

# Indications for Positron-Emission Tomography scans in Nova Scotia: a validation of timing rules and recorded reasons for scan in non small-cell lung cancer

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# Background

- Canadian Partnership Against Cancer (CPAC) sponsored project to describe the use of PET in the diagnosis, staging and treatment of non small-cell lung cancer
- Not all participating provinces were able to provide an 'indication' variable.
- Nova Scotia's PET database includes a standardised field for indication ('Reason for Scan')
- Date of PET scan, date of diagnosis, first treatment date
- Cancer registry for cases, date of diagnosis, date of RT
- Provincial discharge-abstract records for surgical dates
- GOAL: Infer 'indication' from timing rule



# Methods

Apply Receiver Operating Characteristic (ROC) curve analysis

- Binary classification or 'condition'
- Continuous (criterion) scale for evaluation
- Index to maximise (method of choosing 'best' cut-point)
- Common indices:
  - Cohen's Kappa: a measure of agreement
  - Youden's J: sum of sensitivity and specificity
- *Weighting ('costs') of false negative / positive errors*

# Evaluation of a single cut-point

	Condition positive	Condition negative
Criterion above	A <i>True +</i>	B <i>False -</i>
Criterion Below	C <i>False +</i>	D <i>True -</i>
	<b>True positive prop.</b> $P_t = A/(A+C)$ <i>sensitivity</i>	<b>False positive prop.</b> $P_f = B/(B+D)$ <i>1 - specificity</i>

# Data for Validation Study

576 PET scans carried out in the investigation, diagnosis, treatment and monitoring of non small-cell lung cancer cases, diagnosed 2008 – 2011

## Diagnosis and staging

- Diagnosis/Unknown Primary Tumor: To detect a primary tumor site in a patient with a confirmed or strongly suspected metastatic lesion.
- Diagnosis: To determine if a suspicious lesion is cancer.
- Initial Staging of histologically confirmed, newly diagnosed cancer.

## Treatment planning and monitoring

- Radiation therapy planning.
- Monitoring Treatment Response during chemotherapy.
- Monitoring Treatment Response during combined modality therapy (e.g. chemo / radiation / surgery / biologic therapy).
- Monitoring Treatment Response during radiation therapy.
- Restaging after completion of therapy.
- Suspected Recurrence of a previously treated cancer.



# Data for Validation Study

Indication **Gold** Standard:

- Diagnosis and staging vs RT planning, post-treatment monitoring

Continuous criterion scale for evaluation:

- Time between diagnosis and date of PET 😊

Other considerations:

- Date of first treatment (surgery or RT)

- PETs to include:

All	576
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First only	492
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- AJCC timing rule (120 days)



# Results (all PETs)

Any PET	Area Under Curve	Index	Cut point (days)	True positive (%)	False positive (%)
Naïve ☺	.87	J	76	87.2	24.8
		Kappa	109	90.7	31.7
PET before tx ☺	.81	J	52	86.1	38.5
		Kappa			
PET before RT ☺	.85	J	76	87.5	30.0
		Kappa	109	91.1	36.3

# First or All PETs?

Reason for PET	First PETs only	Subsequent PETs
Diagnosis	201	11
Staging	216	3
RT planning	36	9
Monitor results of Tx	14	23
Suspected recurrence	25	38



# Results (first PET only)

Any PET	Area Under Curve	Index	Cut point (days)	True positive (%)	False positive (%)
Naïve ☺	.80	J	18	47.5	1.3
		Kappa	109	93.5	54.7
PET before tx ☺	.81	J	25	61.3	25.4
		Kappa			
PET before RT ☺	.85	J	17	48.0	3.3
		Kappa	109	93.6	58.9

# Conclusions

Most analyses supported the *a priori* rule to declare the indication of 'Diagnosis or Staging' if:

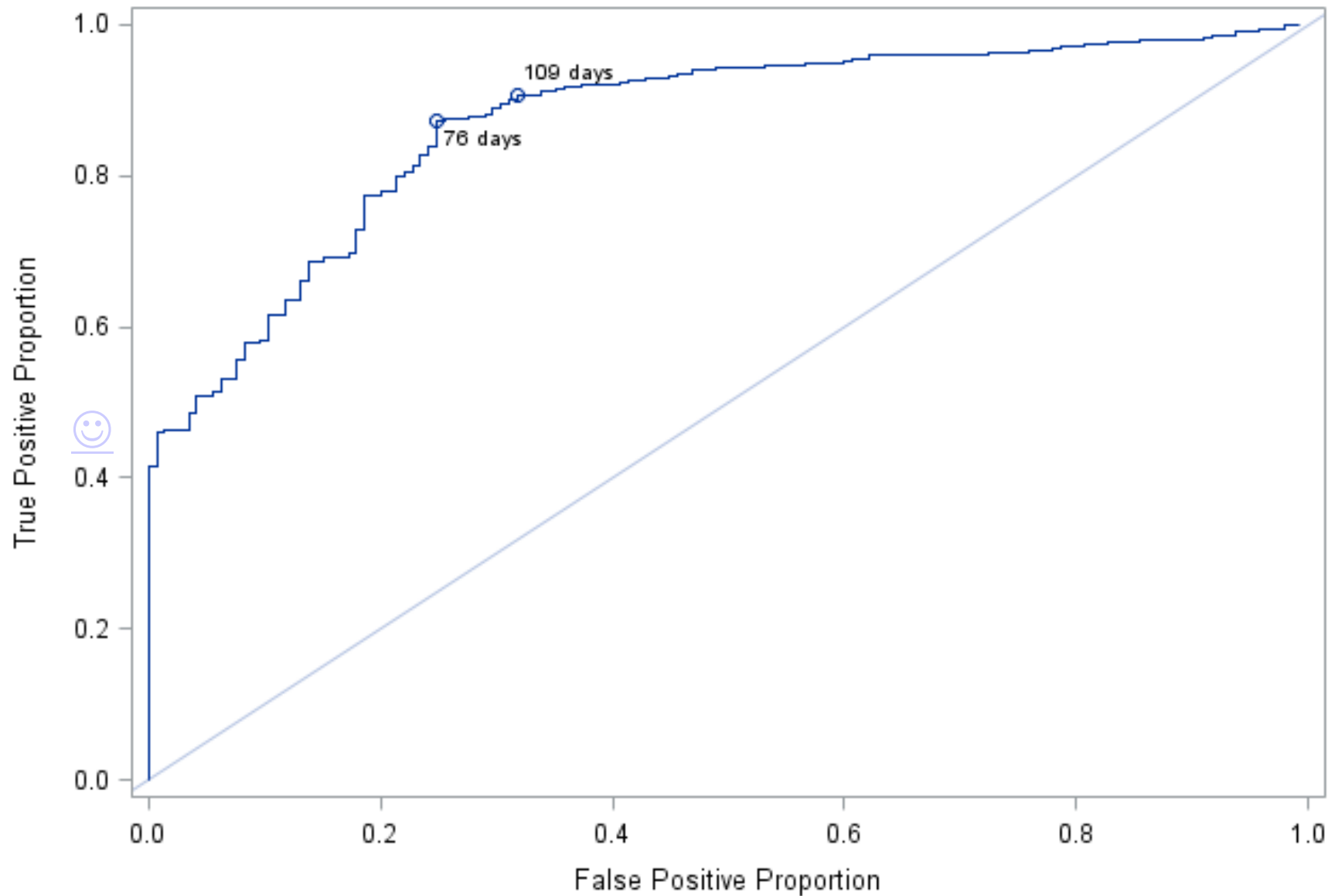
- within AJCC guidelines (up to 120 days after diagnosis)
- Prior to start of radiotherapy

Limitations:

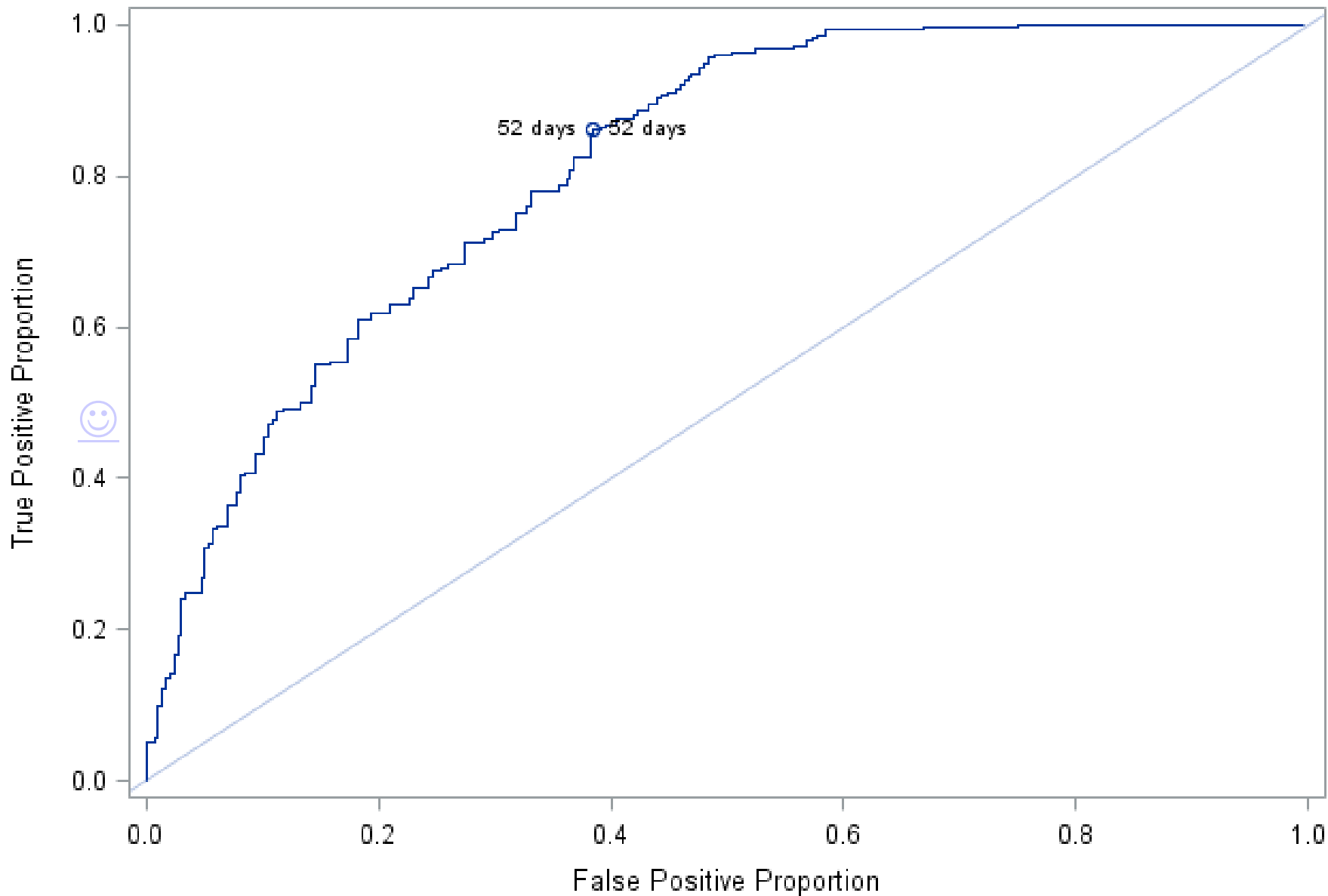
- No information on chemo (relatively rare with NSLC)
- Gold standard is misclassified (gold alloy ~18k)  
→ prefer Kappa (?)
- Some of the later PETs may have been requested for investigation of a new primary



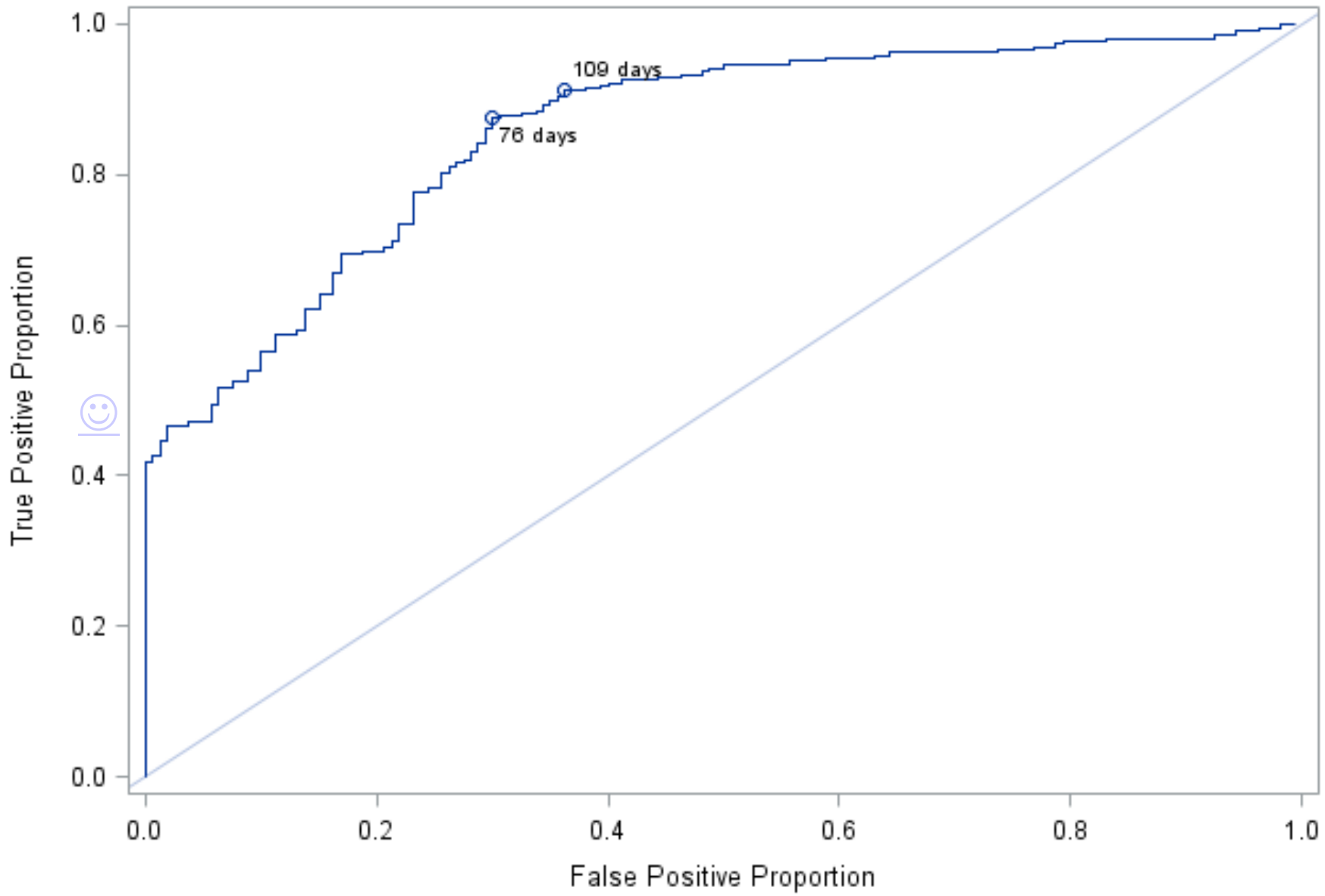
**Condition: Diagnosis or Staging: any PET**  
area under curve is 0.87



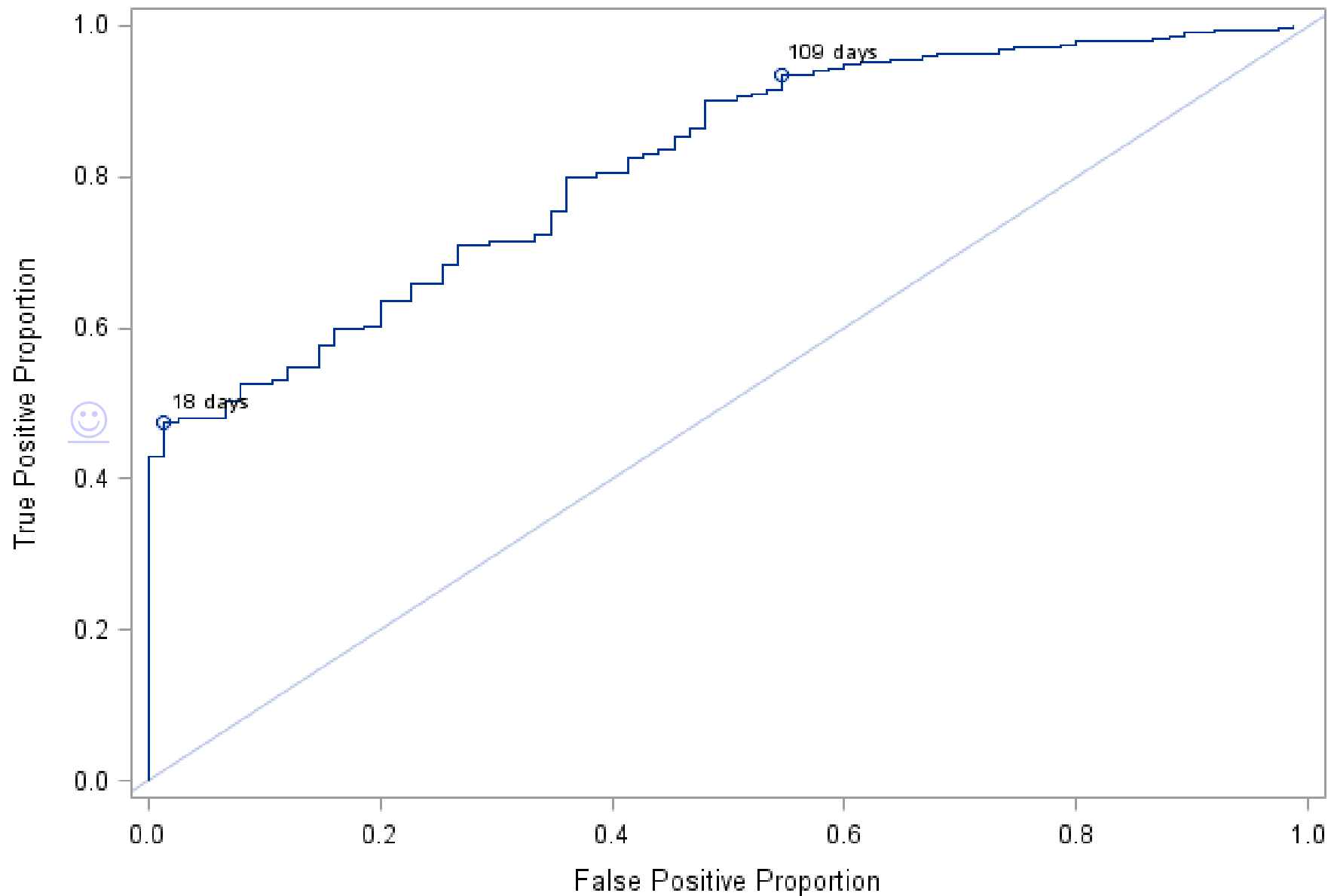
**Condition: Diagnosis or Staging: PET before Tx**  
area under curve is 0.81



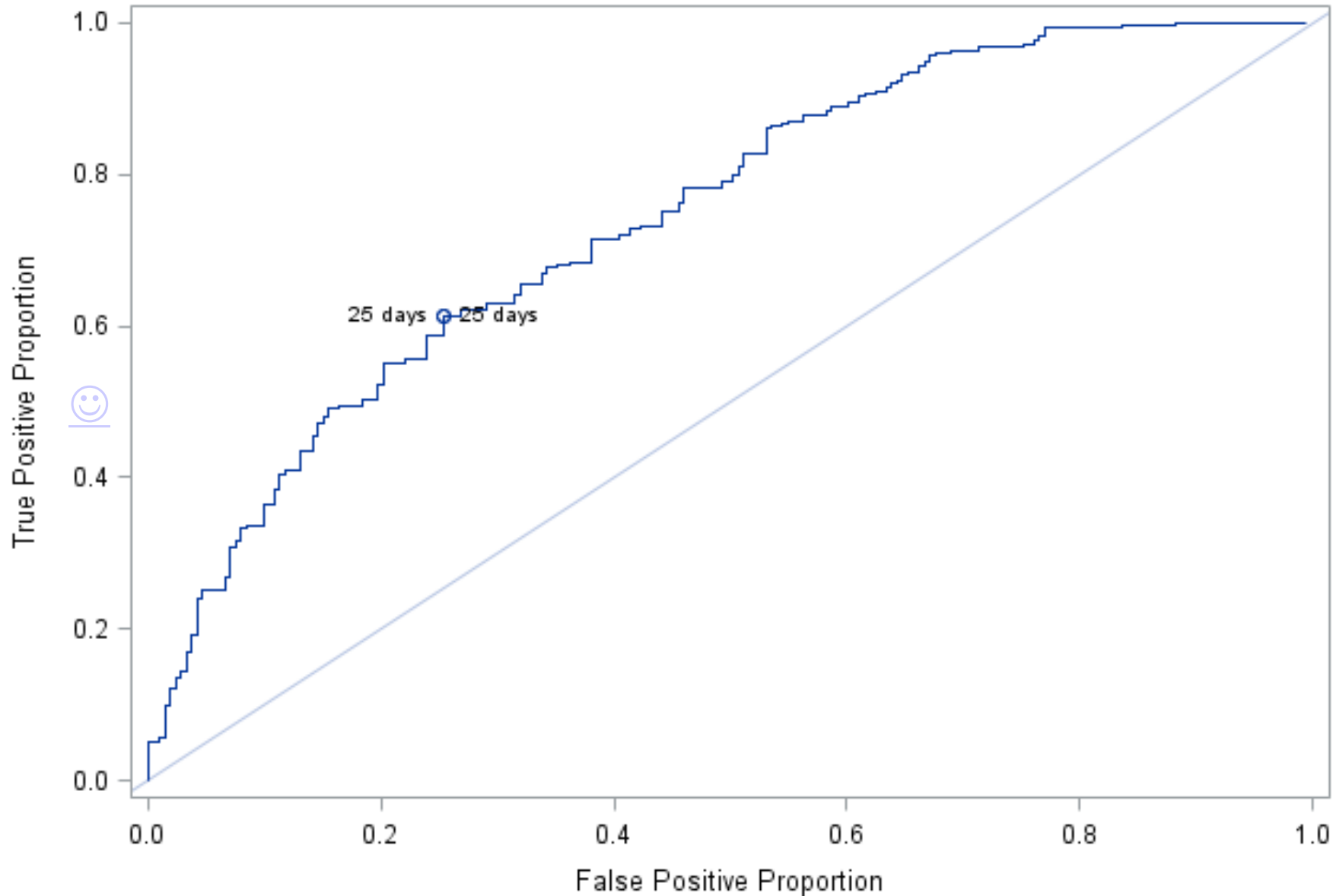
**Condition: Diagnosis or Staging: PET before RT**  
area under curve is 0.85



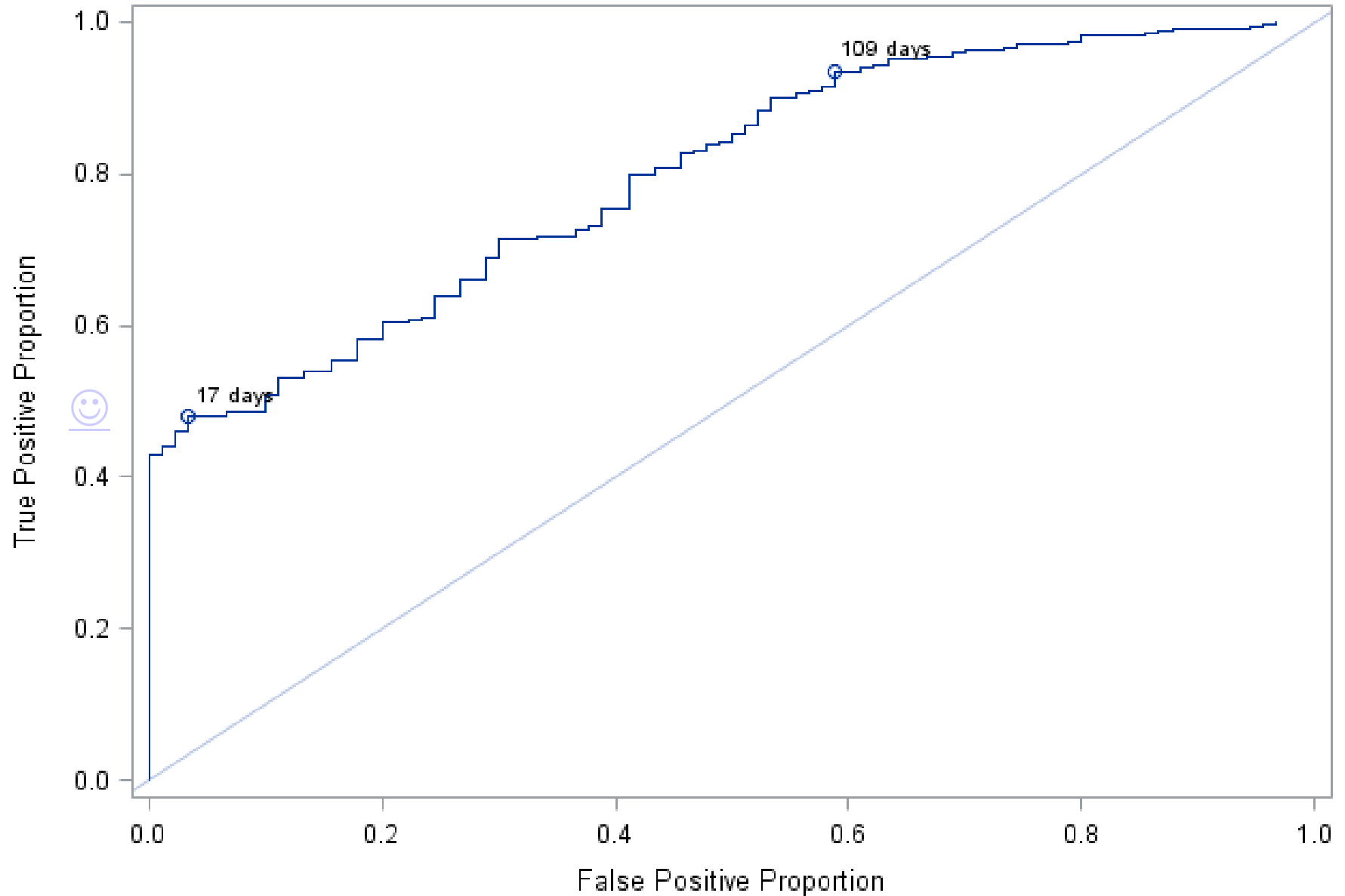
**Condition: Diagnosis or Staging: first PET only**  
area under curve is 0.80



**Condition: Diagnosis or Staging: first PET only, before Tx**  
area under curve is 0.74

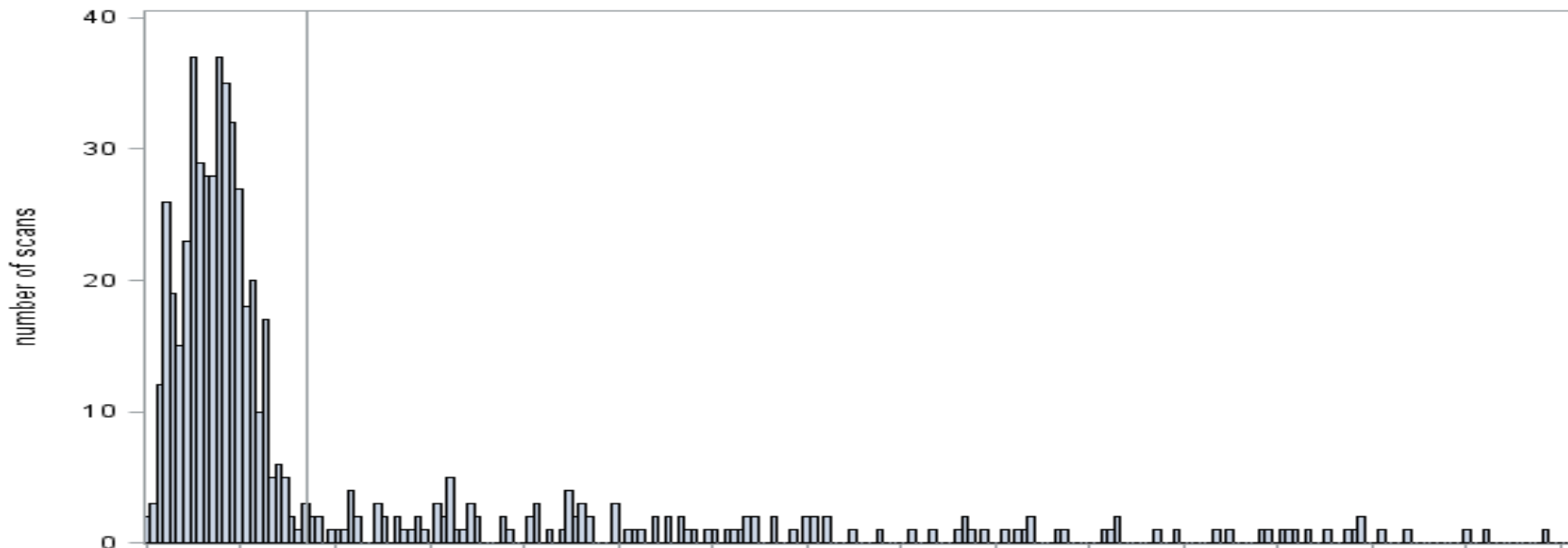


**Condition: Diagnosis or Staging: first PET only, PET before RT**  
area under curve is 0.77





**Distribution of time from diagnosis to PET**  
**All PET scans in dataset**



**Distribution of time from diagnosis to first PET**

