SNM 2010. GP Oncology. June 7, 2010

Variations of clinical PET/CT operations for oncology imaging: An international web-based survey

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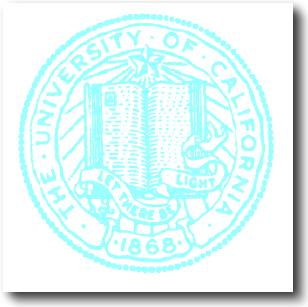


Conflict of interest

- T Beyer

  CEO & Founder of cmi-experts GmbH, Zurich, CH
- LS Freudenberg

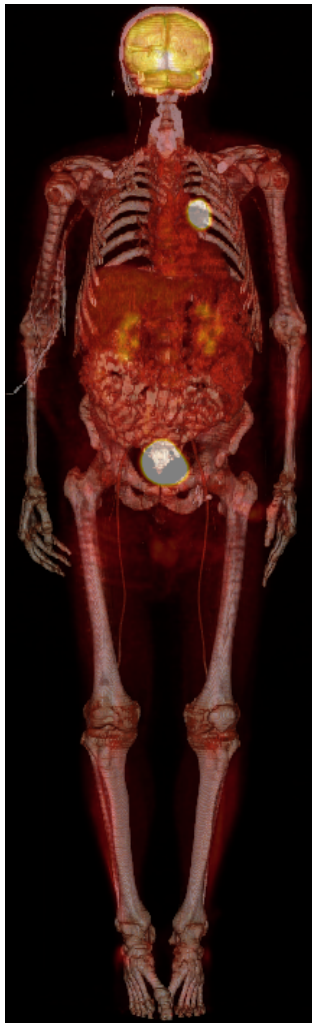
  Advisor to cmi-experts GmbH, Zurich, CH
- J Czernin

  Stockholder Sofie Biosciences, Momentum Biosciences,

  Advisor to cmi-experts GmbH, Zurich, CH

NONE

Clinical PET/CT



Delbeke et al.
JNM 47
2006

PROCEDURE GUIDELINE

Procedure Guideline for Tumor Imaging with ^{18}F-FDG PET/CT 1.0*

Dominique Delbeke[1], R. Edward Coleman[2], Milton J. Guiberteau[3], Manuel L. Brown[4], Henry D. Royal[5], Barry A. Siegel[5], David W. Townsend[6], Lincoln L. Berland[7], J. Anthony Parker[8], Karl Hubner[9], Michael G. Stabin[10], George Zubal[11], Marc Kachelriess[12], Valerie Cronin[13], and Scott Holbrook[14]

Krause et al.
Nuklearmedizin 46
2007

291

DGN

FDG-PET/CT in oncology*

German Guideline

*FDG-PET/CT in der Onkologie** *Leitlinie*

B. J. Krause[1], T. Beyer[2], A. Bockisch[2], D. Delbeke[3], J. Kotzerke[4], V. Minkov[5], M. Reiser[6], N. Willich[7], Arbeitsausschuss Positronenemissionstomographie der Deutschen Gesellschaft für Nuklearmedizin**

Boellaard et al.
EJNMMI 37
2010

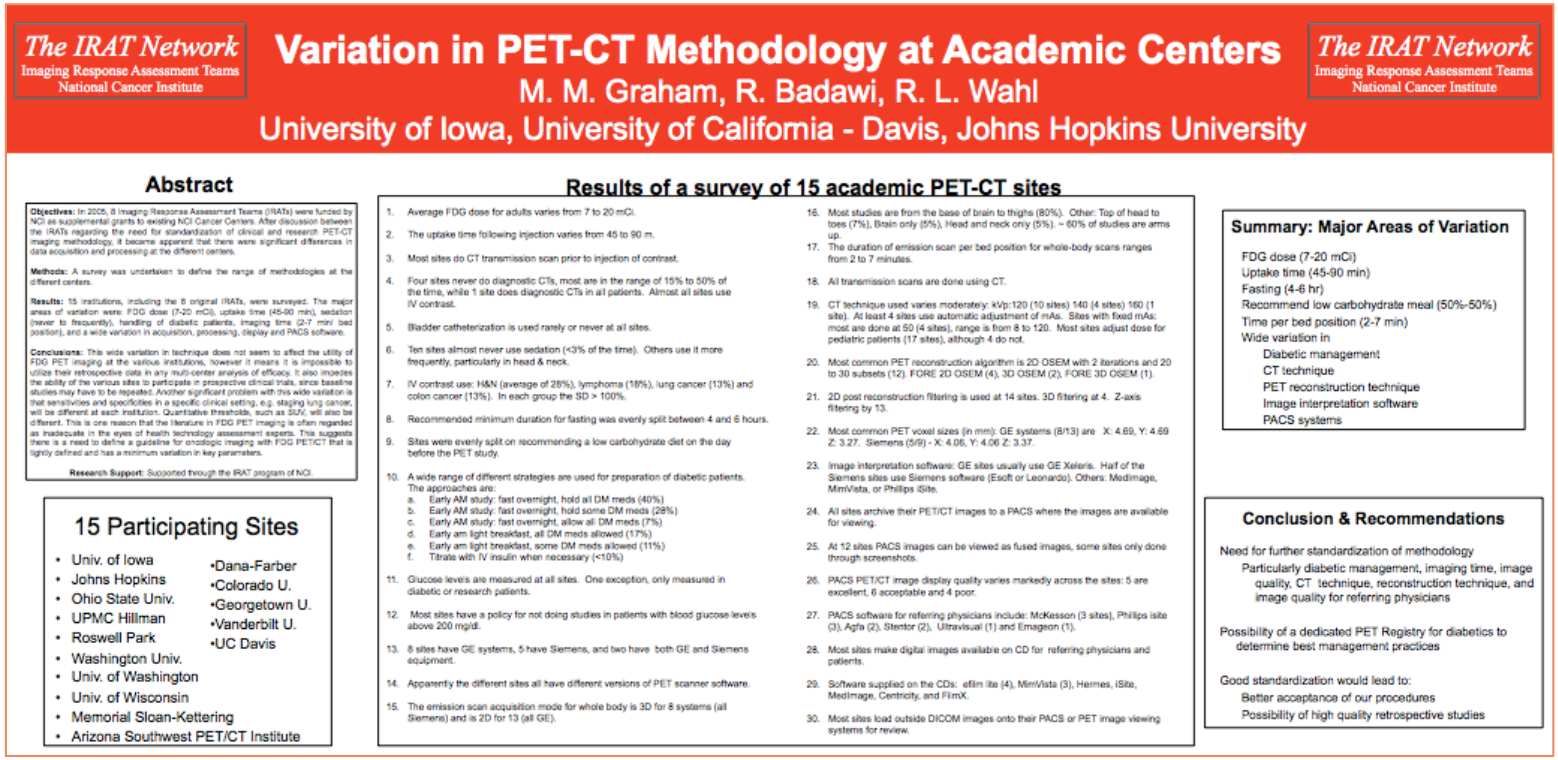
FDG PET and PET/CT: EANM procedure guidelines for tumour PET imaging: version 1.0

Ronald Boellaard & Mike J. O'Doherty & Wolfgang A. Weber & Felix M. Mottaghy & Markus N. Lonsdale & Sigrid G. Stroobants & Wim J. G. Oyen & Joerg Kotzerke & Otto S. Hoekstra & Jan Pruim & Paul K. Marsden & Klaus Tatsch & Corneline J. Hoekstra & Eric P. Visser & Bertjan Arends & Fred J. Verzijlbergen & Josee M. Zijlstra & Emile F. I. Comans & Adriaan A. Lammertsma & Anne M. Paans & Antoon T. Willemsen & Thomas Beyer & Andreas Bockisch & Cornelia Schaefer-Prokop & Dominique Delbeke & Richard P. Baum & Arturo Chiti & Bernd J. Krause

Routine PET/CT operations governed by guidelines

Background

M Graham et al, SNM 2009



The IRAT Network
Imaging Response Assessment Teams
National Cancer Institute

Variation in PET-CT Methodology at Academic Centers

M. M. Graham, R. Badawi, R. L. Wahl
University of Iowa, University of California - Davis, Johns Hopkins University

The IRAT Network
Imaging Response Assessment Teams
National Cancer Institute

Abstract

Objectives: In 2005, 8 Imaging Response Assessment Teams (IRATs) were funded by NCI as supplemental grants to existing NCI Cancer Centers. After discussion between the IRATs regarding the need for standardization of clinical and research PET-CT imaging methodology, it became apparent that there were significant differences in data acquisition and processing at the different centers.

Methods: A survey was undertaken to define the range of methodologies at the different centers.

Results: 15 institutions, including the 8 original IRATs, were surveyed. The major areas of variation were: FDG dose (7-20 mCi), uptake time (45-90 min), sedation (never to frequently), handling of diabetic patients, imaging time (2-7 min/ bed position), and a wide variation in acquisition, processing, display and PACS software.

Conclusions: This wide variation in technique does not seem to affect the utility of FDG PET imaging at the various institutions, however it means it is impossible to utilize their retrospective data in any multi-center analysis of efficacy. It also impedes the ability of the various sites to participate in prospective clinical trials, since baseline studies may have to be repeated. Another significant problem with this wide variation is that sensitivities and specificities in a specific clinical setting, e.g. staging lung cancer, will be different at each institution. Quantitative thresholds, such as SUV, will also be different. This is one reason that the literature in FDG PET imaging is often regarded as inadequate in the eyes of health technology assessment experts. This suggests there is a need to define a guideline for oncologic imaging with FDG PET/CT that is tightly defined and has a minimum variation in key parameters.

Research Support: Supported through the IRAT program of NCI.

15 Participating Sites

- Univ. of Iowa
- Johns Hopkins
- Ohio State Univ.
- UPMC Hillman
- Roswell Park
- Washington Univ.
- Univ. of Washington
- Univ. of Wisconsin
- Memorial Sloan-Kettering
- Arizona Southwest PET/CT Institute
- Dana-Farber
- Colorado U.
- Georgetown U.
- Vanderbilt U.
- UC Davis

Results of a survey of 15 academic PET-CT sites

1. Average FDG dose for adults varies from 7 to 20 mCi.
2. The uptake time following injection varies from 45 to 90 m.
3. Most sites do CT transmission scan prior to injection of contrast.
4. Four sites never do diagnostic CTs, most are in the range of 15% to 50% of the time, while 1 site does diagnostic CTs in all patients. Almost all sites use IV contrast.
5. Bladder catheterization is used rarely or never at all sites.
6. Ten sites almost never use sedation (<3% of the time). Others use it more frequently, particularly in head & neck.
7. IV contrast use: H&N (average of 26%), lymphoma (18%), lung cancer (13%) and colon cancer (13%). In each group the SD > 100%.
8. Recommended minimum duration for fasting was evenly split between 4 and 6 hours.
9. Sites were evenly split on recommending a low carbohydrate diet on the day before the PET study.
10. A wide range of different strategies are used for preparation of diabetic patients. The approaches are:
    a. Early AM study: fast overnight, hold all DM meds (40%)
    b. Early AM study: fast overnight, hold some DM meds (28%)
    c. Early AM study: fast overnight, allow all DM meds (7%)
    d. Early am light breakfast, all DM meds allowed (17%)
    e. Early am light breakfast, some DM meds allowed (11%)
    f. Titrate with IV insulin when necessary (<10%)
11. Glucose levels are measured at all sites. One exception, only measured in diabetic or research patients.
12. Most sites have a policy for not doing studies in patients with blood glucose levels above 200 mg/dl.
13. 8 sites have GE systems, 5 have Siemens, and two have both GE and Siemens equipment.
14. Apparently the different sites all have different versions of PET scanner software.
15. The emission scan acquisition mode for whole body is 3D for 8 systems (all Siemens) and is 2D for 13 (all GE).
16. Most studies are from the base of brain to thighs (80%). Other: Top of head to toes (7%), Brain only (5%), Head and neck only (5%). ~ 60% of studies are arms up.
17. The duration of emission scan per bed position for whole-body scans ranges from 2 to 7 minutes.
18. All transmission scans are done using CT.
19. CT technique used varies moderately: kVp:120 (10 sites) 140 (4 sites) 160 (1 site). At least 4 sites use automatic adjustment of mAs. Sites with fixed mAs: most are done at 50 (4 sites), range is from 8 to 120. Most sites adjust dose for pediatric patients (17 sites), although 4 do not.
20. Most common PET reconstruction algorithm is 2D OSEM with 2 iterations and 20 to 30 subsets (12). FORE 2D OSEM (4), 3D OSEM (2), FORE 3D OSEM (1).
21. 2D post reconstruction filtering is used at 14 sites. 3D filtering at 4. Z-axis filtering by 13.
22. Most common PET voxel sizes (in mm): GE systems (8/13) are X: 4.69, Y: 4.69 Z: 3.27. Siemens (5/9) - X: 4.06, Y: 4.06 Z: 3.37.
23. Image interpretation software: GE sites usually use GE Xeleris. Half of the Siemens sites use Siemens software (Esoft or Leonardo). Others: MedImage, MimVista, or Philips iSite.
24. All sites archive their PET/CT images to a PACS where the images are available for viewing.
25. At 12 sites PACS images can be viewed as fused images, some sites only done through screenshots.
26. PACS PET/CT image display quality varies markedly across the sites: 5 are excellent, 6 acceptable and 4 poor.
27. PACS software for referring physicians include: McKesson (3 sites), Philips isite (3), Agfa (2), Stentor (2), Ultravisual (1) and Emageon (1).
28. Most sites make digital images available on CD for referring physicians and patients.
29. Software supplied on the CDs: efilm lite (4), MimVista (3), Hermes, iSite, MedImage, Centricity, and FilmX.
30. Most sites load outside DICOM images onto their PACS or PET image viewing systems for review.

Summary: Major Areas of Variation

- FDG dose (7-20 mCi)
- Uptake time (45-90 min)
- Fasting (4-6 hr)
- Recommend low carbohydrate meal (50%-50%)
- Time per bed position (2-7 min)
- Wide variation in
  - Diabetic management
  - CT technique
  - PET reconstruction technique
  - Image interpretation software
  - PACS systems

Conclusion & Recommendations

Need for further standardization of methodology
- Particularly diabetic management, imaging time, image quality, CT technique, reconstruction technique, and image quality for referring physicians

Possibility of a dedicated PET Registry for diabetics to determine best management practices

Good standardization would lead to:
- Better acceptance of our procedures
- Possibility of high quality retrospective studies

- Large variability among academic centres

  Injected activity, fasting time, diet and exam parameters

Need for standardization of methodology (cf HTA)

Motivation

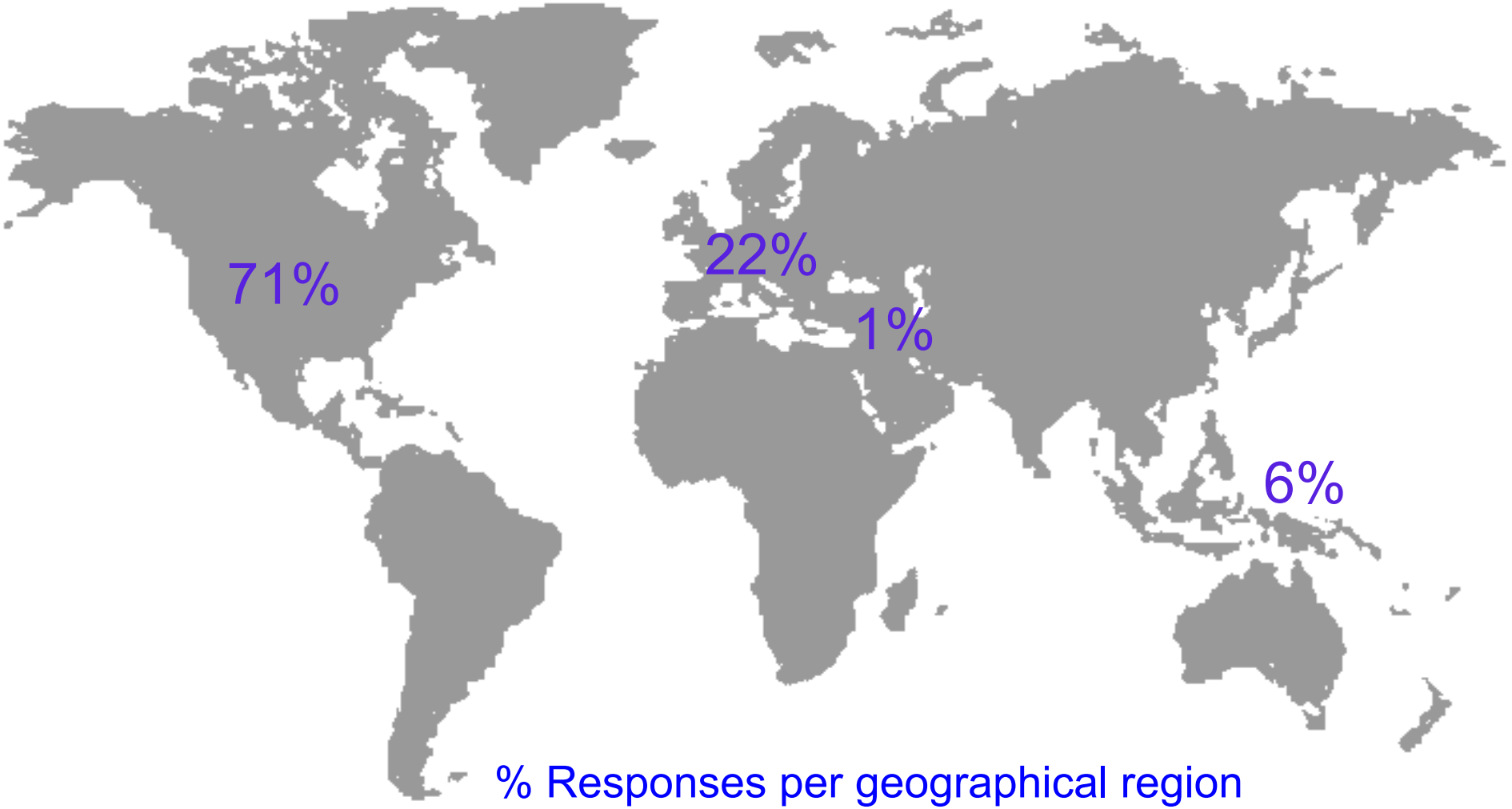
- To assess clinical PET/CT operations worldwide
- To reflect professional experience with PET and PET/CT
- To review imaging protocols for FDG-PET/CT studies
- To cross-reference protocol variabilities to guidelines

Methods

- Survey: 58 questions

Demographics	Professional background, countries, regional factors
Operations	Experience, no. systems, tracer production, indications
Imaging protocol	Routine FDG-PET/CT oncology studies

Results - Demographics



% Responses per geographical region

14% response rate. Mainly from the US and Europe.

Results - Demographics

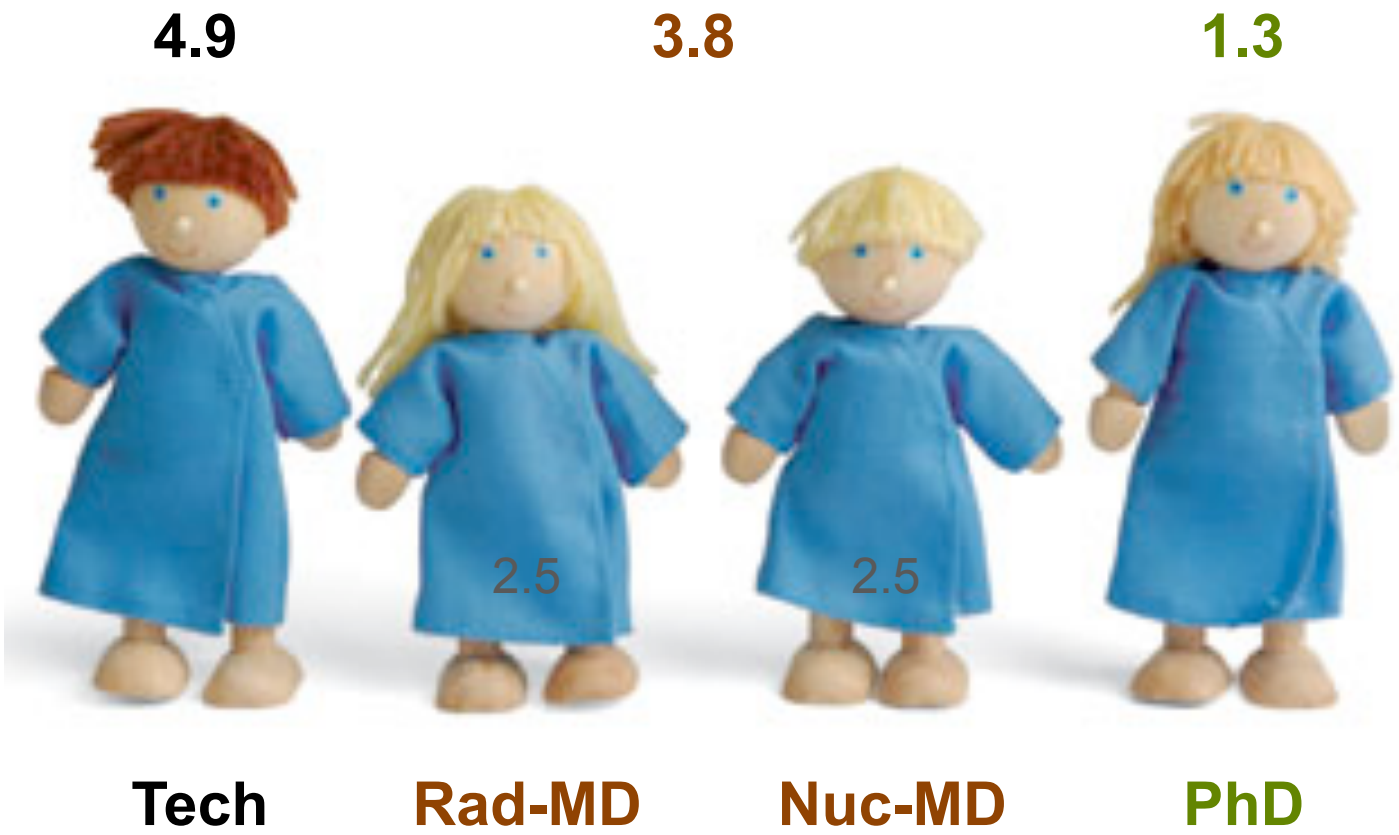
- PET/CT governance

Public	60%
Private	33%
Public/Private	7%

Most sites with 1-2 PET/CT and prior clinical PET experience

Results - Demographics

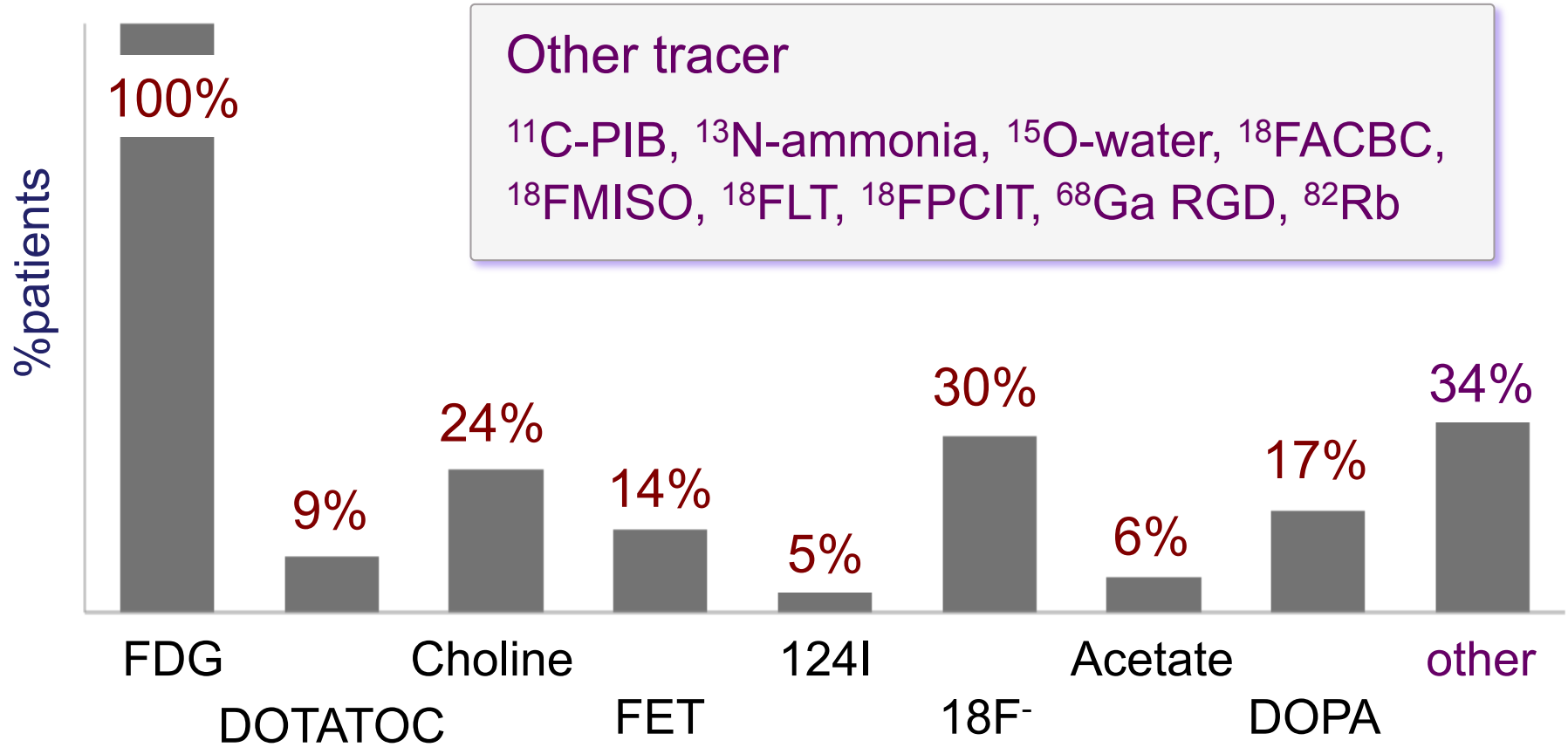
- How many employees are actively involved in PET/CT operations?



More technologists than MD and PhD per PET/CT site

Results - Operations

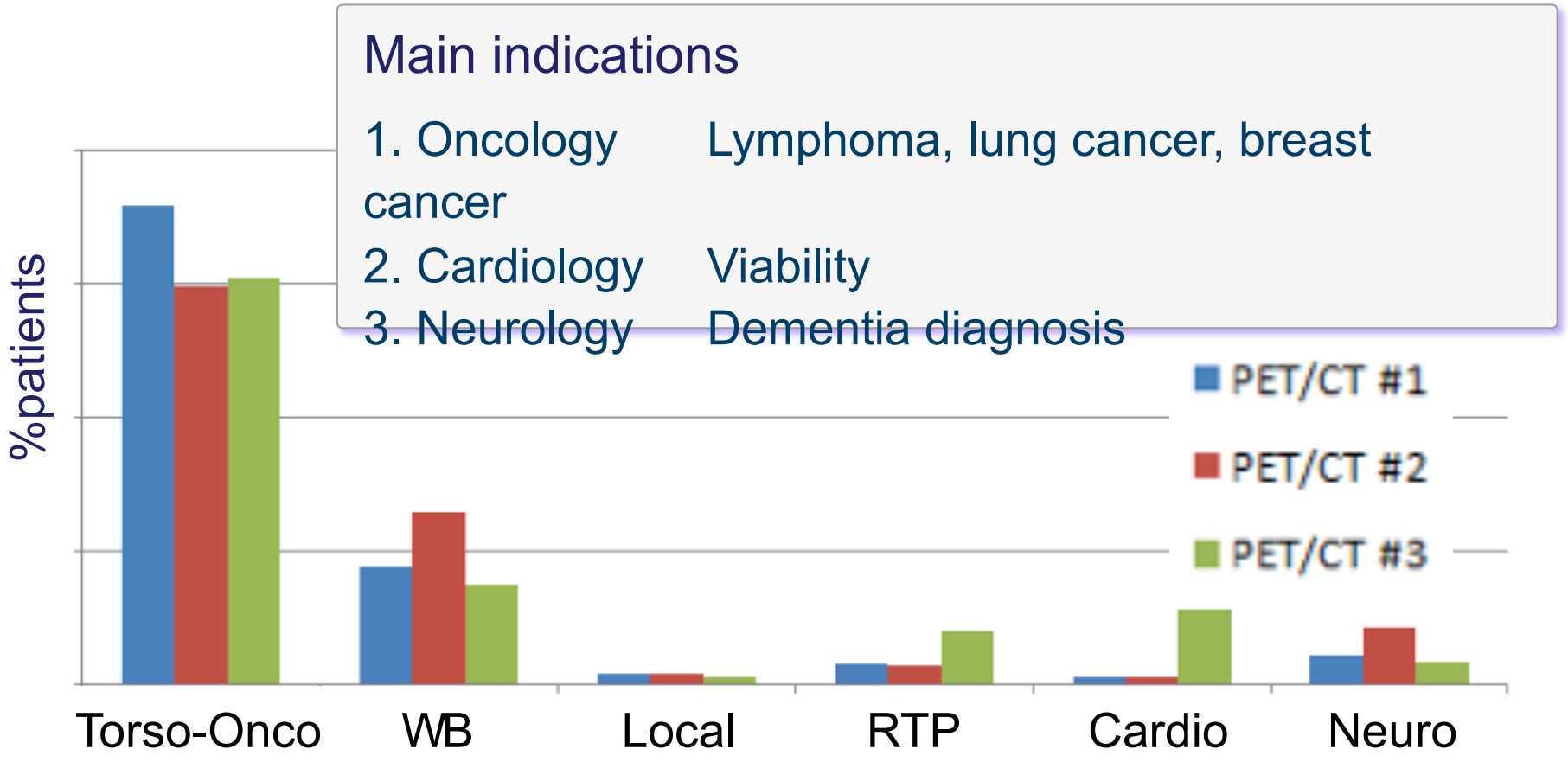
- In how many patients (%) are the following tracers used?



Prevalence of ^{18}F-labelled radiopharmaceuticals

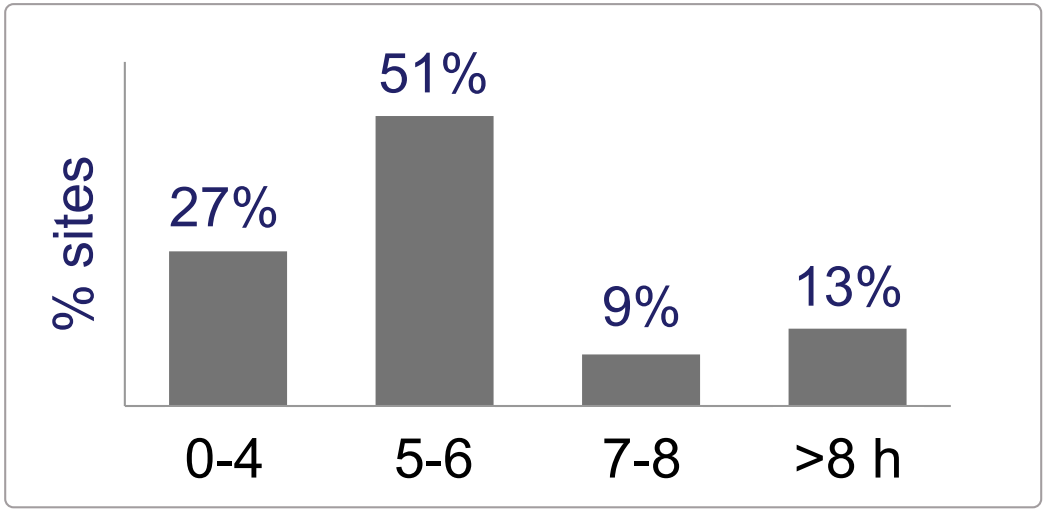
Results - Operations

- Which are the most frequently performed patient examinations?

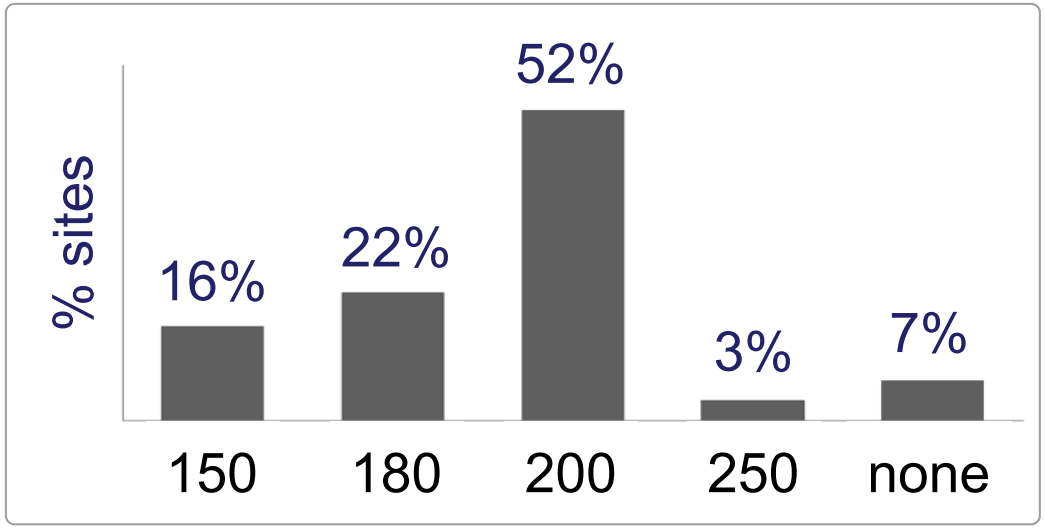


Mainly torso-oncology imaging. Shift to special applications.

Results – Imaging Protocol



- What is the average fasting period (h) prior to FDG-PET/CT?

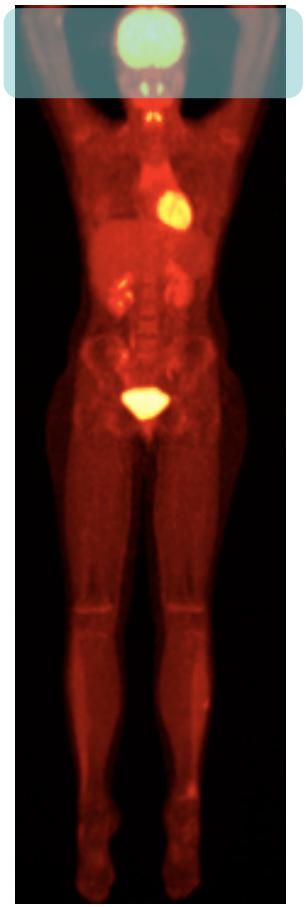


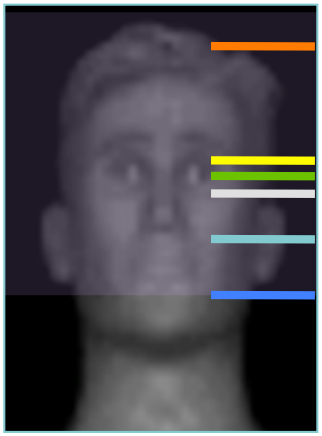
- What is the blood glucose level cut-off point (mg/dl)?

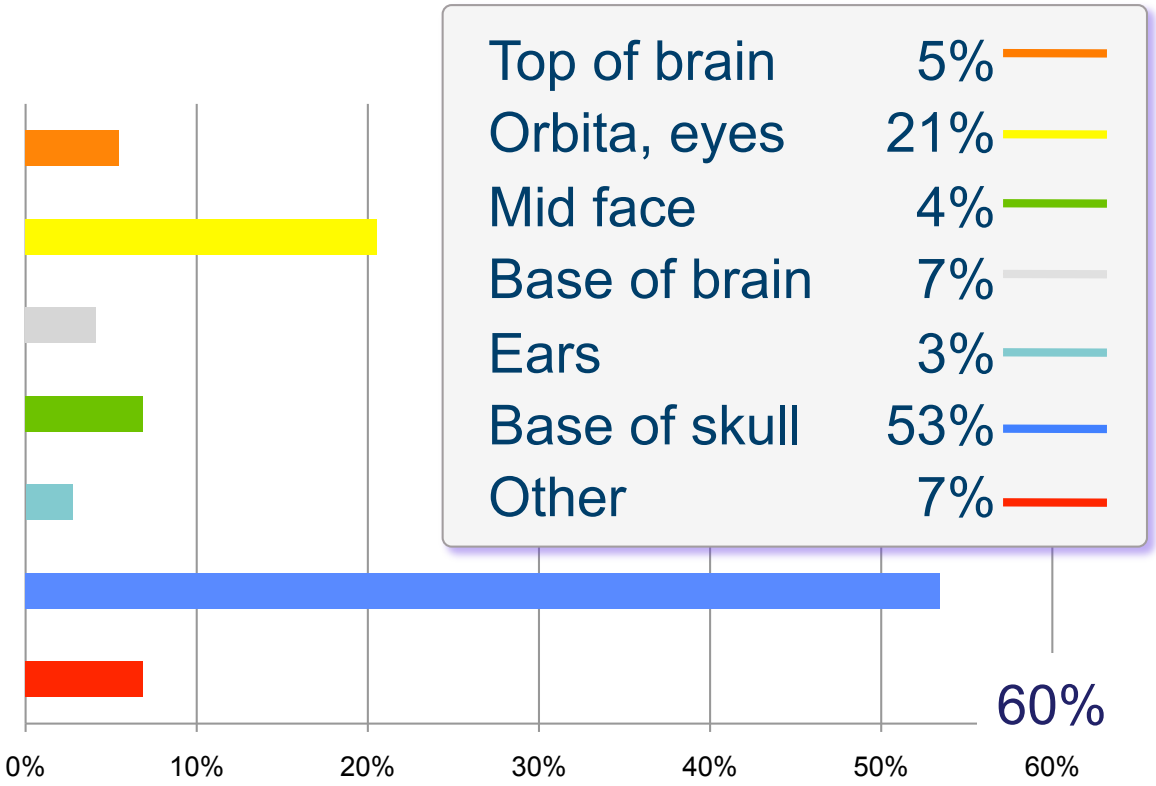
Major variations: Fasting and Blood sugar level cut-off

Results – Imaging Protocol

- Please define co-axial anatomical limits for a torso PET/CT exam.







Note, variations in upper limit translate into variations of lower limit (integer number of PET bed positions).

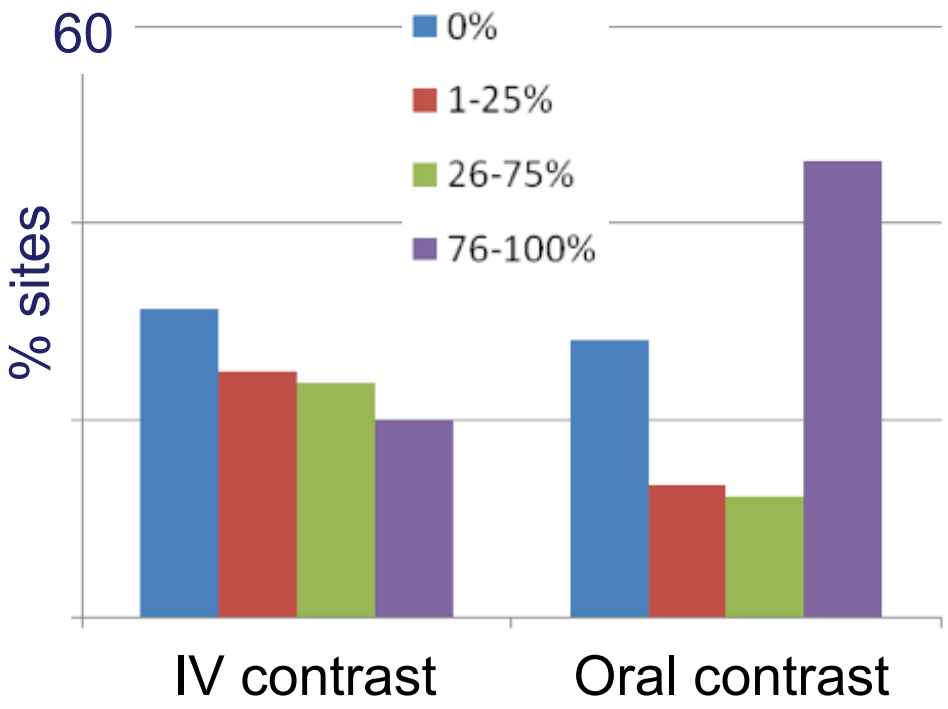
Major variation: Upper co-axial imaging range (± 10 cm)

Results – Imaging Protocol (CT)

- Do you use a dedicated low-dose, non-enhanced CT for CT-AC?

73% yes

- In how many patients (%) do you employ IV or oral CT contrast?



Low-dose CT-AC prevails. More oral than IV contrast.

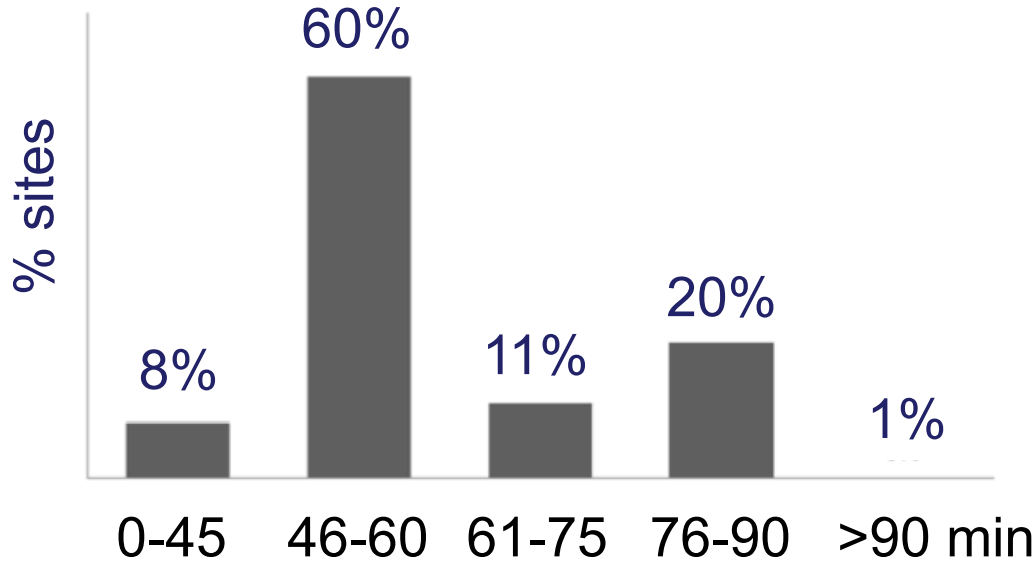
Results – Imaging Protocol (PET)

44% yes

5.2 (1.5 – 7.8) MBq/kg

2D: 524 (370-670) MBq
3D: 465 (200-740) MBq

- Do you perform patient weight based administration of tracer activity?
- If **no**, then please give the absolute activity for a standard 75 kg patient.
- What is the FDG uptake time?

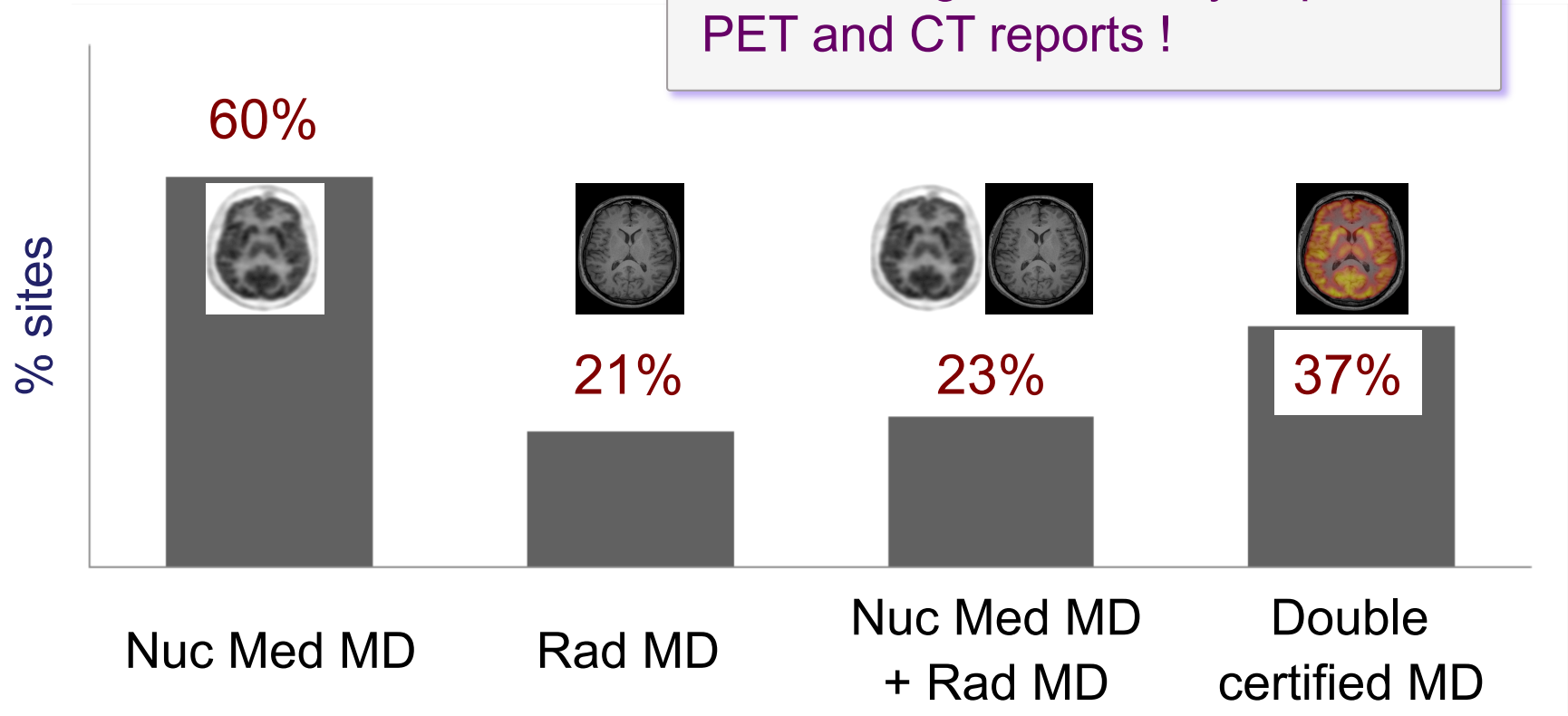


Major variations: Injected activity and FDG uptake time

Results – Imaging Protocol (Reporting)

- Who is PET/CT reporting done by?

17% sites generate fully separate PET and CT reports !

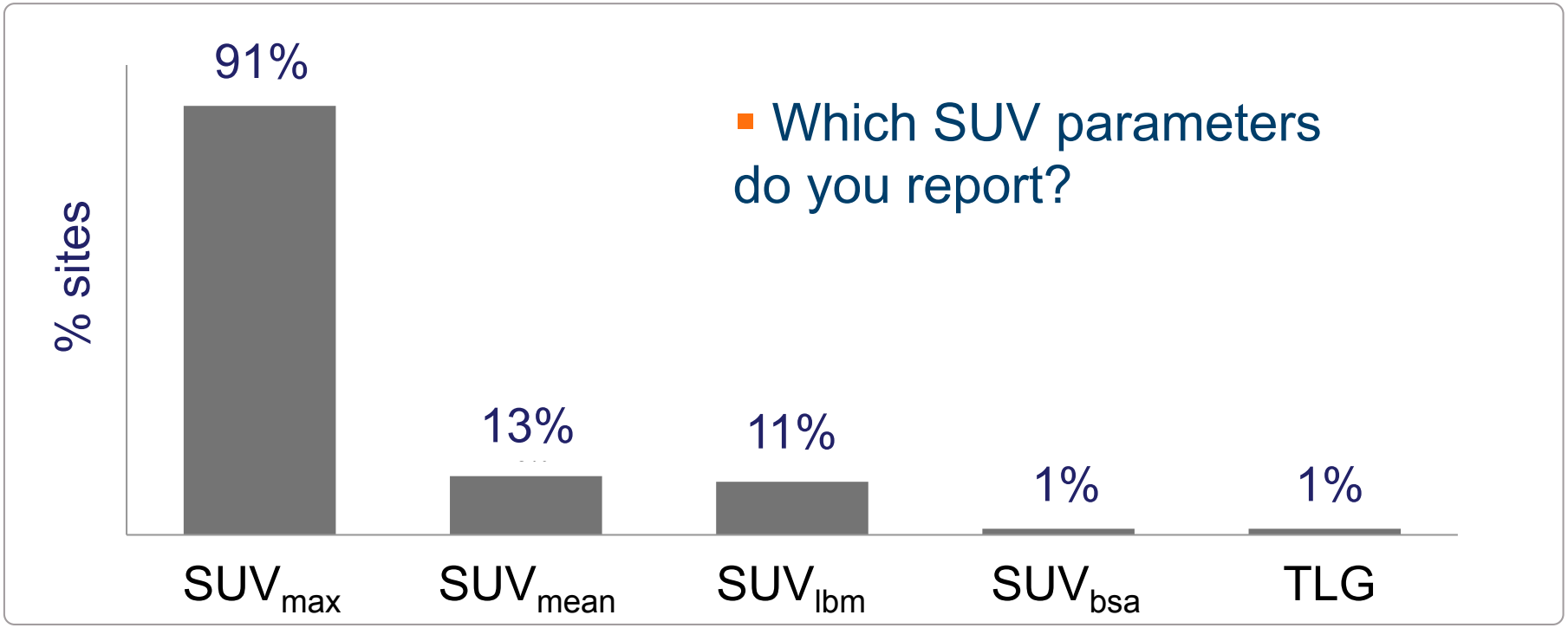


Individual or separate reporting and reports rather popular.

Results – Imaging Protocol (Reporting)

90% yes

- Do you measure and report SUV?



- Which SUV parameters do you report?

91% yes

- Do you use SUV for treatment response descriptions?

SUV_{max} used in diagnosis, staging and follow-up

Discussions

- Eligible response rate of 14% is acceptable
- PET/CT clinically established, multiple systems on site
- Mainly ^{18}F-based tracers for oncology imaging
- Major variations in oncology imaging protocols
  - Patient preparation, injected activity and uptake time
  - Definition of imaging ranges and acquisition parameters
  - Use of CT contrast agents
- High fraction (17%) of fully-separate reports

Conclusions

- Major variations in clinical FDG-PET/CT operations
- Guideline variations encourage protocol variations
- Onset of standardization efforts must be supported
- Need for continuous (cross-specialists) training

Revised guidelines with minimum variations in key parameters

Acknowledgement

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