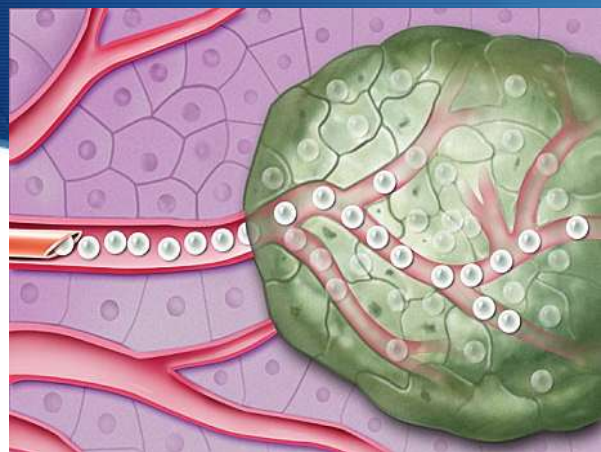




# Selective Internal Radiation Therapy



Jefferson R. Pagsisihan, MD, DPSNM  
The Medical City  
St. Luke's Medical Center



# Selective Internal Radiation Therapy



- catheter-based liver directed modality for patients with primary and metastatic liver cancers
- administration of radionuclide into the hepatic arteries allowing delivery of high radiation dose to tumor while keeping tolerable limits to normal liver parenchyma

# SIR-spheres

- Polymer microspheres
- loaded with Yttrium-90 bearing microspheres
- High-energy beta rays 0.9367 MeV
- 64.1 hrs (2.67 days) half-life
- Tissue penetration: average penetration 2.5 mm  
maximum range 11 mm

# SIR-spheres



Resin microspheres

50 Bq/sphere

40–60 million spheres per treatment

**TheraSphere®**

Glass microspheres

2,500 Bq/sphere

1-2 million spheres per treatment

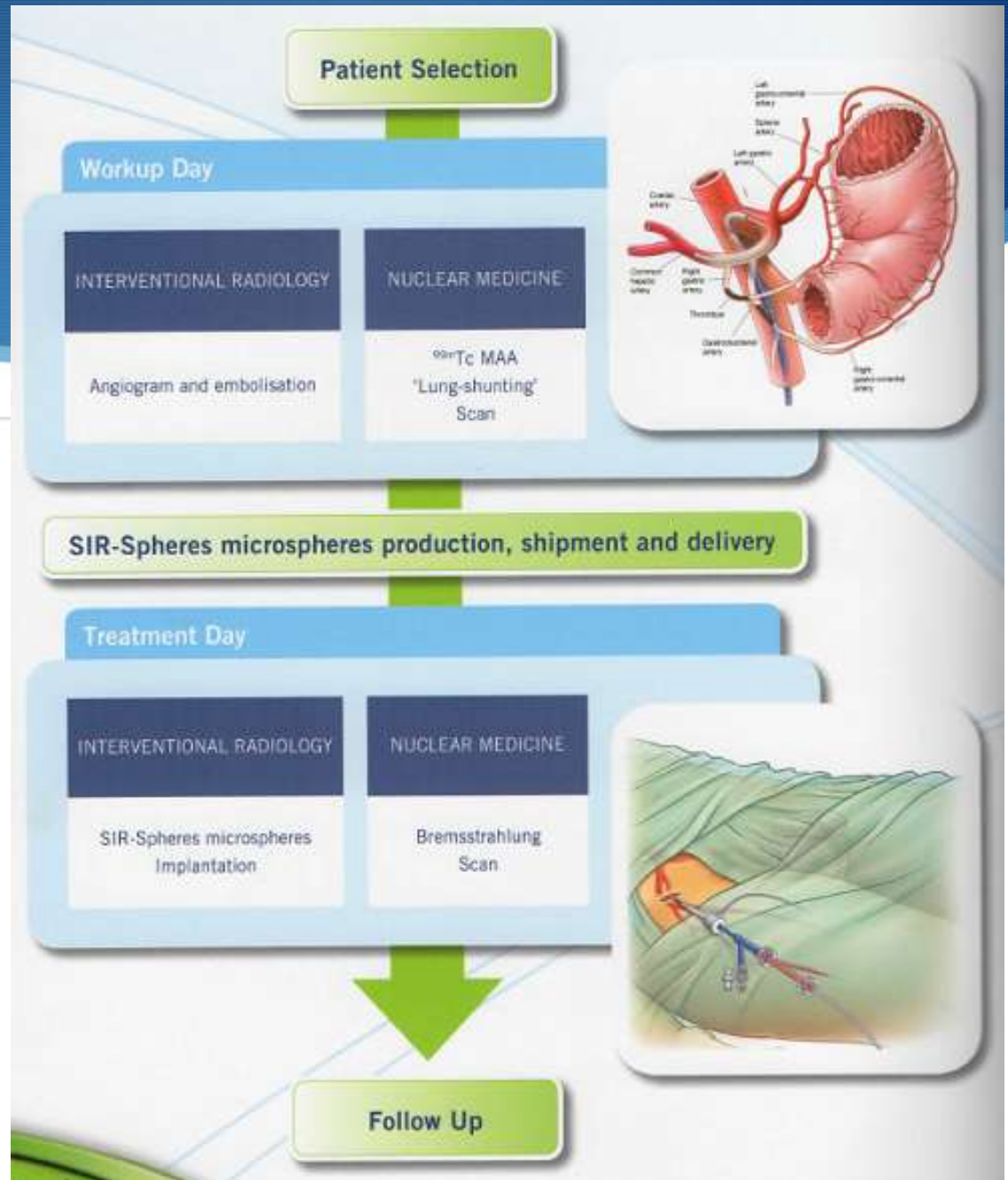


# SIR-spheres

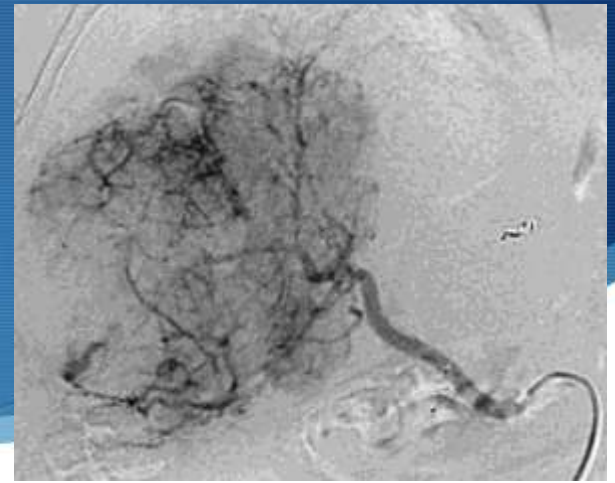


- Due to their size, SIR spheres travel with the blood stream and are taken deep into the tumor vasculature where they become lodged
- Can therefore be delivered in a slow and deliberate manner to achieve an even distribution and optimal tumor coverage

# Protocol



# Hepatic Angiogram



- Fully identify and define all the relevant hepatic and visceral vasculature
- Confirm the ability to selectively catheterize the hepatic arteries supplying the tumor/s
- Identify uncorrectable blood shunting from the liver to GI organs
- Injection of Tc-99m MAA

# Tc-99m MAA scan

- Aid in the safety assessment before the radioembolization
- Allows estimation of activity likely to accumulate in both neoplastic and normal parenchymal vasculature
- Used to assess and quantify for extra-hepatic shunting to the lungs or gastrointestinal tract





# Lung Shunting

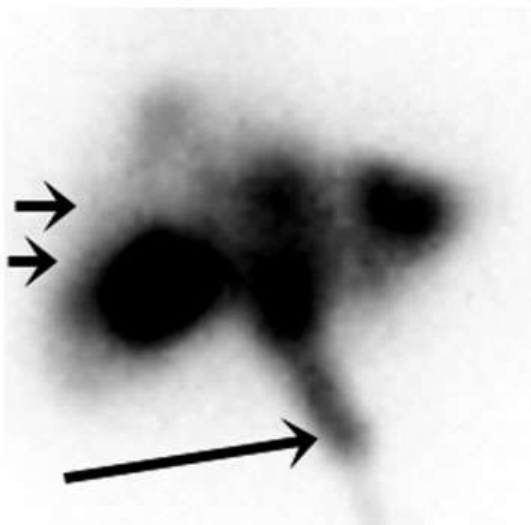
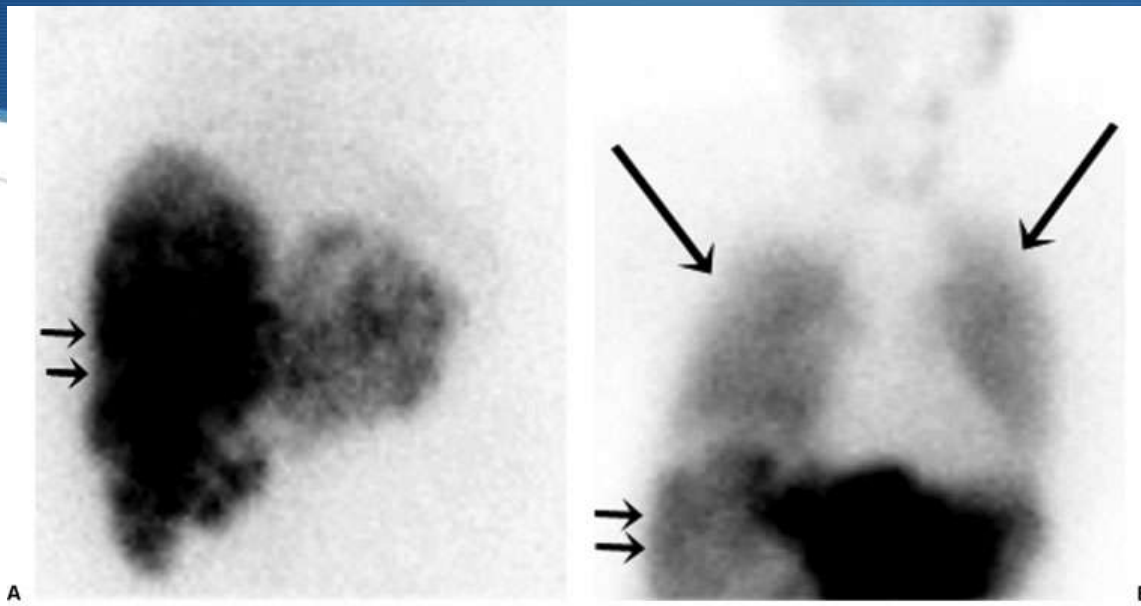
- Used to prevent unacceptable high radiation exposure and as a correction factor when calculating the required microsphere activity
- Doses should preferably remain <20Gy and never >25 Gy

$$\% \text{ LS} = \frac{\text{counts of total lung}}{\text{counts of total lung} + \text{counts of liver}} \times 100\%$$

# Tumor to normal liver ratio (TNR)

- Ratio of the activity in the tumor and normal liver per unit mass
- Will not correlate with the baseline volume of the liver or tumor nor with the proportion of neoplastic involvement
- 2.0 has generally been taken as the lower threshold of safe Y-90 microsphere administration

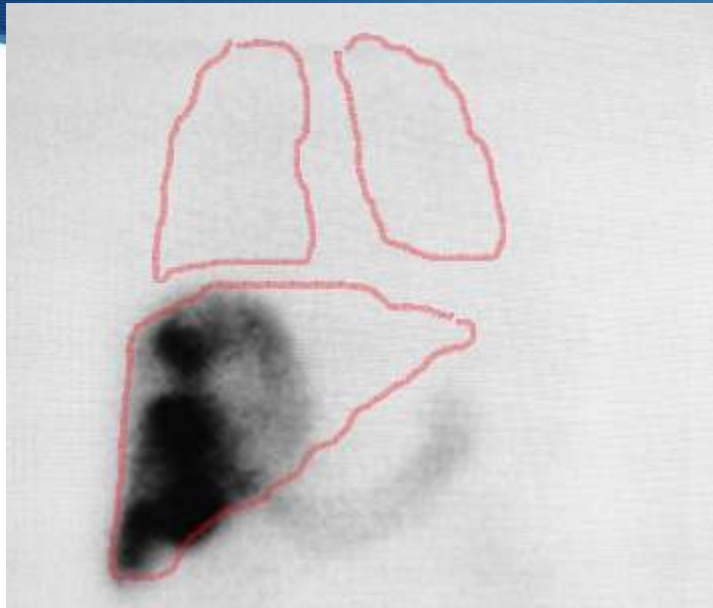
# MAA Scan



79/M with HCC  
right hepatic lobe mass



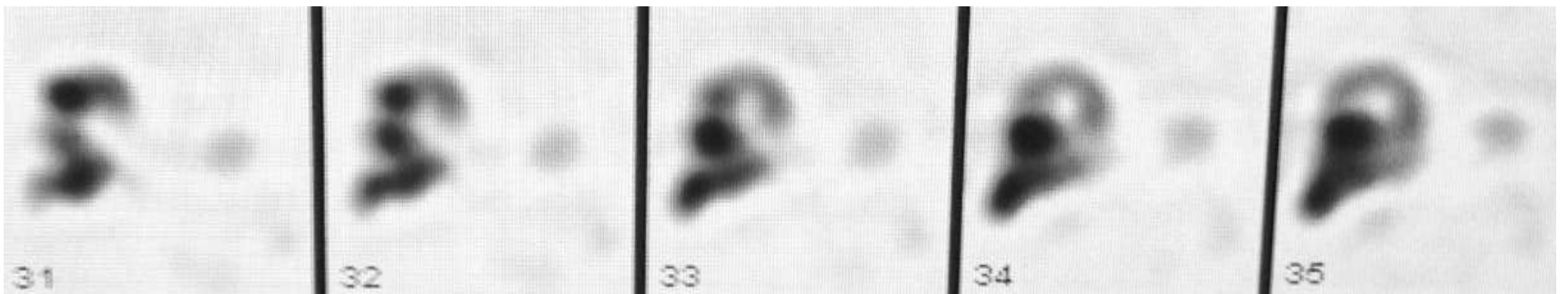
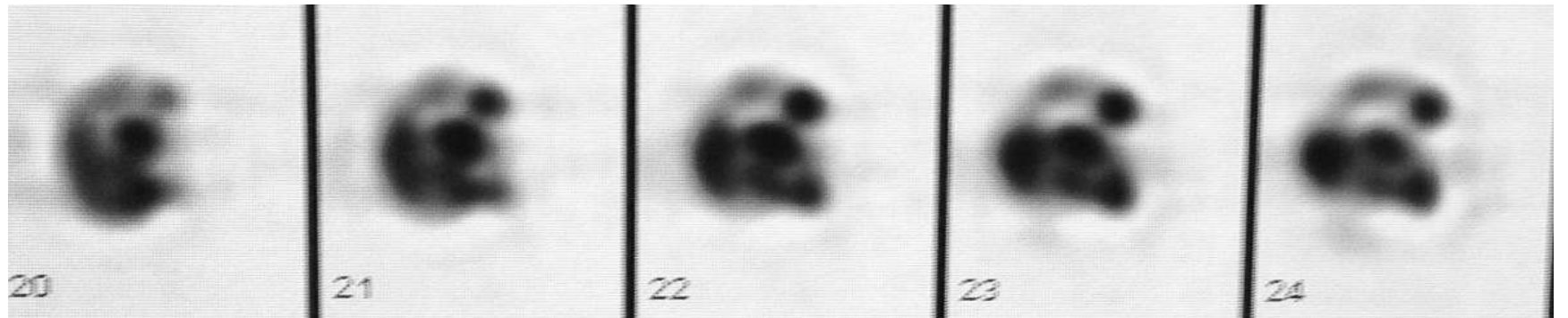
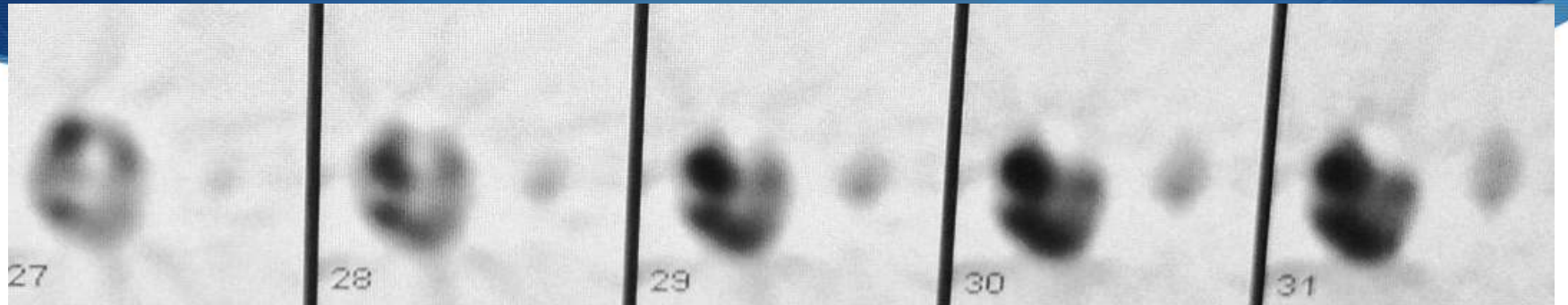




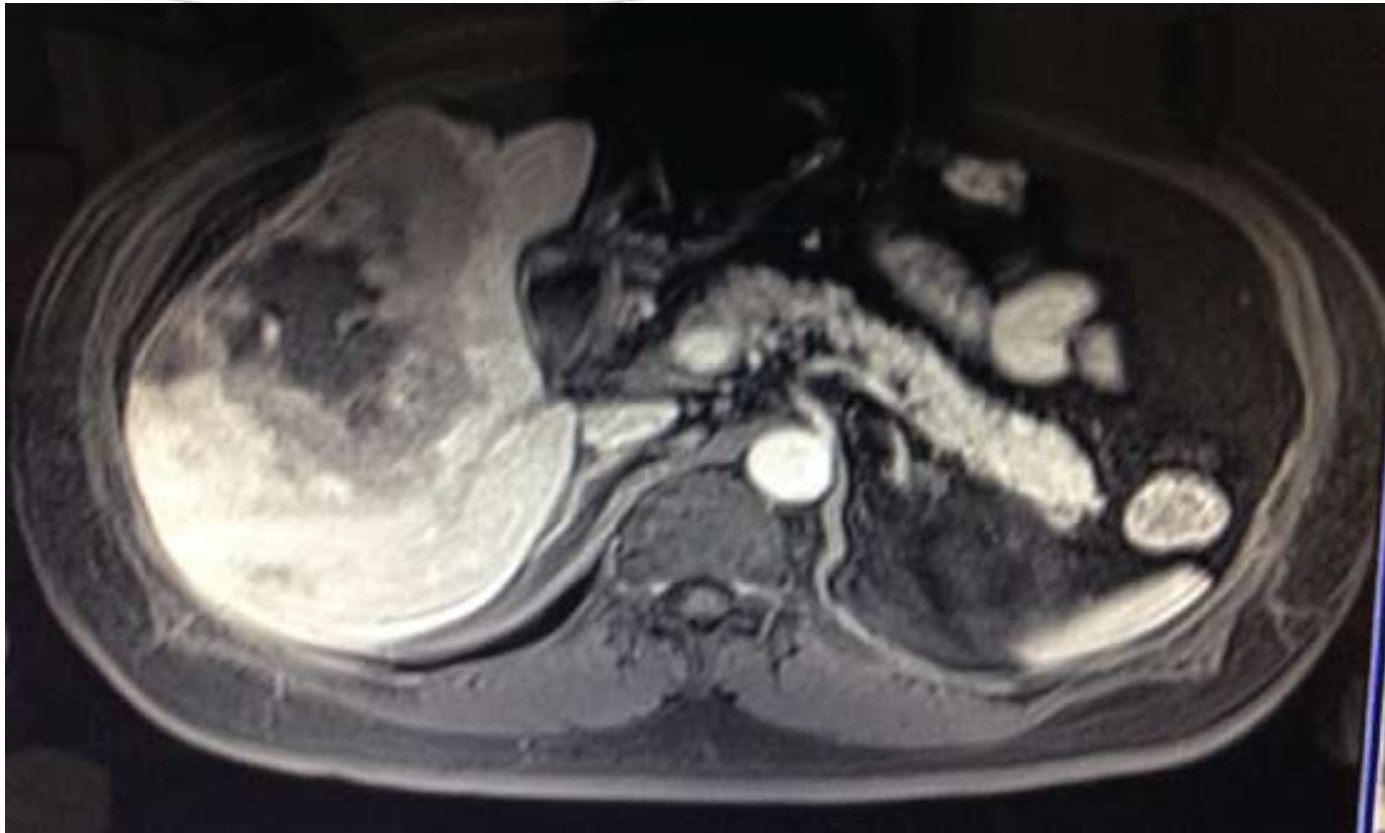
$$\frac{65,305}{578,402 + 65,305}$$

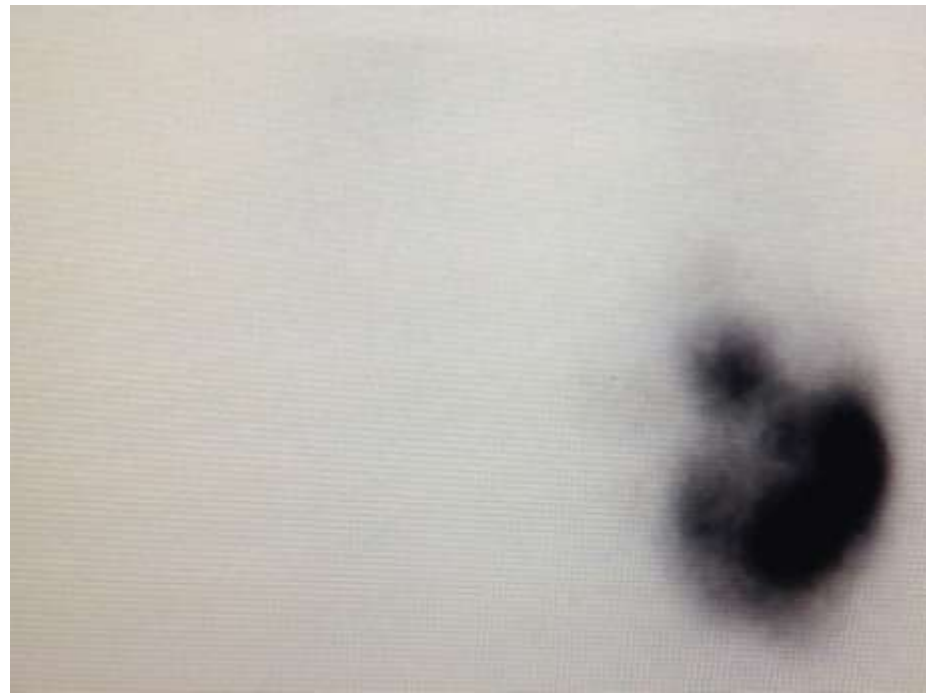
X 100 %

10.1%



59/M with HCC  
right hepatic lobe mass

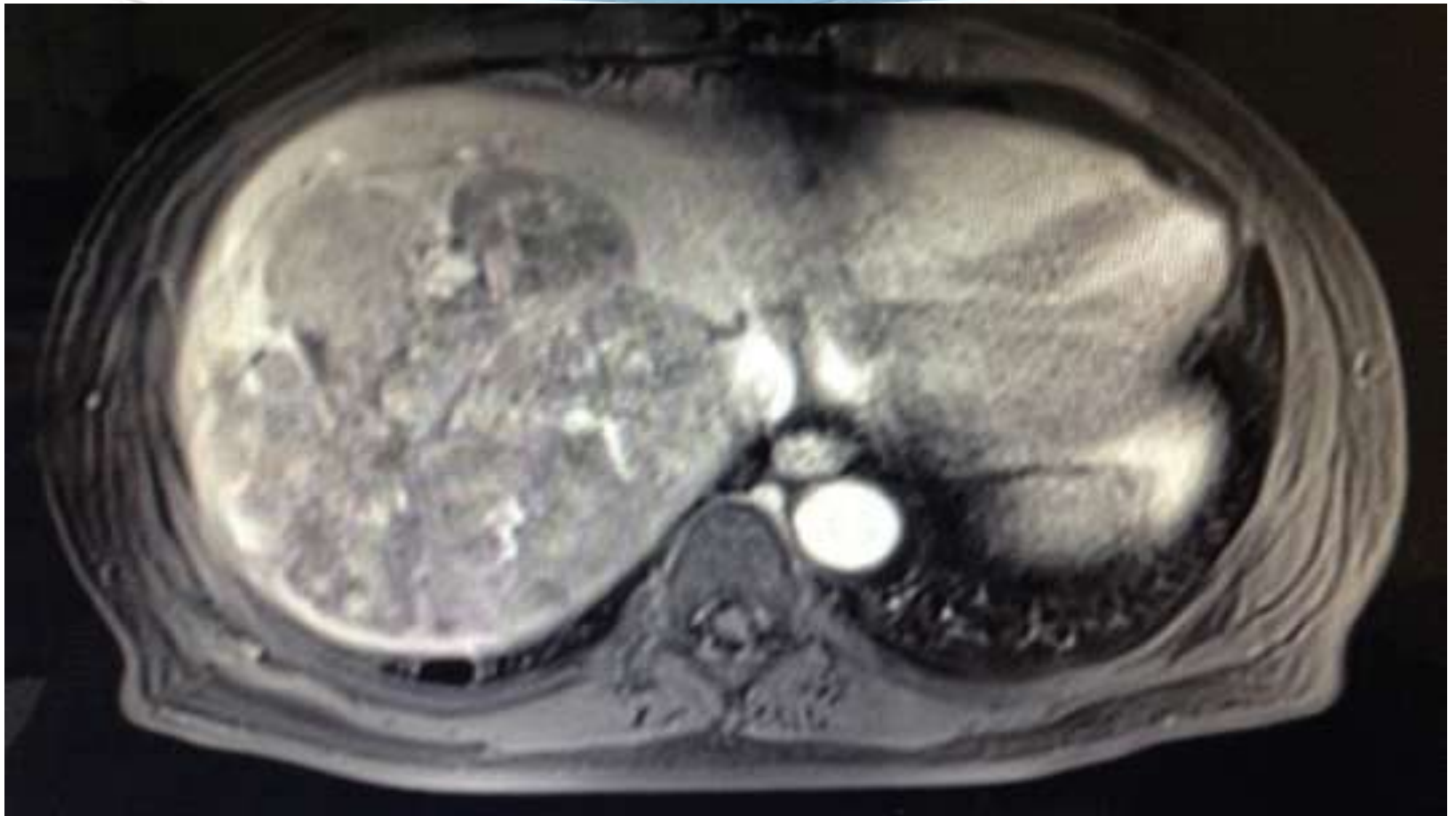


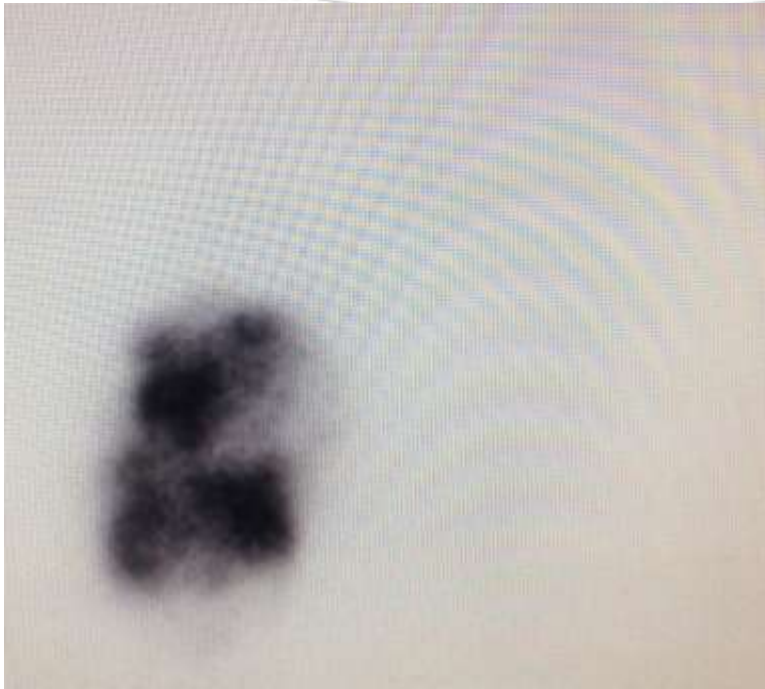


LS = 9.7%



64/M with HCC  
right hepatic lobe mass

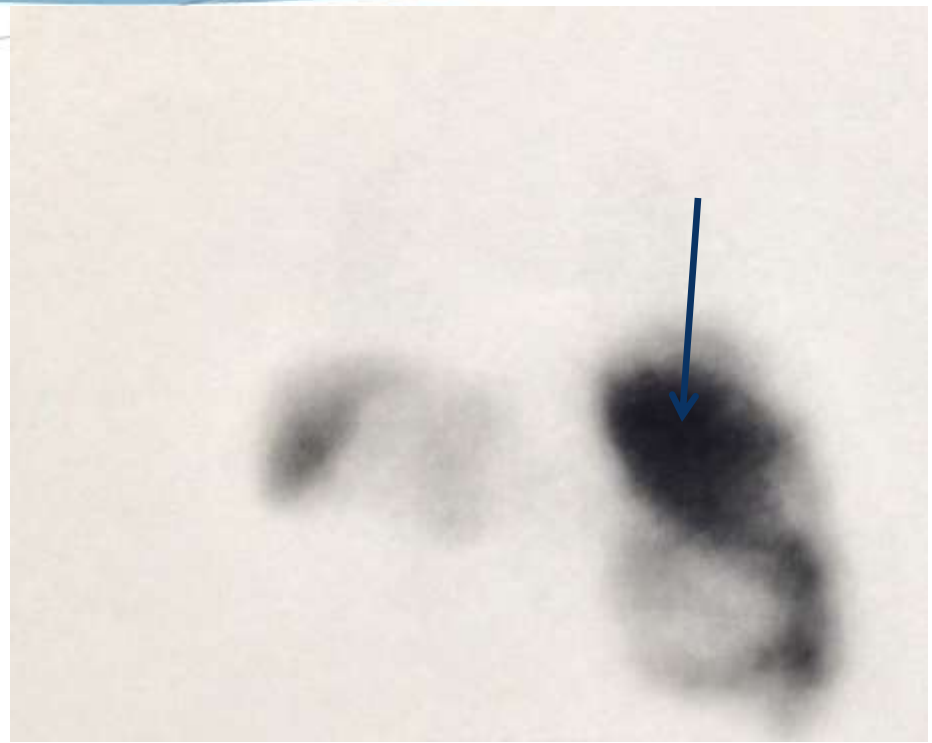
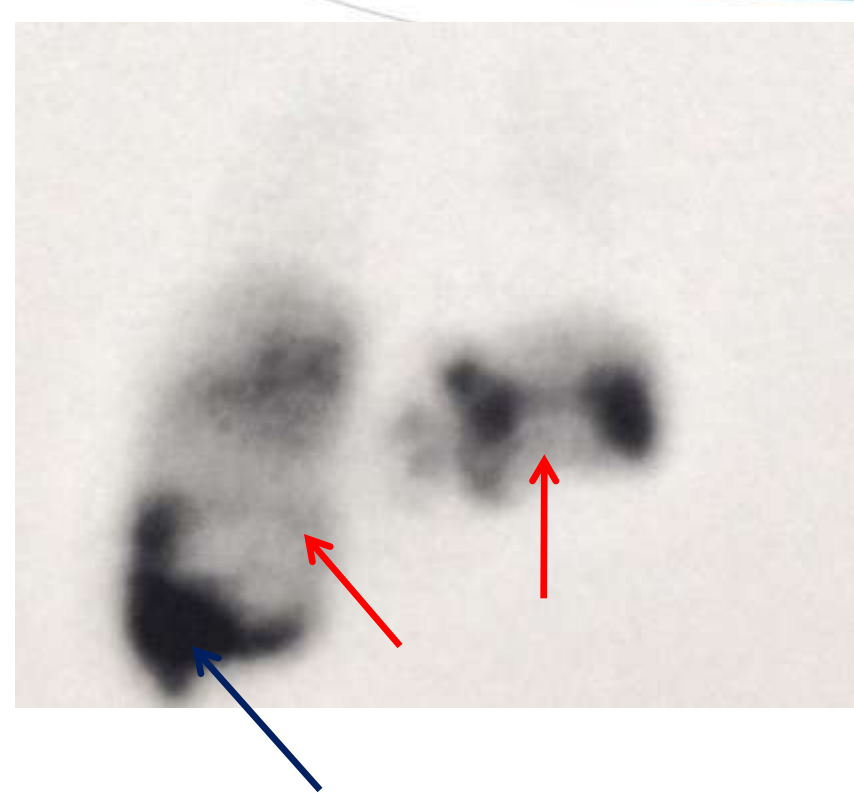




LS = 8.8%

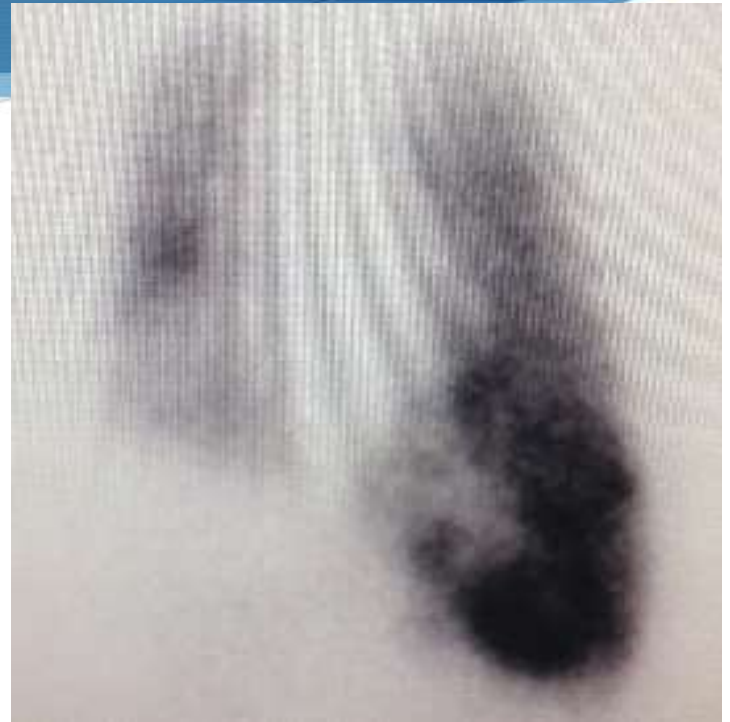
# 59/F with colon cancer with multiple liver metastasis





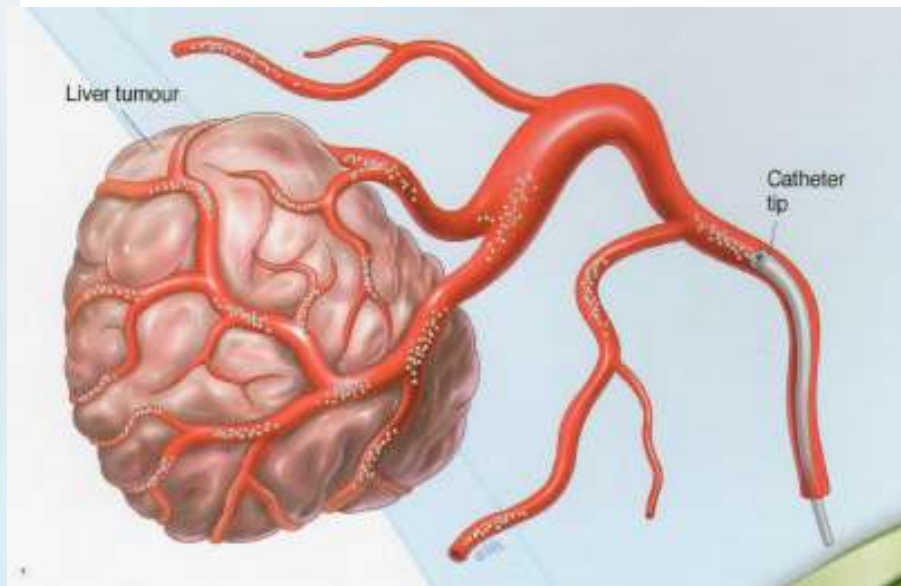
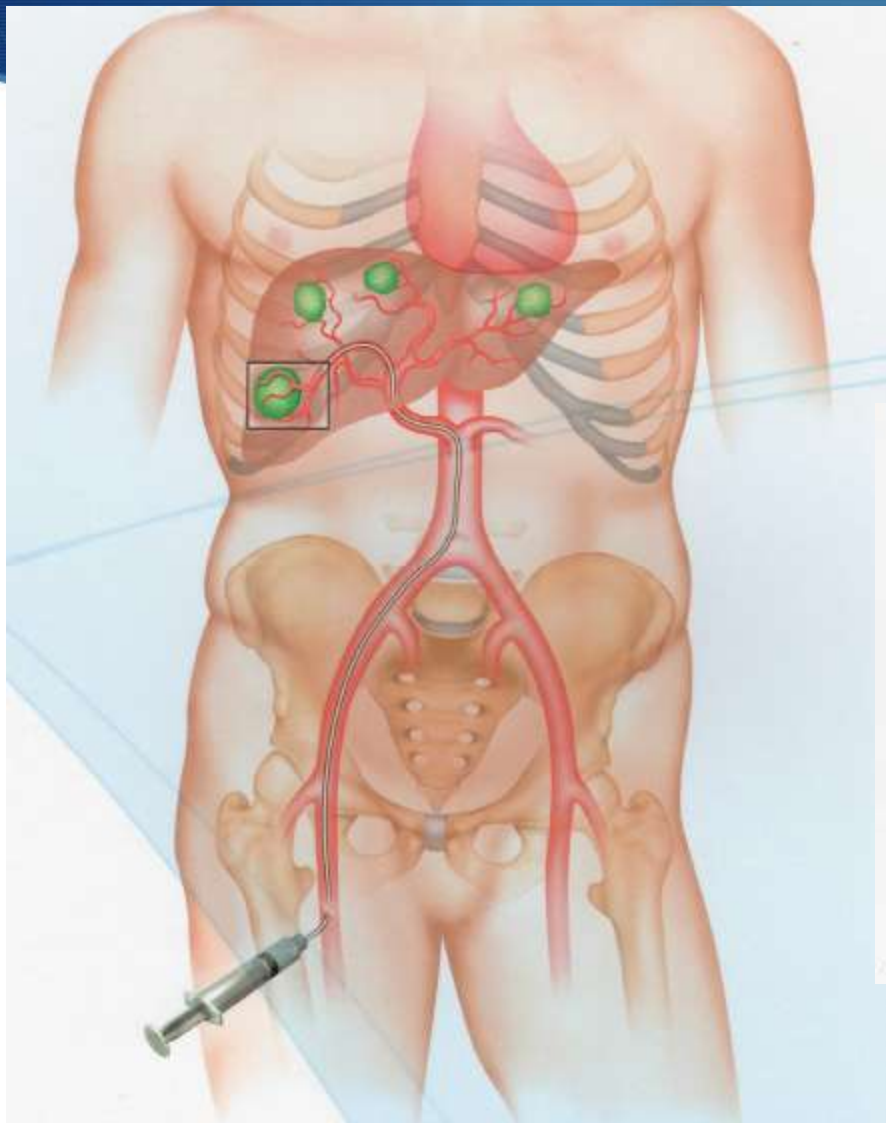


# 53/M with HCC right hepatic lobe mass



LS = 30.5%





# Empiric Method

Estimated Tumour Involvement	<sup>90</sup> Y dose
>50%	3 GBq
25-50%	2.5 GBq
<25%	2 GBq

% Lung Shunting	Recommended SIR-Spheres dose
<10%	Deliver full dose of SIR Spheres
10% to 15%	Reduce amount of SIR Spheres by 20%
15% to 20%	Reduce amount of SIR Spheres by 40%



# Body Surface Area Method

$$\text{BSA}(\text{m}^2) = 0.20247 \times \text{height (m)}^{0.725} \times \text{weight (kg)}^{0.425}$$

$$\text{Activity}(\text{GBq}) = \frac{(\text{BSA} - 0.2) + \text{Volume of Tumor} \times 100}{\text{Liver Volume}}$$

With:

$V_{\text{Tumour}}$  = Volume of the total tumour mass in the liver

$V_{\text{Total Liver}}$  = Volume of the total liver (including tumour)

$\text{BSA} [\text{m}^2]$  =  $0.20247 \times \text{height}[\text{m}]^{0.725} \times \text{weight} [\text{kg}]^{0.425}$



# Partition Model

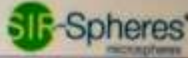
- Used in the calculation of absorbed doses in the tumor, normal liver and lung compartments
- Aim is to deliver dose of  $120 \pm$  Gy to the volume to be treated
- Normal liver should never be  $>70$ Gy and should preferably remain  $<50$ Gy

$$\text{Tissue Radiation Dose [Gy] Liver} = \frac{49670 \times \text{Total } ^{90}\text{Y activity in liver [GBq]}}{\text{Mass of liver [g]}}$$

# SIR-Spheres Microspheres Activity Calculator

- employs the body surface area (BSA) method for the calculation of the prescribed activity of SIR-Spheres microspheres to implant into an individual patient.
- Sirtex recommends the use of the body surface area (BSA) method on the basis of its more favorable safety and toxicity profile, based on its extensive use both within formal clinical trials and in the non-trial setting of routine clinical practice

# SIR-Spheres Microspheres Activity Calculator

**Activity Calculator** 

Date: Auto Generated User reference:

**Patient Data**

Patient height:   Total liver volume (cc/cm<sup>3</sup>):   
Patient weight:

**Target Region**

Volume of liver to be treated (cc/cm<sup>3</sup>):   
Volume of tumour in treated region (cc/cm<sup>3</sup>):


**Lung Shunt**

Lung shunt (%):   
Estimated lung mass:

**Calculated activity (GBq):**

Activity reduction (%):

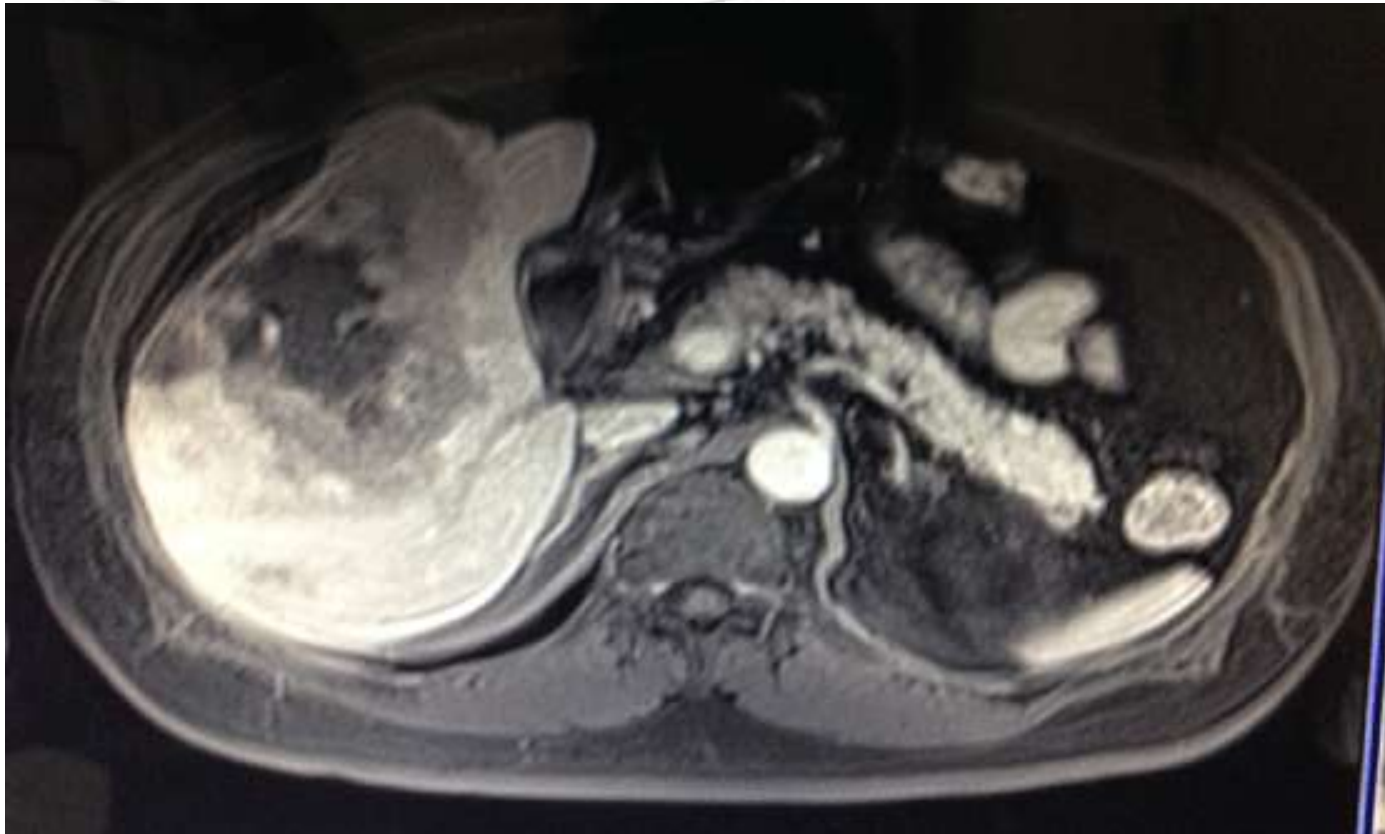
**Activity after reduction (GBq):**

 **Sirtex Medical Limited**  
Level 33, 101 Miller Street  
North Sydney NSW 2060  
Australia  
+61 2 9064 8400

Version 1.1.2

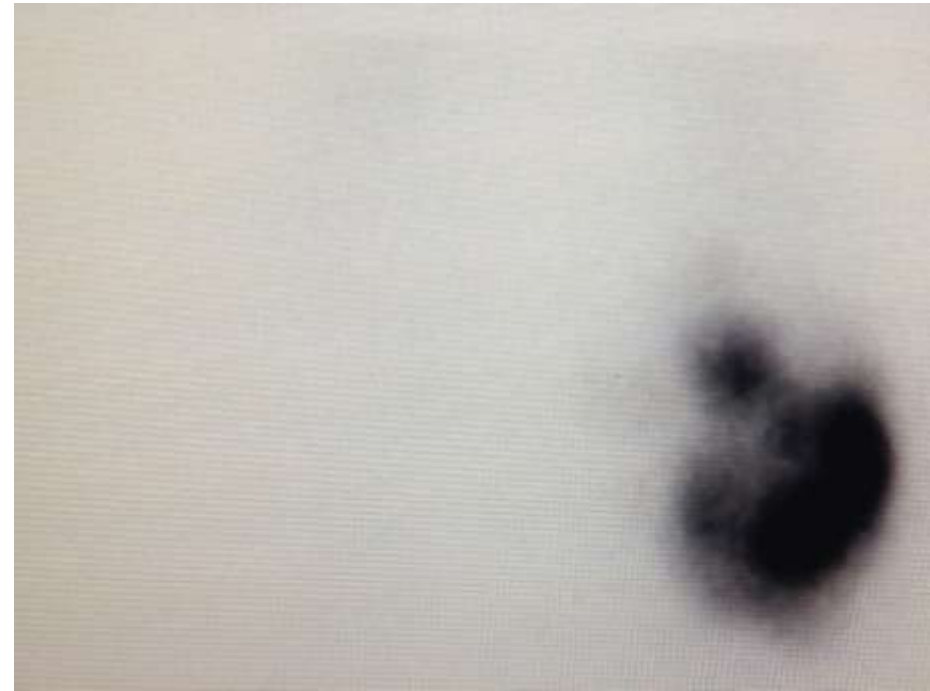
© SIR-Spheres is a registered trademark of Sirtex. SIR-Spheres Pty Ltd

59/M HCC  
right hepatic lobe mass



# 59/M HCC

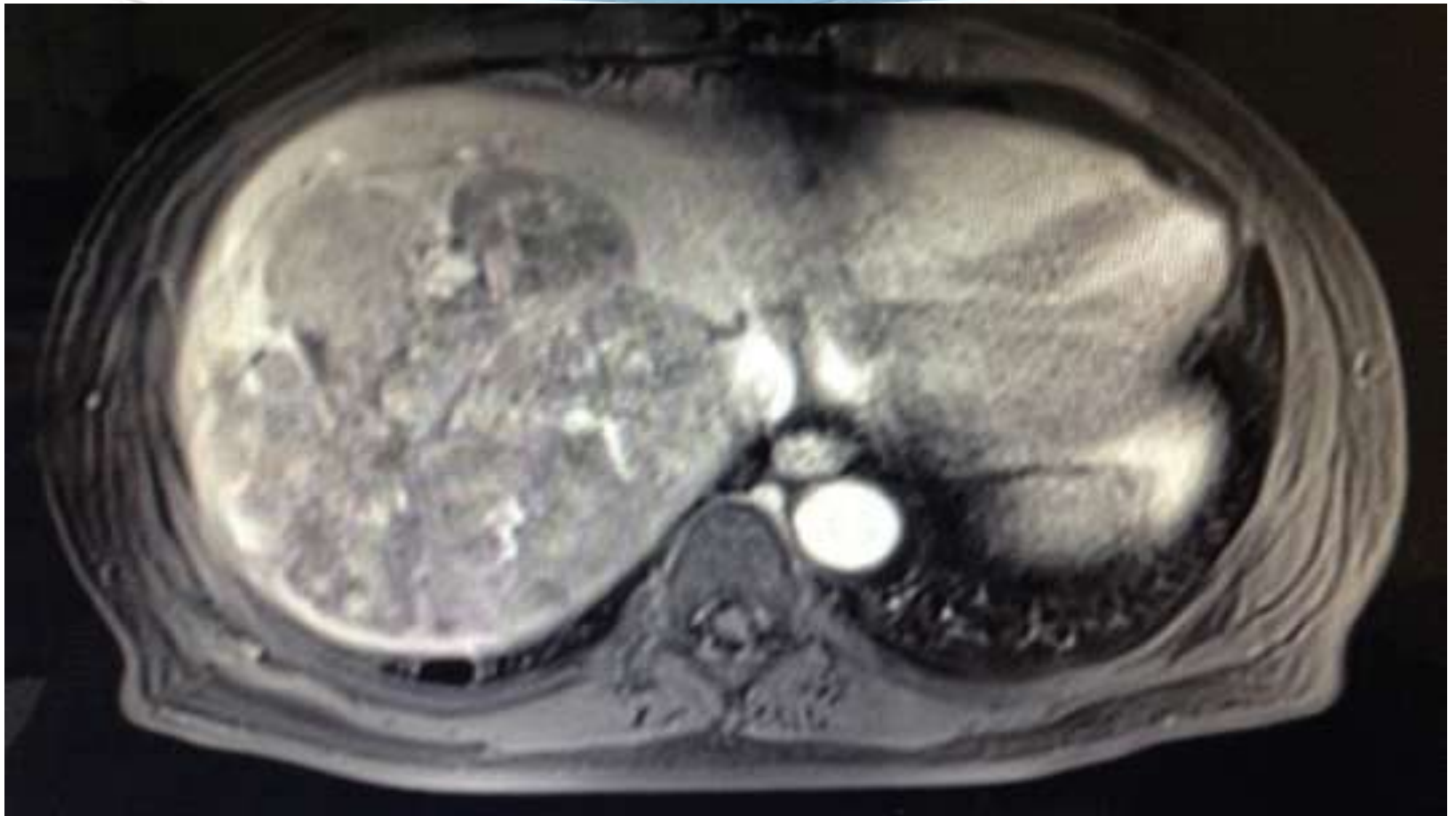
## right hepatic lobe mass



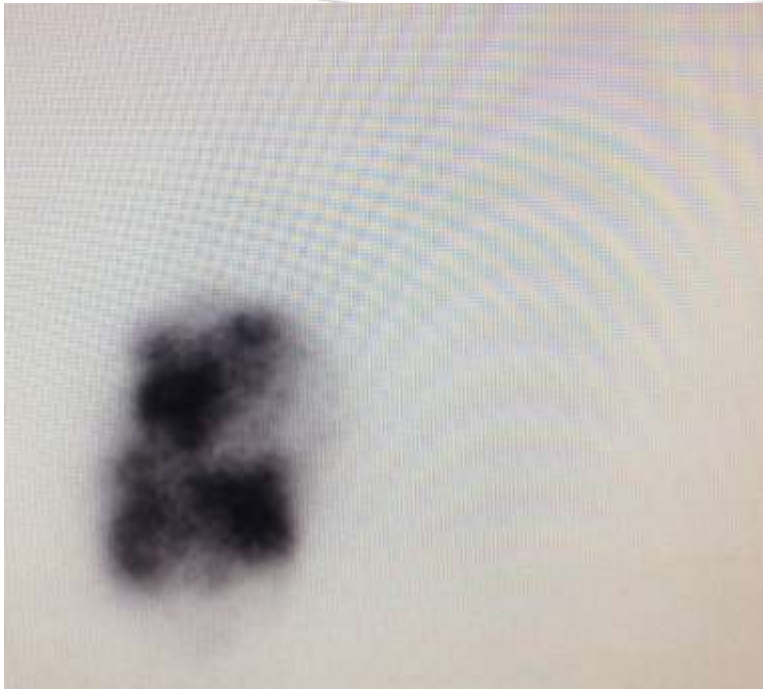
1.77 GBq to the right lobe mass



62/M with HCC  
right hepatic lobe mass



# 62/M with HCC right hepatic lobe mass



1.61 GBq to the right hepatic artery

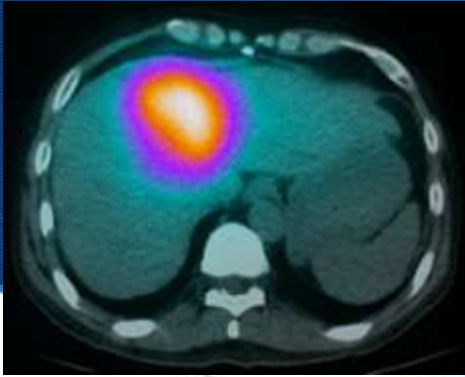
# 65/M with multifocal liver metastases



1.04 GBq to the right lobe mass



0.40 GBq (0.21 GBq + 0.18 GBq)  
to the left lobe



# Bremsstrahlung scan

- Secondary radiation as electrons interact with matter
- Recommended to document the distribution of microspheres (within 24 hours)
- Unwanted deposition of Y-90 microspheres in other organs other than the liver

# 59/M HCC

## right hepatic lobe mass



MAA



1.77 GBq to the right lobe mass

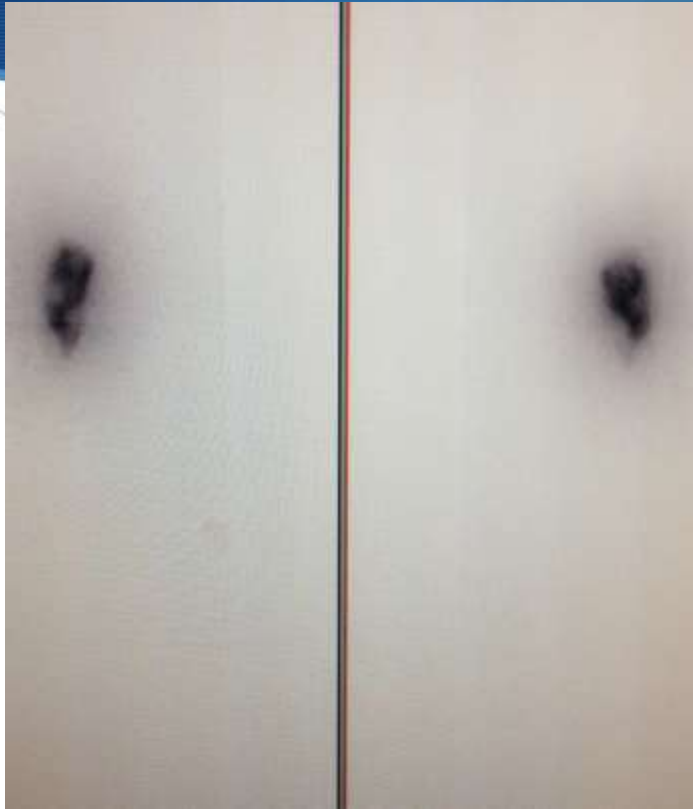
Bremsstrahlung



# 65/M with multifocal liver metastases



MAA scan



1.04 GBq to the right lobe mass



0.40 GBq (0.21 GBq + 0.18 GBq)  
to the left lobe

## Bremsstrahlung scan

# Adverse Effects

## Relatively Common

abdominal pain, fever, nausea

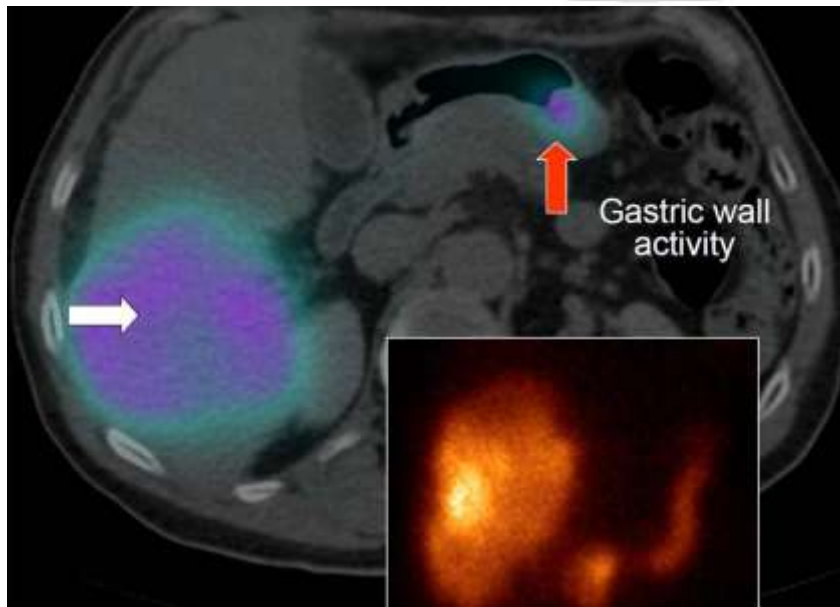
## Rare and avoidable

pancreatitis, cholecystitis, gastritis, peptic ulceration  
radiation pneumonitis, radiation dermatitis

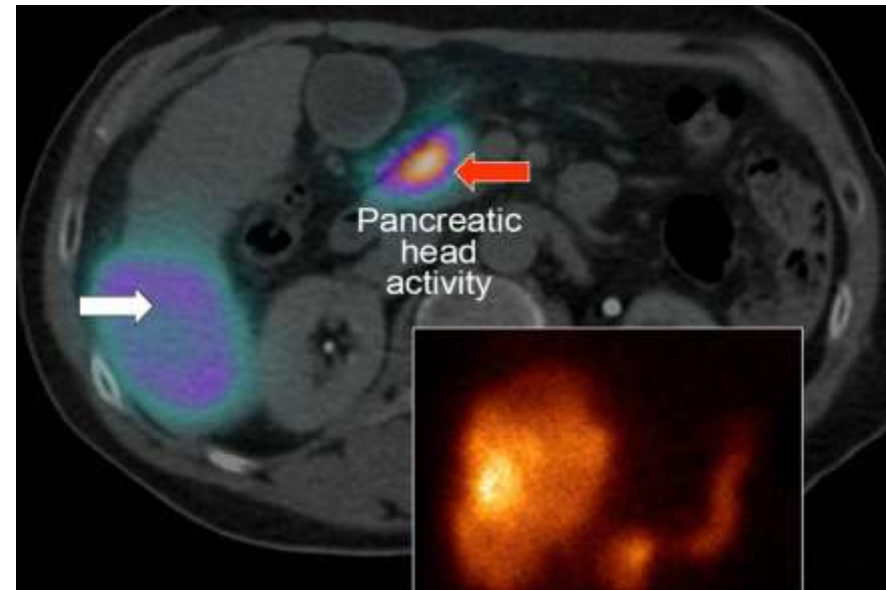
## Unpredictable

radiation hepatitis

# Adverse Effects

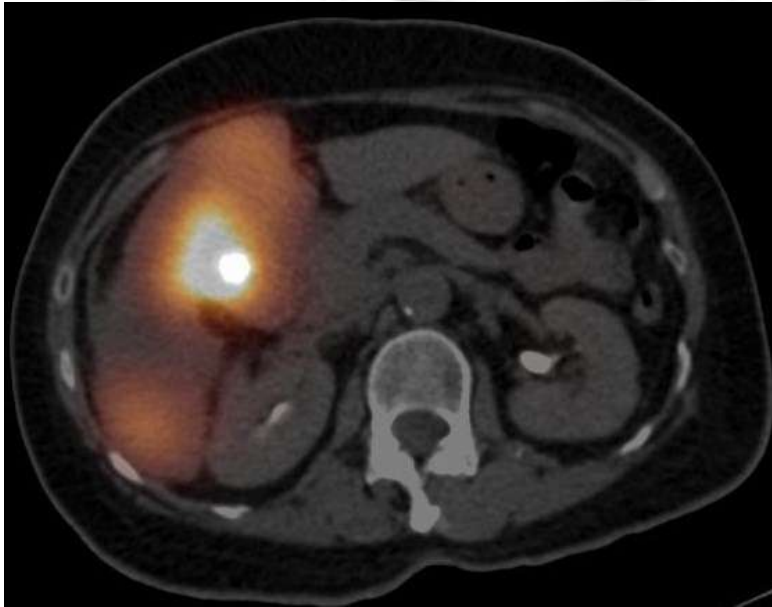


gastritis



pancreatitis

# Adverse Effects



cholecystitis



dermatitis



# Radiation Exposure

- Half life of 2.67 days
- 94% is gone in 11 days
- Almost 100% in one month

A blue curved banner or ribbon shape at the top of the page, with a gradient from dark blue to light blue.

THANK YOU