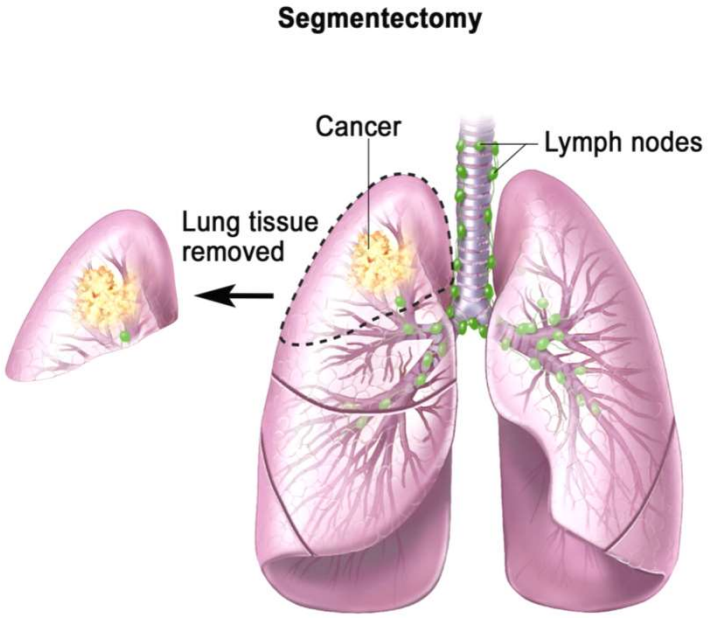
Lung 2023 Part 1

NAACCR 2023-2024 Monthly Webinar Series



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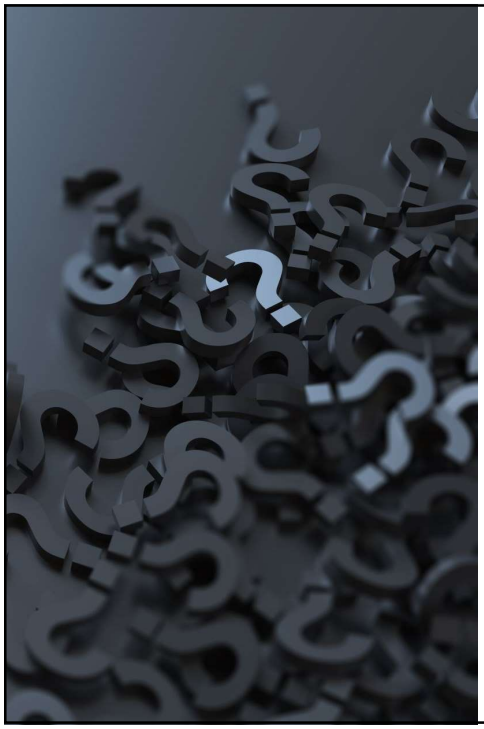

Q&A

Please submit all questions concerning the webinar content through the Q&A panel.

If you have participants watching this webinar at your site, please collect their names and emails.

We will be distributing a Q&A document in about one week. This document will fully answer questions asked during the webinar and will contain any corrections that we may discover after the webinar.

2

2

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Fabulous Prizes

3

3

Guest Presenter

- Wilson Apollo, CTR
- Gillian Howell, PhD, CTR

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4

4

Agenda

- Diagnostic Staging Procedures
- Surgery of Primary Site
- Scope of Regional Lymph Node Surgery
- System Therapy
- Genetics
- Radiation

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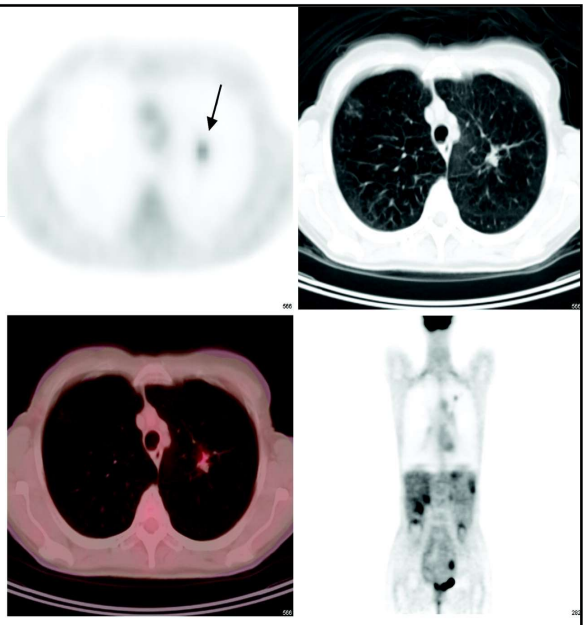
5

Imaging

- Low-Dose Computed Tomography (LDCT) scan
  - Screening tool
- Chest X-Ray
- CT Scans
- PET and PET/CT
- MRI



https://jnm.snmjournals.org/content/48/2/214

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6

Lung-RADS® v2022

- Lung-RADS® is a quality assurance tool designed to standardize lung **cancer screening CT** reporting and management recommendations, reduce confusion in lung cancer screening CT interpretations, and facilitate outcome monitoring.

Lung-RADS® Category Descriptor

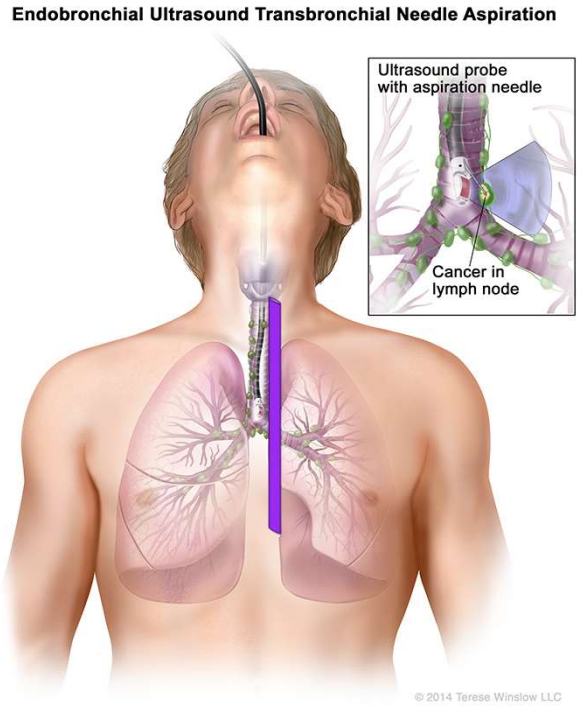
- 0-Incomplete
- 1-Negative (no lung nodules)
- 2-Benign
- 3-Probably benign
- 4A-Suspicous
- 4B-Very Suspicious
- 4X
- S-Significant or Potentially Significant

American College of Radiology Committee on Lung-RADS®. Lung-RADS Assessment Categories 2022. Available at https://www.acr.org/-/media/ACR/Files/RADS/Lung-RADS/Lung-RADS-2022.pdf.

7

Procedures

- Endoscopic ultrasound (EUS)
  - Gastrointestinal
- Endobronchial ultrasound (EBUS)
  - Bronchoscopy
  - Navigational bronchoscopy
  - Robotic bronchoscopy
- Mediastinoscopy
- Percutaneous biopsy
- Pleuracentesis



8

Pop Quiz 1

Remember:
- Biopsy of lung tissue or distant lymph node or site of distant mets is coded as a Dx Staging Procedure.
- Biopsy of a regional lymph node is coded in scope of regional lymph nodes

Indicate what data item should be used to code the following? Each biopsy is positive for squamous cell carcinoma from lung primary.

A 1. Navigational bronchoscopy with biopsy of mass in the right peripheral lobe of the left lung.
C 2. EBUS of hilar lymph node
C 3. Mediastinoscopy with biopsy of station 2R lymph node
D 4. Excisional biopsy of level 3 cervical lymph node

A. Surgical Diagnostic and Staging Procedure
B. Surg Primary Site 2023
C. Scope of Regional Lymph Node Surgery
D. Surgical Procedure/Other Site

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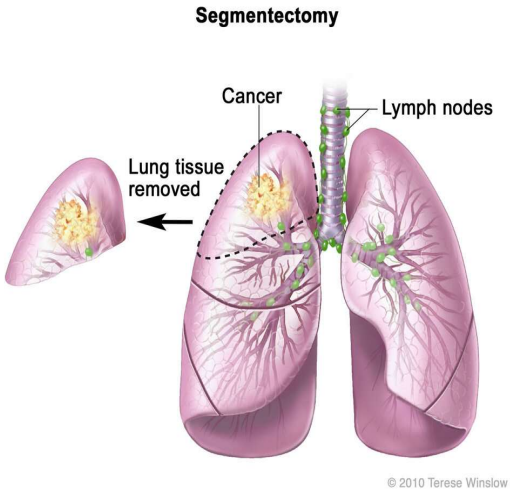
9

Sublobar Resection (less than a full lobe)

- A200 Excision or resection of less than one lobe, NOS
  - A230 Excision, NOS
  - A240 Laser excision
  - A250 Bronchial sleeve resection ONLY
  - A210 Wedge resection
  - A220 Segmental resection, including lingulectomy



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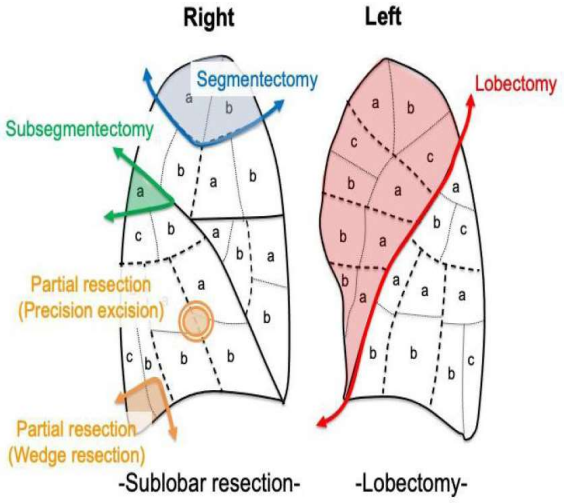
10

Sublobar Resection:
Wedge Resection and Segmentectomy

Right
- Upper lobe
  - apical segment
  - posterior segment
  - anterior segment
- Middle lobe
  - lateral segment
  - medial segment
- Lower lobe
  - superior segment
  - medial-basal segment
  - anterior-basal segment
  - lateral-basal segment
  - posterior-basal segment

Left
- Upper lobe
  - segment
  - Inferior lapicoposterior segment
  - anterior ingula
  - Superior lingula
- Lower lobe
  - Lateral
  - Anteromedial
  - Superior
  - posterior

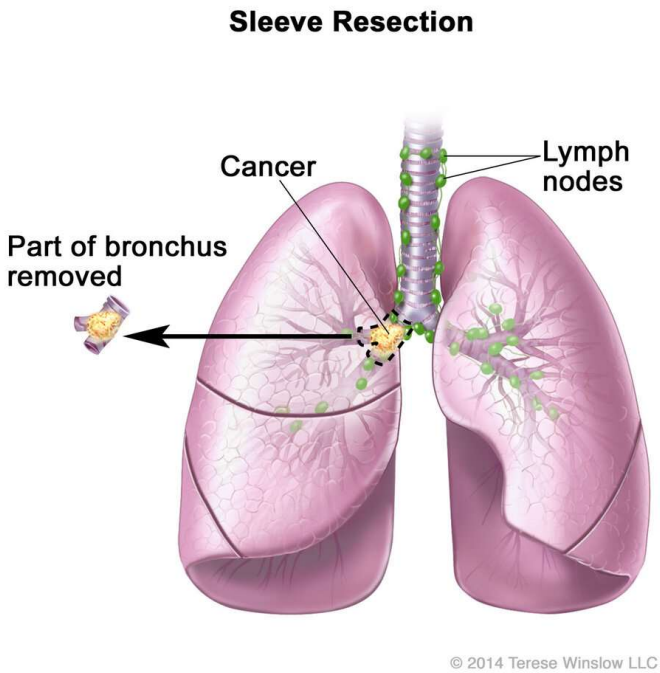


Kato H, Oizumi H, Suzuki J, Suzuki K, Takamori S. Indications and technical details of sublobar resections for small-sized lung cancers based on tumor characteristics. *Mini-invasive Surg* 2021;5:5. http://dx.doi.org/10.20517/2574-1225.2020.98

11

Sleeve Resection

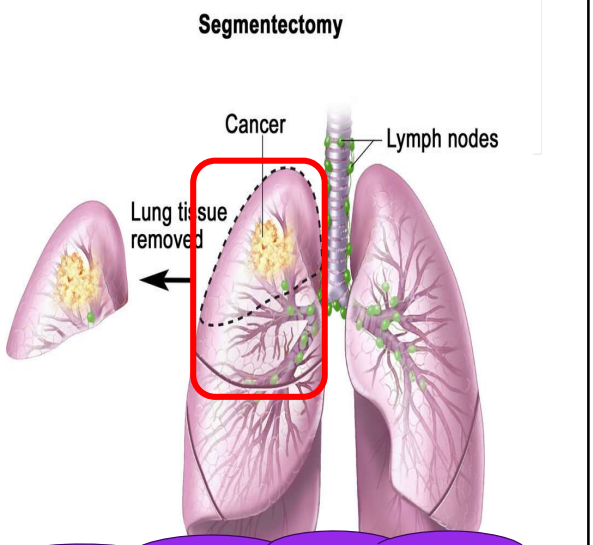
- Circumferential excision of a part of the bronchus and/or pulmonary vessels during lung parenchyma resection while preserving the uninvolved portions of the lung



12

Lobectomy

- A300-Resection of [at least one] lobe or bi-lobectomy, but less than the whole lung (partial pneumonectomy, NOS)
- A330-Lobectomy WITH mediastinal lymph node dissection
  - The lymph node dissection should also be coded under Scope of Regional Lymph Node Surgery (NAACCR #1292).
  - [SEER Note: Assign code A300 when lymph node dissection is not performed, but lymph nodes are obtained as part of the lobectomy specimen.]



VATS-Video Assisted Thoracic Surgery
Robotic Thoracic Surgery
Do not change surgery code!

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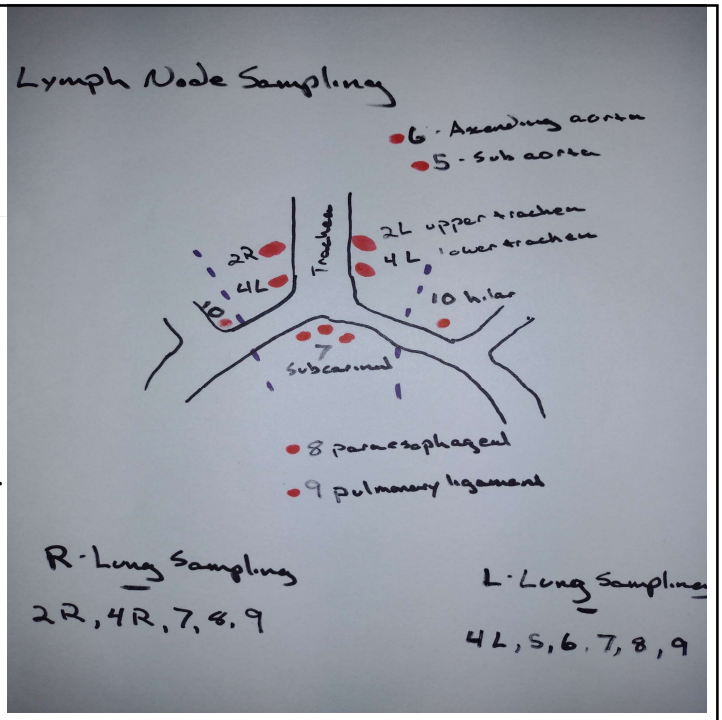
13

Mediastinal Lymph Node Sampling/ Mediastinal Dissection

- Sampling
  - An option (instead of mediastinal LN dissection) for patients with early stage cN0 cN1 disease
  - A minimum of 3 mediastinal lymph node stations should be sampled.
  - Stations sampled may vary due to location and histology of the primary tumor.
- Dissection
  - An option for cN0, cN1, or sometimes cN2 disease
  - Removal of all accessible mediastinal nodes
  - Stations dissected may vary due to location and histology of the primary tumor



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14

Pop Quiz 2

B 1. Lingula-Sparing LUL Lobectomy & Mediastinal Lymph Node Dissection

C 2. RT VATS middle lobectomy and lymph node dissection

B 3. Removal of the apical and posterior segments of the right upper lobe lung.

A. A210 Wedge resection
B. A220 Segmental resection, including lingulectomy
C. A300 Resection of [at least one] lobe or bi-lobectomy, but less than the whole lung (partial pneumonectomy, NOS)
D. A330 Lobectomy WITH mediastinal lymph node dissection

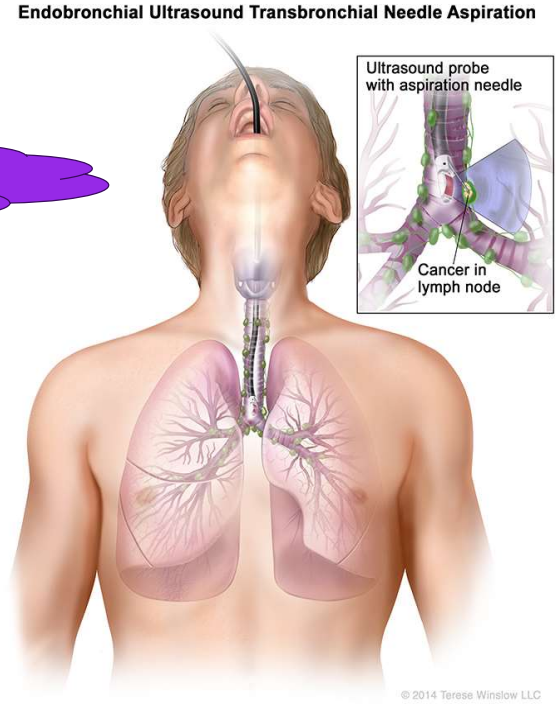
15

Scope of Regional Lymph Nodes

1-Less than a full node
3-Minimum of 1 entire node excised

- 0-No regional lymph nodes removed or aspirated; diagnosed at autopsy.
- 1-Biopsy or aspiration of regional lymph node, NOS
- 2-Sentinel lymph node biopsy [only]
- 3-Number of regional lymph nodes removed unknown, not stated; regional lymph nodes removed, NOS
- 4- *1 to 3* regional lymph nodes removed
- 5- *4* or more regional lymph nodes removed

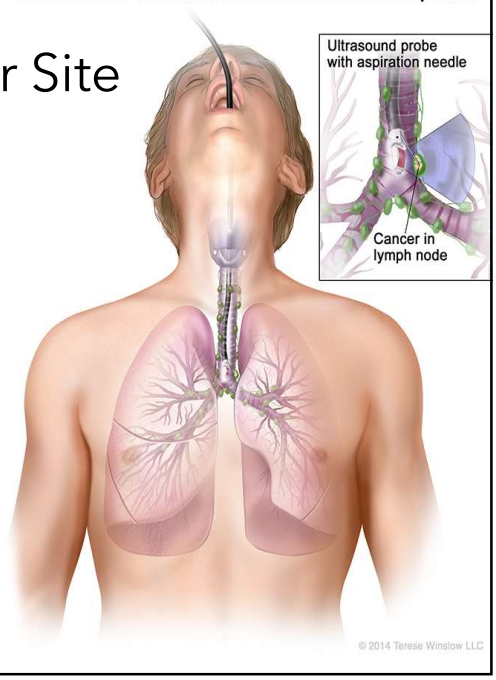
SEER Program Coding and Staging Manual 2023



16

Surgical Procedure of Other Site

- 0 None; diagnosed at autopsy
- 1 Non-primary surgical procedure performed
- 2 Non-primary surgical procedure to other regional sites
- 3 Non-primary surgical procedure to distant lymph node(s)
- 4 Non-primary surgical procedure to distant site
- 5 Combination of codes 2, 3, or 4
- 9 Unknown



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17

Pop Quiz 3

F 1. Lung cancer patient had a core biopsy of an enlarged level 3 cervical lymph node that was negative for malignancy

A 2. Lung cancer patient had a core biopsy of an enlarged level 3 cervical lymph node that was positive for malignancy

D 3. Lung cancer patient had an excisional biopsy of an enlarged level 3 cervical lymph node that was negative for malignancy

E 4. Patient had single metastatic liver lesion excised. Most likely from lung primary.

A. 01- Bx of metastatic site
   - *Diagnostic Staging Procedure*

B. 02- Bx of primary site
   - *Diagnostic Staging Procedure*

C. 3 Biopsy or aspiration of regional lymph node, NOS
   - *Scope of Regional Lymph Node Surgery*

D. 03 Non-primary surgical procedure to distant lymph node(s)
   - *Surgical Procedure Other*

E. 04 Non-primary surgical procedure to distant site
   - Surgical Procedure Other

F. Do not code

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18

Systemic Therapy

- Cisplatin plus pemetrexed
  - Non-squamous, non-small cell carcinoma
- Cisplatin plus either gemcitabine or docetaxel
  - Squamous cell, non-small cell carcinoma
- Atezolizumab, pembrolizumab, or osimertinib for eligible patients with the appropriate biomarkers,

19

Biomarkers

Gillian Howell, PhD, CTR

20

GENETIC TESTING IN LUNG CANCER

Gillian Howell PhD, CTR,

Tumor Registry, NE Methodist Hospital, Omaha NE

CANCER: ORGAN SPECIFIC DISEASE TO GENETIC DISEASE

- PRIOR TO THE DEVELOPMENT OF FIELD OF GENETICS, CANCER CONSIDERED AN ORGAN SPECIFIC DISEASE
- WE CHARACTERIZE OF TUMOR BY SIZE, GRADE AND INVASIVENESS, LNS, REGIONAL SPREAD OR DISTANT METSTASIS- STAGING
- IN STAGING TRY TO GROUP CANCER CHARACTERISTICS INTO GROUPS WITH SIMILAR PROGNOSIS
- DOES NOT INFORM ABOUT THE INTRINSIC “AGGRESSIVENESS” CHARACTERISTICS OF THE TUMOR
- MOLECULAR STUDIES INFORM “PERSONALIZED” TREATMENTS

MAJOR GENE PROCESSES IN CANCER

- ONCOGENES
- PROMOTE TUMORIGENESIS
- PROLIFERATION
- INVASION
- INHIBIT APOPTOSIS
- ALLOW DNA INSTABILITY

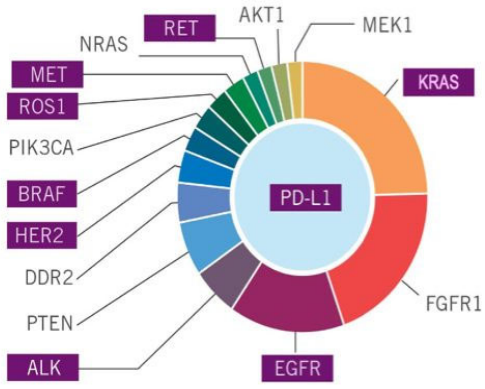
- TUMOR SUPPRESSORS
- INHIBIT TUMORIGENESIS
- INHIBIT PROLIFERATION
- INHIBIT INVASION
- PROMOTE APOPTOSIS
- PROMOTE DNA STABILITY

- GENETICS CODED IN SSDI'S
- HOWEVER, WHAT ARE WE CODING AND WHY IS IT IMPORTANT?
- COLLECT DATA FOR RESEARCHERS TO ID LINKS BETWEEN SPECIFIC GENE MUTATIONS
- IDENTIFY VIABLE GENETIC TARGETS – SPECIFIC MUTATIONS IN SPECIFIC CANCERS
- HOW NEW THERAPIES PERFORMING IN THE PRESENCE OF THESE MUTATIONS
- INFORM TREATMENT GUIDELINES
- LUNG CANCER WAS AMONG FIRST CANCERS WHERE TARGETED THERAPIES
- WERE TESTED

LUNG CASE SCENARIO

- **Pertinent Negative Results:**
- **AKT1, ALK, BRAF, CHEK1, DDR2, EGFR, ERBB2, FGFR1, MAP2K1M, MET, NRAS, NTRK1, PIK3CA, POLE, ROS1, STK11, TERT.**
- **KEYTRUDA PD-L1 Immunohistochemical Analysis (NSCLC):**
- **Tumor Proportion Score <1%/Negative**

LUNG BIOMARKER TESTING PER NCCN GUIDELINES

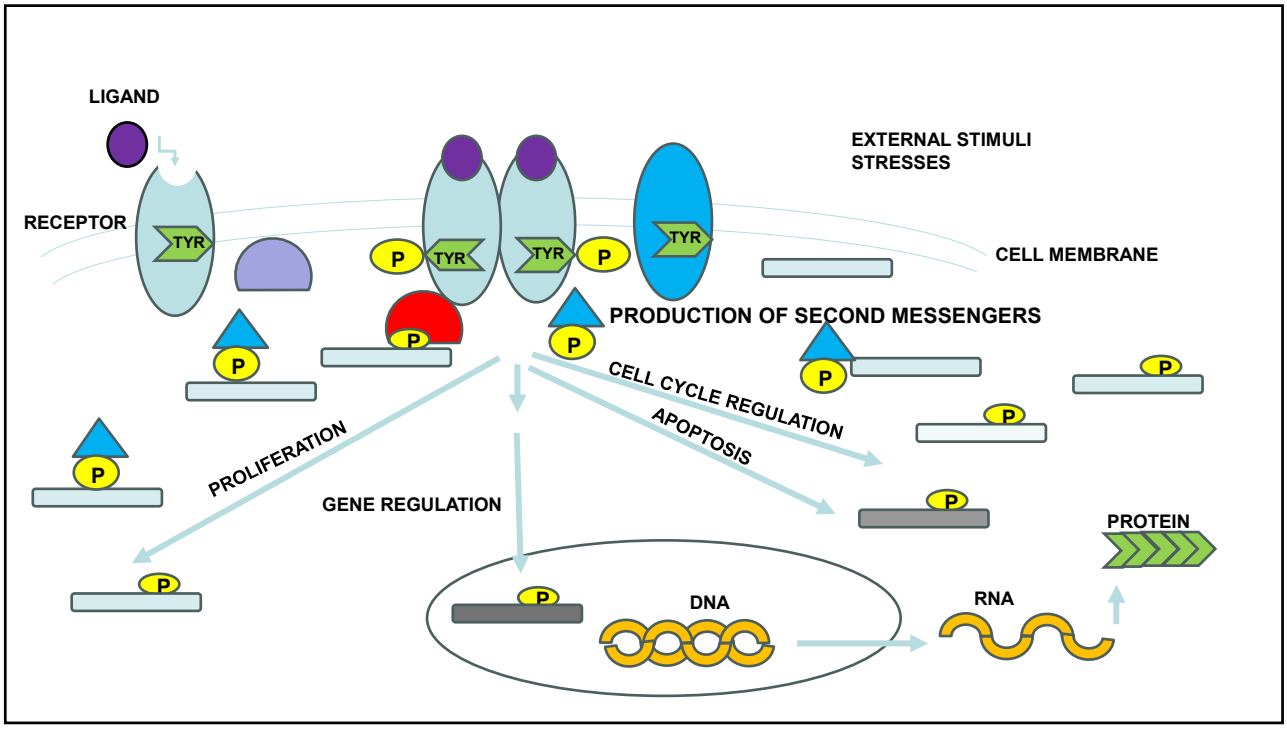


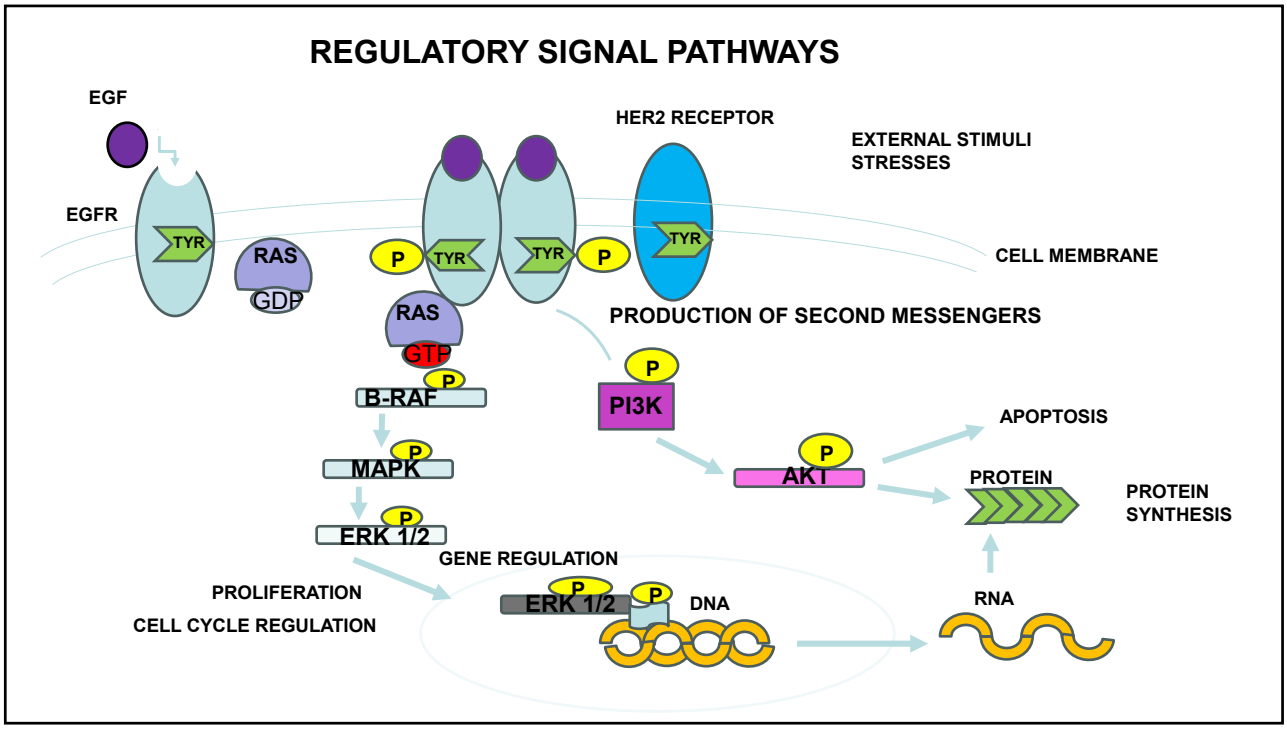
AKT1=AKR mouse thymoma kinase; ALK=anaplastic lymphoma kinase; BRAF=v-raf murine sarcoma viral oncogene homolog B1; DDR2=discoidin domain receptor 2; EGFR=epidermal growth factor receptor; FGFR1=fibroblast growth factor receptor 1; HER2=human epidermal growth factor receptor 2; KRAS=Kirsten rat sarcoma 2 viral oncogene homolog; MEK1=mitogen-activated protein kinase kinase 1; MET=met proto-oncogene; NRAS=neuroblastoma rat; PIK3CA=phosphatidylinositol-4,5-bisphosphate 3-kinase, catalytic subunit alpha; PD-L1=programmed death-ligand 1; PTEN=phosphatase and tensin homolog; RET=rearranged during transfection; ROS1=ROS proto-oncogene 1.

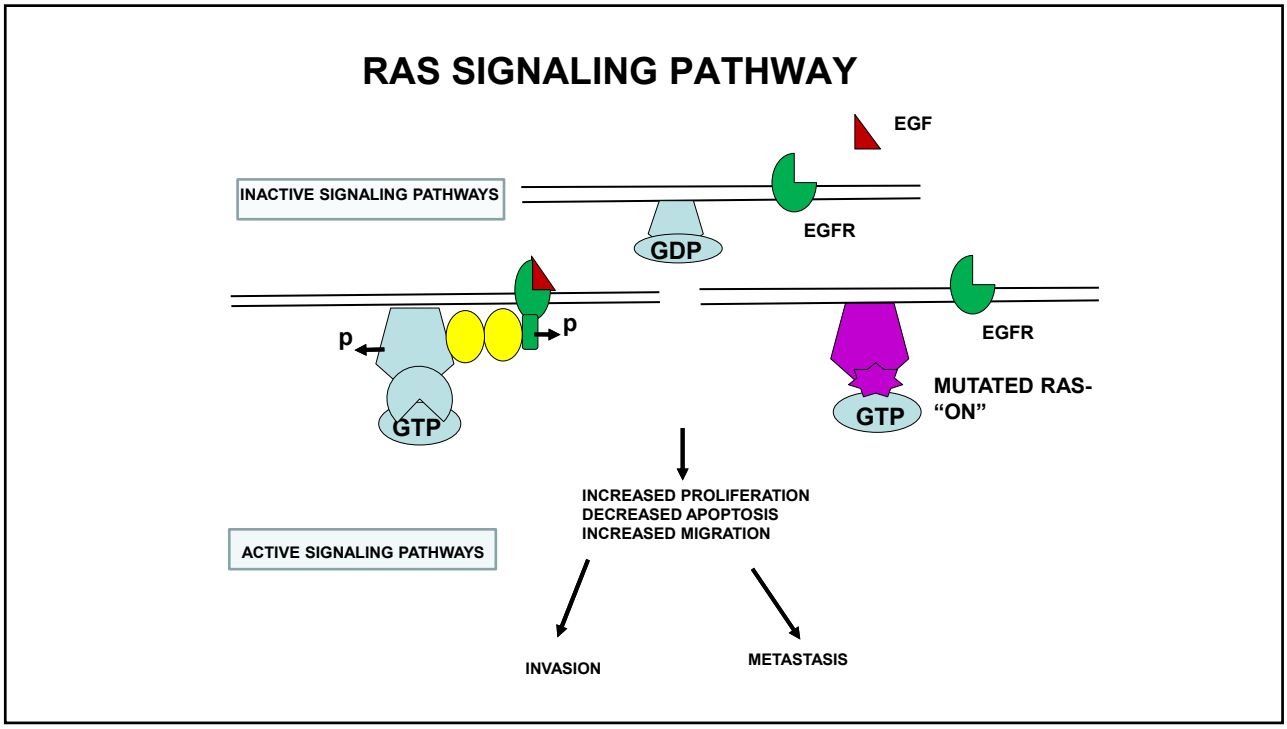
GENENTECH WEBSITE

SIGNAL TRANSDUCTION PATHWAYS

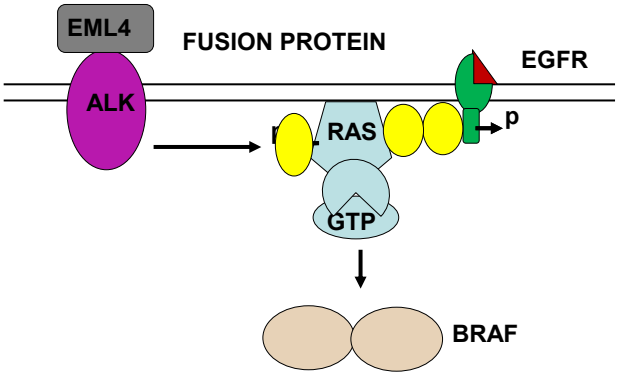
CHECKPOINT INHIBITOR PATHWAYS




REGULATORY SIGNAL PATHWAYS
EGF
EGFR
TYR
RAS
GDP
HER2 RECEPTOR
EXTERNAL STIMULI
STRESSES
CELL MEMBRANE
P
TYR
RAS
GTP
B-RAF
MAPK
ERK 1/2
PRODUCTION OF SECOND MESSENGERS
PI3K
AKT
APOPTOSIS
PROTEIN
PROTEIN
SYNTHESIS
GENE REGULATION
PROLIFERATION
CELL CYCLE REGULATION
DNA
RNA

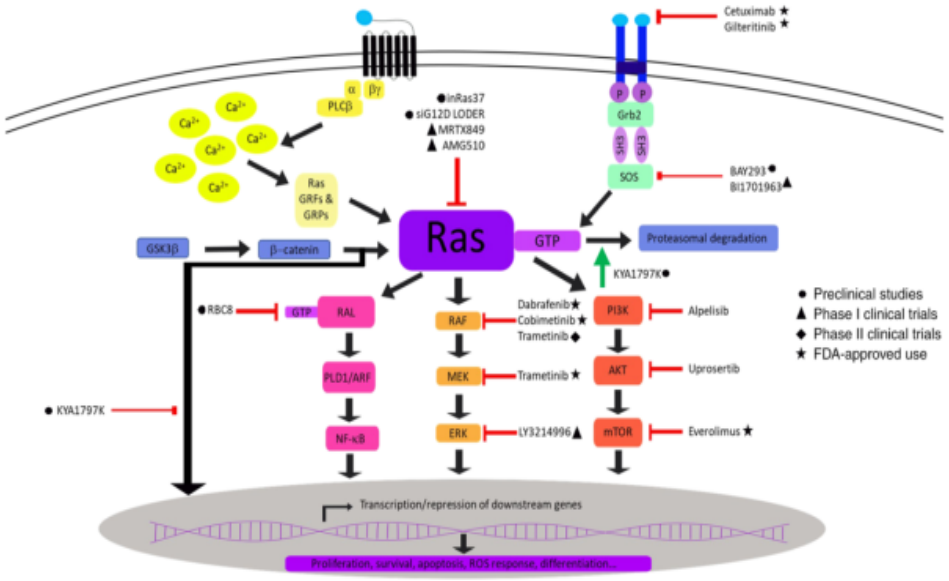

RAS SIGNALING PATHWAY
EGF
INACTIVE SIGNALING PATHWAYS
EGFR
GDP
p
p
GTP
EGFR
MUTATED RAS-
"ON"
GTP
INCREASED PROLIFERATION
DECREASED APOPTOSIS
INCREASED MIGRATION
ACTIVE SIGNALING PATHWAYS
INVASION
METASTASIS

ANAPLASTIC LYMPHOMA KINASE (ALK) GENE



- ALK POSITIVITY FOUND 4% LUNG CANCERS, MOSTLY ADENOCARCINOMA
- ASSOCIATED
  - YOUNGER AGE
  - NON SMOKING HX
- TREATMENT OPTIONS:
  - CRIZOTINIB
  - CERTINIB
  - ALECTINIB
  - BRIGATINIB
  - LORATINIB
- CHEMO- PEMETREXED

3 RAS-MEDIATED PATHWAYS AND ASSOCIATED INHIBITORS.



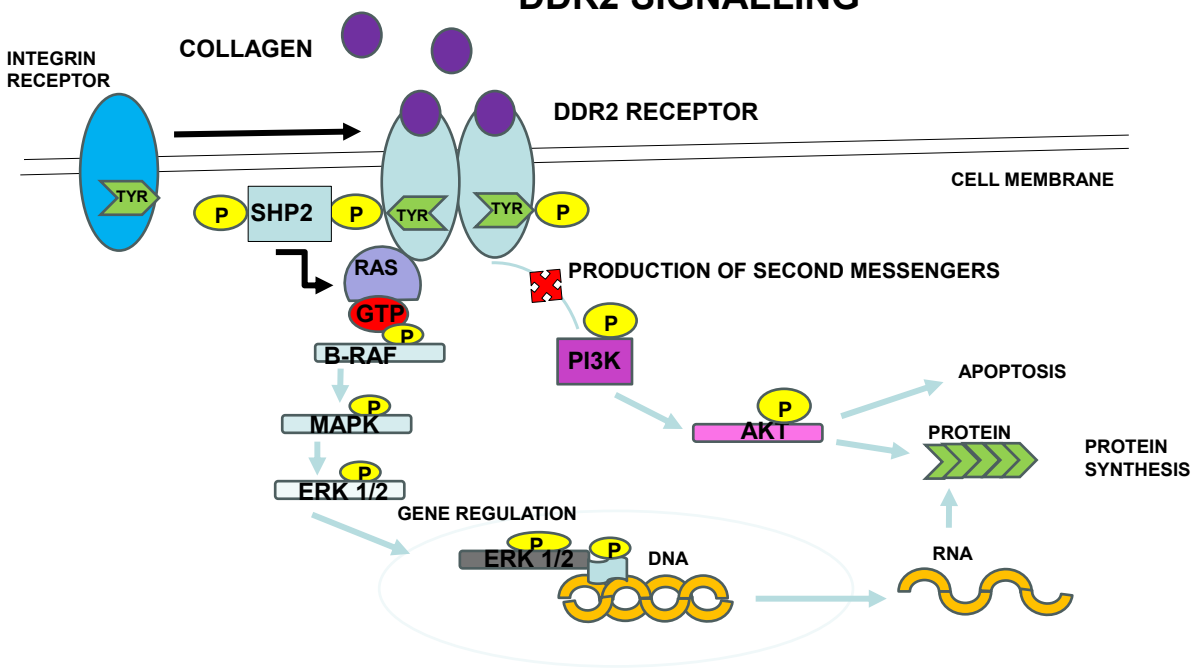
TARGETS OF SMALL MOLECULE INHIBITORS AND MONOCLONAL ANTIBODIES USED ACROSS A RANGE OF CANCERS TO INHIBIT PROLIFERATIVE SIGNALLING AND SURVIVAL OF CANCER CELLS.

FROM: Healy, Fiona M, Ian A Prior, and David J MacEwan. 2022. "The Importance of Ras in Drug Resistance in Cancer." *British Journal of Pharmacology* 179 (12): 2844–67. doi:10.1111/bph.15420

RAS PATHWAY

- RAS MUTATION OCCURS 19% OF ALL CANCERS
- CONTRIBUTES TO DRUG RESISTANCE
- DIFFICULT TO TARGET THE RAS PATHWAY
- LACK OF OF BINDING SITES FOR SMALL MOLECULE INHIBITORS AND ANTIBODIES DIFFICULTY CROSSING THE CELL MEMBRANE
- TARGET DOWNSTREAM MEK I TRAMETINIB- LUNG W/ BRAF V600E- BUT STLL ACTIVATION OF OTHER PATHWAYS eg AKT, PI3K
- <u>BUT</u> NEW PAN RAS ACTIVATION INHIBITORS IN CLINICAL DEVELOPMENT

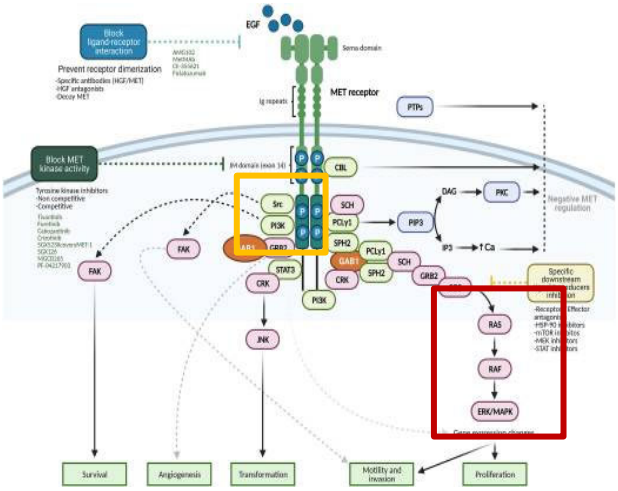
DDR2 SIGNALLING



DISCOIDIN DOMAIN RECEPTOR 2 (DDR2)

- DDR2 PRESENT IN 4% OF SCC LUNG CANCERS
- TUMOR SUPPRESSOR, DECREASED LUNG CANCER
- BUT MUTATED RECEPTOR ACTIVATES RAS/RAF PATHWAY
- TYROSINE RECEPTOR KINASE
- BINDS TO COLLAGEN
- CYTOSKELETAL REMODELLING AND SURVIVAL
- CONFERS SENSITIVITY TO DASATINIB
- MUTATION OVERCOMES EGFR TARGETING

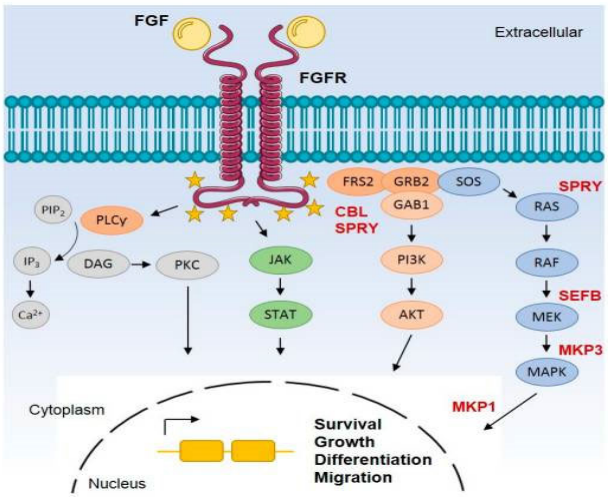
MET SIGNALING ADAPTORS AND MEDIATORS AND SIGNALING PATHWAYS AND ROS 1



MESENCHYMAL EPITHELIAL TRANSITION RECEPTOR (MET)
*LIGAND HGF
*MET IS A DRIVER ONCOGENE
*INTERARACTS EGFR RECEPTOR
*THERAPIES- CAPMATINIB
CABOZATINIB

c-ROS ONCOGENE 1 (ROS1)
*REARRANGEMENT IN LUNG ADENOCA
*MEMBER IGF FAMILY, RELATED TO ALK BUT NO KNOWN LIGAND)
*UNDERGOES FUSION/ REARRANGEMENT
*YOUNGER PTS, NEVER SMOKERS, WOMEN
*ALSO ACTIVATES SHP/PI3K
*TKIi:
CRIZOTINIB
ENTRECTINIB (CAN REACH BRAIN)
*AN EGFRi MECHANISM

FGFR SIGNALING PATHWAYS



FGFR1
- **GENE AMPLIFICATION**
- **7&% OCCURRENCE SCC**
- **RATHER THAN MUTATION**

THIS LEADS TO INCREASED RECEPTOR HOMODIMERIZATION = INCREASED RECEPTOR ACTIVATION
- **LEADS INCREASED FGFR1 INHIBITOR**
- **SENSITIVITY**
- **DOVITINB**

FROM: Pacini L, Jenks AD, Lima NC, Huang PH. Targeting the Fibroblast Growth Factor Receptor (FGFR) Family in Lung Cancer. Cells. 2021 May 10;10(5):1154. doi

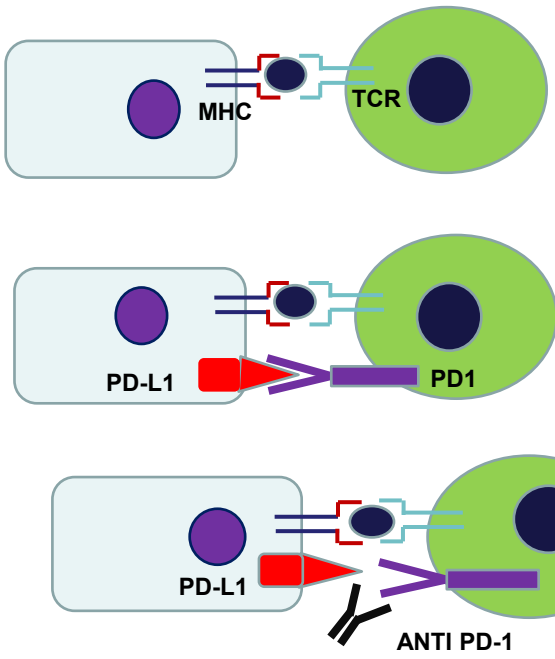
NEUROTROPHIC TROPOMYOSIN RECEPTOR KINASE (NTRK1)

- **NTRK1 PREDOMINANTLY IN NERVE TISSUE- BINDS NERVE GROWTH FACTOR**
- **MUTATION IN FORM OF FUSION PROTEINS HAVE NOW BEEN FOUND IN MANY SOLID TUMORS**
- **PRESENT LUNG CANER 0.1-0.3%**
- **TRK PATHWAY ACTIVATOR- MAY BE INVOLVED IN THE DEVELOPMENT OF EGFR INHIBITOR RESISTANCE**
- **IMPORTANCE- THERE ARE INHIBITORS**

- **ALSO SIGNALS THROUGH ANOTHER SIGNALING PATHWAY (JAK-STAT) TO INCREASE PDL-1 EXPRESSION IN TUMORS**

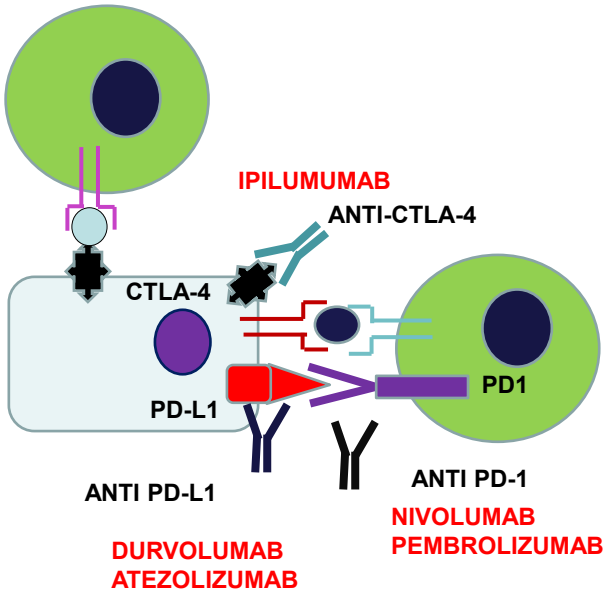
SIGNAL TRANSDUCTION PATHWAYS

CHECKPOINT INHIBITOR PATHWAYS



PD1 AND PDL-1 FUNCTION TO INHIBIT T-CELL ACTIVATION

IMMUNE CHECKPOINT INHIBITORS



TELOMERASE REVERSE TRANSCRIPTASE (TERT)

- CATALYTIC SUBUNIT OF TELOMERASE
- MAINTAINS TELOMERES ON THE END OF CHROMOSOMES
- TELOMERE LENGTH DETERMINES CELL AGE
- WHEN GETS SHORT ENOUGH- CELL STOPS DIVIDING AND ENTERS SCENESCENCE- AN ANTICANCER MECHANISM
- mutTERT- HIGHLY ACTIVE- CELLS DIVIDE BUT NOW LIABLE TO GET DNA REPLICATION ERRORS
- CONTRIBUTES HIGH TUMOR MUTATIONAL BURDEN
- TMB CELLS RESPONSIVE TO IPILUMUMAB- THE CTL4-A INHIBITOR

STK 11 GENE (LIVER KINASE B1 [LKB1] PROTEIN)

- TUMOR SUPPRESSOR
- INSERTION /DELETION MUTNS OR CHROMOSOME DELETION ASSOCD KRAS DELETION
- INVOLVED IN CELL METABOLISM
- SUBSRTATE INHIBITORS
- PREDICTOR OF PDL1 INHIBITOR RESPONSE
- LOSS OF THIS GENE ASSOCIATED WITH A LACK OF T-CELLS IN THE TUMOR MICROENVIROMENT

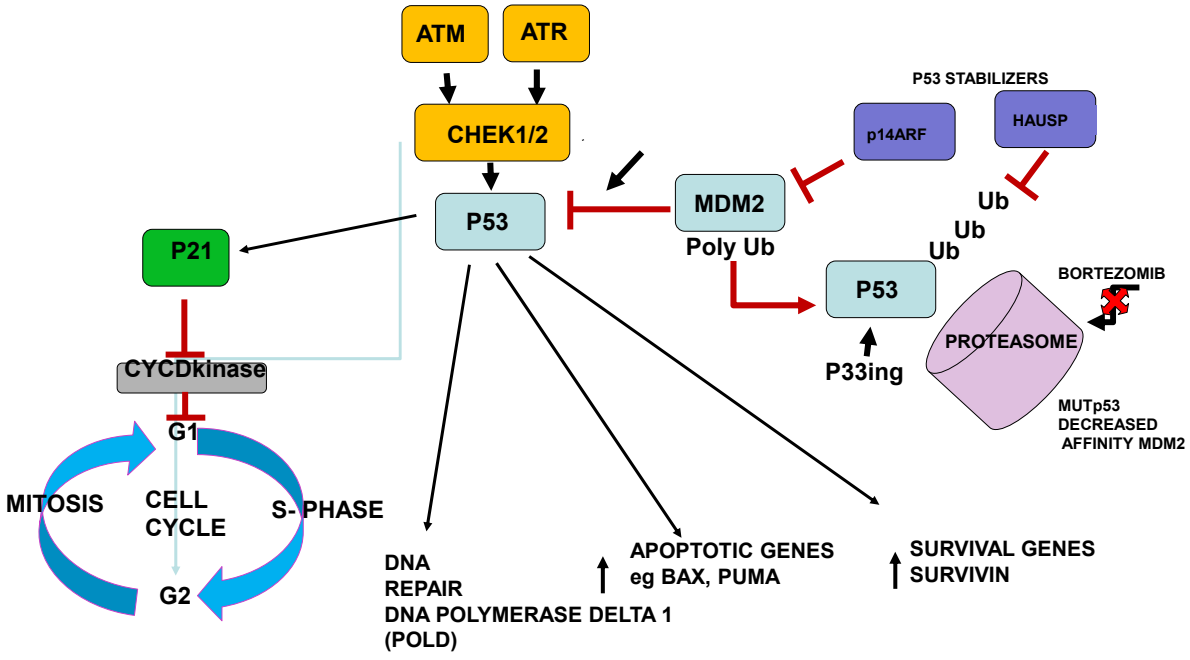
THE DNA POLYMERASE EPSILON (POLE) GENE

- ENCODES A SUBUNIT OF DNA POLYMERASE
- MUTATION OCCURS 3-4% NSCLC- ADENOCARCINOMA
- MUTATION IS ASSOCIATED WITH FAVORABLE PROGNOSIS
- ASSOCIATED:
  - HIGH TUMOR MUTATION BURDEN (TMB)
  - HIGH INFILTRATION OF T-CELLS INTO THE TUMOR MICROENVIROMENT

P53 TUMOR SUPPRESSOR GENE

- P53 MUTATED 33-90% LUNG CANCER (DEPENDING HISTOLOGICAL SUBTYPE.
- SCC>ADENOCARCINOMA
- SMOKING INCREASED INCIDENCE (DUE BENZOaPYRENE) THAN NON-SMOKERS
- NUCLEAR PROTIEN- TRANSCRIPTION FACTOR
- POINT MUTATIONS OCCUR PREDOMINANTLY IN THE CORE DNA BINDING DOMAIN EXONS 5-9
  - PROLONGS HALF LIFE
  - PROMOTES NUCLEAR ACUMULATION
- 85% LUNG CANCERS HAVE ABNORMALITIES IN GENES IN THE P53 PATHWAY
- LOSS OF P53- DEREGULATES CELL CYCLE AND APOPTOSIS
- ALSO "GSIN OF FUNCTION" PRO CANCER:
  - DISTANT METASTASES
  - INCREASED RESITANCE CANCER THERAPIES

P53 TUMOR SUPPRESSOR GENE PATHWAYS



P53 THERAPIES

- **TPmutp53- RESISTANCE TO XRT**
- **GENE THERAPY- ADENOVIRUSp53- BRONCHOSCOPIC INTRTUMORAL INJECTION**
- **TWO COMPOUNDS (NCI SCREENING CHEMICAL LIBRARY) THAT REACTIVATE p53 ACTIVATION AND FUNCTION (DNA BINDING)**
  - **RITA**
  - **PRIMA 1**

CONCLUSIONS

- **TARGETED THERAPIES HOLD PROMISE IN THE TREATMENT OF LUNG CANCER**
- **HOWEVER, THERE ARE CHALLENGES GIVEN THE ABILITY OF THE CANCER TO ACQUIRE NEW MUTATIONS AND SWITCH SIGNALING PATHWAYS**
- **GENETIC TESTING INFORMS BOTH INITIAL AND SUBSEQUENT TREATMENTS**

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Case Scenarios

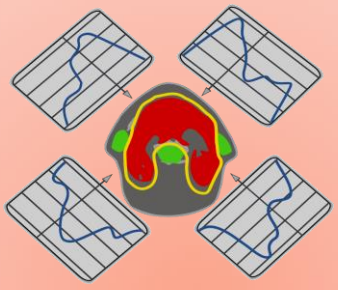
Cases 1-3

21

Radiation

Wilson Apollo

22



Lung Cancer & Radiation Therapy

Wilson Apollo, MS, CTR
WHA Consulting
NAACCR
October 5, 2023

2

Part 1: Lung Cancer-the picture

Table 1. Estimated Number* of New Cancer Cases and Deaths by Sex, US, 2023

	Estimated New Cases			Estimated Deaths		
	Both sexes	Male	Female	Both sexes	Male	Female
Respiratory system	256,290	131,150	125,140	132,330	71,170	61,160
Larynx	12,380	9,900	2,480	3,820	3,070	750
Lung & bronchus	238,340	117,550	120,790	127,070	67,160	59,910
Other respiratory organs	5,570	3,700	1,870	1,440	940	500

3

Non-small cell lung cancer(NSCLC)

- Comprises ~84% of all lung cancer cases,
- Subtypes of NSCLC;
  a. Adenocarcinoma, 40-50% (more peripherally)
  b. Squamous cell carcinoma (SCC), 25% (centrally located)
  c. Large cell carcinoma, 10%
  d. Other (large cell neuroendocrine carcinomas, sarcomatoid carcinomas)

4

Small cell lung cancer(SCLC)

- Comprises ~15% of all lung cancer cases,
  a. More aggressive than NSCLC, prone to early metastasis
  b. Most patients with metastatic disease @ time of diagnosis,
  c. 1/3 of pts with early-stage disease @ time of diagnosis,
  d. Poor prognosis,
  e. However, 6.7% decrease in mortality when low-dow CT screening is used for heavy smokers.

5

Small cell lung cancer(SCLC)

Supplemental Table 2. ICD-O-3 Histology Codes for Lung Cancer Subtype

Subtypes	ICD-O-3 Histology Codes
Non-small-cell lung cancer	8010 (carcinoma, NOS), 8012(large cell ca, NOS), 8013(large cell neuroendocrine ca), 8020(carcinoma, undifferentiated, NOS), 8046 (NSCLC0, 8050–8052, 8070–8078, 8140 (adenocarcinoma, NOS), 8141 (scirrhous adenoca), 8143 (superficial spreading adenoca), 8147 (basal cell adenoca), 8250–8255, 8260, 8310 (clear cell adenoca), 8430 (mucoid epidermoid ca), 8480 (mucinous adenoca), 8481 (mucin-producing adenoca), 8490 (signet-ring cell ca), 8560 (adenosquamous ca), and 8570–8575
Small-cell lung cancer	8002 (malignant tumor, small cell type), 8041 (small cell carcinoma, NOS) 8042 (Oat cell carcinoma), 8043 (small cell carcinoma, fusiform cell), 8044 (small cell carcinoma, intermed cell), and 8045 (combined small cell carcinoma).

6

The Challenge-where to start?

- Linac
- Gamma Knife
- Cyberknife
- IGRT
- SBRT
- VMAT
- SRS
- Gamma Tiles (START)
- Zeiss Intrabeam
- ZOFT Axxent
- Mammosite
- I-125 eye plaques (EPBT)
- Pd-103 eye plaques
- Prone breast (LNs?)
- Coplanar dose dynamic fields
- Bolus/no bolus
- Field in Field
- Cone beam CT planning
- SIB
- En face
- Electronic brachy
- I-131 radioablative therapy vs. imaging
- Optune
- GRID therapy
- Lattice therapy
- ART (adaptive RT)
- Hybrid RT
- BgRT (Biology-guided RT)
- kVCT

7

Total dose?

- Pt presented w/ a left lung primary, with mets to contralateral lung and T-spine.

RT Completion Summary

Plan ID	Energy	Fractions	Dose/fx (cGy)	Total Dose delivered (cGy)	Start Date	End Date
Lung, LUL	6X/SBRT	4	1,200	4,800	3/6/23	3/9/23
Lung, RLL	6X/SBRT	5	600	3,000	3/6/23	3/10/23
T9-T10 spine	6X/SBRT	5	600	3,000	3/13/23	3/17/23

Number of Phases of Rad Treatment	(03) 3 phases
Radiation Treatment Discontinued	(01) Radiation treatment completed as prescribed
Total Dose	(004800)

8

KNOW THE EQUIPMENT YOUR FACILITY USES!!

"*Where is the Data*? (STORE 2023, p. 425).

Section contains useful suggestions on where to find the RT data needed to accurately code RT treatments.

9

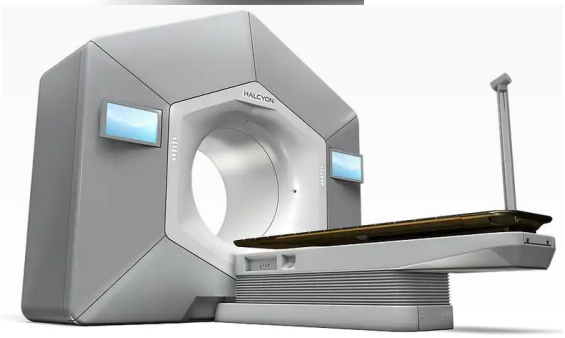
Linear Accelerator-Linac

Gantry

Collimator

Modern Linacs deliver a single modality external beam radiation therapy (EBRT).
Linac ⟶ Photons ⟶ Modality = 02

10



Linear Accelerator-Linac

Planning Technique

Modern Linacs can deliver RT treatments via multiple planning techniques, including 2D, 3D Conformal, IMRT (VMAT/rotational/arc therapy), Stereotactic Body Radiation Therapy (SBRT), SRS, Adaptive online/Adaptive off-line EBRT (**STORE 2023, p. 259**)

11

Reach out to your Rad Onc Dept and cultivate a rapport with their staff

12

SRS for brain mets in pts w/ SCLC

- Pt's diagnosed w/ SCLC tend to experience rapid tumor growth and early onset of brain mets (BM), 10% @ time of dx and 50% within 2 yrs from dx.
- More likely to see prophylactic cranial irradiation (PCI) in this subset of pts,
- SRS more effective in pts w/ 5 or less brain mets lesions (better local control rates),
- For pts w/ >5 brain mets lesions, WBRT preferred

Advances in Radiation Oncology (2023) 8, 101237

13

Adaptive Lung RT

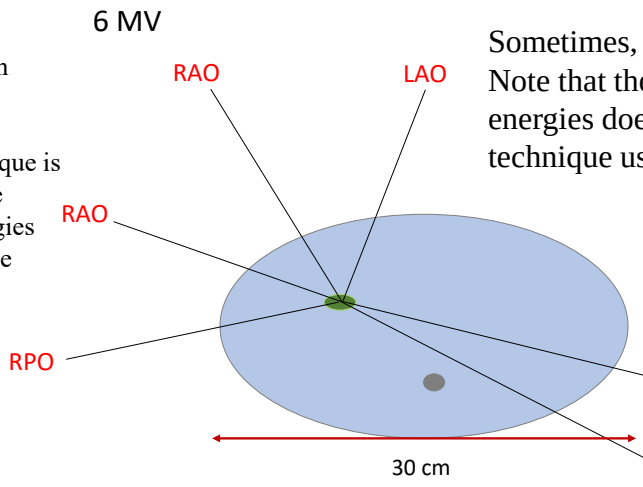
Advances in Radiation Oncology July 2023

- Approximately 85% of lung cancer cases comprise of Non-small cell lung cancer (NSCLC), with about 20-25% of these cases being locally advanced at time of dx.
- Standard of Care: for pts w/ good performance status (KPS), chemoRT + Durvalumab.
- Adaptive radiation therapy (ART) allows for anatomic/physiologic changes to tumor during treatment. Off-line ART involves changes to the treatment plan in between fractions.

14

Beam energy & pt thickness

Seen commonly in breast tangents treatments.
If planning technique is 3D conformal, the mixed beam energies will not change the code of **04 (3D).**



Sometimes, mixed energies work well. Note that the use of multiple beam energies does not alter the treatment technique used (**STORE 2023, p. 266**)

10 MV/10X/10MVX. Distance PA photon beam needs to traverse through tissue is > AP beam

15

Adaptive Lung RT…

Advances in Radiation Oncology July 2023

- Prescribed dose= 60 Gy.
- Of 25 pts in study, 10 pts had adapted plans with the remaining 15 used as control group.
- All pts on concurrent chemo (carboplatin, paclitaxel),
- Most pts on pembrolizumab (N-15), 5 on ipilimumab & nivolumab; 3 on single agent nivolumab; 2 on single agent durvalumab.
- 32 clinical trials currently using online and offline ART.

16

Adaptive Lung RT-Conclusions

Advances in Radiation Oncology July 2023

- Preliminary findings suggest ART could reduce impact of toxicity associated with chemo & immunotherapy treatment for lung cancer.
- Phase II trial (NCT04751747) currently under way looking at role of ART and toxicity in patients with more locally advanced lung cancer undergoing adjuvant chemo/immunotherapy.

17

Coding challenges-Hybrid RT

Journal of Radiotherapy Practice, Vol 22, Issue 5, December 2023

- Study looked at using hypofractionated RT for left chestwall and regional lymph nodes using three different hybrid RT techniques, delivering 40.5 Gy in15 fractions (75% of dose delivered with base-dose component & 30% with hybrid component);

1. 3DCTR + IMRT
2. 3DCTR + VMAT
3. IMRT + VMAT (*delivered more dose to heart/ipsilat lung*)

No current code in CTR Guide for hybrid techniques.

18

Biology-Guided RT(SCINTIX)

Our Technology - RefleXion

- Use of RefleXion Medical Radiotherapy System (RMRS),
- FDA classified it as Fludeoxyglucose F18-Guided radiation therapy system in 2023,
- RT delivery combined with simultaneous PET imaging.
- PET tracers administered to patients via IV,
- Tracers bind to cancer cells & emit signals that are picked up by PET, giving location of cancer,
- With this information, RT plan performed to accurately target cancer cells

19

Biology-Guided RT(SCINTIX, X1)

Our Technology - RefleXion

J Appl Clin Med Phys. 2022 June; 23(6)

- Unit consists of a Linac (**6 MV**), fan-beam KVCT (for imaging), PET imaging,
- Addresses tumor motion,
- Currently calibrated for treating lung primaries/mets and bone mets,

Key coding points:

- Planning techniques include SBRT, IMRT,
- RT delivered via **photons**.

20

02: External beam, photons

Zeiss Intrabeam
XOFT Axxent
Esteya (skin ca)

Small-scale Linacs.
They **do not** use radioactive isotopes (seeds).
Planning Technique: 02, Low energy x-ray/photon therapy

Gy

04: External beam, electrons

Liac 10, Liac 12
Novac
Movetron

All units deliver electron therapy.
Planning Technique: Can be 2D or 3D conformal.

09: Brachytherapy, Intracavitary, HDR

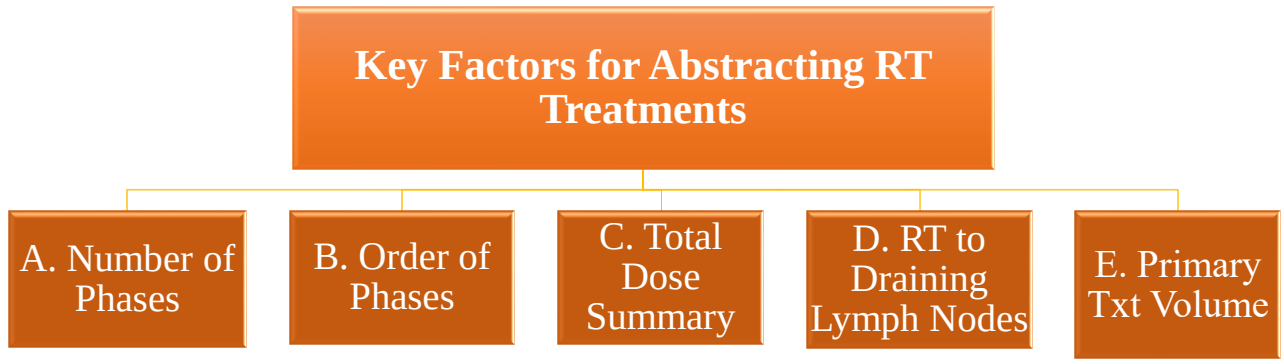
Strut Assisted Volume Implant (SAVI),
Mammosite
Contura MLB

Total dose: in cGy!

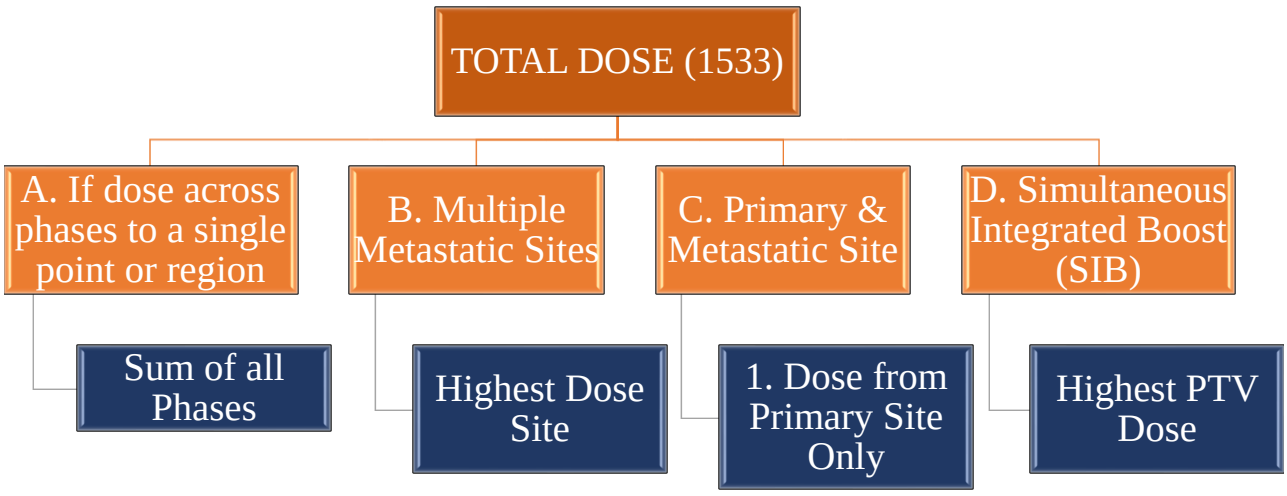
Units use Ir-192 seeds.
Inserted into **cavity** created by breast conservation surgery (BCS).
Planning Technique: 88,NA

IORT FOR BREAST CANCER, Volume: 41-Partial Breast. Lymph nodes not targeted!

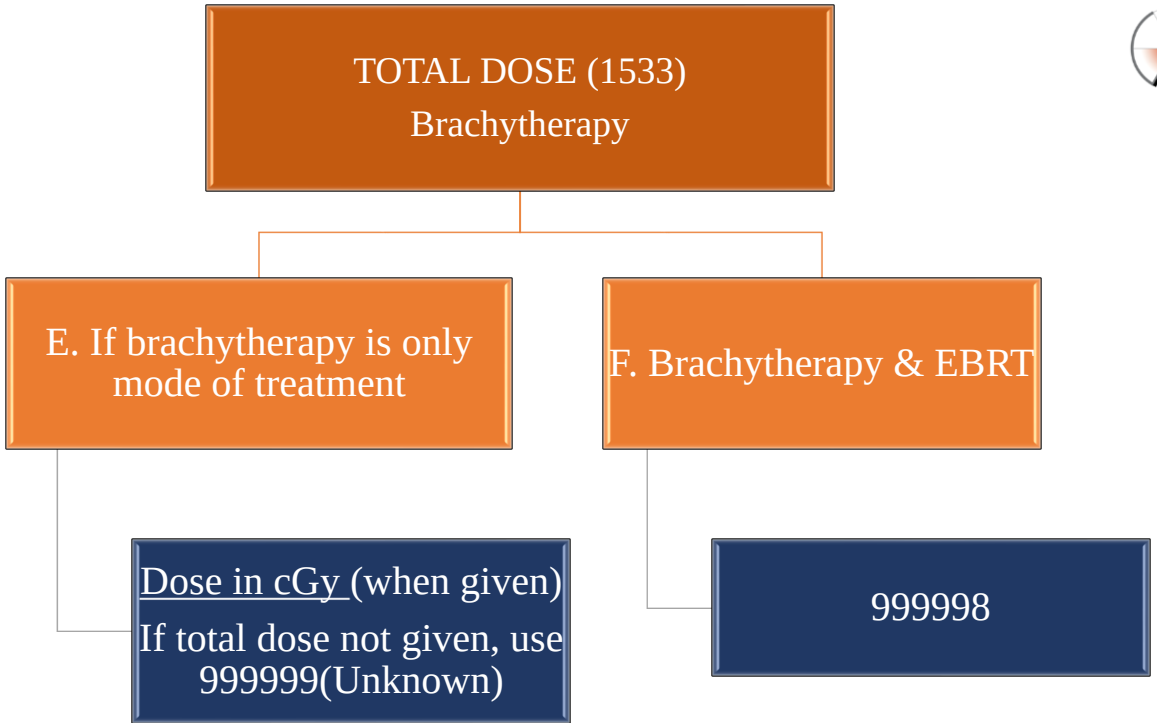
21


Key Factors for Abstracting RT Treatments
A. Number of Phases
B. Order of Phases
C. Total Dose Summary
D. RT to Draining Lymph Nodes
E. Primary Txt Volume

22


TOTAL DOSE (1533)
A. If dose across phases to a single point or region
Sum of all Phases
B. Multiple Metastatic Sites
Highest Dose Site
C. Primary & Metastatic Site
1. Dose from Primary Site Only
D. Simultaneous Integrated Boost (SIB)
Highest PTV Dose

23



24

PART 2
CLINICAL SCENARIOS

25

Case 1: LT Lung SCC

71 yr-old male w/ h/o HTN, HLD, GERD, CAD, who presented w/ intermittent mild cough, nonproductive. Pt also reports some weight loss. Former heavy smoker. 25 PK-YR

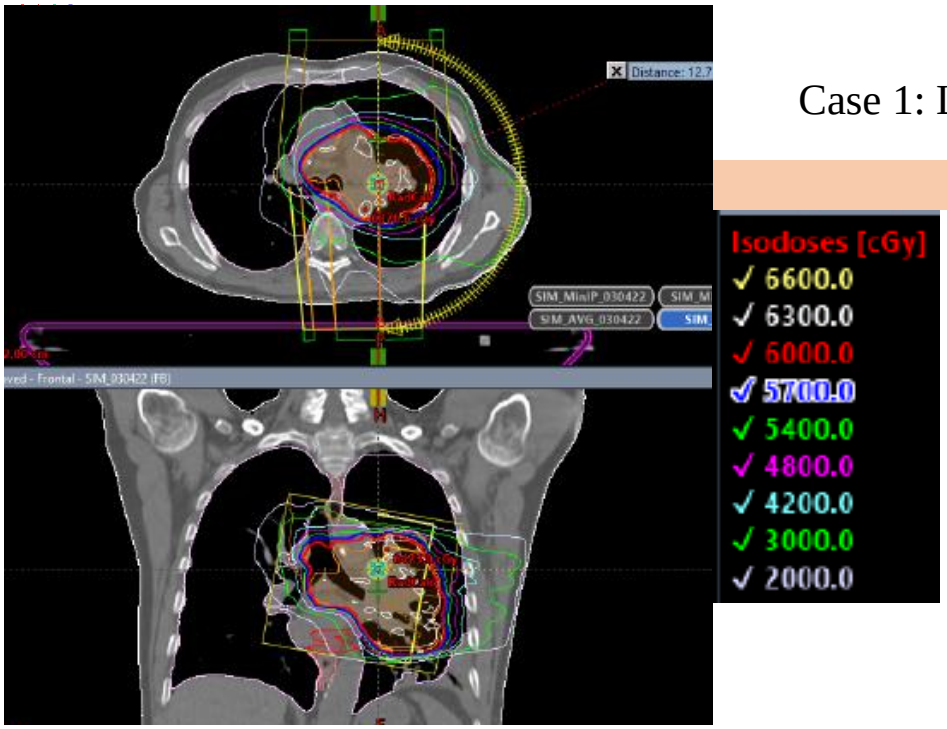
Radiation Therapy Treatment Summary:

No mention of lymphatic

However, w/u revealed LN involvement.

Site	Energy	Dose/fx cGy	# fx	Total dose cGy	Start date	End date
LT lung	6X/IMRT	200	30/30	6,000	12/6/2022	1/16/2023

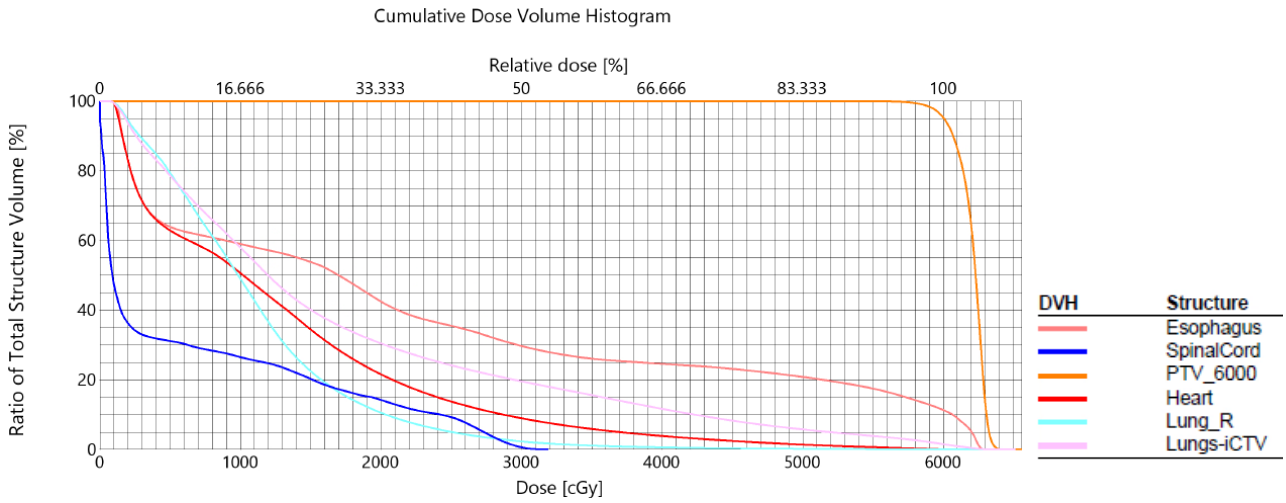
26



Case 1: LT Lung SCC

27

Case 1: LT Lung SCC



28

Case 1-Lung

Seg	#	Field	Code/Definition
Summary	1	Rad/Surg Sequence	0 No RT and/or surgical procedures
	2	Reason No Rad	0 Radiation was admin..
	3	Location of Rad	All RT at this facility
	4	Date RT Started/Flag	12/06/2022
	5	Date RT Ended/Flag	01/16/2023
	6	Number of Phases of RT	01
	7	RT Discontinued Early	01 Radiation completed
	8	**Total Dose**	**006000**
Phase 1	9	Primary Treatment Volume	30 Lung/bronchus
	10	Rad to Draining LNs	02 Thoracic LN region
	11	Treatment Modality	02 Photons
	12	Planning Technique	05 IMRT
	13	Dose per Fraction	00200
	14	Number of Fractions	030
	15	Phase I Total Dose	006000
Phase 2	16	Primary Treatment Volume	00
	17	Rad to Draining LNs	
	18	Treatment Modality	00
	19	Planning Technique	
	20	Dose per Fraction	
	21	Number of Fractions	
	22	Phase II Total Dose	
Phase 3	23	Primary Treatment Volume	
	24	Rad to Draining LNs	
	25	Treatment Modality	
	26	Planning Technique	
	27	Dose per Fraction	
	28	Number of Fractions	
	29	Phase III Total Dose	

Case 1 Rationale:

#10: CT simulation images revealed involved LNs coverage. A check with radiation oncologist confirmed coverage. PET/CT positive for LN involvement. Level 7 LN FNA positive for SCC.

#11: Beam energy of 6X indicative of photon therapy.

#12: IMRT plan clearly stated in RT completion summary.

29

Case 2: RT Lung

69 yr-old female w/ h/o heavy smoking hx in the past (quit two yrs ago), who presented w/ screen-detected right lung cancer during low-dose screening chest CT. Patient is asymptomatic. RT post surgery.

Radiation Therapy Treatment Summary:

Site	Energy	Dose/fx cGy	# fx	Total dose cGy	Start date	End date
RT lung	6X/VMAT	200	30/30	6,000	2/20/23	4/3/23

Five non-coplanar beams technique used.

30

Case 2-Lung

Seg	#	Field	Code/Definition
Summary	1	Rad/Surg Sequence	3 RT after surgery
	2	Reason No Rad	0 Radiation was admin..
	3	Location of Rad	All RT at this facility
	4	Date RT Started/Flag	02/20/2023
	5	Date RT Ended/Flag	04/03/2023
	6	Number of Phases of RT	01
	7	RT Discontinued Early	01 Radiation completed
	8	**Total Dose**	**006000**
Phase 1	9	Primary Treatment Volume	30 Lung/bronchus
	10	Rad to Draining LNs	00 No RT to draining LNs
	11	Treatment Modality	02 Photons
	12	Planning Technique	05 IMRT
	13	Dose per Fraction	00200
	14	Number of Fractions	030
	15	Phase I Total Dose	006000
Phase 2	16	Primary Treatment Volume	00
	17	Rad to Draining LNs	
	18	Treatment Modality	00
	19	Planning Technique	
	20	Dose per Fraction	
	21	Number of Fractions	
	22	Phase II Total Dose	
Phase 3	23	Primary Treatment Volume	
	24	Rad to Draining LNs	
	25	Treatment Modality	
	26	Planning Technique	
	27	Dose per Fraction	
	28	Number of Fractions	
	29	Phase III Total Dose	

Case 2 Rationale:

#9: Code to primary site, even if primary site is resected,
#10: No lymph nodes involvement documented.
#11: Beam energy of 6X is indicative of photon therapy.
#12: VMAT (arc therapy) is delivered via IMRT technique.

31

Case 3: RT Lung

- 60 yr-old male w/ h/o GERD, HTN, HLD, who presented w/ interval change in size of known right upper lobe lung nodule. Former heavy smoker. Social etoh. -FHX.

Radiation Therapy Treatment Summary:

Site	Energy	Dose/fx cGy	# fx	Total dose cGy	Start date	End date
RT lung	6X/SBRT	800	5/5	4,000	11/28/22	12/2/23

Note: There were no LNs involved clinically or pathologically. Given small volumes targeted by SBRT, LNs not in irradiated field.

32

Case 3: RT Lung

Energy
6X/SBRT

6X beam energy: refers to photon energy delivered by a Linac.
All we need to know to code Modality= 02-photons

SBRT (Stereotactic Body Radiotherapy): characterized by large fraction size, hypofractionation, and small number of fractions.
It also targets very small volumes, 5 cm or less.
We have specific code for SBRT, 06.

33

Case 3-Lung

Seg	#	Field	Code/Definition
Summary	1	Rad/Surg Sequence	3 RT after surgery
	2	Reason No Rad	0 Radiation was admin..
	3	Location of Rad	All RT at this facility
	4	Date RT Started/Flag	11/28/2022
	5	Date RT Ended/Flag	12/02/2023
	6	Number of Phases of RT	01
	7	RT Discontinued Early	01 Radiation completed
	8	**Total Dose**	**004000**
Phase 1	9	Primary Treatment Volume	30 Lung/bronchus
	10	Rad to Draining LNs	00 No RT to draining LNs
	11	Treatment Modality	02 Photons
	12	Planning Technique	06 SBRT
	13	Dose per Fraction	00800
	14	Number of Fractions	005
	15	Phase I Total Dose	004000
Phase 2	16	Primary Treatment Volume	00
	17	Rad to Draining LNs	
	18	Treatment Modality	00
	19	Planning Technique	
	20	Dose per Fraction	
	21	Number of Fractions	
	22	Phase II Total Dose	
Phase 3	23	Primary Treatment Volume	
	24	Rad to Draining LNs	
	25	Treatment Modality	
	26	Planning Technique	
	27	Dose per Fraction	
	28	Number of Fractions	
	29	Phase III Total Dose	

Case 3 Rationale:

#9: Code to primary site, even if primary site is resected,
#10: No lymph nodes involvement documented, clinically and pathologically. Also, when SBRT is used, it does not include lymphatics.
#11: Beam energy of 6X is indicative of photon therapy.
#12: SBRT has its own code.

34

Case 4: Primary & metastatic site

- 76-year-old male was initially diagnosed with metastatic right lung cancer.

Radiation Therapy Treatment Summary:

Site	Energy	Dose/fx cGy	# fx	Total dose cGy	Start date	End date
RT hip	6X/3D	800	1/1	800	8/21/23	8/21/23
RT lung	15X/3D	400	5/5	2,000	8/21/23	8/25/23

35

Case 4-Lung mets

Seg	#	Field	Code/Definition
Summary	1	Rad/Surg Sequence	0 No RT and/or surgical procedures
	2	Reason No Rad	0 Radiation was admin..
	3	Location of Rad	All RT at this facility
	4	Date RT Started/Flag	08/21/23
	5	Date RT Ended/Flag	08/25/23
	6	Number of Phases of RT	02
	7	RT Discontinued Early	01 Radiation completed
	8	**Total Dose**	**002000**
Phase 1	9	Primary Treatment Volume	30 Lung/bronchus
	10	Rad to Draining LNs	00 No RT to draining LNs
	11	Treatment Modality	02 Photons
	12	Planning Technique	04 3D conformal
	13	Dose per Fraction	00400
	14	Number of Fractions	005
	15	Phase I Total Dose	002000
Phase 2	16	Primary Treatment Volume	84 Hip
	17	Rad to Draining LNs	00 No RT to draining LNs
	18	Treatment Modality	02 Photons
	19	Planning Technique	04 3D conformal
	20	Dose per Fraction	00800
	21	Number of Fractions	001
	22	Phase II Total Dose	000800
Phase 3	23	Primary Treatment Volume	00
	24	Rad to Draining LNs	
	25	Treatment Modality	00
	26	Planning Technique	
	27	Dose per Fraction	
	28	Number of Fractions	
	29	Phase III Total Dose	

Case 4 Rationale:

#08: When a primary site and a metastatic site are irradiated, you cannot add the delivered dose from different target volumes to get total dose. As per rule, total dose is dose to primary site.
#10/17: In general, when metastatic dz or metastatic site is irradiated, LNs are not included.
#12/19: Planning technique is clearly stated in treatment summary.
#23/25: At our facility, if we do not populate field #25 with zeroes (00), we get an edit.

36

Case 5: Gamma Tiles for CNS mets

Surgically targeted radiation therapy (**STaRT**)

- FDA-approved therapy. First used in 2021.
- Each tile contains four Cesium-131(Cs-131) gamma rays emitting radioisotope; # of tiles used based on size & location of tumor,
- Biocompatible, permanent,
- Considered Low-dose rate (LDR),
- Surgically inserted into brain cavity, post resection of metastatic disease (case can be made for coding it intracavitary),
- ~ 50% of dose delivered within 10 days post implant,
- 95% of dose delivered within six weeks post implant,
- Applied to high grade gliomas & recurrent meningiomas.

37

Case 5: Gamma Tiles for CNS mets

Txt Site	Energy	Dose/fx	# of fx	Total dose	Start date	End date
Brain-partial	Cs-131 Gamma tiles	5000 cGy	1	5000 cGy	8/17/23	8/17/23

38

Case 5-Lung mets

Seg	#	Field	Code/Definition
Summary	1	Rad/Surg Sequence	0 No RT and/or surgical procedures
	2	Reason No Rad	0 Radiation was admin..
	3	Location of Rad	All RT at this facility
	4	Date RT Started/Flag	08/17/23
	5	Date RT Ended/Flag	08/17/23
	6	Number of Phases of RT	01
	7	RT Discontinued Early	01 Radiation completed
	8	**Total Dose**	**005000**
Phase 1	9	Primary Treatment Volume	13 Brain-Limited
	10	Rad to Draining LNs	00 No RT to draining LNs
	11	Treatment Modality	08 Brachytherapy, intracavitary, LDR
	12	Planning Technique	88 NA
	13	Dose per Fraction	05000
	14	Number of Fractions	001
	15	Phase I Total Dose	005000
Phase 2	16	Primary Treatment Volume	00
	17	Rad to Draining LNs	
	18	Treatment Modality	00
	19	Planning Technique	
	20	Dose per Fraction	
	21	Number of Fractions	
	22	Phase II Total Dose	
Phase 3	23	Primary Treatment Volume	
	24	Rad to Draining LNs	
	25	Treatment Modality	
	26	Planning Technique	
	27	Dose per Fraction	
	28	Number of Fractions	
	29	Phase III Total Dose	

Case 5 Rationale:

#08: If brachytherapy dose is given in cGy, code it here.
#9: Only a small brain volume is targeted with Gamma Tiles.
#11: Cs-131 is a low-dose rate (LDR) radioisotope. Tiles are surgically implanted into resection cavity.
#13/15: If dose is given in cGy (absorbed dose) unit, code it.

39

GRID Therapy
Spatial Fractionated RT

- Not a novel approach (around since the 1990s); modern RT delivery equipment makes use of GRID therapy more precise,
- Dose distribution of high dose/low dose regions delivered in grid pattern,
- Delivers high and low dose to separate target volumes within the primary site,
- Initially used for palliative intent; now seen more for curative intent in H&N, lung, cervical cancer, sarcoma, melanoma,
- Used w/ conventional fractionated RT, w/ IMRT recommended,
- H&N SFRT dose: 15 Gy in single fx to bulky LNs,
- Total dose typically ~70 Gy,

40

GRID Therapy
Spatial Fractionated RT

- Question remains for CTRs (ODS?):

a. What modality and planning technique is used?

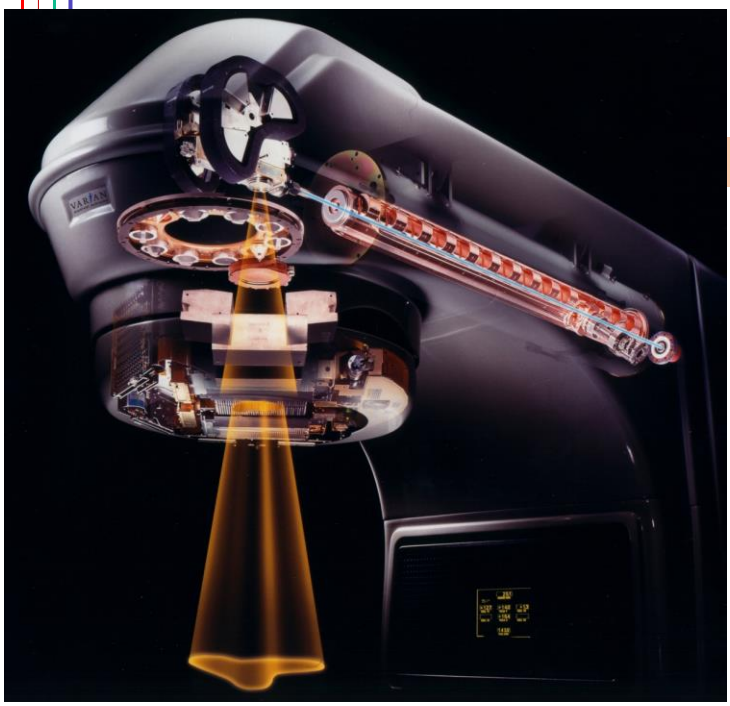
b. Are lymphatics included in irradiated fields?

Back to the basics;

What equipment was used? If a Linac, then it's **photon** modality (02). Look for beam energy to confirm, such as 6X, 6MV, 12X, 12 MV, 10 MVX.

Look for key words such as VMAT, Arc, conformal, etc.

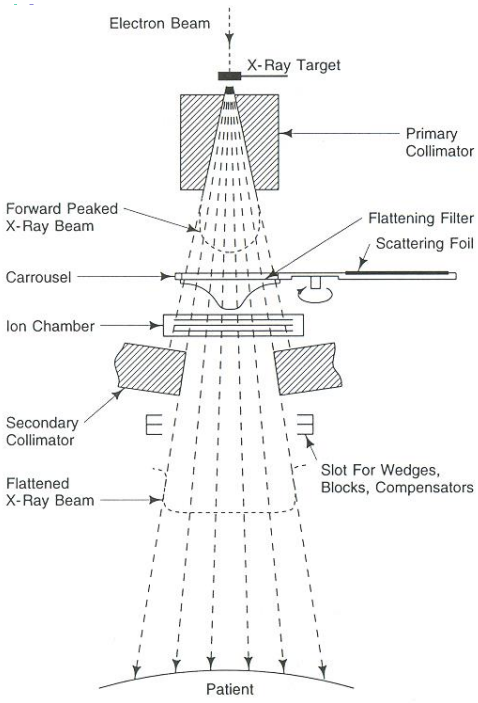
41



FFF
Flattening Filter-Free

How do you code a FFF technique?

42

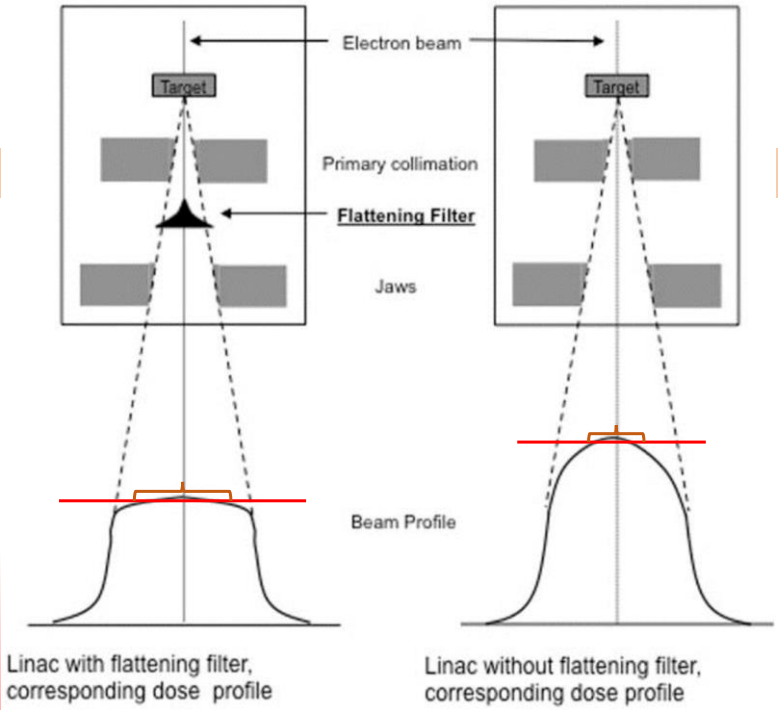


Flattening Filter-Free(FFF)

	Varian (TrueBeam)		Elekta (Versa)	
Nominal E	6 FFF	10 FFF	6 FFF	10 FFF
Filtration	0.8 mm Brass		2 mm Stainless steel	
d_{max} (cm)	1.5	2.3	1.7	2.4
Dose @ 10 cm depth (%)	64.2	71.7	67.5	73
Max dose rate @ d_{max} (cGy/min)	1400	2400	1400	2200

Flattening filter in the path of a photon beam serves to "flatten" the dose distribution at a specified depth within the patient (target volume).

43



FFF…

- With flattening filter, homogeneous area at specified depth is longer (flatter), allowing for larger volume to be irradiated.
- Without flattening filter, homogeneous area is much smaller, more suitable for small target volumes.

44

FFF Advantages

- Higher dose rates (2-4 times faster than conventional treatments with FF) = reduced time patient is on the treatment couch; less likely that target/tumor motion may come into play; more patients can be treated in same time frame (more profitable for facilities),
- Targets smaller volumes; suitable for SBRT plans,
- Reduces out of field dose (scatter dose outside of planned target volume),

Abstracting Points:

➢FFF is not a planning technique that we code,

➢More important is the *delivery system used* with FFF, *Linac in photon mode*,

➢Planning technique can be 3D, IMRT, SBRT, SRS; still need to review completion summary or consult with radiation oncologist on this.

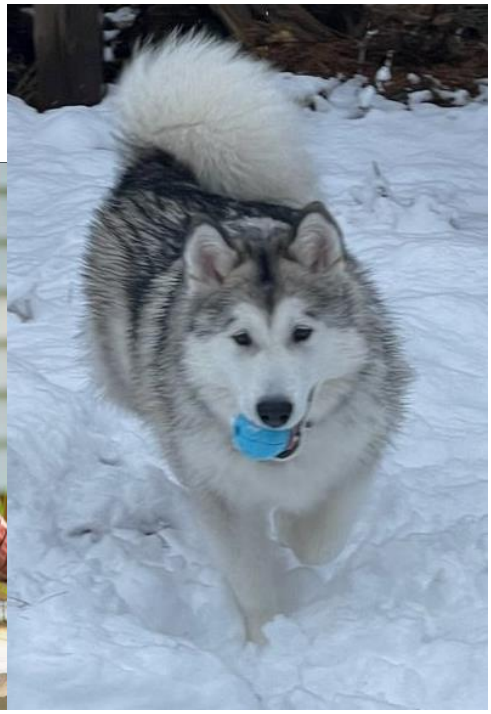
45


STaRT
Gamma Tiles
GTV
VMAT
kVCT
Interdigitated
Rarc
CSI
SART
Quad Shot
Hybrid RT
OAR
FFF
Adaptive RT
SCLV
EPBT
BgRT
IFRT
PTV
46

46


Shane & Lilly
Apollo. ☺

47



48

23

Kathleen Lykes

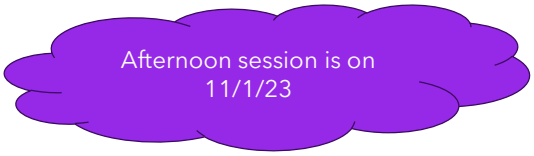
Sandra Reay

Fabulous Prizes

24

Coming UP…

- Lung 2023 Part 2
  - Denise Harrison, CTR
  - Noah Reid, CTR
- Radiation and Radiology
  - Wilson Apollo



NAACCR

25

CE Certificate Quiz/Survey

CE Phrase

Link

https://survey.alchemer.com/s3/7513560/Lung-2023-Part-1

NAACCR

26

Thank you!!!

27