EMORY UNIVERSITY

CURRENT CONCEPTS IN RADIOACTIVE IODINE (RAI) THERAPY FOR THYROID CANCERS

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DISCLOSURES

Consultant:

- Curium Radiopharmaceuticals
- Adaptive Research

Nothing relevant to this presentation

LEARNING OBJECTIVES

- Discuss principles of radio-iodine ablation in thyroid cancer.
- Discuss 2015 ATA guidelines for management of thyroid cancer and the subsequent controversies and change in treatment paradigms.

MANAGEMENT OF THYROID CANCER IN USA

Thyroid cancer – Diagnosis (Surgeon/Endocrinologist, U/S and pathologist)

Total or near total thyroidectomy (Surgeon)

Post op whole body scan (Nuclear Medicine)

Na I-131 treatment (Nuclear Medicine)

7-10 days post therapy scan(Nuclear Medicine)

Thyroxine suppressive therapy (Endocrinologist)

Thyroglobulin (Endocrinologist/Surgeon)

Ultrasound (Endocrinologist/Surgeon)

Na I-131 Whole body scan for follow up
FDG PET/CT (Nuclear Medicine)

TKI and other MKI (Med Onc)

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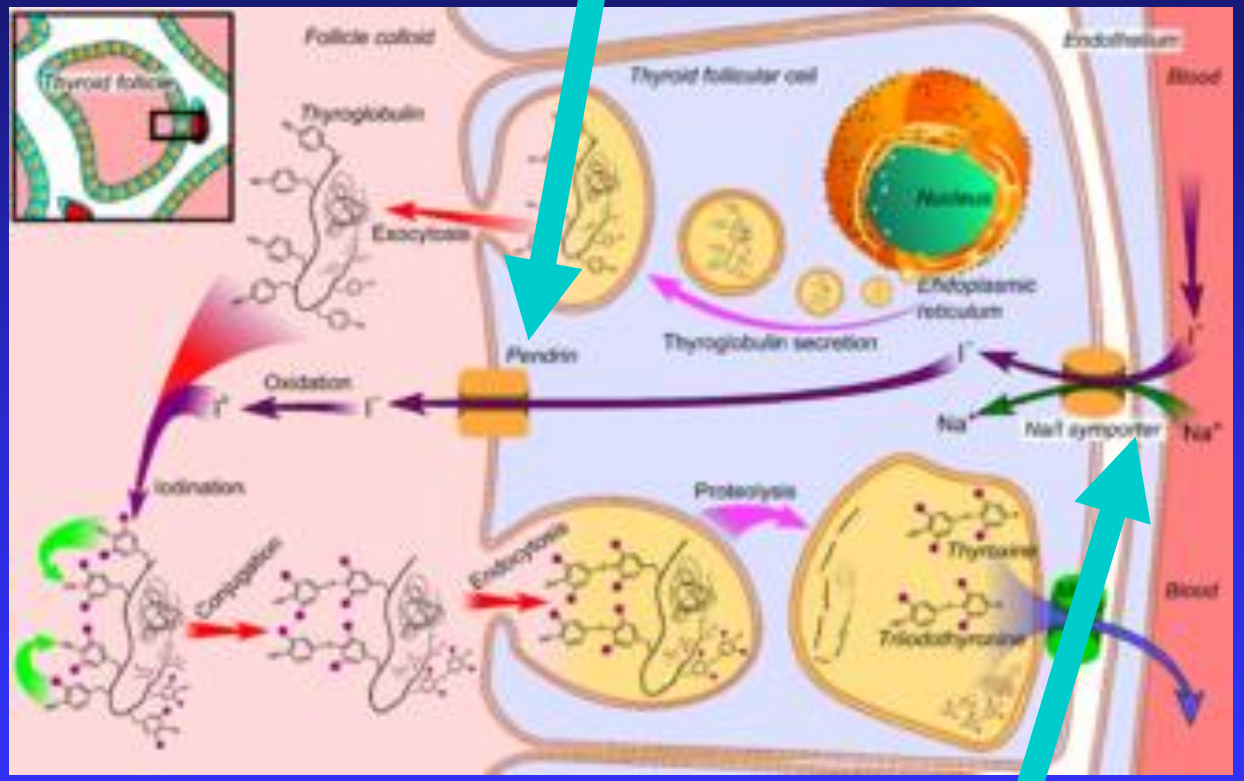
IODINE TRAPPING & ORGANIFICATION

- Iodine is an integral component of thyroid hormones produced in the thyroid gland by the thyroid cells
- Iodide trapping: NaI symporter (NIS) plays the major role, & the instruction comes from SLC5A5 - gene
- Organification is a multi step process: Pendrin gene (SLC26A4) facilitates organification by mediating the efflux of iodide across the apical membrane of the thyrocyte

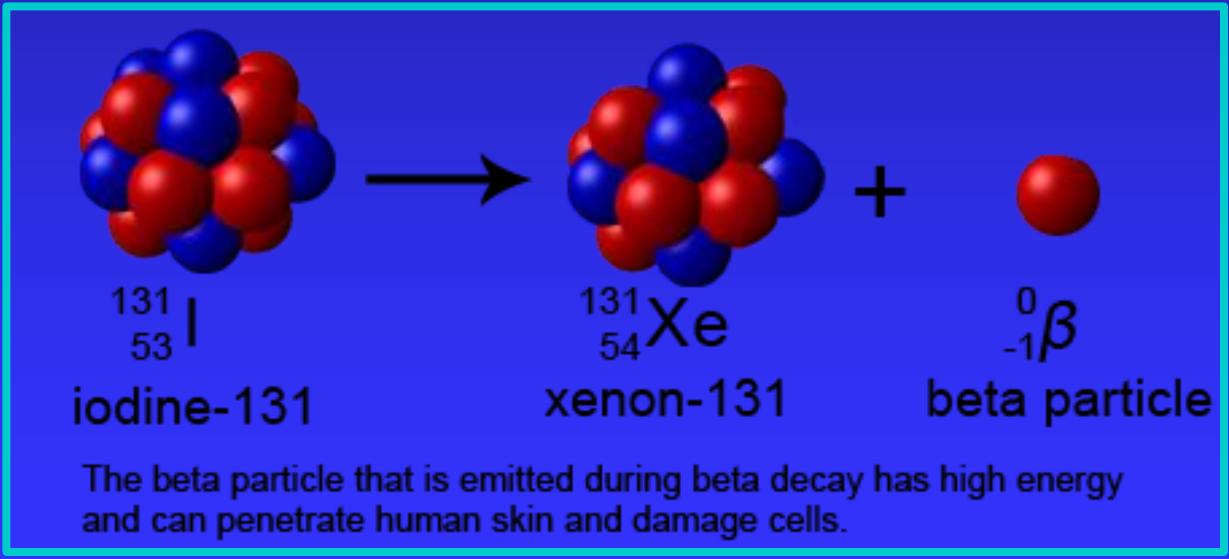
SLC26A4 gene for Pendrin

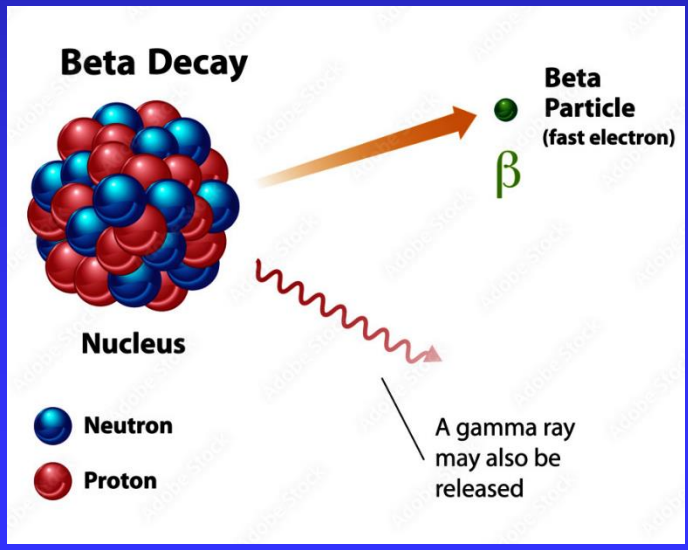


SLC5A5 : gene for NIS

IODINE

- Chemical element, Symbol: **I**, Atomic Number 53
- Halogen: 4th in the group 17 periodic table (after fluorine, chlorine, & bromine; and followed by astatine & tennessine)
- About 35-40 iodine isotopes found in nature or produced
- I-127 is the only stable one
- 1-123, I-124, I-125, I-131 have use in Nuclear Medicine





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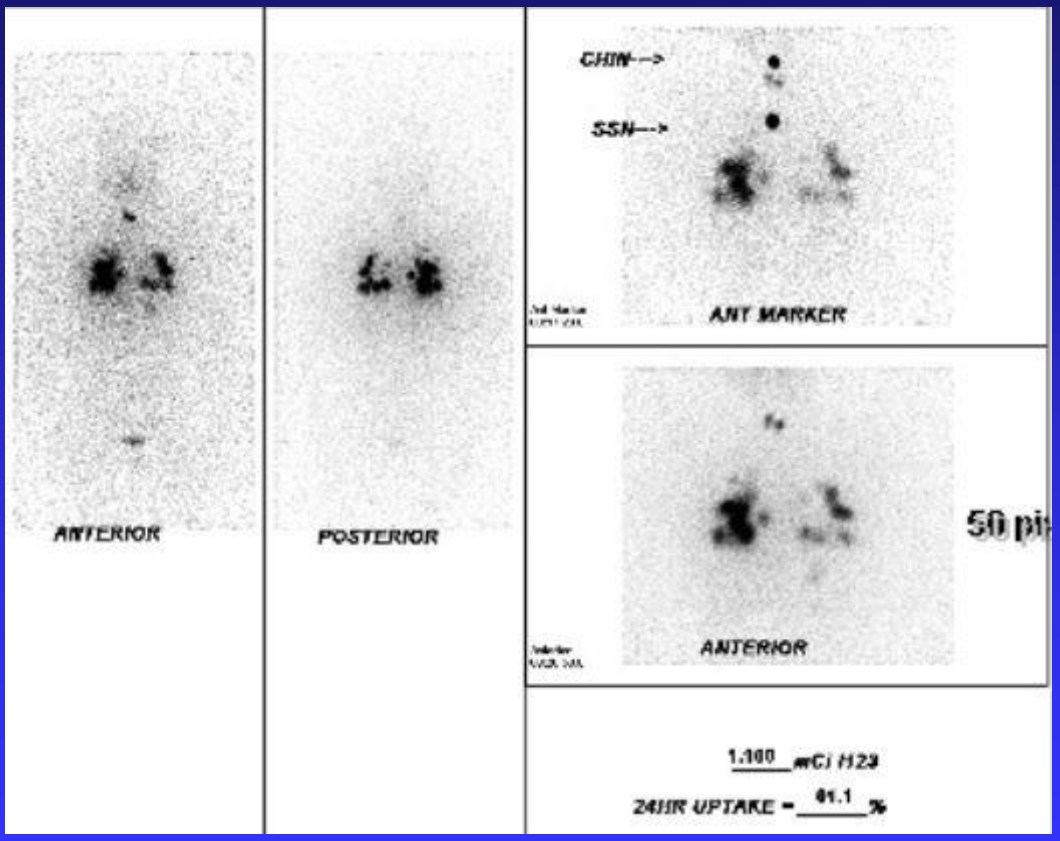
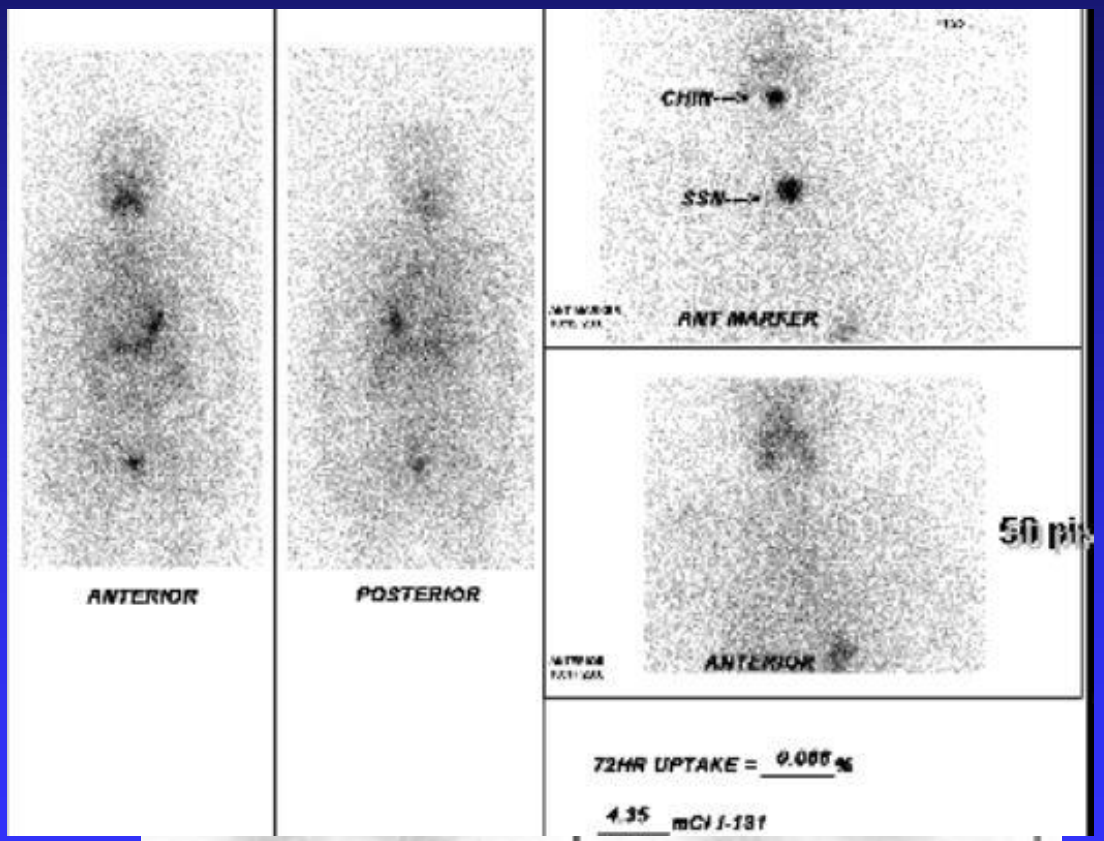
I-131 RAI FOR LUNG METASTASES

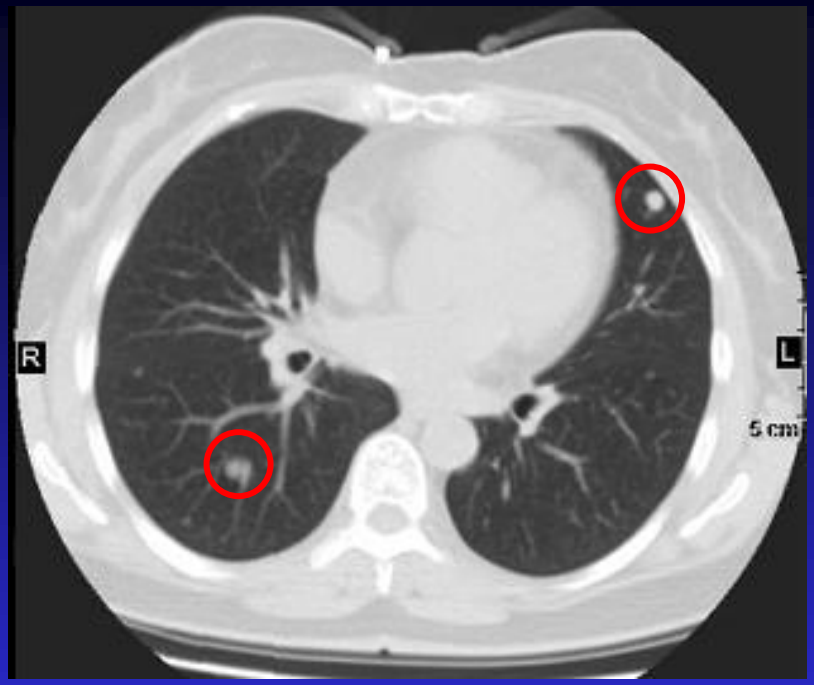
54 yr old Rt.lobectomy in California 1987. In 2009 CT showed lung nodules – biopsy showed papillary cancer. Completion thyroidectomy and LN dissection; Tg normal, anti-Tg Ab high

I-123 WB Scan 2009

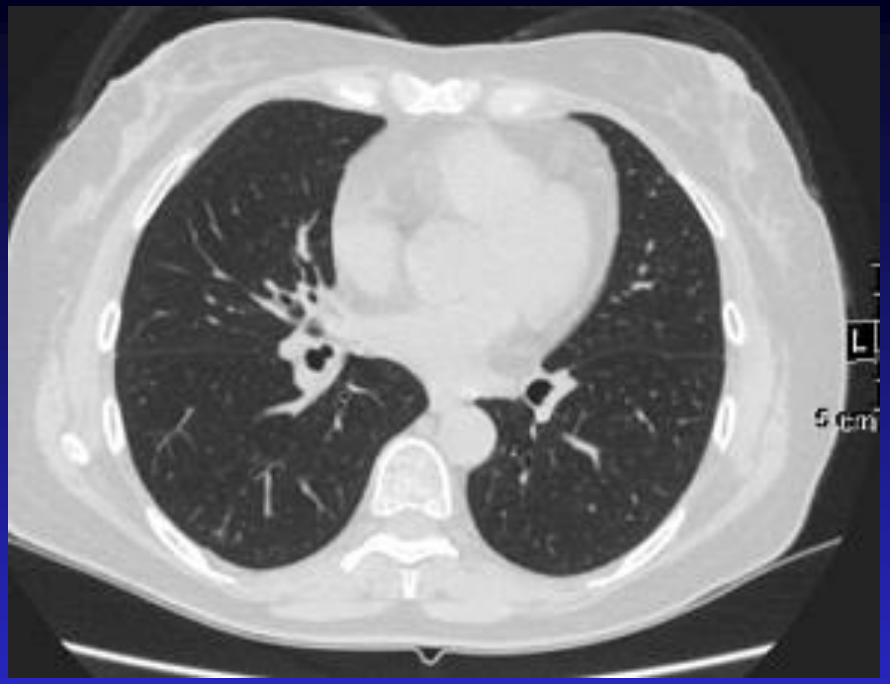


I-123 WB scan 2011 7 day post therapy scan





CT 2009: Lung nodules +



CT 2011: Lung nodules –ve

After 11 years, the patient is still doing well

NEED FOR RAI ABLATION

Post total / near-total Thyroidectomy:

- Ablation of functional residual thyroid tissue (without an explicit commitment to specific benign or malignant target)
- Ablation of gross or microscopic residual disease
- Ablation of neck nodal disease (gross or microscopic)
- Ablation of distant metastatic disease

Remnant Thyroid Ablation:

- Eliminate Tg & facilitate follow-up
- Potential reduction of recurrence risk

CHANGES OVER TIME

- Management of thyroid cancer has undergone a lot of changes over the last decade or so.

Last decade or so presentation

Many cases were detected as thyroid incidentalomas!

- 2015 ATA management guidelines for thyroid nodules and thyroid cancer recommend a patient-centered approach to evaluating the risk of thyroid cancer recurrence and overall prognosis for each individual patient.
- Recommend less total thyroidectomies but more lobectomies or lobectomies with isthmusectomies (keeping the other non-cancerous lobe intact) and less use of radioactive iodine therapy post surgery.

TABLE 11. ATA 2009 RISK STRATIFICATION SYSTEM WITH PROPOSED MODIFICATIONS

ATA low risk	Papillary thyroid cancer (with all of the following): • No local or distant metastases; • All macroscopic tumor has been resected • No tumor invasion of loco-regional tissues or structures • The tumor does not have aggressive histology (e.g., tall cell, hobnail variant, columnar cell carcinoma) • If ^{131}I is given, there are no RAI-avid metastatic foci outside the thyroid bed on the first posttreatment whole-body RAI scan • No vascular invasion • Clinical N0 or ≤5 pathologic N1 micrometastases (<0.2 cm in largest dimension)[a] Intrathyroidal, encapsulated follicular variant of papillary thyroid cancer[a] Intrathyroidal, well differentiated follicular thyroid cancer with capsular invasion and no or minimal (<4 foci) vascular invasion[a] Intrathyroidal, papillary microcarcinoma, unifocal or multifocal, including *BRAF*^{V600E} mutated (if known)[a]
ATA intermediate risk	Microscopic invasion of tumor into the perithyroidal soft tissues RAI-avid metastatic foci in the neck on the first posttreatment whole-body RAI scan Aggressive histology (e.g., tall cell, hobnail variant, columnar cell carcinoma) Papillary thyroid cancer with vascular invasion Clinical N1 or >5 pathologic N1 with all involved lymph nodes <3 cm in largest dimension[a] Multifocal papillary microcarcinoma with ETE and *BRAF*^{V600E} mutated (if known)[a]
ATA high risk	Macroscopic invasion of tumor into the perithyroidal soft tissues (gross ETE) Incomplete tumor resection Distant metastases Postoperative serum thyroglobulin suggestive of distant metastases Pathologic N1 with any metastatic lymph node ≥3 cm in largest dimension[a] Follicular thyroid cancer with extensive vascular invasion (> 4 foci of vascular invasion)[a]

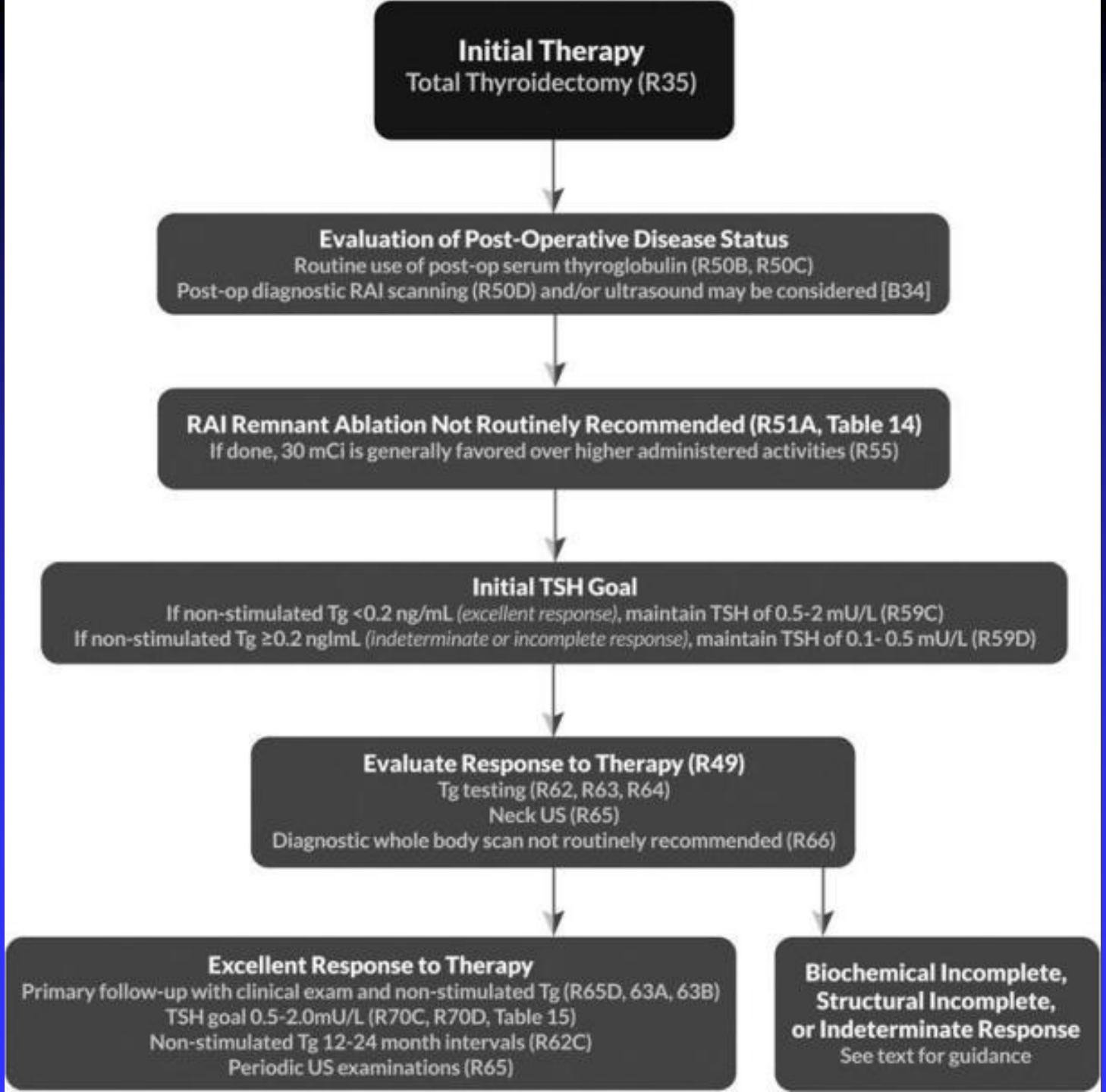
2015 ATA Guidelines

Modifications to incorporate:

- Extent of lymph node involvement
- Mutational status
- Specific FTC histologies

TABLE 13. CLINICAL IMPLICATIONS OF RESPONSE TO THERAPY RECLASSIFICATION IN PATIENTS WITH DIFFERENTIATED THYROID CANCER TREATED WITH TOTAL THYROIDECTOMY AND RADIOIODINE REMNANT ABLATION

Category	*Definitions*[a]	*Clinical outcomes*	*Management implications*
Excellent response	Negative imaging ***and either*** Suppressed Tg <0.2 ng/mL[b] ***or*** TSH-stimulated Tg <1 ng/mL[b]	1%–4% recurrence[c] <1% disease specific death[c]	An excellent response to therapy should lead to an early decrease in the intensity and frequency of follow up and the degree of TSH suppression
Biochemical incomplete response	Negative imaging ***and*** Suppressed Tg ≥1 ng/mL[b] ***or*** Stimulated Tg ≥10 ng/mL[b] ***or*** Rising anti-Tg antibody levels	At least 30% spontaneously evolve to NED[d] 20% achieve NED after additional therapy[a] 20% develop structural disease[a] <1% disease specific death[a]	If associated with stable or declining serum Tg values, a biochemical incomplete response should lead to continued observation with ongoing TSH suppression in most patients. Rising Tg or anti-Tg antibody values should prompt additional investigations and potentially additional therapies.
Structural incomplete response	Structural or functional evidence of disease With any Tg level With or without anti-Tg antibodies	50%–85% continue to have persistent disease despite additional therapy[c] Disease specific death rates as high as 11% with loco-regional metastases and 50% with structural distant metastases[a]	A structural incomplete response may lead to additional treatments or ongoing observation depending on multiple clinico-pathologic factors including the size, location, rate of growth, RAI avidity, ^{18}FDG avidity, and specific pathology of the structural lesions.
Indeterminate response	Nonspecific findings on imaging studies Faint uptake in thyroid bed on RAI scanning Nonstimulated Tg detectable, but <1 ng/mL Stimulated Tg detectable, but <10 ng/mL ***or*** Anti-Tg antibodies stable or declining in the absence of structural or functional disease	15%–20% will have structural disease identified during follow-up[a] In the remainder, the nonspecific changes are either stable, or resolve[a] <1% disease specific death[a]	An indeterminate response should lead to continued observation with appropriate serial imaging of the nonspecific lesions and serum Tg monitoring. Nonspecific findings that become suspicious over time can be further evaluated with additional imaging or biopsy.



Clinical decision-making and management recommendations in ATA low-risk DTC patients that have undergone total thyroidectomy.
R, recommendation in text

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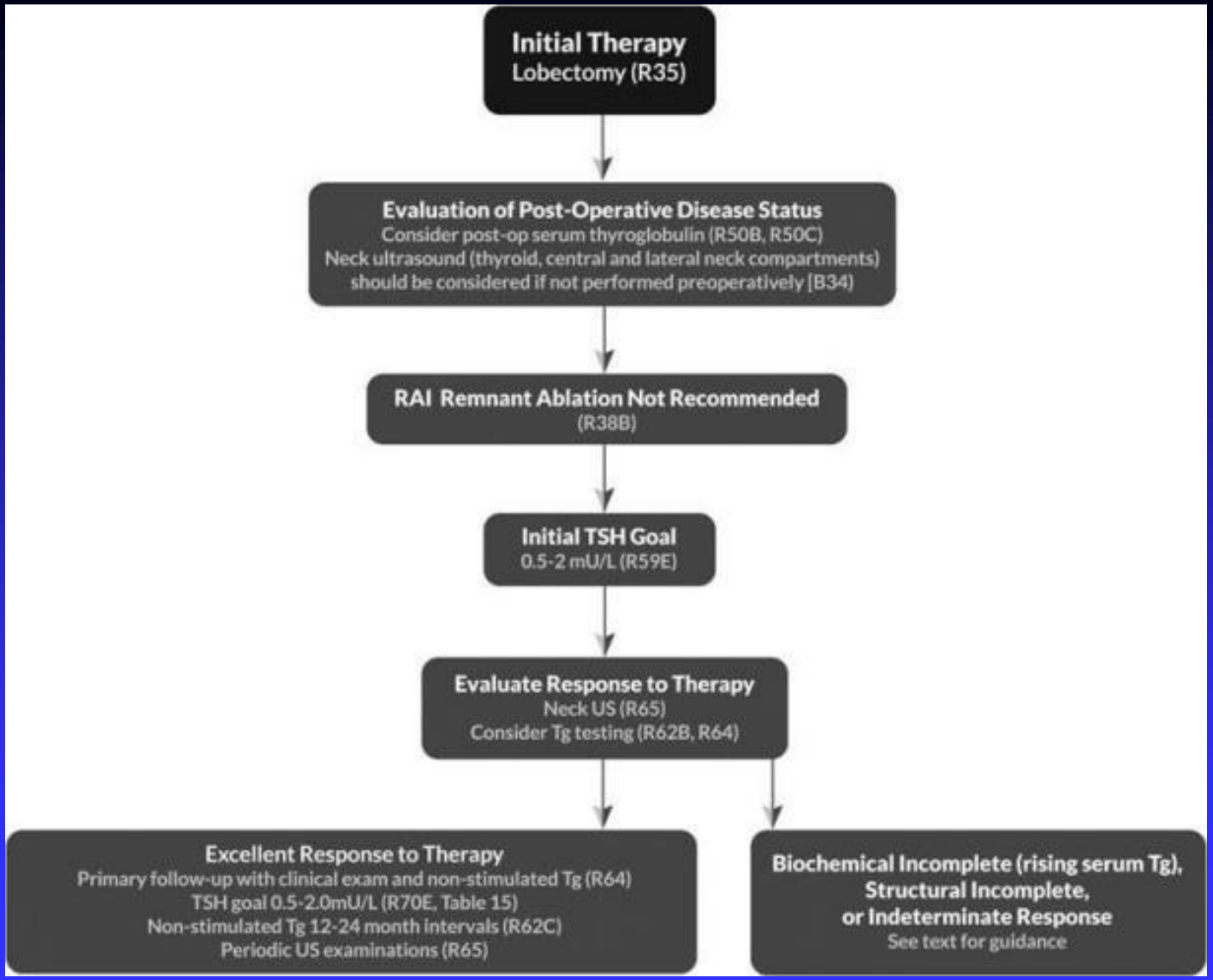
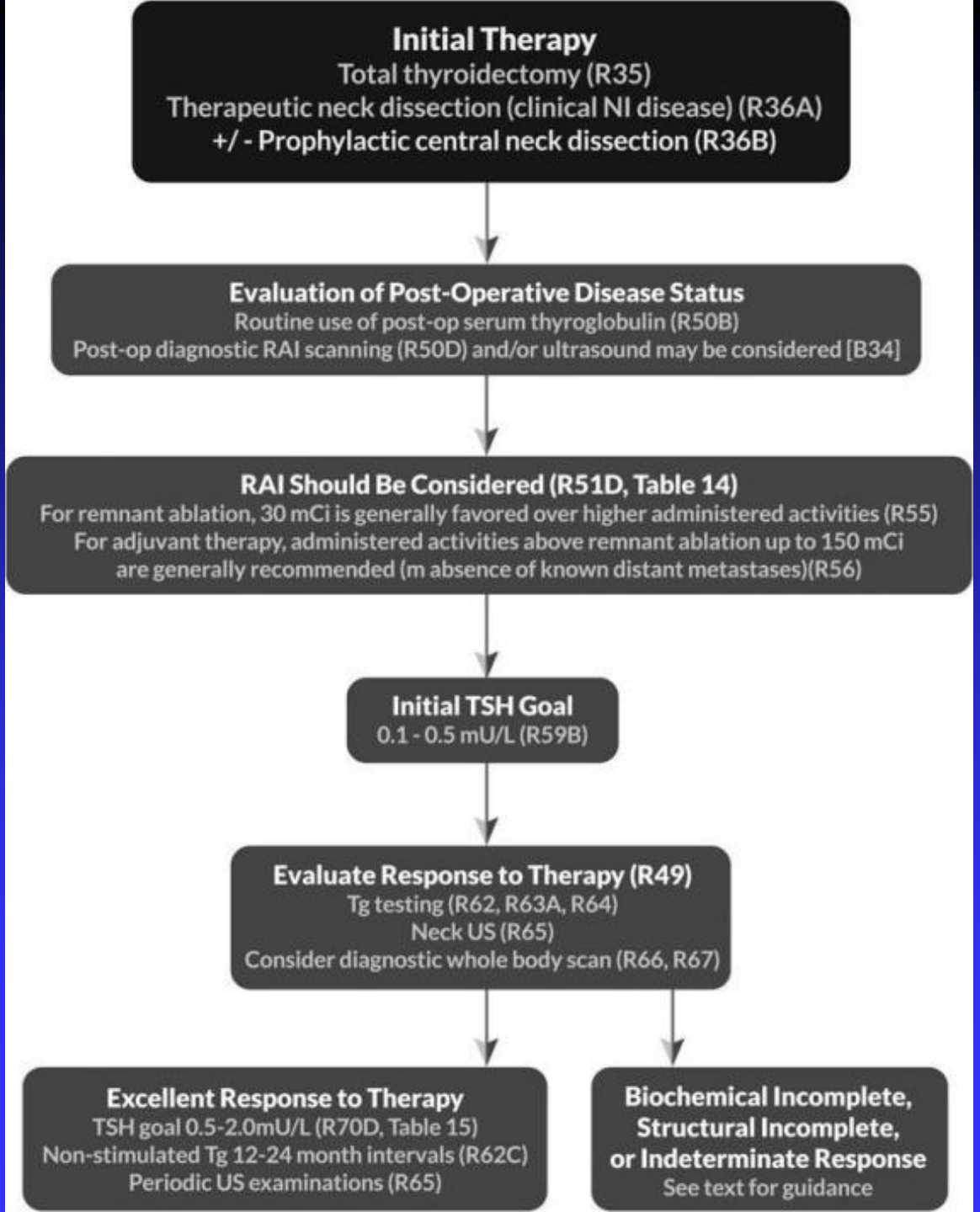


Clinical decision-making and management recommendations in ATA low risk DTC patients that have undergone less than total thyroidectomy (lobectomy or lobectomy with isthmusectomy).
R, recommendation in text.



Clinical decision-making and management recommendations in ATA intermediate risk DTC patients that have undergone total thyroidectomy.
R, recommendation in text.

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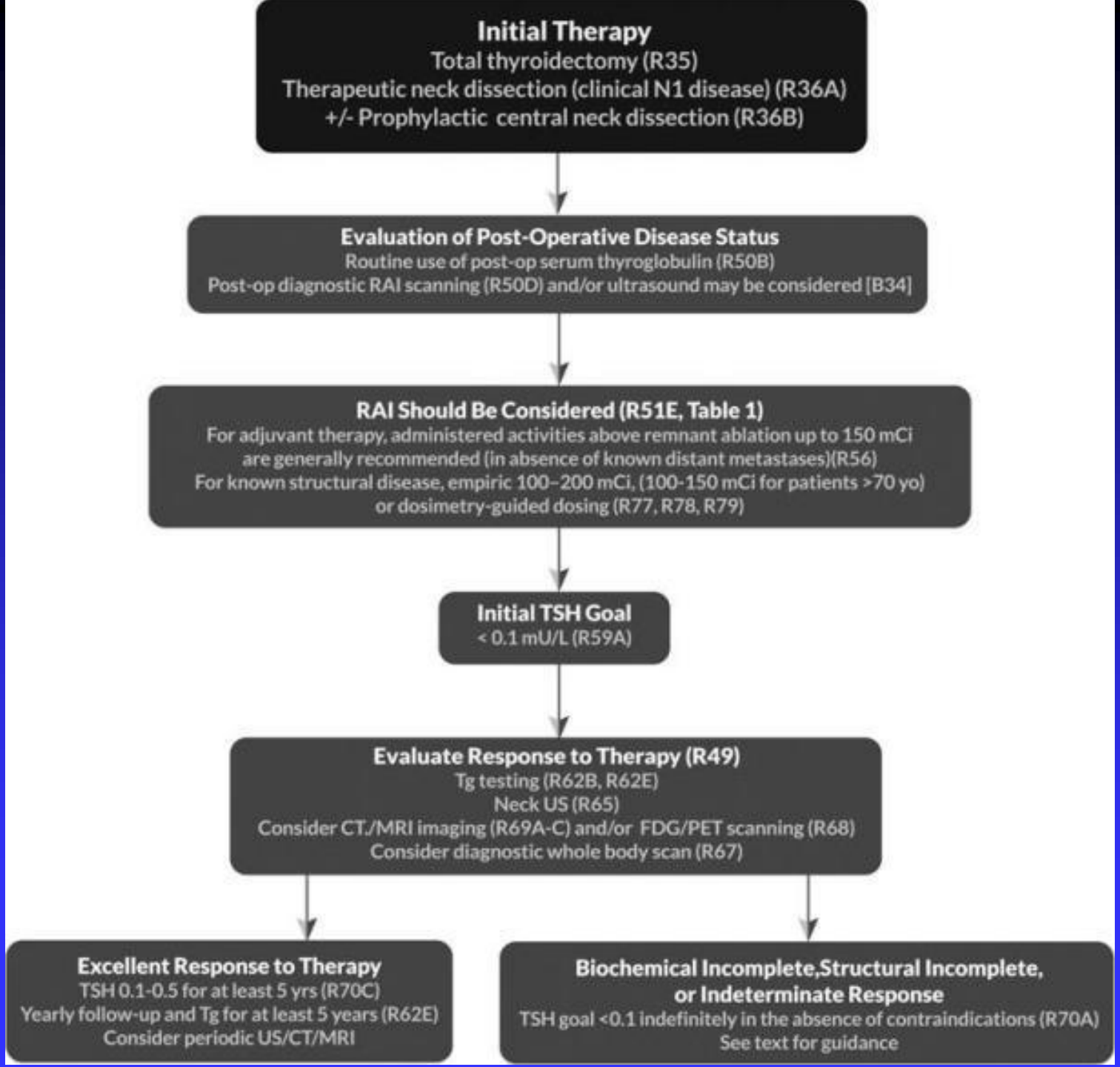

Clinical decision-making and management recommendations in ATA high risk DTC patients that have undergone total thyroidectomy and have no gross residual disease remaining in the neck.
R, recommendation in text.

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POST 2015 ATA GUIDELINES

2015 ATA guidelines influenced practice patterns in management of low-risk papillary thyroid cancers to some extent:

- Less use of radioactive iodine as they intended
- But not so much adoption of lobectomy and active surveillance

After 2015:

- Use of radioactive iodine: significantly declined
- Adoption of lobectomy: only incremental
- Uptake of active surveillance & non-surgical management: almost nonexistent

So surgeons did not change their surgery practice patterns much but did change use of RAI!

Pasqual E, et al. Trends in the Management of Localized Papillary Thyroid Carcinoma in the United States (2000–2018). *Thyroid.* 2022;doi:10.1089/thy.2021.0557.

AMERICAN THYROID ASSOCIATION GUIDELINES 2015

CONTROVERSIAL

- 2015 : Guideline has 1070 references!
  - A to D : about >75 recommendations!! Many with weak evidence!!!
  - Lots of controversies:
    - RAI not recommended for low risk disease
    - Low dose RAI (30 mCi) recommended for intermediate risk disease
    - Low iodine diet for ~ 1–2 weeks should be considered for patients undergoing RAI remnant ablation or treatment: was qualified as “Weak recommendation, Low-quality evidence”
- SNMMI & EANM both declined to endorse these guidelines
  - A Matter of Controversy: Is Radioiodine Therapy Favorable in Differentiated Thyroid Carcinoma? Schmidt et al, J Nucl Med 2018; 59:1195–1201

Table 14. Characteristics According to the American Thyroid Association Risk Stratification System and AJCC/TNM Staging System That May Impact Postoperative Radioiodine Decision-Making

ATA risk Staging (TNM)	*Description*	*Body of evidence suggests RAI improves disease-specific survival?*	*Body of evidence suggests RAI improves disease-free survival?*	*Postsurgical RAI indicated?*
ATA low risk T1a N0,Nx M0,Mx	Tumor size ≤1 cm (uni-or multi-focal)	No	No	No
ATA low risk T1b,T2 N0, Nx M0,Mx	Tumor size >1–4 cm	No	Conflicting observational data	Not routine[b]—May be considered for patients with aggressive histology or vascular invasion (ATA intermediate risk).
ATA low to intermediate risk T3 N0,Nx M0,Mx	Tumor size >4 cm	Conflicting data	Conflicting observational data	Consider[b]—Need to consider presence of other adverse features. Advancing age may favor RAI use in some cases, but specific age and tumor size cutoffs subject to some uncertainty.[a]
ATA low to intermediate risk T3 N0,Nx M0,Mx	Microscopic ETE, any tumor size	No	Conflicting observational data	Consider[b]—Generally favored based on risk of recurrent disease. Smaller tumors with microscopic ETE may not require RAI.
ATA low to intermediate risk T1-3 N1a M0,Mx	Central compartment neck lymph node metastases	No, except possibly in subgroup of patients ≥45 years of age (NTCTCSG Stage III)	Conflicting observational data	Consider[b]—Generally favored, due to somewhat higher risk of persistent or recurrent disease, especially with increasing number of large (>2–3 cm) or clinically evident lymph nodes or presence of extranodal extension. Advancing age may also favor RAI use.[a] However, there is insufficient data to mandate RAI use in patients with few (<5) microscopic nodal metastases in central compartment in absence of other adverse features.
ATA low to intermediate risk T1-3 N1b M0,Mx	Lateral neck or mediastinal lymph node metastases	No, except possibly in subgroup of patients ≥45 years of age	Conflicting observational data	Consider[b]—Generally favored, due to higher risk of persistent or recurrent disease, especially with increasing number of macroscopic or clinically evident lymph nodes or presence of extranodal extension. Advancing age may also favor RAI use.[a]
ATA high risk T4 Any N Any M	Any size, gross ETE	Yes, observational data	Yes, observational data	Yes
ATA high risk M1 Any T Any N	Distant metastases	Yes, observational data	Yes, observational data	Yes

DIFFERENTIATED THYROID CANCER (DTC)

- Vast majority (> 80%) are indolent in behavior
- Difficult to assess survival benefit
- Very few long term randomized prospective studies
- Short term follow ups may not show any difference

Leads to "Clinical Equipoise":
failure to prove any proposed difference in RAIT approaches for DTC because of paucity in randomized clinical trials

REMNANT THYROID ABLATION

Mazzaferri et al. Long-term impact of initial surgical and medical therapy on papillary and follicular thyroid cancer. Am J Med 1994; 97(5): 418-28.
Ablation of remnant thyroid tissue: if the scans disclosed no uptake of radioiodine outside the thyroid bed and the treating physicians, operative notes, and pathology reports made no mention of residual tumor.
Intended for the eradication of benign remnant thyroid.

30 years of follow-up
Showed statistically significant benefits of Remnant thyroid ablation: for recurrence prevention, cumulative incidence of recurrence: 38% without RAI *vs* 16% with RAI ($p<0.001$)
Improved cancer mortality from 9% without RAI *vs* 3% with RAI ($p = 0.03$).

2015 ATA guidelines fail to acknowledge this positive effect of RAI for remnant ablation on the disease-specific survival rate and recurrence rate.

One limitation: Patients who were treated between 1950 and 1993 had no Tg measurements (not yet routinely available) to assure that complete biochemical response had occurred.

Remnant ablation with Low dose NaI-131
Look at the follow up period : Too short for an indolent disease!!!

Table 1. Selected Characteristics of the 9 Randomized Trials and the Methods of TSH Stimulation

First Author, Year (Ref.)	Country	Patients Enrolled (n)	TNM	Pathology (P/F)	Type of Surgery	Dose (MBq)	Follow-up Time (mo)	Definition of Successful Ablation	Method of TSH Stimulation[a]
Bal, 1996 (13)	India	149	TxNxMo	87/62	NTT and STT	1100 vs 1850	6–12	No uptake on neck and WBS scan	Withdrawal
Bal, 2004 (14)	India	509	TxNxMo	410/99	NTT and STT/HT	1100 vs 1850	6	No uptake on WBS and Tg ≤10 ng/ml	Withdrawal
Zaman, 2006 (15)	Pakistan	40	TxNxMo	23/17	TT and NTT	1850 vs 3700	6	No uptake on WBS and Tg <2.0 ng/ml	Not mentioned
Pilli, 2007 (16)	Italy	72	T1-3NxMo	66/6	NTT	1850 vs 3700	6–8	No uptake on WBS and Tg <1.0 ng/ml	rhTSH
Mäenpää, 2008 (17)	Finland	160	TxNxMo	146/11[b]	TT and NTT	1100 vs 3700	4–8	No uptake on WBS and Tg ≤1.0 ng/ml	Withdrawal and rhTSH
Fallahi, 2012 (18)	Iran	341	TxNxMo	326/15	TT and NTT	1100 vs 3700	12	No uptake on WBS and Tg <2.0 ng/ml with anti-Tg-off <100 IU/ml	Withdrawal
Caglar, 2012 (19)	Turkey	108	T1-2NxMo	101/4[b]	TT	800 vs 3700	6–12	Neck uptake <0.2%, Tg <2.0 ng/ml and neck ultrasound (-)	Withdrawal
Mallick, 2012 (20)	United Kingdom	438	T1-3NxMo	NC	TT and NTT	1100 vs 3700	6–9	Neck uptake <0.1% and Tg ≤2.0 ng/ml	Withdrawal and rhTSH
Schlumberger, 2012 (21)	France	752	T1-2NxMo	693/59	TT	1100 vs 3700	6–10	Neck ultrasound (-) and Tg ≤1.0 ng/mlF	Withdrawal and rhTSH

Abbreviations: P/F, papillary/follicular; TT, total thyroidectomy, NTT, near total thyroidectomy; STT, subtotal thyroidectomy; HT, hemithyroidectomy; NC, not clear; Tg, thyroglobulin.

[a] Withdrawl, withdrawn from L-T_4 for at least 4 wk; rhTSH, administered rhTSH on 2 consecutive days before ablation.

[b] Three patients with both papillary and follicular.

[c] In cases of detectable antithyroglobulin antibody, if the control ^{131}I total-body scan was normal, ablation was also considered complete.

MARTINIQUE PRINCIPLES

- Best thyroid cancer management requires cooperation between endocrinologists, surgeons & nuclear medicine physicians
- Goal of RAI therapy should be specifically defined as (a) destroying remaining normal thyroid tissue, (b) treatment of suspected microscopic cancer remaining after surgery or (c) treatment of known visible cancer
- Proper patient selection for radioactive iodine therapy requires assessment of postoperative cancer status and not simply preoperative staging
- Evaluation of postoperative cancer status should be standardized in terms of blood tests and imaging tests
- Proper patient selection for radioactive iodine therapy also requires evaluation of multiple factors, including patient preference, potential side effects, and availability and quality of medical resources
- The best administered radioactive iodine therapy cannot be determined from the available literature, favoring more individualized dosing decisions
- Identification of cancers that are unlikely to respond to radioactive iodine therapy should not to exclude them from consideration of radioactive iodine therapy

MARTINIQUE PRINCIPLES (CONT'D)

- Criteria used to identify cancers that are unlikely to respond to radioactive iodine therapy will continue to evolve, especially with progress in evidence-based studies and better imaging
- Prospective studies are needed to address knowledge and evidence gaps with regard to radioactive iodine therapy

Implications:

Defining the best use of radioactive iodine therapy in thyroid cancer

- remains controversial
- is subject to interpretation of evidence
- is influenced by many patient and health care delivery variables

Collaboration between endocrinologists, surgeons & NM physicians will help refine the use of RAI therapy in the patient-centered care of thyroid cancer.

Tuttle et al. Controversies, Consensus, and Collaboration in the Use of 131I Therapy in Differentiated Thyroid Cancer: A Joint statement from ATA, EANM, SNMMI, ETA) Thyroid 2019; 29(4): 461-70. PMID: 30900516 http://dx.doi.org/10.1089/thy.2018.0597

THE EMORY WAY

- Formal Nuclear Medicine Consult: ~2 weeks before treatment
  - In-person vs Telemedicine (due to Covid)
  - With the patient and family
  - Assess home situation & support
  - Explain radiation hazards & necessary precautions
  - Cognition & compliance for precautions
  - Explain rationale for treatment, expected benefits, side-effects, alternatives, etc
  - Get consent signed
  - Determine dose (assess risk based on histopathology, mutation, staging, patient age, prior Rx, etc)

- Schedule of events for RAI Rx:
  - Low Iodine Diet for 7-14 days prior to pre-Rx scan
  - Thyrogen stimulation (95%) vs Thyroid hormone withdrawal (with TSH assessments)
  - Labs (TSH for THW; stimulated Tg, Day 3 & 5 in relation to Thyrogen)
  - I-123 Whole body scan (I-131 scan if dosimetry needed)
  - Na I-131 therapy (95% out patient)
  - Continue low iodine diet for 3 days, one day after start sucking candies for a week
  - 7 day post therapy scan

- Follow-up:
  - Telephone follow-up: 6 weeks, 6 months
  - Endocrine follow-up with labs & US as needed

PATIENT QUESTIONNAIRE

Patient Information:

1.	Are you breast-feeding?	N/A Y	N
2.	If yes, patient received written instructions on discontinuing breast-feeding.	Y	N
3.	Are you pregnant? Due date/LMP:_____	N/A Y	N
4.	Are you able to care for yourself?	Y	N*
5.	Are you prone to stomach upset or nausea?	Y†	N
6.	Do you plan to, or is it possible for you to drive home alone after you are released? How long does it take to drive home? _____ hours	Y	N
7.	Do you live alone? (If yes, skip to question 14.)	Y	N
8.	Do you live in a nursing home or other communal living facility?	Y*	N
9.	Are there children living with you? (If no, skip to question 11.) Children's ages	Y	N
10.	Is there someone at your home who can care for the children for up to 7 days after therapy, or can they stay with another caregiver?	Y	N
11.	Do you live with a pregnant woman?	Y	N
12.	Do you sleep alone or can you sleep alone for up to 7 days after therapy?	Y	N
13.	Can you have sole use of a bathroom for up to 7 days after therapy?	Y	N
14.	Can you avoid traveling by plane, bus, or train for up to 7 days after therapy?	Y	N
15.	Will you be able to limit visits by family and friends for up to 7 days after therapy?	Y	N
16.	Can you stop working or volunteering outside the home for up to 7 days after therapy?	Y	N
17.	Do you require any type of special equipment for your health needs?	Y	N
18.	Are you able to swallow a pill?	Y	N#
19.	Do you have complete bowel and bladder control?	Y	N$
20.	Has the neck wound completely healed?	Y	N%

_____ _____

Patient Signature Date

M.D.

OUT-PATIENT *vs* IN-PATIENT

NaI-131 Therapy Occupancy Factor Calculation

- ☐ Questions 4, 7, 14, 15, and 16 on the Patient Information form are YES
  → Occupancy factor of 0.125 is used for the period 8 hours to total decay (E_2)
- ☐ Questions 10, 14, 15 and 16 on the Patient Information form are YES
  → Occupancy factor of 0.25 is used for the period 8 hours to total decay (E_2)
- ☐ Question 11 on the Patient Information form is YES
  → Occupancy factor of 0.75 is used for the period 8 hours to total decay (E_2)
- ☐ Questions 4, 10, 12, 13, 14, 15, or 16 on the Patient Information form are NO
  → Occupancy factor of 0.75 is used for the period 8 hours to total decay (E_2)

Patient Release Criteria*

Use table if thyroid uptake fraction is < 5% for thyroid cancer or < 80% for hyperthyroidism. Otherwise, contact the Radiation Safety Officer.

	Hyperthyroidism		Thyroid Cancer	
Occupancy Factor	Immediate	Inpatient Therapy	Immediate	Inpatient Therapy
0.125	**101 mCi**	**27.4 mrem/hr**	**303 mCi**	**172.8 mrem/hr**
0.25	**56.5 mCi**	**13.7 mrem/hr**	**220 mCi**	**86.4 mrem/hr**
0.75	**20.4 mCi**	**4.6 mrem/hr**	**105 mCi**	**28.8 mrem/hr**
Effective Half-life extrathyroid, T_1	0.32 days		0.32 days	
Effective Half-Life thyroid, T_2	5.2 days		7.3 days	
Uptake fraction extrathyroid, F_1	0.2		0.95	
Uptake fraction, thyroid, F_2	0.8		0.05	

Release Instructions
(to be completed by Authorized User)

Prescribed Dose:_____mCi of NaI-131

- ☐ The prescribed dose is less than the activity listed above for the patient's occupancy factor. The patient may be released following treatment as long as the patient is not suffering any ill effects.
- ☐ The patient must be admitted for therapy. The patient may be released after an overnight stay if the patient's dose rate at one meter is less than that listed above for the occupancy factor.
- ☐ The patient must be admitted for therapy. The patient may not be released until the patient's dose rate is less than 5 mR/hr at one meter.

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DOSING GUIDELINES

In general:
Remnant Thyroid Ablation: 75 - 100 mCi*
Positive lymph nodes: 125 - 150 mCi*
Metastases to lungs, bones: 175 - 200 mCi
Recurrent disease: consider >200 mCi with dosimetry

*: Consider risk stratification based on histopathology

- More aggressive histologic sub-types: poorly differentiated, tall cell, Hurthle cell, hobnail, insular, columnar and diffuse sclerosing variants
- Vascular Invasion
- Extrathyroidal extension
- No. & size of nodal involvement
- Mutational status (BRAF via ThyroSeq… done on FNA at Emory)

Consider steroids for uptake >5% on pre-Rx I-123 scan

If uptake on diagnostic scan is >10%, consider 30 mCi ablation first and reschedule full therapy 3-6 months later or consider surgical consult for reoperation.

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Precautions for patients receiving NaI-131 thyroid cancer

General Recommendations (see chart).

Take care to not contaminate others with urine, saliva or sweat.
Do not become pregnant for at least 12 months. Discontinue breastfeeding your current child.
Maintain low iodine diet for 3 days after therapy.
Drink extra fluids and use the bathroom frequently, especially for the first 48 hours.
Sucking on hard candies may help prevent sore throat and injury to your salivary glands. However, it is recommended to wait 24 hours after therapy to begin sucking candies.
Gentle brushing of the entire mouth with a soft toothbrush 6 times a day.
Do not share food, dishes or glasses. Use dishwasher or wash your dishes separately.
Wear disposable gloves if preparing food for other people. May dispose of gloves in garbage.
Flush the toilet several times after use. Use a separate toilet, or clean the toilet thoroughly after each use if you have to share a toilet.
Wash your hands frequently and shower every day.
Wash your laundry separately, and use an extra rinse cycle.
Avoid open mouth kissing and sex.

Circle One Column:

Prescribed Dose	≤ 50 mCi	50 - 124 mCi	125-174 mCi	175 + mCi
1. The number of days that you need to sleep alone in a bed that is >6 feet away from another person. If possible, use a separate room.	1	3	5	7
2. The number of days that you need to sleep in a separate bed away from pregnant partners, infants, or children.	7	7	7	7
3. The number of days you need to stay home from work (if working with adults)	1	3	5	7
4. The number of days that you need to stay >3 feet away from adults.	1	3	5	7
5. The number of days that you need to stay >6 feet away from babies, children younger than 18 years old and pregnant women.	7	7	7	7
6. The number of days that you need to avoid close contact with others in public places (movies, shopping, etc).	1	3	5	7
7. The number of days that you need to stay away from school or day-care (includes both teachers and students).	7	7	7	7
8. The number of days that you need to follow General Recommendations.	3	5	7	7

*Note these are standard recommendations based on an average patient, but may be modified by information from your post-ablation scan.

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SPECIAL SITUATIONS

- Poor renal function: decrease the dose by 50%
- ESRD: One dose of Thyrogen is enough
- Dialysis: dialysis just before Rx & skip 1 dialysis; decrease dose by 50%
- Patients who cannot swallow tabs: consider liquid form (**DO NOT** break open capsule)
- Patients who cannot swallow: consider gastric tube with liquid form; ensure tube is past stomach into duodenum
- Patients prone for upset stomach: consider antiemetic (Ondansetron 4mg PO TID PRN nausea; unless contraindicated for prolonged QT, apomorphine)
- Pregnancy: Female patients < 50 yrs old must have negative serum pregnancy within 72 hrs of Rx (unless hysterectomy/tubal ligation); don't get pregnant for at least 6 months, preferably for 1 year.
- Breast feeding/Lactation: Lactating breast can get a high dose of radiation from NaI-131. So, stop lactation for at least 4 weeks prior or use lactation suppressants. Stop breast feeding for good after the treatment for that baby. Futures babies can be safely breast fed

DOSIMETRY

- We want to give maximum radioactive iodine dose, but want to spare the bone marrow (not to give more than 3 Gy to bone marrow, esp in presence of bone mets) and lungs (not to give more than 30Gy to lungs, esp in presence of lung mets).
- AT EUH, we have used a criteria of <70 cGy to whole body
- I-131 Scan with THW, serial scans up to 48 or 72 hrs (at least 2 data points, preferably 3)
- THW preferred over Thyrogen as Thyrogen has short-half life and is pulsatile (after 48 hrs, TSH levels come down)
- I-123 not good as short half-life (13.2 hrs)
- I-124 PET can be used if available (half-life: ~4 days)

SIDE EFFECTS

- Siladenitis and dry mouth <5%, rarely severe (only one case needed dental extraction – but had Sjogreens disease to start with)
- Epiphora: <2%
- Vision issues: rare (1 patient)
- Chances higher with higher dose (>150 mCi)
- Second malignancy- very, very rare (mostly stochastic)

IODINE-RESISTANT OR NON-AVID METASTASES

- How often we see them?
  - depends on your practice – referral center like Emory we see ~10% of all our cases
- Is it multiple or single: Often multiple, rarely single
  - Single - External beam , RF ablation
  - Multiple TKI, MKI etc
- Location:
  - Spine , brain – need to act fast – External beam therapy or surgery
- What is the life expectancy of the patient
  - Too old or too young – don’t rush to TKI

WHAT NEXT AFTER I-131

Alpha therapy:

- α-particles with higher LET and shorter penetration range in comparison to β-particles, have distinct advantages for use in targeted therapy
- Ac-225 is promising in Lu-177 resistant/relapsed setting (NETs, PCa)

Alpha emitting iodine surrogate???

6 Halogens: fluorine, chlorine, bromine, iodine, astatine, & tennessine (2010)
Astatine: 3 isotopes, all are alpha emitters with 6-8 hours half-life. At-211
Astatide ion accumulates in thyroid & stomach, with uptake in macrophage-bearing organs (spleen, lung) higher than that of iodide.
^{211}At astatide ion may be suitable for the treatment cancers with upregulated sodium iodide symporter (NIS).
Animal experiments: biodistribution of ^{211}At in mice bearing anaplastic or follicular undifferentiated thyroid carcinomas showed tumor accumulation of 11-28% of injected dose

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