Technical guide:

Lung Shunt Estimation by Tc-99m MAA SPECT/CT - How to minimise errors due to the diaphragm

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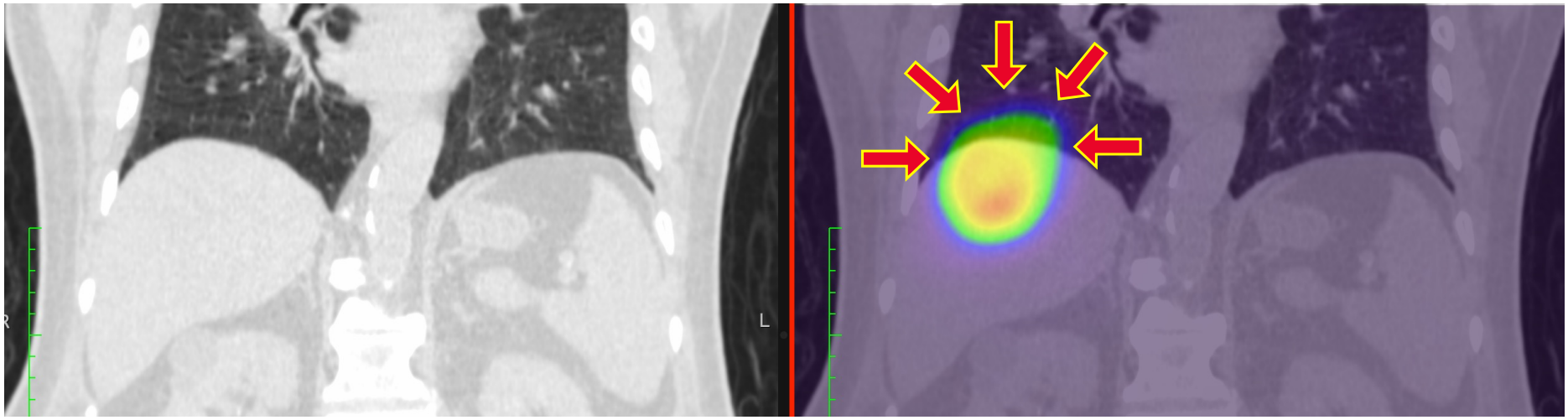
Lung Shunt Fraction by Tc-99m MAA SPECT/CT
How to deal with the diaphragm

First and foremost,

Respiratory-gated SPECT/CT or **deformable SPECT registration** to CT are good solutions to deal with mis-registration at the diaphragm. If your department has this capability, then please continue to use it. Otherwise, this presentation will provide you with some guidance.



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Lung Shunt Fraction by SPECT/CT is more accurate than planar methods because SPECT/CT has:

- Attenuation and scatter correction
- Anatomical correlation

But both SPECT/CT and planar methods are vulnerable to artifacts due to the diaphragm.

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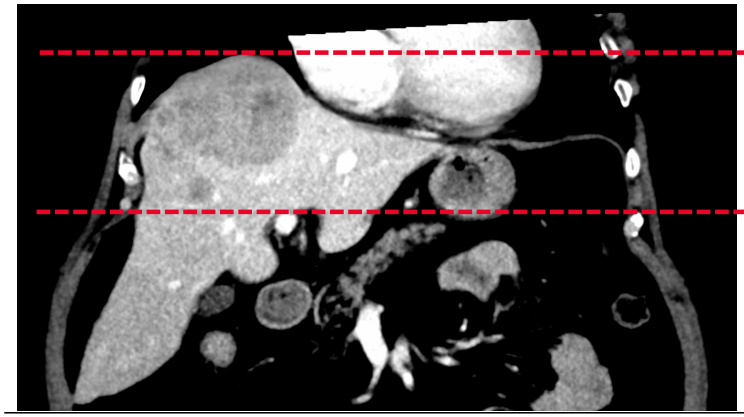
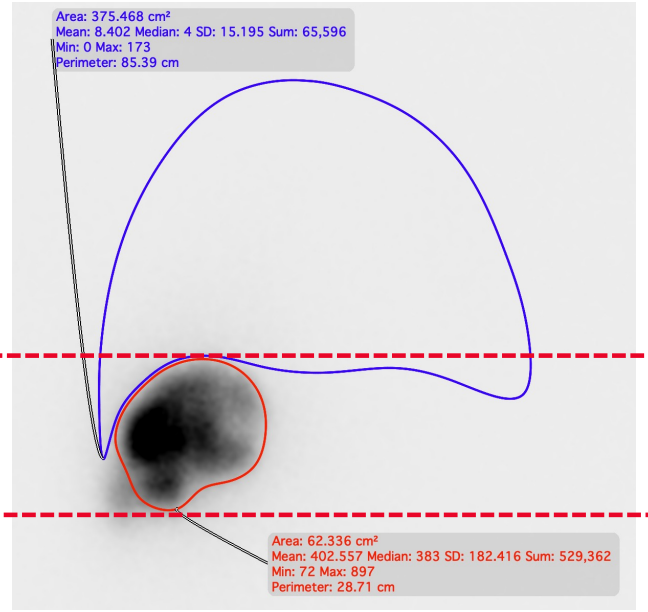
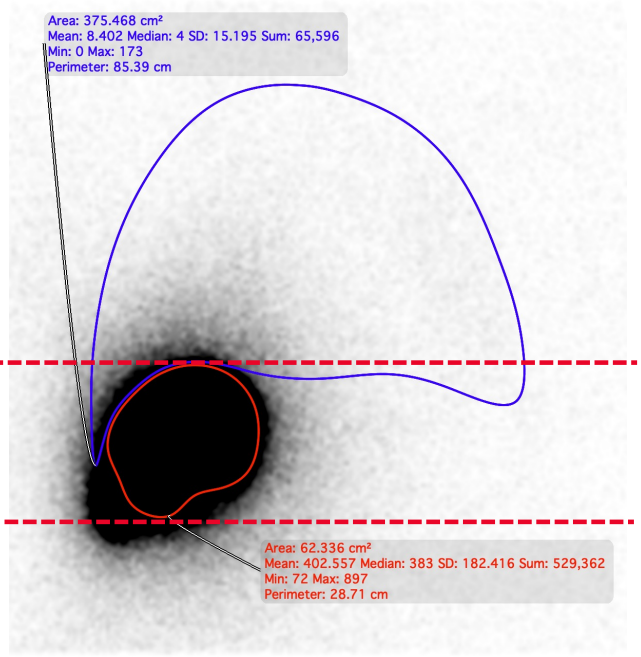
Consider this example of a large liver tumour abutting the right diaphragm.

Concept of Tumour-to-Lung shunt:
https://journals.lww.com/nuclearmedicinecomm/Citation/2014/03000/Dosimetric_theory_for_tumor_to_lung_shunt_fraction.16.aspx

The planar Tumour-to-Lung shunt fraction (not "Liver-to-Lung" shunt) fraction was approximately 12%, which is obviously wrong because we can clearly see that left lung activity is only slightly greater than background activity.







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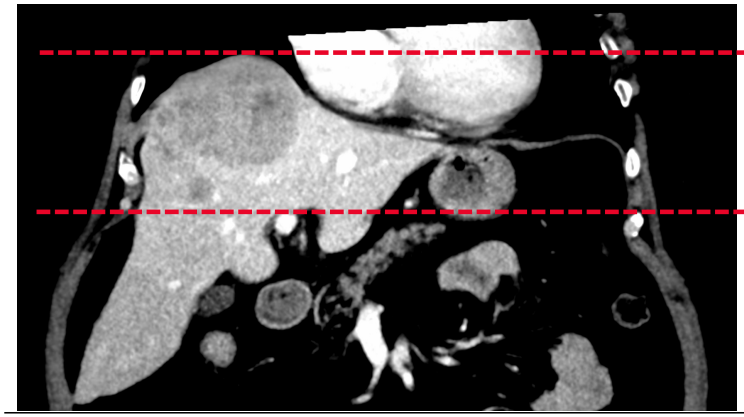
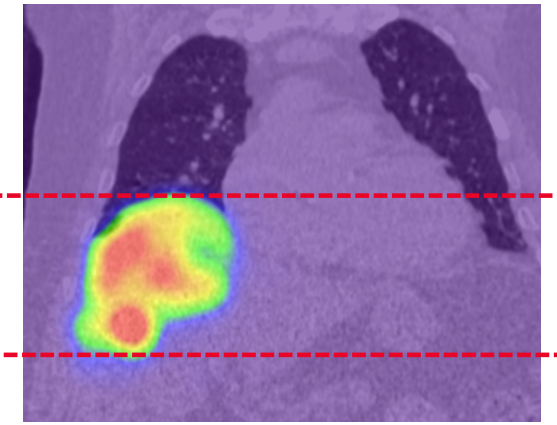
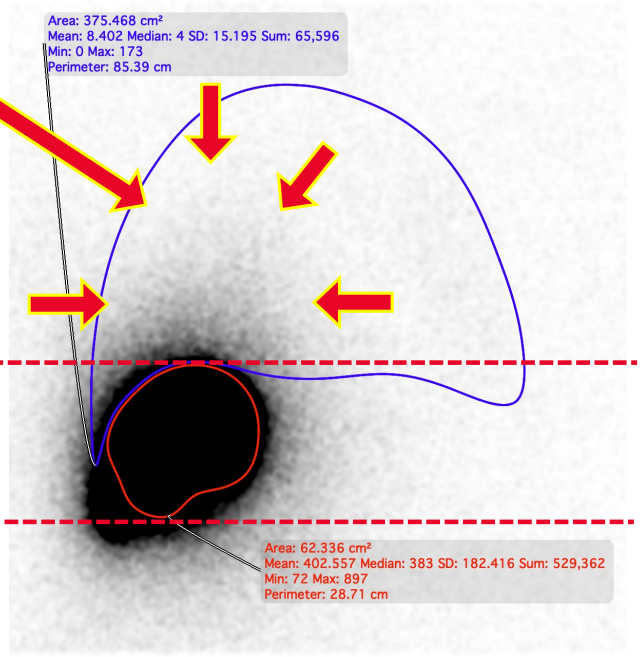
Consider this example of a large liver tumour abutting the right diaphragm.

Most of the inaccuracy is due to sub-diaphragmatic scatter present on planar scintigraphy but is significantly less on SPECT/CT







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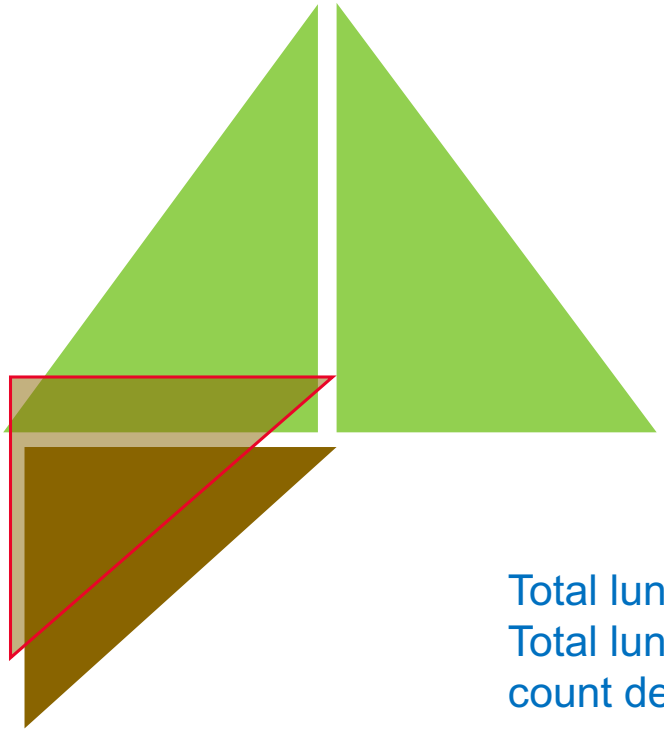
How to deal with the diaphragm

Include top 2/3 of right lung for lung mean count density (counts/cm3)

Exclude bottom 1/3 of right lung



Include whole left lung for lung mean count density (counts/cm3)

Total lung counts is simply:
Total lung volume (cm3; by CT) x lung mean count density (counts/cm3)

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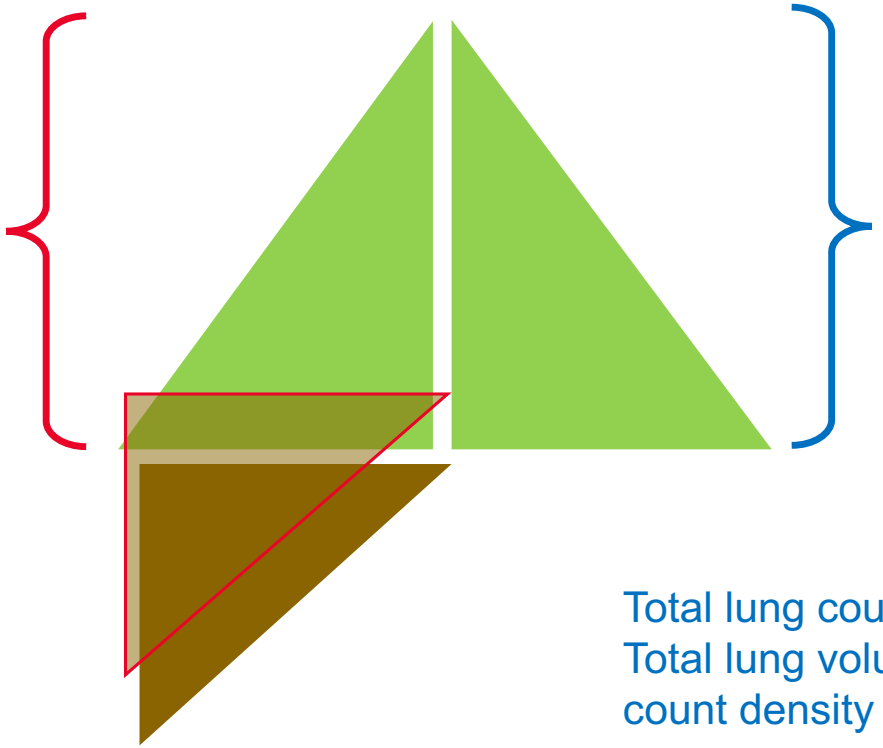
Alternatively, some have chosen to exclude the whole right lung and rely only on the left lung to calculate the mean count density.

This simplification assumes that the mean count density of the left lung is identical to the right lung, which might not always be true.



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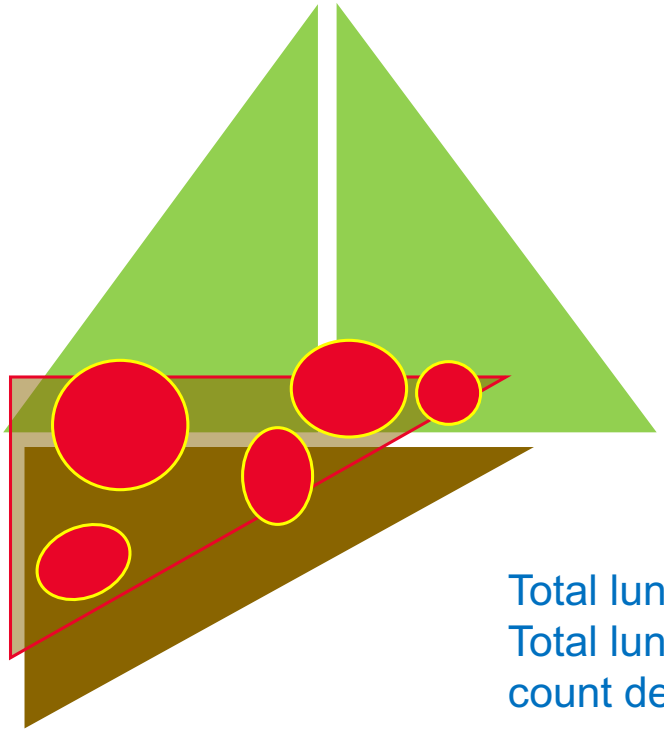

Include top 2/3 of left lung for lung mean count density (counts/cm3)

Exclude bottom 1/3 of left lung

We sometimes encounter large bulky tumours that extend to the **left diaphragm** (usually hepatocellular carcinoma)

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Here are two technical papers to help you make sense of it all:

Kao et al. *Personalized predictive lung dosimetry by technetium-99m macroaggregated albumin SPECT/CT for yttrium-90 radioembolization*. EJNMMI Res. 2014;4:33
https://ejnmmires.springeropen.com/track/pdf/10.1186/s13550-014-0033-7.pdf

Kao YH. *Dosimetric theory for tumor-to-lung shunt fraction calculation in yttrium-90 radioembolization of noncirrhotic livers*. Nucl Med Commun. 2014;35:331-332
https://journals.lww.com/nuclearmedicinecomm/Citation/2014/03000/Dosimetric_theory_for_tumor_to_lung_shunt_fraction.16.aspx