyroid	ECHOGENIC FOCI None / Comet Macro Rim / peripheral Micro punctate	SIZE (cm)	SPREAD
RIGHT NODULES							
1							
2							
3							
4							
LEFT NODULES							
A							
B							
C							
D							

Revised Nov 2017

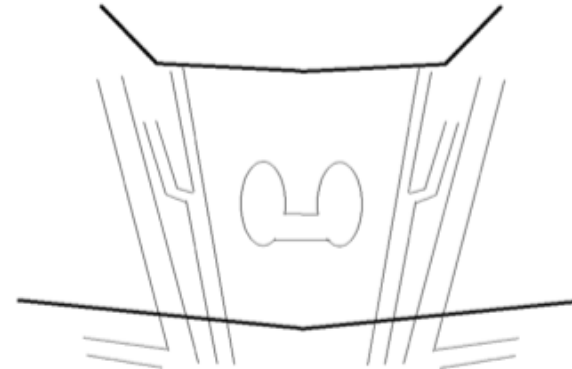
SONOGRAPHER _____

SONOGRAPHER WORKSHEET

NECK LYMPH NODES

This is NOT a diagnosis by a medical practitioner
Please refer to the radiologist's report for final results

Patient label



	RIGHT				LEFT			
	SIZE	Hilum?	Ca?	Shadow? Vascular?	SIZE	Hilum?	Ca?	Shadow? Vascular?
1								
A								
2								
B								
3								
C								
4								
D								
5								
E								

SONOGRAPHER _____

Revised Nov 2017

REPORTING CONSIDERATIONS

Additional considerations when reporting using TI-RADS

- Nodules targeted for surveillance numbered sequentially
- Definition of growth
 - at least 20% increase in two dimensions
 - minimum increase of 2 mm
 - or >50% increase in volume
- Discourage usage of the term dominant nodule

ACR FU Recommendations

- ACR believes that scanning intervals of less than 1 year are not warranted
- Except for proven cancers under active surveillance

Ajmal S et al. The natural history of the benign thyroid nodule: what is the appropriate follow-up strategy? J Am Coll Surg 2015;220:987-92.

Follow-up Recommendations

- **TR3:** follow up: 1, 3 and 5 years
- **TR4:** follow up: 1, 2, 3 and 5 years
- **TR5:** annual follow up for up to 5 years

- If Ti-Rads level changes go to yearly

- Imaging can stop at 5 years

Number of Nodules to Biopsy

- Biopsy of three or more nodules is poorly tolerated
- No more than two nodules with the highest score
- Size should not be the primary criterion

Cases

Case 1

- 52 female
- Incidental on Carotid US
- Size 1.2 (AP) x 0.9 (TR) x 1.3 (CC)
- Management?

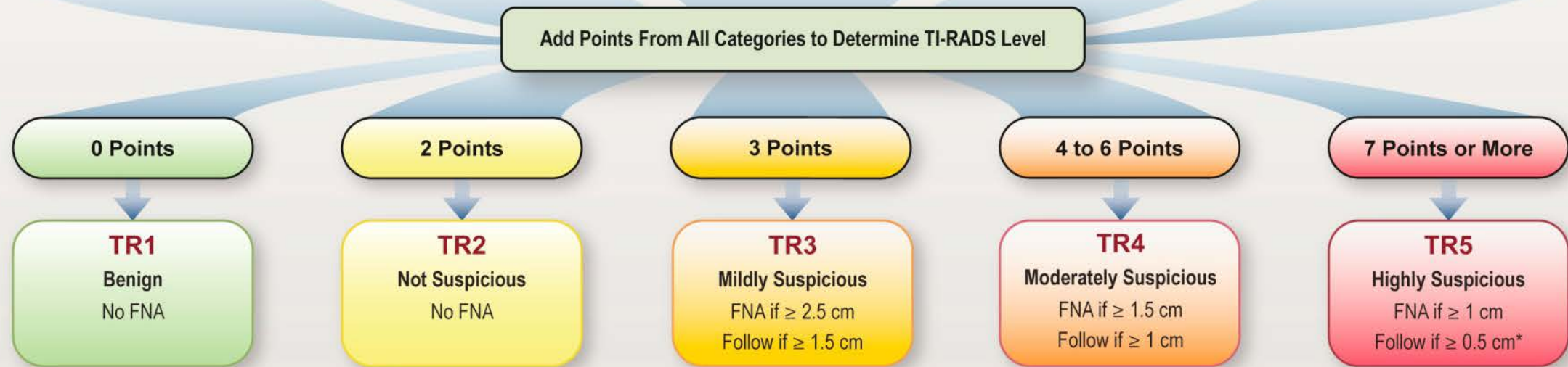


Case 1

- Size 1.2 (AP) x 0.9 (TR) x 1.3 (CC)
- Composition: Solid 2
- Echogenicity: Hypoechoic 2
- Shape: Wider than tall 0
- Margins: Irregular 2
- Echogenic foci: Macrocalcifications 1
and punctate echogenic foci 3
- Total point: 10

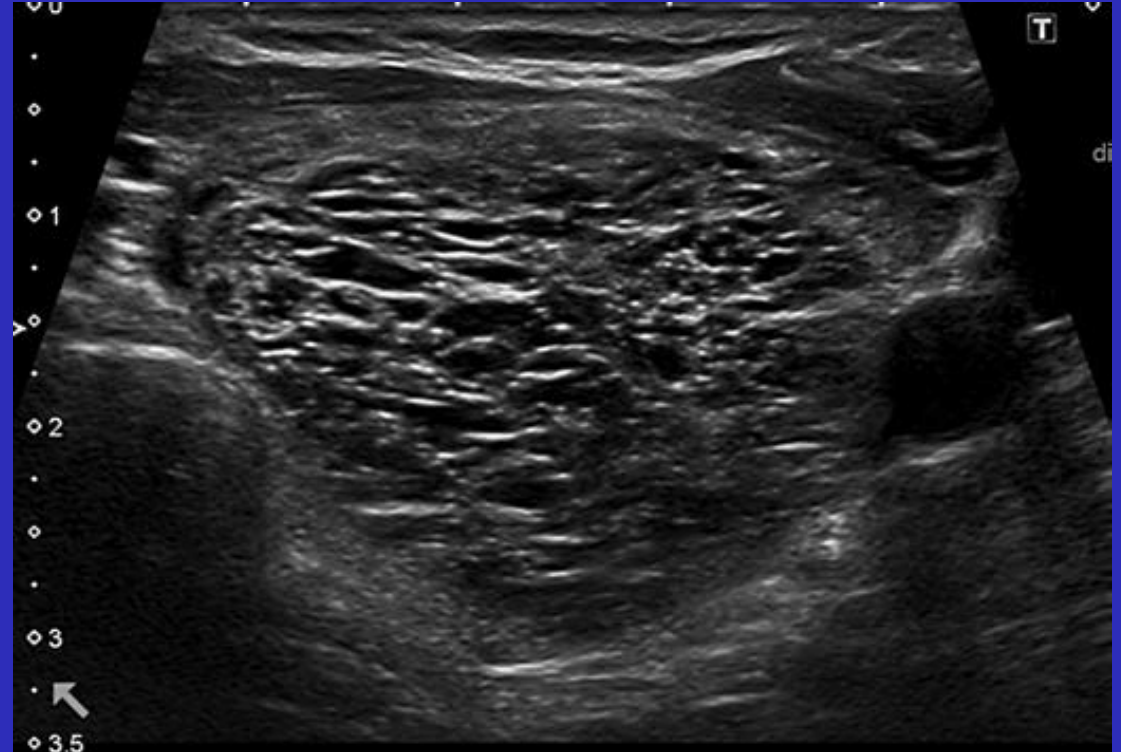
TI-RADS 5





Case 2

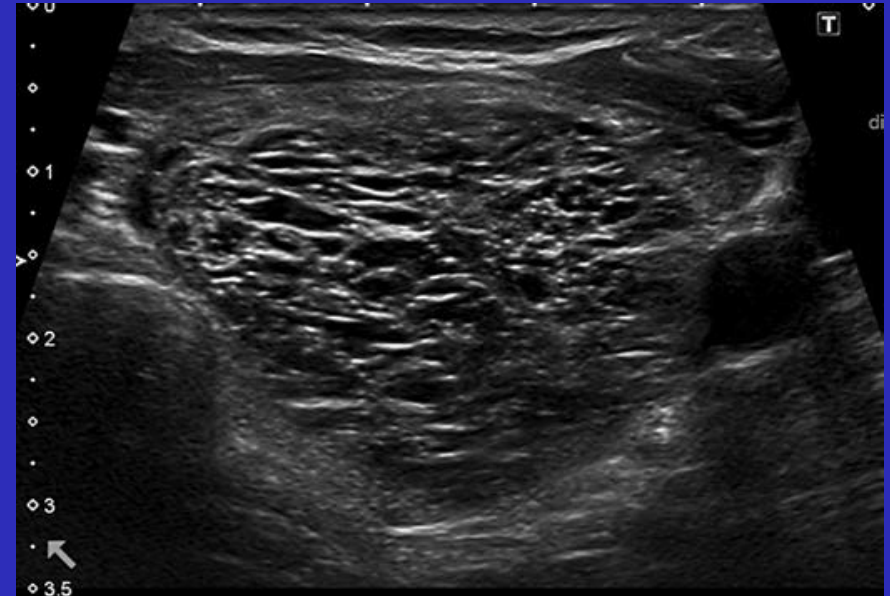
- Size 2.0 (AP) x 1.6 (TR) x 1.7 (CC)
- 43 female
- 5mm growth 1 year
- Biopsy?



Case 2

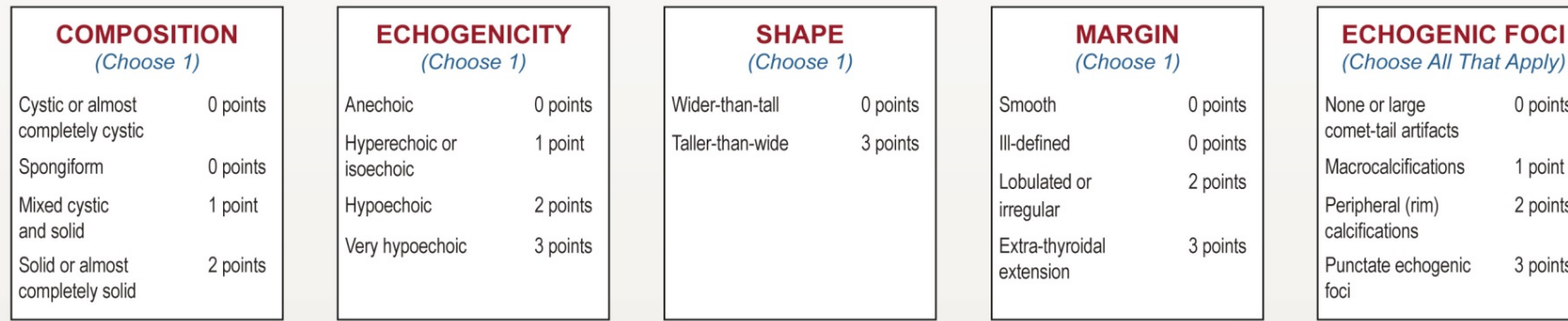
- Size 2.0 (AP) x 1.6 (TR) x 1.7 (CC)
- Composition: Spongiform: 0
- Echogenicity: Doesn't matter: 0
- Shape: Doesn't matter: 0
- Margins: Doesn't matter: 0
- Echogenic foci: Doesn't matter: 0

- Total points: 0

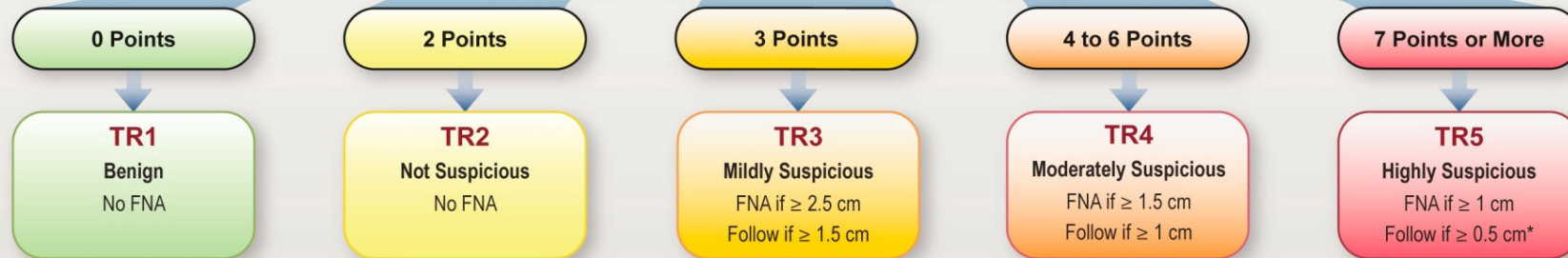


TI-RADS 1

ACR TI-RADS



Add Points From All Categories to Determine TI-RADS Level

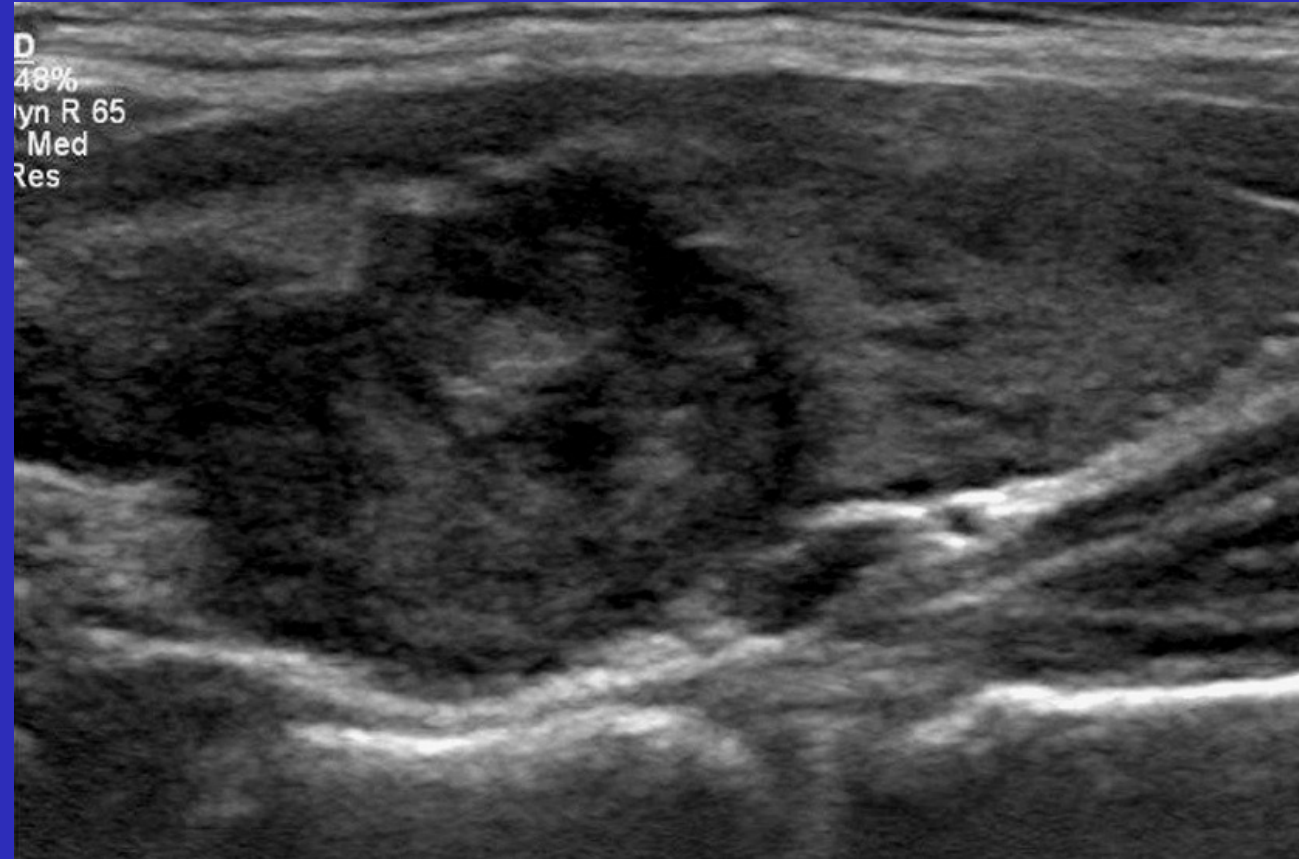


COMPOSITION	ECHOGENICITY	SHAPE	MARGIN	ECHOGENIC FOCI
<p><i>Spongiform:</i> Composed predominantly (>50%) of small cystic spaces. Do not add further points for other categories.</p> <p><i>Mixed cystic and solid:</i> Assign points for predominant solid component.</p> <p>Assign 2 points if composition cannot be determined because of calcification.</p>	<p><i>Anechoic:</i> Applies to cystic or almost completely cystic nodules.</p> <p><i>Hyperechoic/isoechoic/hypoechoic:</i> Compared to adjacent parenchyma.</p> <p><i>Very hypoechoic:</i> More hypoechoic than strap muscles.</p> <p>Assign 1 point if echogenicity cannot be determined.</p>	<p><i>Taller-than-wide:</i> Should be assessed on a transverse image with measurements parallel to sound beam for height and perpendicular to sound beam for width.</p> <p>This can usually be assessed by visual inspection.</p>	<p><i>Lobulated:</i> Protrusions into adjacent tissue.</p> <p><i>Irregular:</i> Jagged, spiculated, or sharp angles.</p> <p><i>Extrathyroidal extension:</i> Obvious invasion = malignancy.</p> <p>Assign 0 points if margin cannot be determined.</p>	<p><i>Large comet-tail artifacts:</i> V-shaped, >1 mm, in cystic components.</p> <p><i>Macrocalcifications:</i> Cause acoustic shadowing.</p> <p><i>Peripheral:</i> Complete or incomplete along margin.</p> <p><i>Punctate echogenic foci:</i> May have small comet-tail artifacts.</p>

*Refer to discussion of papillary microcarcinomas for 5-9 mm TR5 nodules.

Case 3

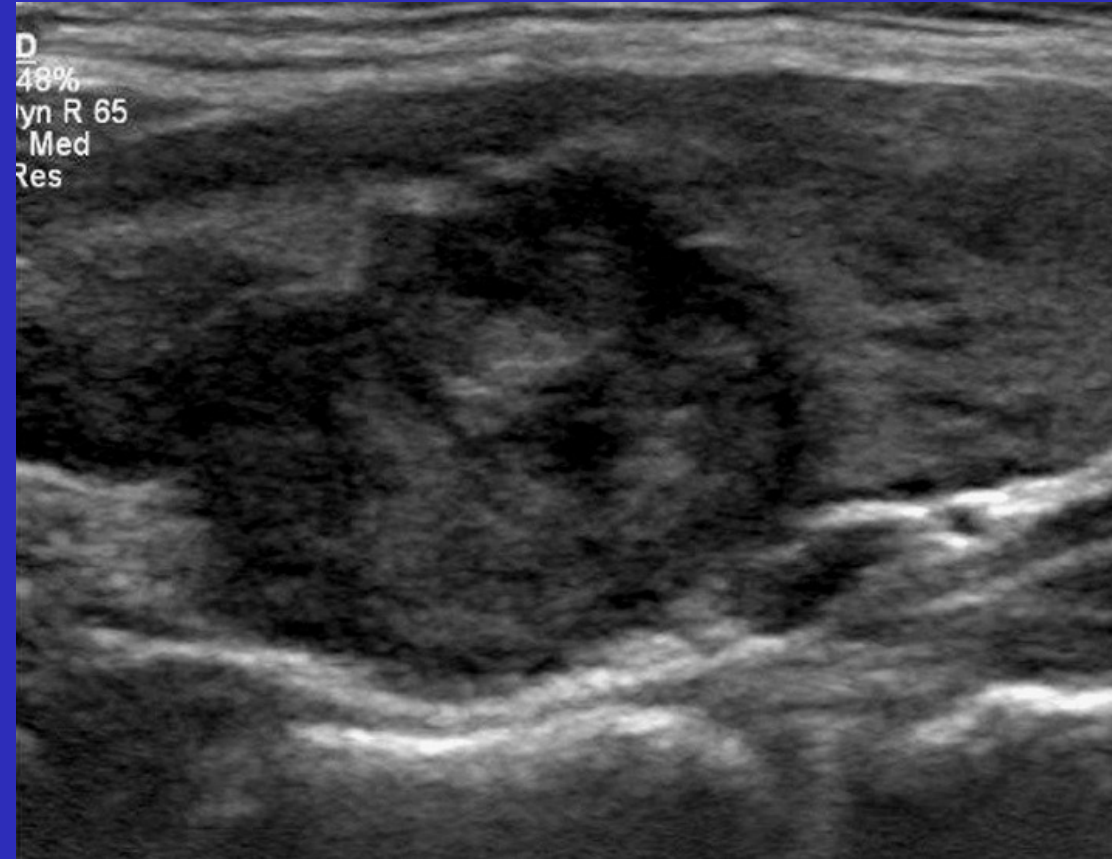
- Size 1.2 (AP) x 1.6 (TR) x 1.8 (CC)
- Male 55
- Incidental on CT Chest
- Recent biopsy "inadequate"
- Management?



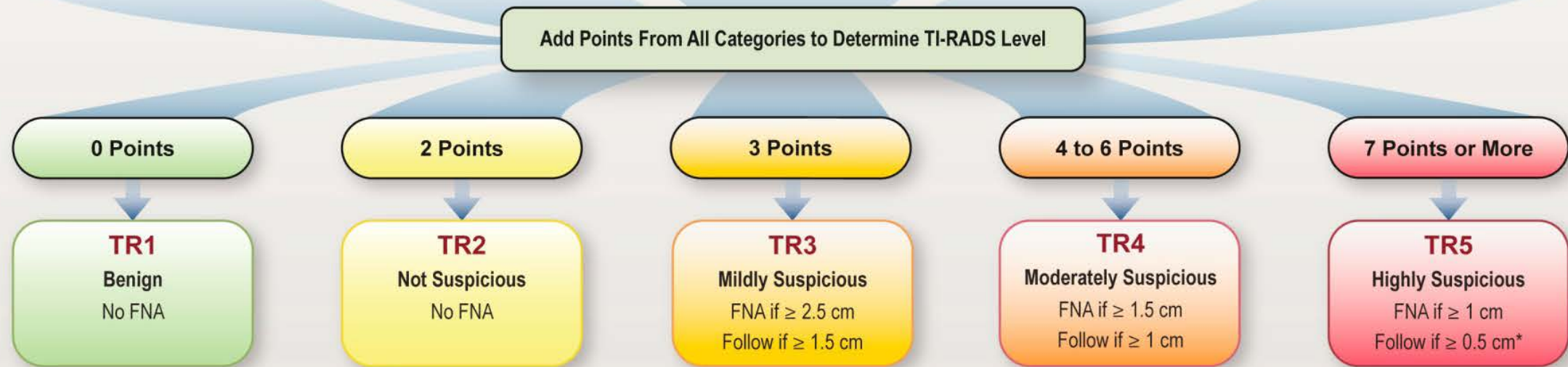
Case 3

- Composition: Solid: 2
- Echogenicity: Hypo 2
- Shape: Wider than Tall: 0
- Margins: Extra thyroid ext: 3
- Echogenic foci: No: 0

- Total points: 7



TI-RADS 5: Repeat biopsy (or surgery?)



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

Hyperechoic or isoechoic 1 point

Hypoechoic 2 points

Very hypoechoic 3 points

Shape (Choose 1)* Wider-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

Echogenic Foci (Choose All That Apply)* None or large comet-tail artifacts 0 points

Macrocalcifications 1 point

Peripheral (rim) calcifications 2 points

Punctate echogenic foci 3 points

Total Points

0

TI-RADS Score

TR1



Recommendations

Benign: No FNA

Reset

Web page:
tiradscalculator.com

EXAMPLE 3

- 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
 - Hyperechoic or isoechoic 1 point
 - Hypoechoic 2 points
 - Very hypoechoic 3 points

- Shape (Choose 1)***
- Wider-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

- Echogenic Foci (Choose All That Apply)***
- None or large comet-tail artifacts 0 points
 - Macrocalcifications 1 point
 - Peripheral (rim) calcifications 2 points
 - Punctate echogenic foci 3 points

Total Points

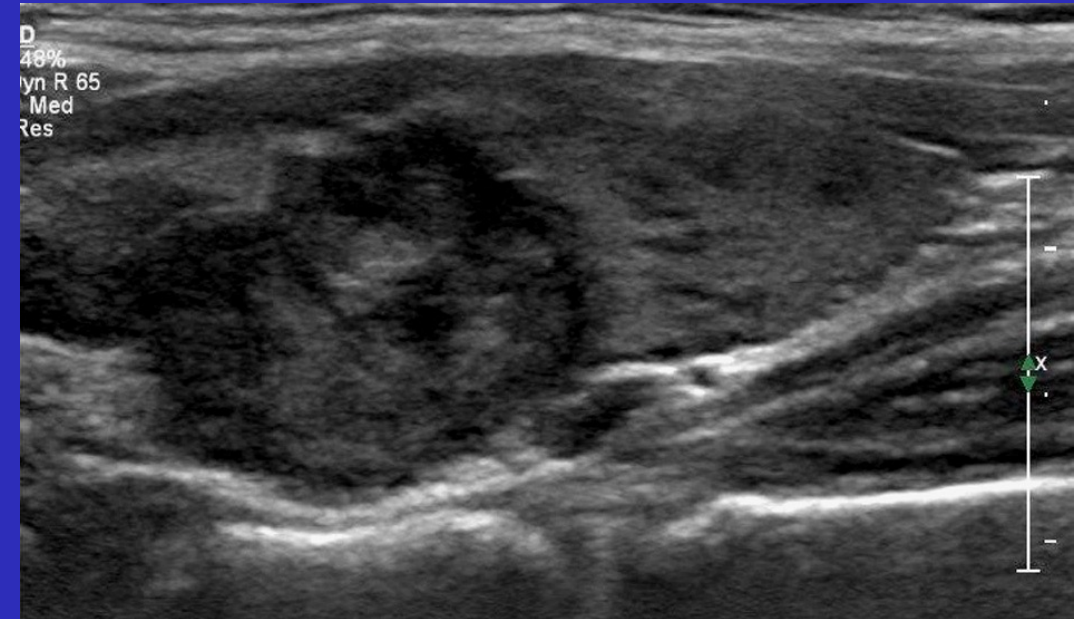
7

TI-RADS Level

TR5

Recommendations

Highly Suspicious: FNA if ≥ 1 cm; Follow if ≥ 0.5 cm*



SUMMARY

SUMMARY

- Consistent reports and recommendations
- Improves communication
- System that most can live with (for now)

SUMMARY

- Multidisciplinary approach required to mitigate overdiagnosis and overtreatment Papillary thyroid cancer
- TI-RADS Not perfect, oversimplifies
- Not the goal to diagnose every cancer
- Identifying clinically important cancers

SUMMARY

- Multidisciplinary approach
 - Previous reports
 - Indication of Urgency
 - Risk factors
- Risk stratification which also incorporates clinically relevant data and risk factors

MISC THYROID CONTROVERSIES

for discussion

- What to do with High Risk Patients? Does TI-RADS Apply?
- What to do with request for TI-RADS 1-2 nodules?
- Significant proportion still in TI-RADS 3 and 4
- From Survey: TI RADS is a misguided attempt to lend a sense of accuracy to a test that is inherently inaccurate

Cancer Risk ACR TI-RADS 2018

- **These guidelines are not rules!**

ACR TI-RADS 2018

- These guidelines are not rules!

Estimated Cancer Risk

- TR1: <2%
- TR2: <2%
- TR3: <5%
- TR4: 5-20%
- TR5: >20%

Sens	74.7%
Spec	67.3%
PPV	40.2%
NPV	90.1%
Acc	69.0%

*Tessler FN et al. ACR Thyroid Imaging, Reporting and Data System (TI-RADS): JACR. 14 (5): 587-595
Ha EJ et al. Radiology. 2018 Jun. 287(3)*

References

- Tessler FN et al. ACR Thyroid Imaging, Reporting and Data System (TI-RADS): White Paper of the ACR TI-RADS Committee. (2017) JACR. 14 (5): 587-595.
- Grant et al. Thyroid Ultrasound Reporting Lexicon: White Paper of the ACR Thyroid Imaging, Reporting and Data System (TIRADS) Committee. 2015. JACR. 12 (12 Pt A): 1272-9.
- Hoang JK et al. Managing incidental thyroid nodules detected on imaging: white paper of the ACR Incidental Thyroid Findings Committee. 2015. JACR. 12 (2): 143-50.
- <http://tiradscalculator.com>

The End