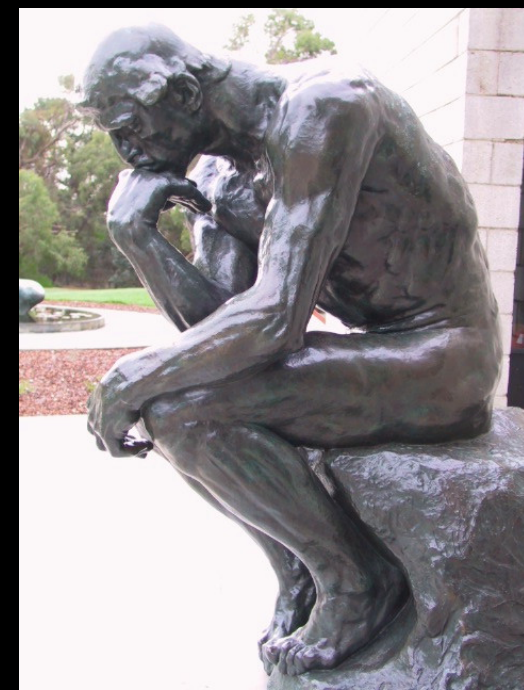


DIAGNOSTIC ONCOLOGY: PET ARRIVES IN BALLARAT

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OVERVIEW

PRINCIPLES OF PET and PET TRACER #1 DIAGNOSTIC CT IS INDISPENSABLE THE FOUR DIAGNOSTIC ONCOLOGY TASKS CANCER BY CANCER

- solitary pulmonary nodule
- non small cell lung cancer
- melanoma
- colorectal cancer
- ovarian cancer
- esophageal/gastroesophageal cancer
- head and neck cancer
- lymphoma
- sarcoma
- carcinoma of the cervix
- glioma
- breast carcinoma
- prostate carcinoma
- testicular carcinoma
- small cell lung cancer/blue round cell tumours
- pancreatic cancer
- non-oncology indications

PATIENT EXPERIENCE

WHAT YOU GET

PET DOES NOT REPLACE BIOPSY and FALSE NEGATIVES

OBJECTIVES

On completion of this lecture, participants will be able to:

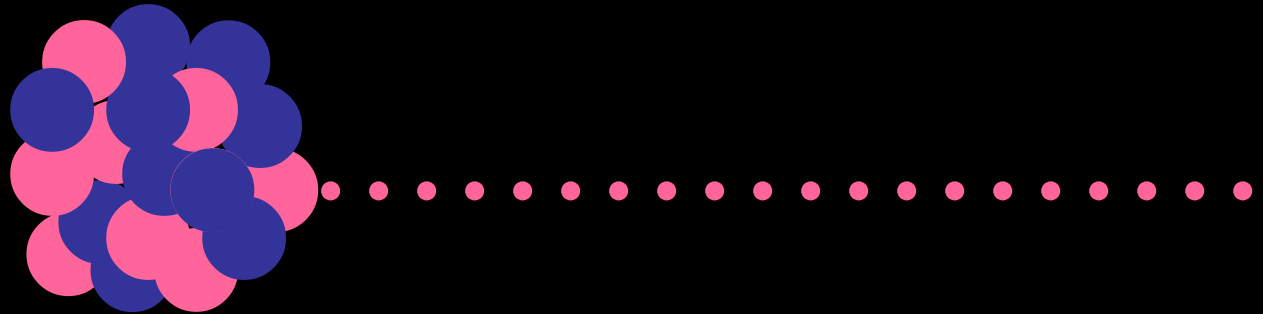
1. understand the difference between FDG-PET scans and diagnostic CT scans, the relative strengths and weaknesses of each, and their complementary role
2. understand and be conversant with the four tasks of diagnostic oncology (characterisation; staging/restaging; localisation/RT planning; and therapeutic monitoring)
3. (SAFETY) understand the limitations of FDG-PET, its capacity for false positives and false negatives, and have realistic expectations of its diagnostic accuracy.

How can you safeguard this knowledge?

1. critically read and question the oncologic CT and oncologic PET reports of your patients, and be an active participant in resultant decision making

PRINCIPLES OF PET

All PET tracers emit positrons

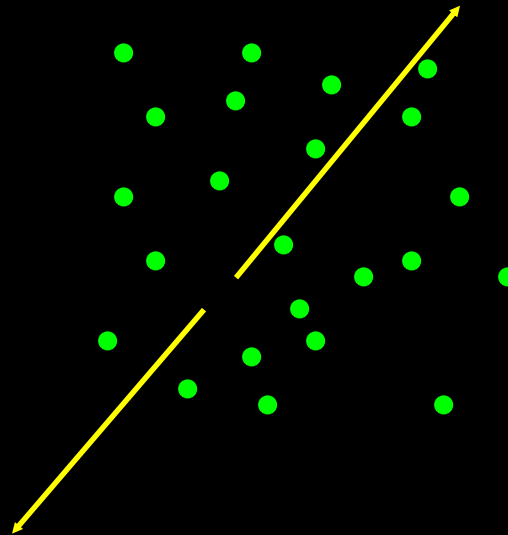


O-18 OXYGEN

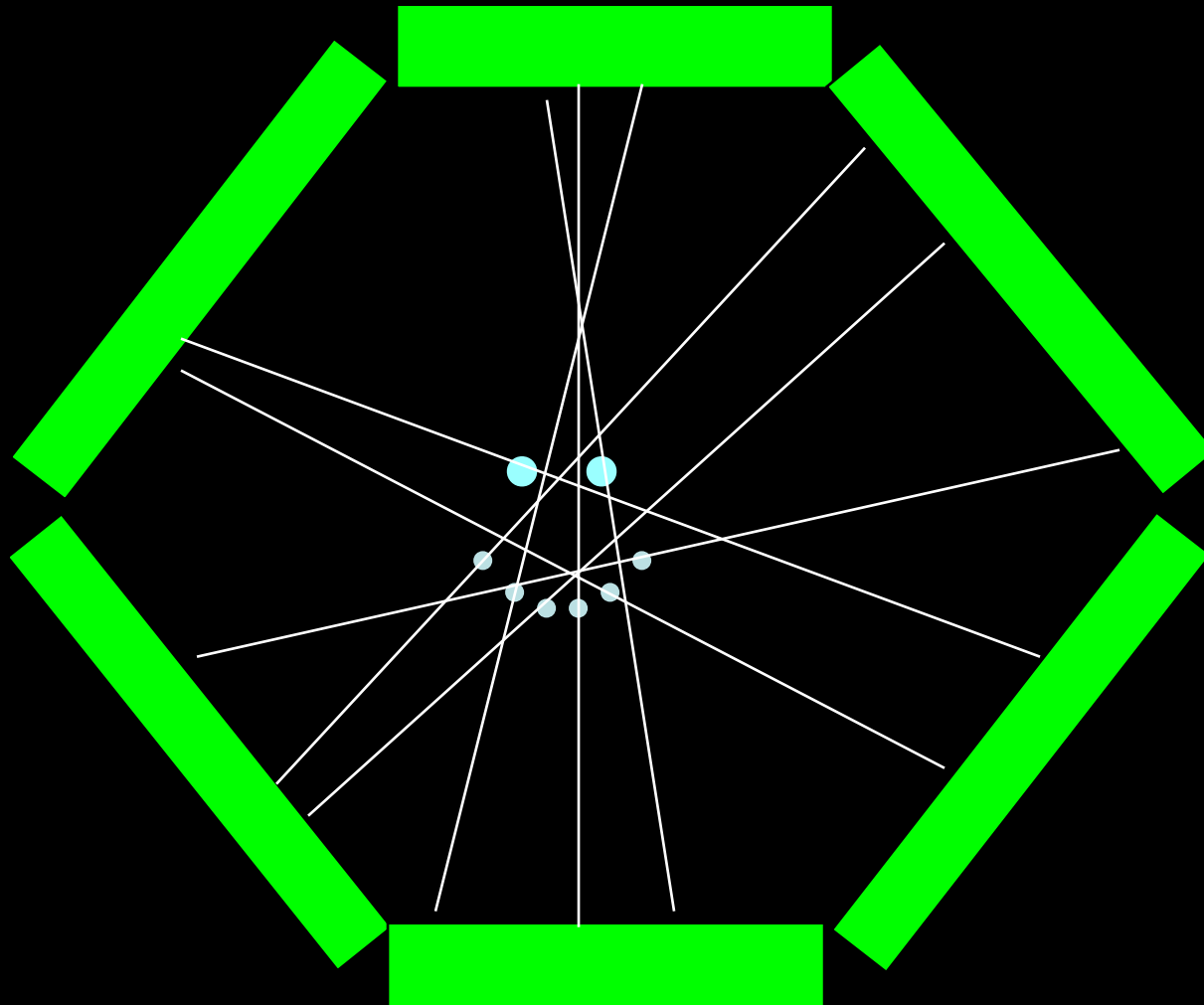
PRINCIPLES OF PET

Emitted positron annihilates with any electron

Two 511 keV photons are emitted at 180°



PRINCIPLES OF PET

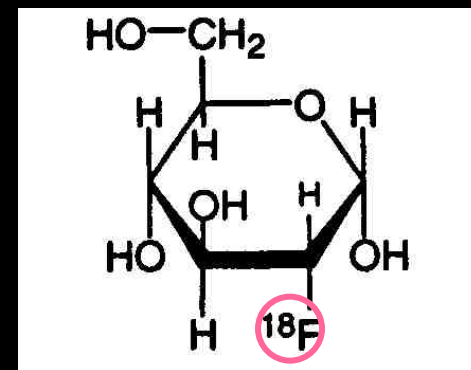
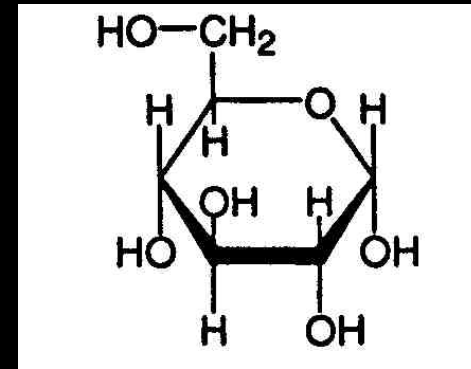


#1 PET TRACER

MOLECULE: GLUCOSE

TRACER: F-18 FLUORO
DEOXY GLUCOSE

PROCESS: GLUCOSE UPTAKE
AND METABOLISM



FLUORODEOXYGLUCOSE

FDG – NORMAL UPTAKE

Brain

Liver, spleen, bone marrow

Myocardium (variable)

Active muscle: vocal cords, ocular muscles, etc

Peristalsing bowel, mucosal uptake

Testes and ovary with corpus luteum

Blood pool (red blood cells)

Brown fat (heat producing)

Excreted in urine – very hot bladder, renal pelves

FLUORODEOXYGLUCOSE

FDG – TUMOURAL UPTAKE

Tumours have inefficient glucose metabolism
Tumours have upregulated glucose receptors
Tumours take up FDG

HIGH GRADE TUMOURS

take up more FDG than background – very visible!

LOW GRADE TUMOURS

may not be visible especially if in warm background:
e.g. low grade hepatocellular, low grade breast and
prostate carcinomas

ALL PETs COME WITH NON DIAGNOSTIC CT

Every modern PET scanner incorporates a CT scanner

low dose non diagnostic CT is done with every PET scan for attenuation correction and anatomical localisation

THIS CT IS INADEQUATE FOR ACCURATE ANATOMICAL STAGING

DIAGNOSTIC CT IS INDISPENSABLE

PRIMARY STAGING:

tumour margins, invasion of structures, resectability, anatomical relations, structures in danger, structures compressed...

T STAGING IS DONE BY CT AND NOT BY PET

LUNGS AND LIVER:

CT detects lung metastases before FDG PET
liver is metabolically active: small metastases are not seen by FDG PET

DIAGNOSTIC CT: HOW DIFFERENT?

SHARPER ANATOMICAL BOUNDARIES:

- full diagnostic radiation dose – no image noise;
- done in suspended respiration (usually inspiration);
- sharp bone, noiseless soft tissue;

INTRAVENOUS CONTRAST (if no contraindication):

- unequivocal identification of blood vessels;
- contrast between vascular organs and tumour masses (e.g. liver, spleen, pulmonary hila);
- multiphase acquisition shows tumour vascularity (e.g. hepatocellular carcinoma, pancreatic carcinoma)

ORAL CONTRAST (we use negative oral contrast):

- identification of bowel and distinction from collections;

DELAYED SCANS, PRONE SCANS, etc:

- specifically targeting particular structures e.g. ureters and renal collecting systems

THE FOUR DIAGNOSTIC ONCOLOGY TASKS 1

CHARACTERISATION:

is this likely to be cancer?

solitary pulmonary nodules, pancreatic masses, sarcomas

is this sterilised disease or residual disease?

glioma, lymphoma, presacral scar

THE FOUR DIAGNOSTIC ONCOLOGY TASKS 2

LOCALISATION:

where is the cancer?

metastases, search for primary

head and neck, melanoma, adenocarcinoma

and

RT PLANNING:

where are the cancer's margins?

head and neck, esophagus, lung, rectum,
cervix, prostate, many others

THE FOUR DIAGNOSTIC ONCOLOGY TASKS 3

STAGING:

how far has the cancer spread (first presentation)?

EVERY cancer except leukemia, solar keratoses

and

RESTAGING:

where is the cancer (subsequent presentation)?

by definition, treatment is COMPLETED

THE FOUR DIAGNOSTIC ONCOLOGY TASKS 4

THERAPY MONITORING:

is the cancer responding to treatment?

by definition, treatment is ongoing


lymphoma, sarcoma, head and neck

CANCER BY CANCER

This is how I would stage common cancers with the tools that are reasonably available in Australia in 2009

My recommendations are neither guidelines nor law

I have identified those indications for which there is Medicare support with the  logo. Please check the Medicare website for full descriptor of item and cancer eligibility.

Where no Medicare support is available, I have also indicated it: . The service is available at its cost (note: Austin and Royal Prince Alfred Hospitals have block PET funding).

SOLITARY PULMONARY NODULE

CHARACTERISATION

CT
FDG-PET
BIOPSY



LUNG CANCER (NSCLC)

STAGING

CT
FDG-PET
BONE SCAN
MR (brachial plexus)



RESTAGING

FDG-PET
CT



RT PLANNING

FDG-PET
CT



MONITORING

FDG-PET
CT



MALIGNANT MELANOMA

STAGING

CT
FDG-PET
MR (brain)



RESTAGING

FDG-PET
CT



MONITORING
(surveillance)

FDG-PET
CT (lungs)
MR (brain)



COLORECTAL CANCER

STAGING

MR (T)

medicare

CT (N, M)

medicare

FDG-PET (N,M)



RESTAGING

FDG-PET

medicare

CT

medicare

RT PLANNING

MR

medicare

MONITORING
(neoadjuvant)

FDG-PET

medicare

MR

medicare

OVARIAN CANCER

STAGING

MR (T)
CT (N,M)
FDG-PET

medicare

medicare



RESTAGING

FDG-PET
CT

medicare

medicare

MONITORING

FDG-PET
CT

medicare

medicare

ESOPHAGEAL / GASTROESOPHAGEAL CANCER

STAGING

DEDICATED CT
FDG-PET



RT PLANNING

FDG-PET
CT



RETAGGING

FDG-PET
CT



MONITORING

FDG-PET



GASTRIC CANCER



HEAD AND NECK CANCER

LOCALISATION

FDG-PET

MR

DEDICATED CT

medicare

medicare

medicare

STAGING and
RT PLANNING

MR (T)

FDG-PET

CT (T, also lungs)
(BONE SCAN)

medicare

medicare

medicare

medicare

RESTAGING

FDG-PET

CT (lungs)

medicare

medicare

MONITORING

FDG-PET

MR (T)

medicare

medicare

LYMPHOMA (HD or NHL)

STAGING

FDG-PET

CT

MR (bone marrow,
brain)

medicare

medicare

medicare

CHARACTERISATION
(residual)

FDG-PET

medicare

RETAGGING

FDG-PET

?CT

medicare

medicare

MONITORING

FDG-PET

?CT

medicare

medicare

SARCOMA

CHARACTERISATION
(biopsy guidance)

FDG-PET

medicare

STAGING

MR

medicare

FDG-PET

medicare

CT (T and lungs)

medicare

BONE SCAN

medicare

RETAGGING
(if structural findings)

FDG-PET

medicare

CT (lungs)

medicare

MR

medicare

MONITORING
(neoadjuvant)

FDG-PET



MR

medicare

CERVICAL CANCER

STAGING

MR (T,N)
CT (N,M)
FDG-PET



RT PLANNING

MR
FDG-PET



RESTAGING

FDG-PET
CT



MONITORING

FDG-PET
MR



GLIOMA

STAGING

MR and MRS

medicare

CHARACTERISATION
(residual)

FDG-PET
MR and MRS
Thallium

medicare

medicare

medicare

RT PLANNING

MR

medicare

MONITORING

FDG-PET
MR



medicare

FLT and FET PET is likely to take over from FDG PET

BREAST CANCER (!problematic)

DIAGNOSIS and
PROBLEM SOLVING

MAMMOGRAPHY and US
BREAST MR
BIOPSY



STAGING

BREAST MR (T, other side)
CT
FDG-PET
LYMPHOSCINTIGRAPHY
BONE SCAN



RESTAGING

WHATEVER WORKS

MONITORING

MAMMOGRAPHY and US
BREAST MR?
FDG-PET?



PROSTATE CANCER (!problematic)

LOCALISATION and PROBLEM SOLVING MR AND MR SPECTROSCOPY
US GUIDED AND UNGUIDED Bx



STAGING MR (prostate), MR (bone marrow)
CT
BONE SCAN
Ferrumoxides MR (pre surgery)



RT PLANNING MR



MONITORING and RESTAGING MR, MR SPECTROSCOPY



FUTURE ?FLUORO-CHOLINE PET



TESTICULAR CANCER

STAGING

CT

medicare

FDG-PET

RT PLANNING

FDG-PET

CT

medicare

RESTAGING

CT

medicare

FDG-PET

MONITORING

FDG-PET

SCLC and SMALL ROUND BLUE CELL TUMOURS

STAGING

FDG-PET
CT
MR (CNS)



RESTAGING

FDG-PET
CT
MR (CNS)



MONITORING

FDG-PET



IF EWING'S TUMOUR CALLED EWING'S SARCOMA



PANCREATIC CANCER

STAGING

DEDICATED CT
MR
FDG-PET



RT PLANNING

CT



RESTAGING

CT
FDG-PET if FDG avid



MONITORING

FDG-PET if FDG avid



NON ONCOLOGIC INDICATIONS

MYOCARDIAL VIABILITY
REST MIBI
STRESS MIBI
24 hour Thallium
FDG-PET



(if others equivocal)

REFRACTORY EPILEPSY
MR
FDG-PET



(presurgical)

ONCOLOGY PATIENT EXPERIENCE

WE DO BOTH THE DIAGNOSTIC CT AND THE
FDG-PET DURING ONE PATIENT VISIT

Our patients have both their PET and diagnostic CT done directly one after another at the same appointment

Our PET and CT technologist swap at the console, and fit around our patients

I read the PET and the diagnostic CT together for maximal accuracy and patient benefit

ONCOLOGY PATIENT EXPERIENCE

PREPARATION

Fasting overnight or at least 6 hours
Ample hydration (plain water, non sugary)
Aim for blood glucose <8

NIDDM – in addition to above

Need to have an early morning appointment
No morning oral hypoglycemics
Prefer no metformin for 48 hours (less gut uptake)

IDDM

Very individualised – please discuss with us

ONCOLOGY PATIENT EXPERIENCE

IN DEPARTMENT – PET PREPARATION

Patient questionnaire and interview by technologist
Secure IV line, injection of FDG
Quiet uptake period (at least 1 hour) on trolley

IN DEPARTMENT – CT PREPARATION

Need normal renal function for IV contrast!
Drinking **NEGATIVE** oral contrast during FDG uptake
IV line is used for both FDG and IV contrast injections

Total time for both PET and diagnostic CT is around
3 hours in our Department

WHAT YOU GET

REPORT - CARCINOMA

Structured semi synoptic report

Both metabolic and structural findings reported together

Primary tumour

Nodal metastases

Hematogenous metastases

Further findings

Conclusion: TNM stage if possible and reasonable

REPORT - LYMPHOMA

Structured semisynoptic report

Both metabolic and structural findings reported together

Primary mass

Remote spread

Extranodal disease

Further findings

Conclusion: (Ann Arbor stage if relevant)

WHAT YOU GET

REPORT - CARCINOMA

Structured semi synoptic report

Both metabolic and structural findings reported together

Primary tumour

Nodal metastases

Hematogenous metastases

Further findings

Conclusion: TNM stage if possible and reasonable

REPORT - LYMPHOMA

Structured semisynoptic report

Both metabolic and structural findings reported together

Primary mass

Remote spread

Extranodal disease

Further findings

Conclusion: (Ann Arbor stage if relevant)

WHAT YOU GET

TARGETS TABLE AND TARGET MEASUREMENTS

Structural measurements suitable for RECIST

Metabolic activity measurements suitable for therapy monitoring

Tumoral FDG uptake quoted as SUV(max)

Reference FDG uptake in blood pool and liver quoted as SUV(mean)

Target 1	Current size	SUVmax	Series/Image
	Previous size	SUVmax	Series/Image

The size and Series/Image refers to the diagnostic CT, if done same visit

Previous is that target's measurements last visit

BEWARE OVERRELIANCE ON THE SUV

SUV is not a substitute for diagnostic opinion

SUV's done at different institutions are not comparable

SUV's done with different protocols are not comparable

PET DOES NOT REPLACE BIOPSY

FDG – NON TUMOURAL UPTAKE

Healing scar

Radiation pneumonitis

Infective pneumonia

Abscess

Tuberculous or fungal granulomatous focus

Sarcoidosis

Corpus luteum of ovary

Urine in an unexpected location (eg ileal conduit)

Large bowel in patients taking metformin

Brown fat – in a cold patient

Muscular uptake – respiratory, voluntary, vocal

FDG FALSE NEGATIVES

LOW GRADE TUMOUR (often well differentiated)

- Low grade lymphoma
- Low grade pancreas
- Low grade prostate
- Bronchial carcinoid

SMALL FOCUS OF TUMOUR

- Microscopic metastases
- Small lung metastases
- Small liver metastases

METABOLICALLY ACTIVE BACKGROUND

- Brain
- Liver

THE END!

