

Stochastic Models of Prostate Cancer Screening and Detection at Johns Hopkins

10th Annual Prostate Cancer Research Day, 2015
Yates Coley, PhD

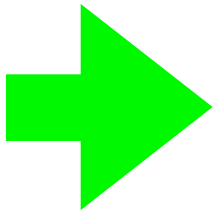
On Behalf of Stochastic Population Modeling Core:
Bal Carter, Mufadal Mamawala, Karthik Rao, Ken Pienta, Scott Zeger

Can we build a statistical model that integrates all the available data to inform clinical decision-making in a way that improves health outcomes in the long term?

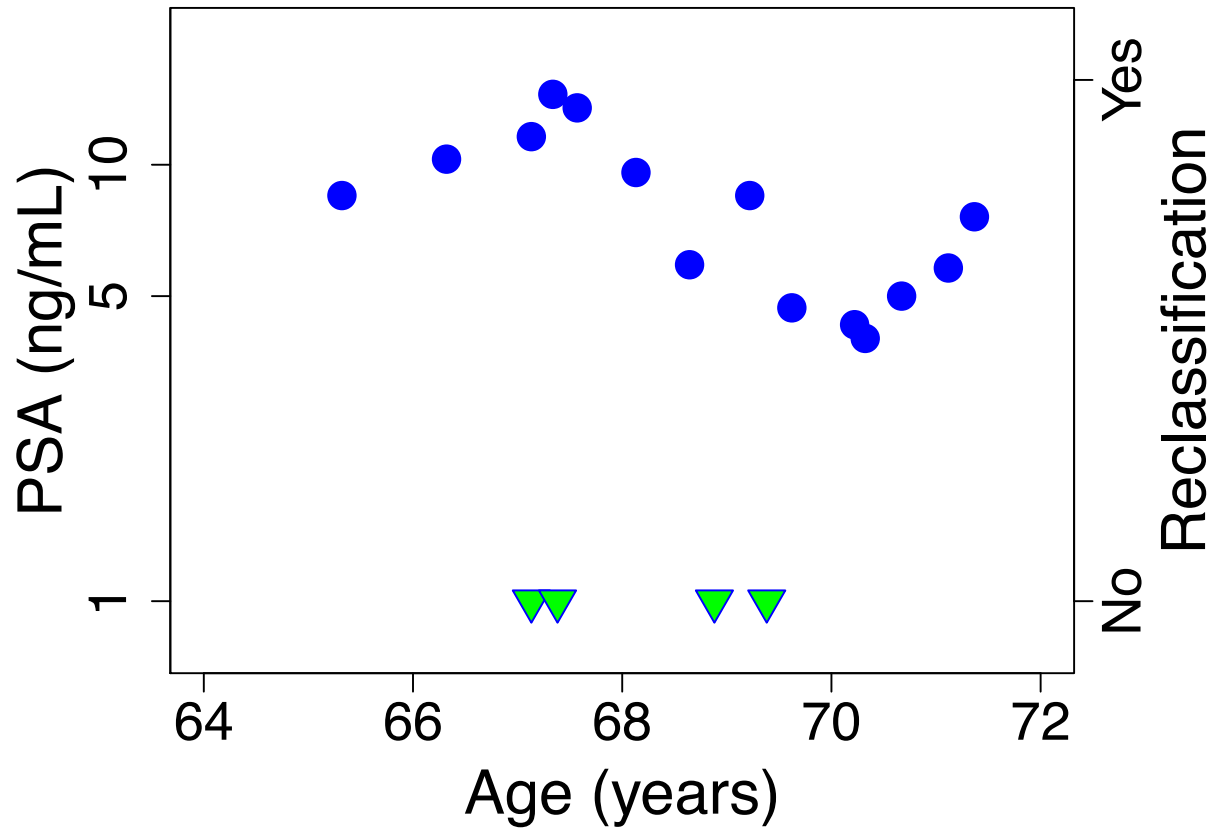
Can we communicate results with doctors and patients in a way that effectively informs their decision-making process?

Questions doctors want to answer for a patient:

- Should I get screened for prostate cancer?
- Should I choose immediate curative intervention or active surveillance?
- How frequently should I get biopsies done?



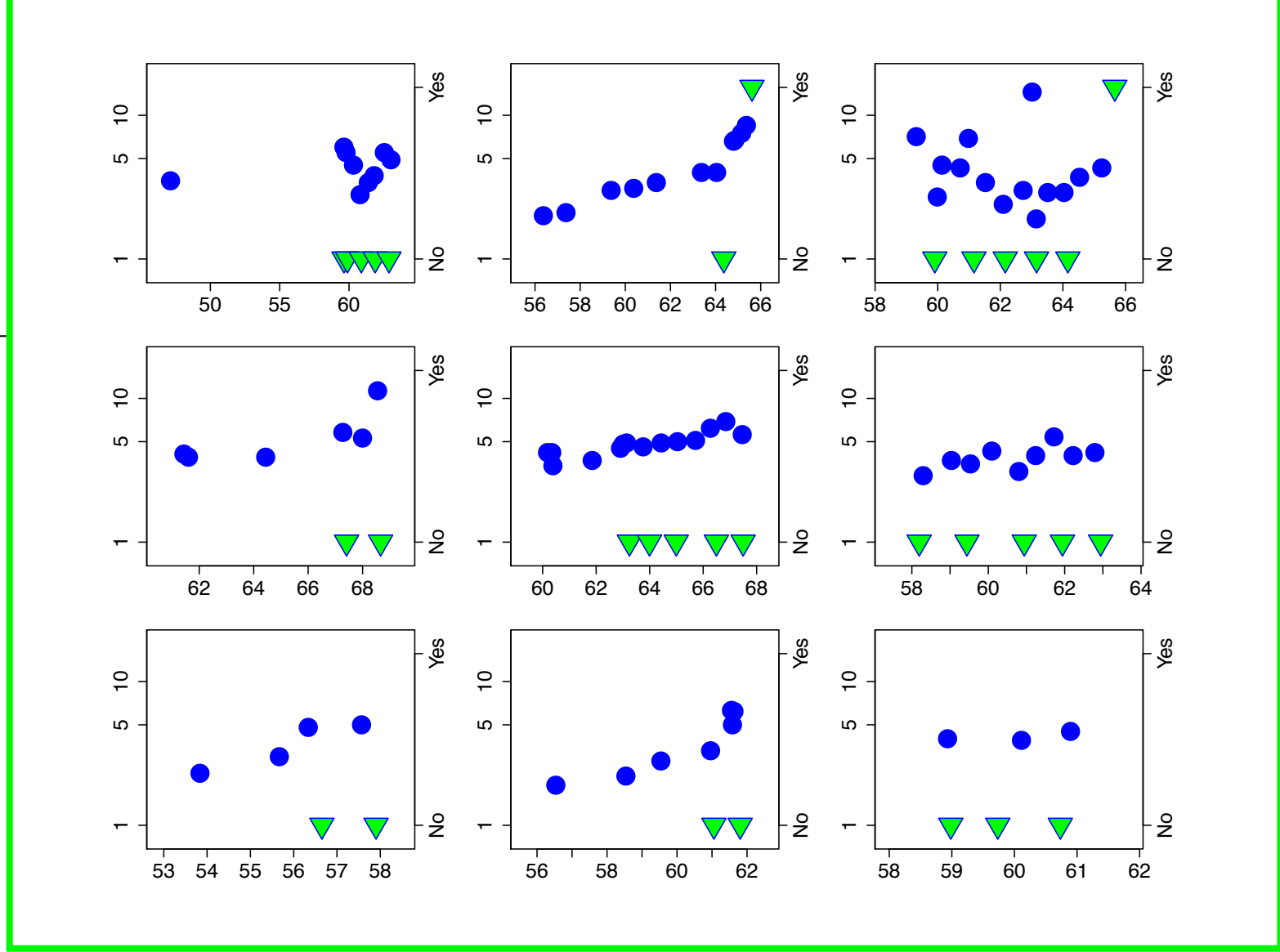
What is the probability I have life-threatening prostate cancer?

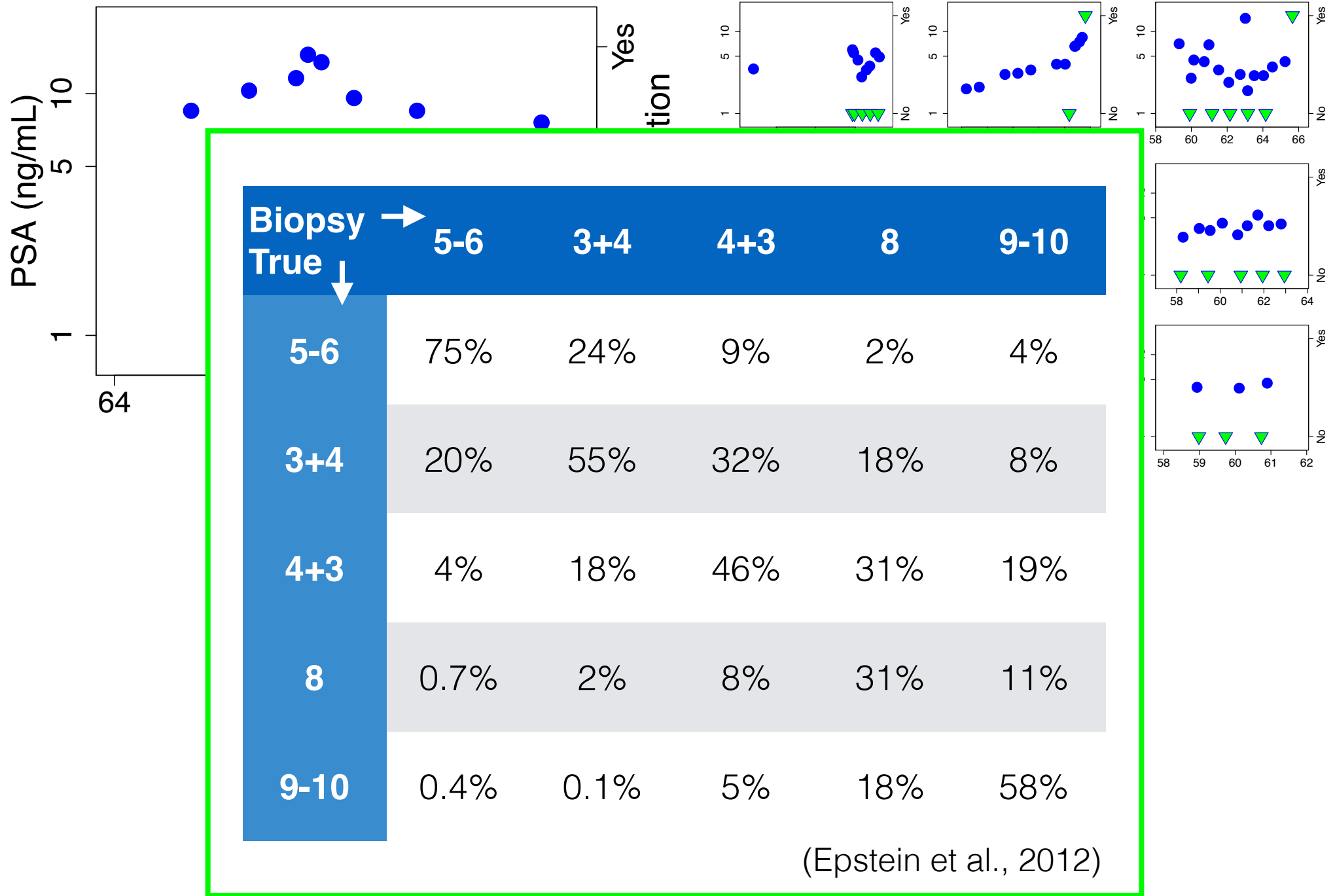


PSA (ng/mL)

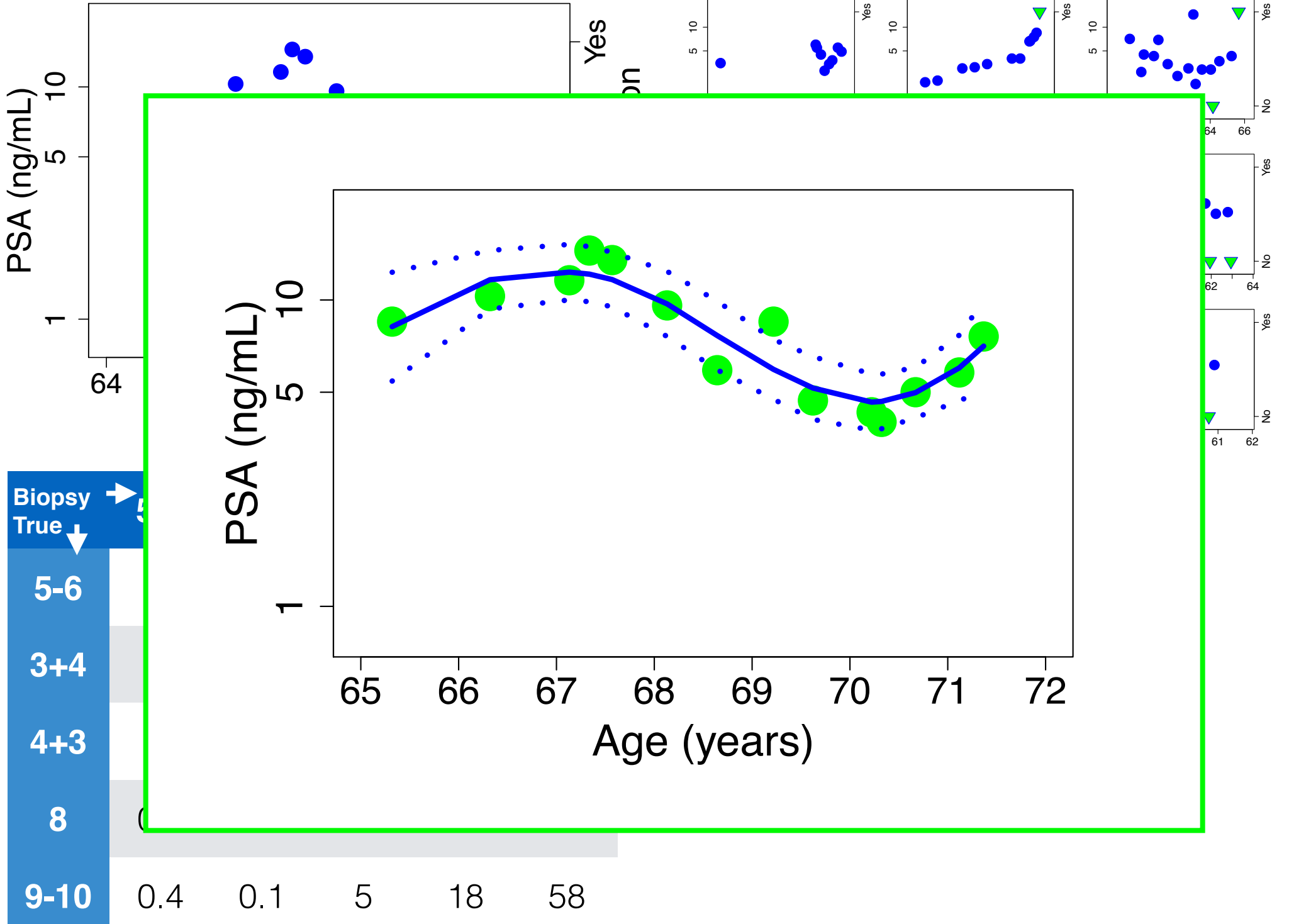
1 5 10

64





Probability of biopsy grade given true prognostic grade group



PSA (ng/mL)

Biopsy True
 5-6
 3+4
 4+3
 8
 9-10

PSA (ng/mL)

Age (years)

Yes

Yes

Yes

Yes

No

Yes

No

Yes

No

64

65 66 67 68 69 70 71 72

10

1

10

1

5 10

5 10

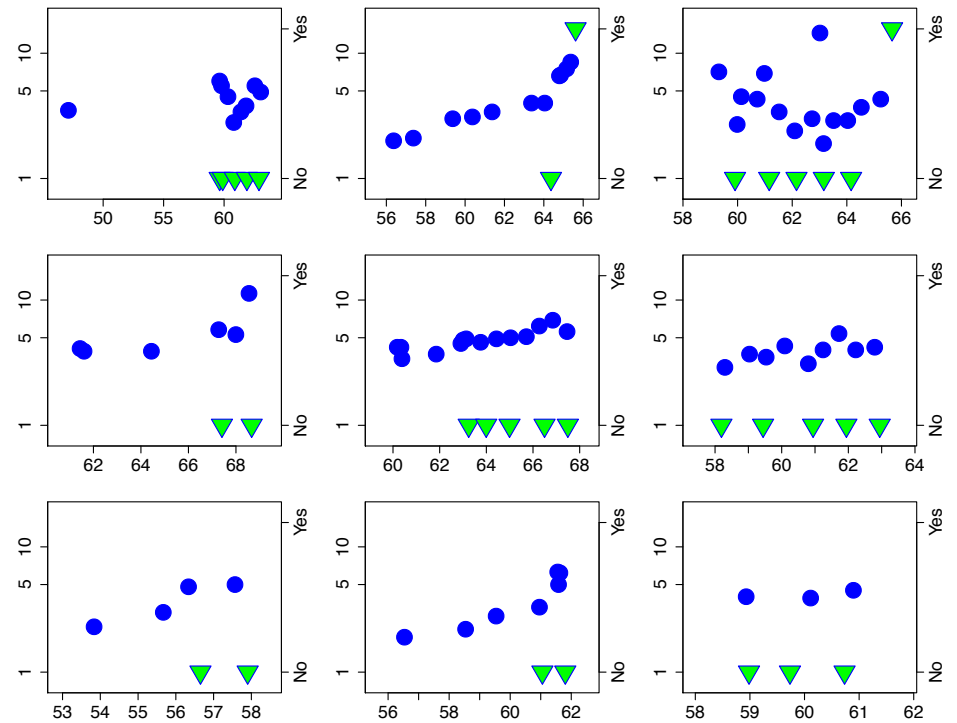
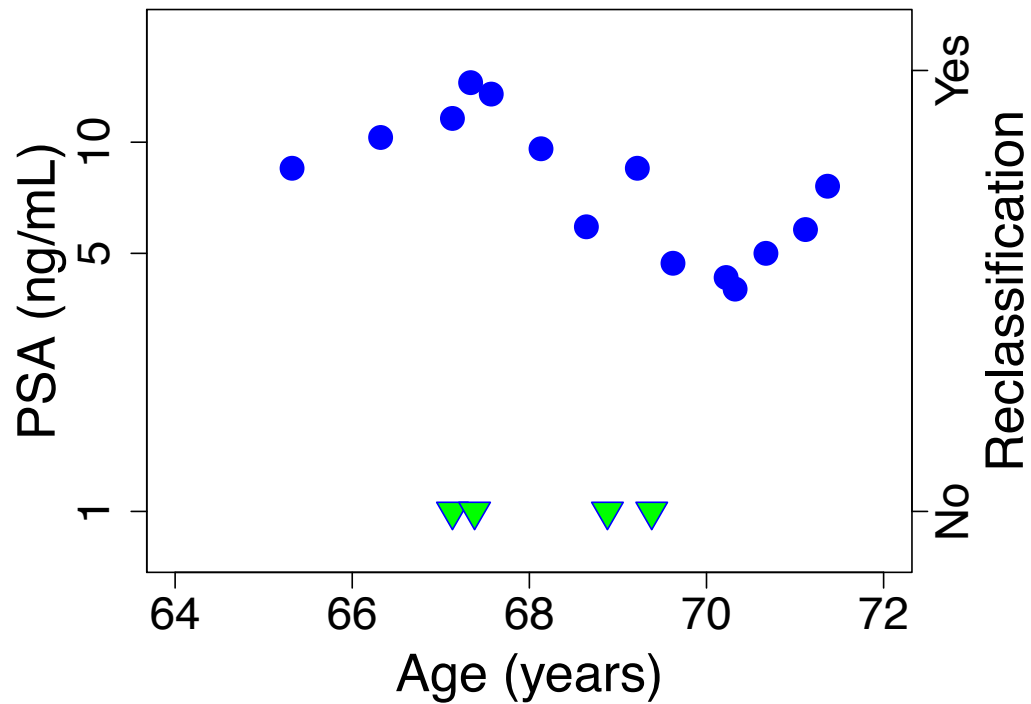
5 10

64 66

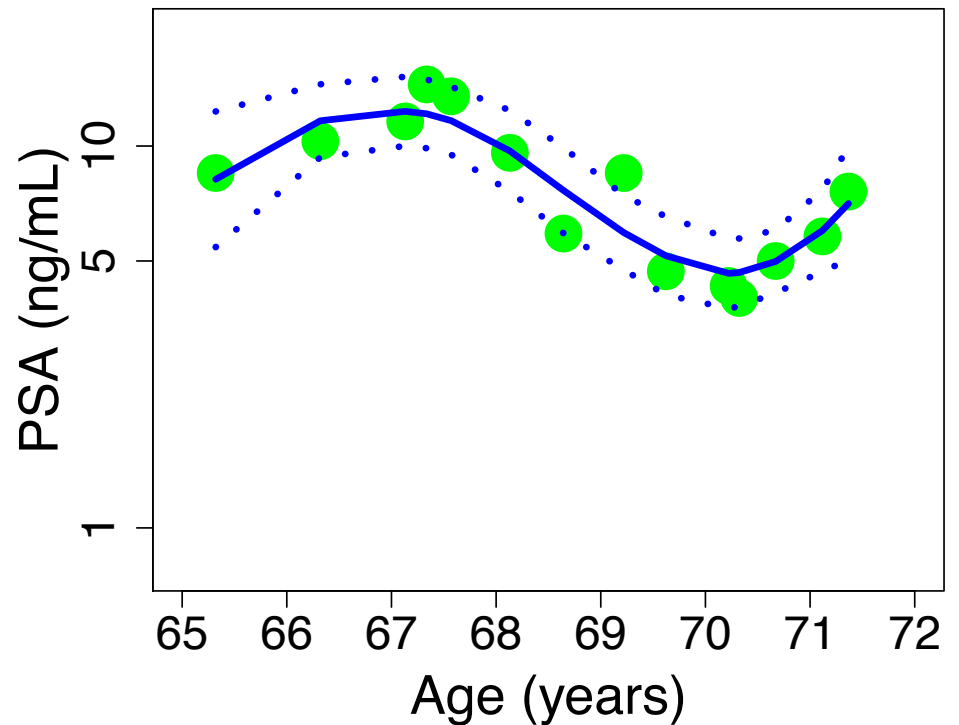
62 64

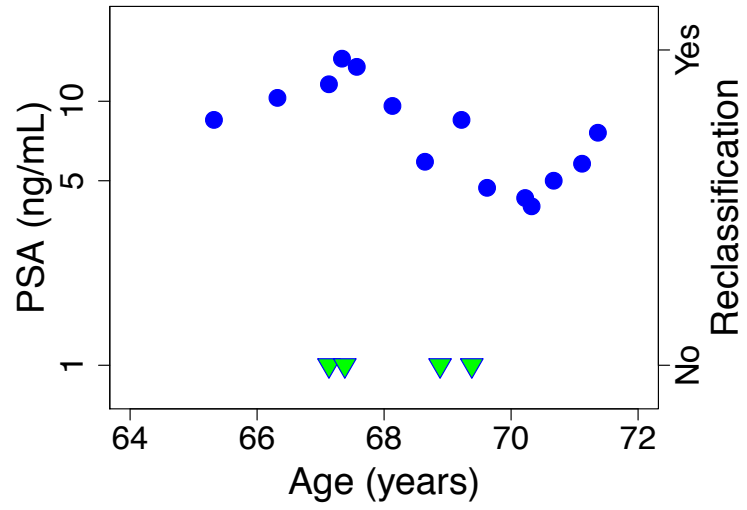
61 62

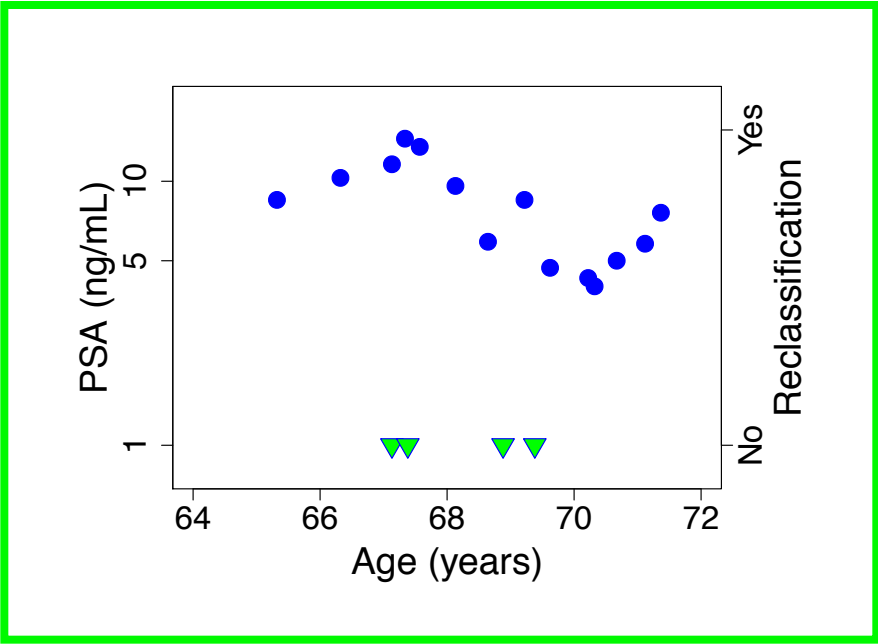
0.4 0.1 5 18 58



Biopsy True	5-6	3+4	4+3	8	9-10
5-6	75	24	9	2	4
3+4	20	55	32	18	8
4+3	4	18	46	31	19
8	0.7	2	8	31	11
9-10	0.4	0.1	5	18	58



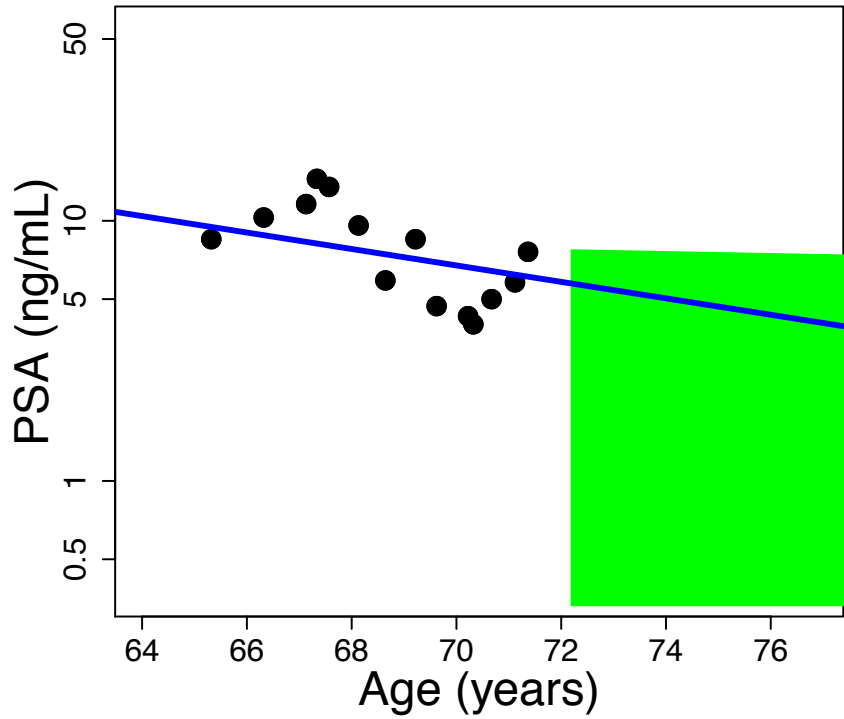




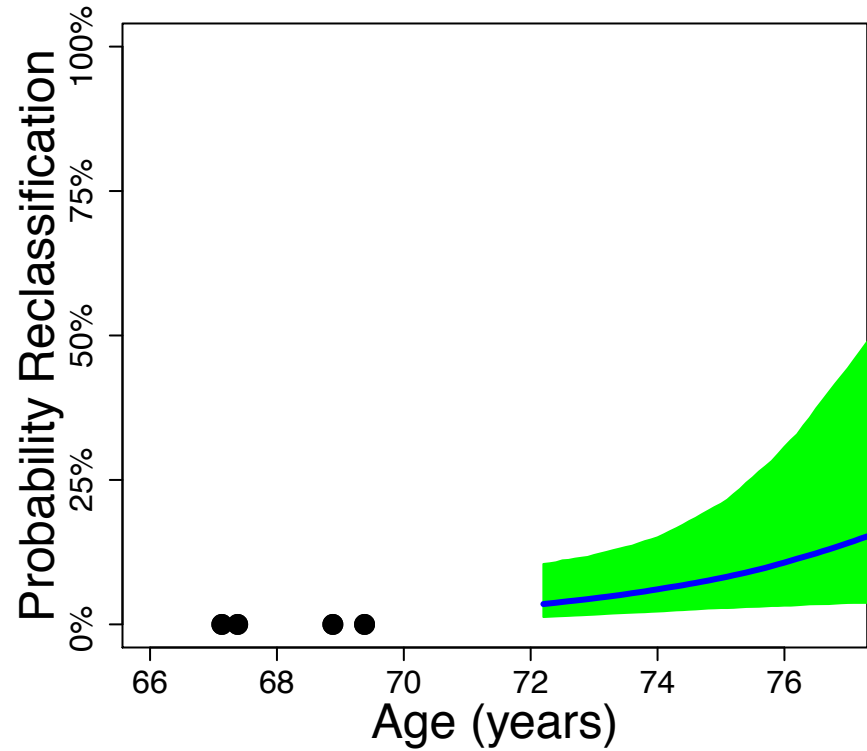
Probability Prognostic Grade Group II-V

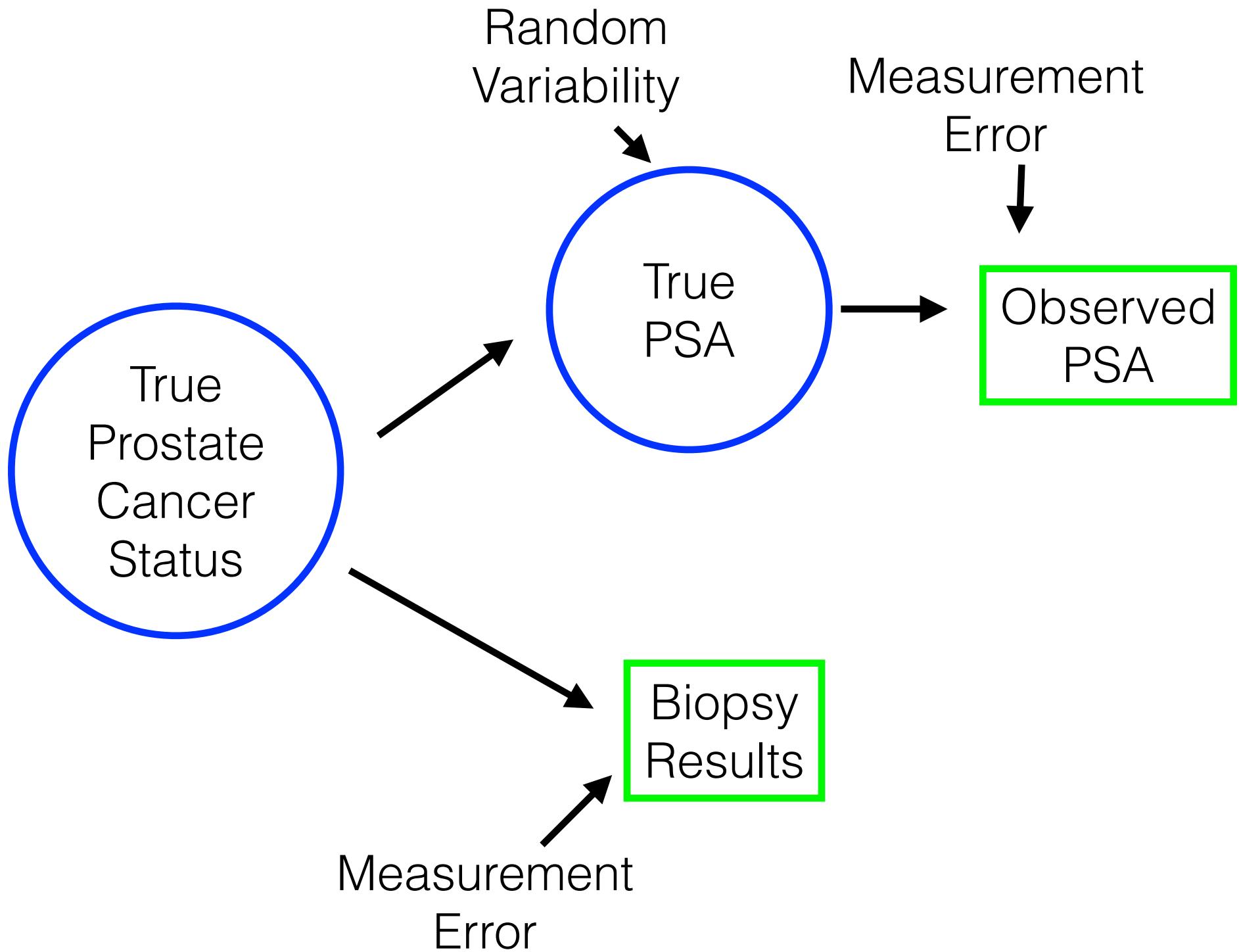


Projected PSA Trajectory



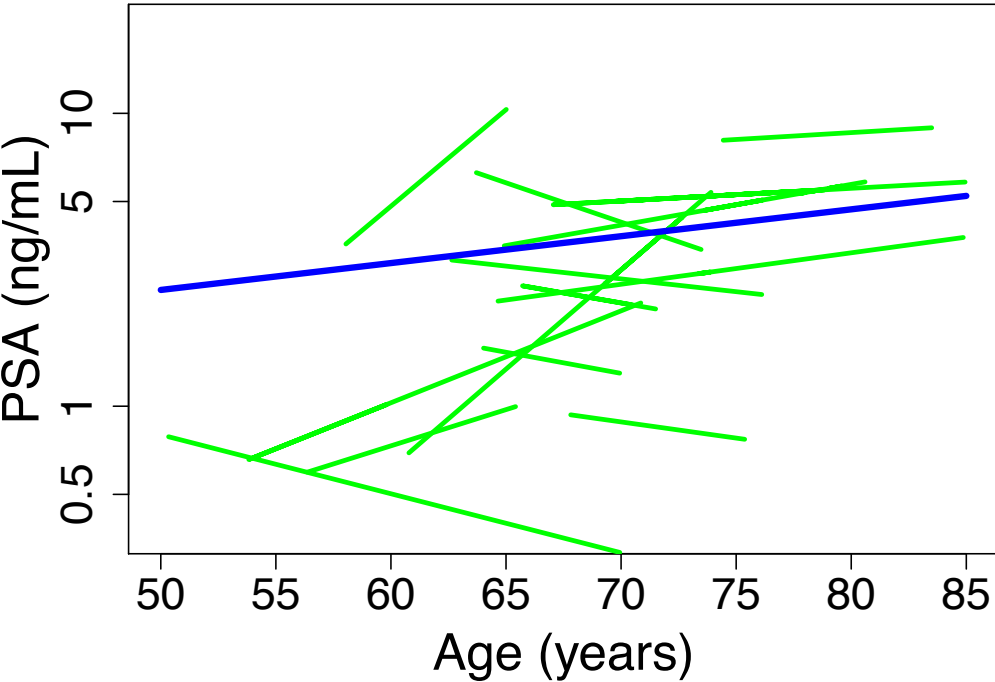
Risk of Reclassification



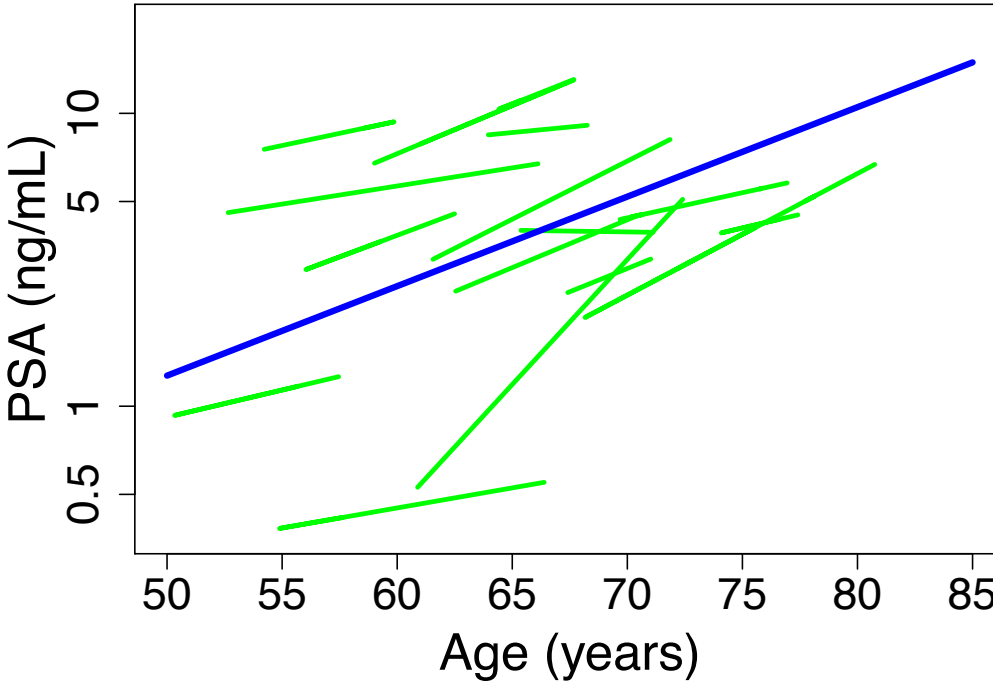


PSA Trajectories

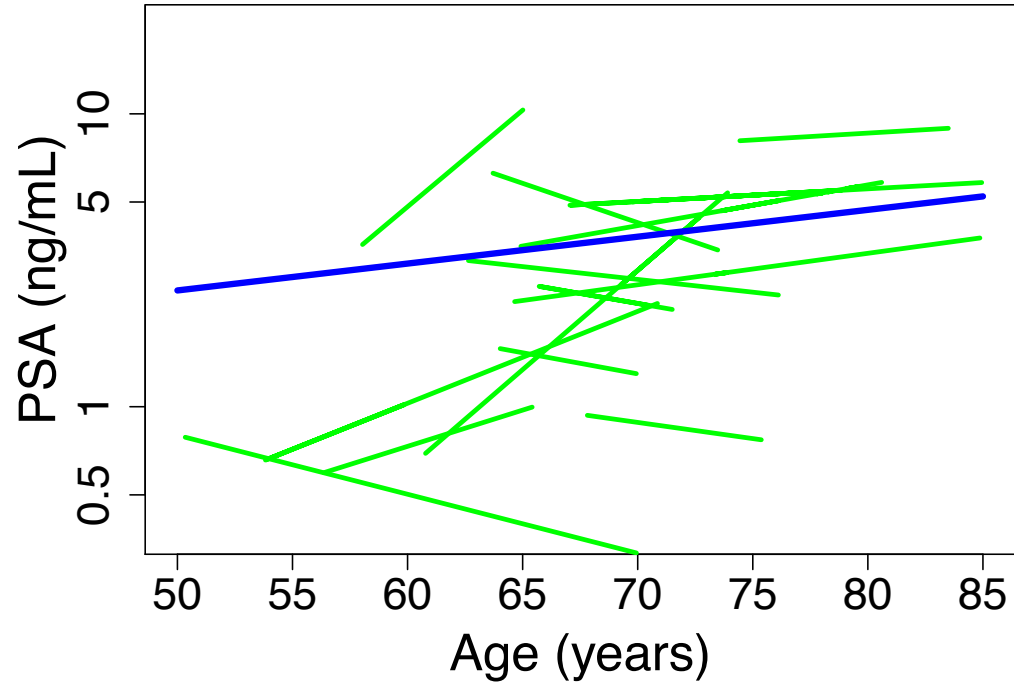
Prognostic Grade Group I



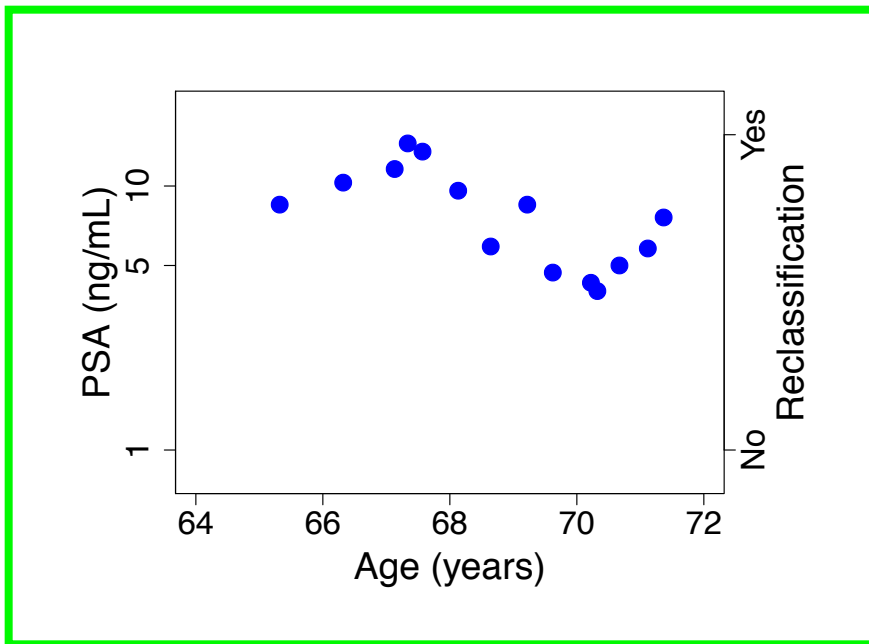
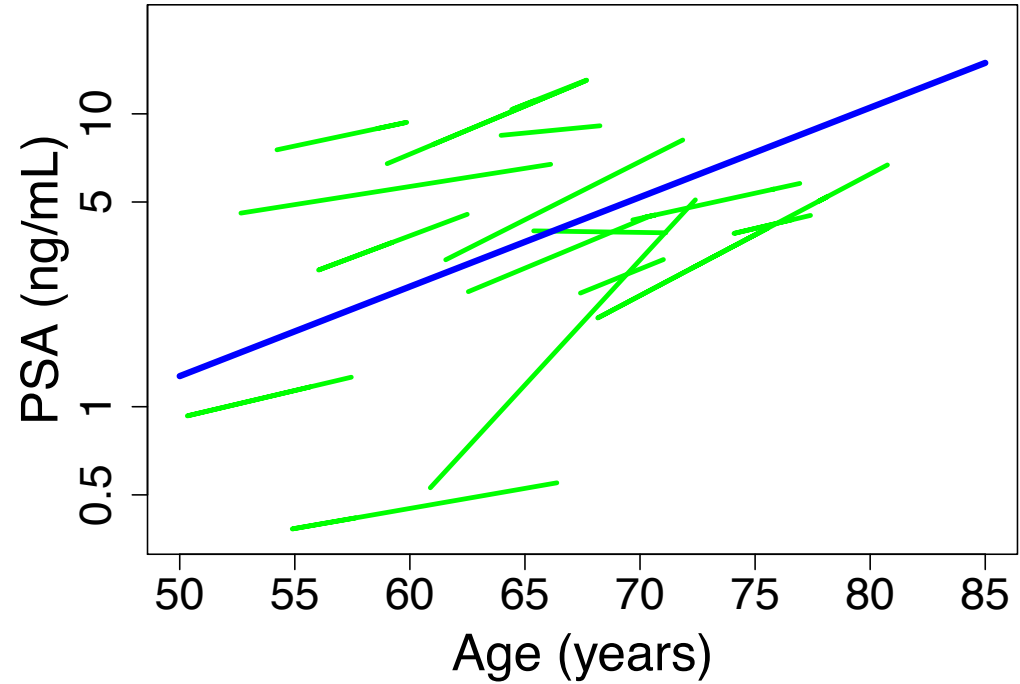
Prognostic Grade Group II-V



Prognostic Grade Group I



Prognostic Grade Group II-V



With which group would this PSA trajectory be more consistent?

Bayes Theorem

Would we expect to see these PSA and biopsy results if an individual had Gleason 7+ CaP?

$P(\text{Hypothesis} \mid \text{Data})$

$$= \frac{P(\text{Data} \mid \text{Hypothesis}) \times P(\text{Hypothesis})}{P(\text{Data})}$$

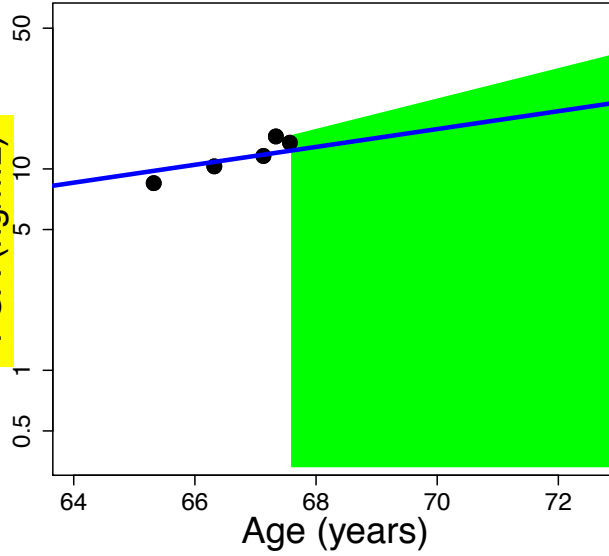
How probable is it that an individual has Gleason 7+ given their observed PSA and biopsy results?

Diagnosis

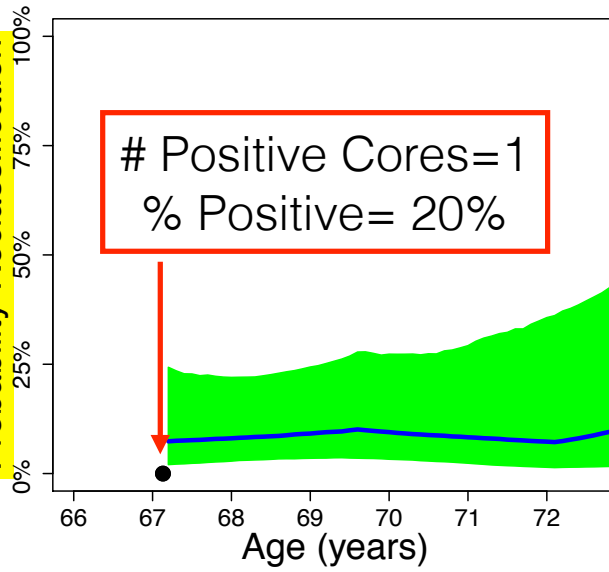
P(Gleason 7+)

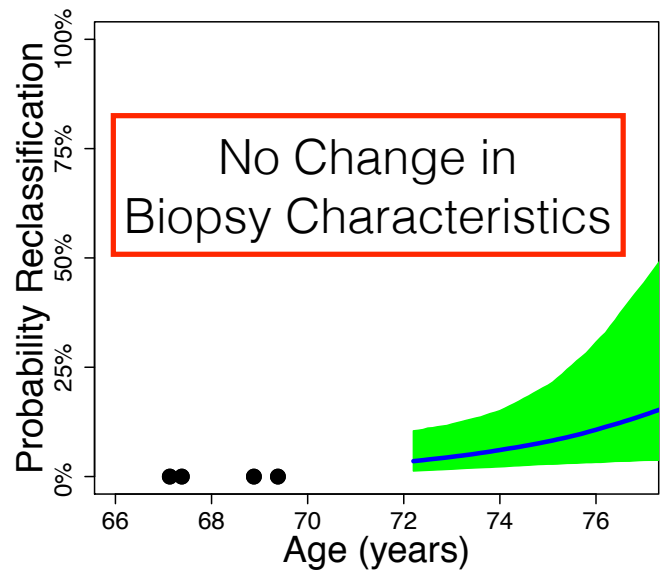
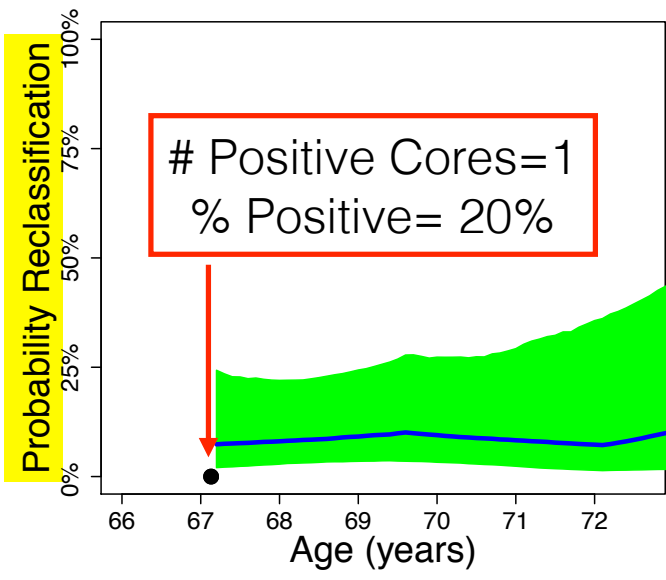
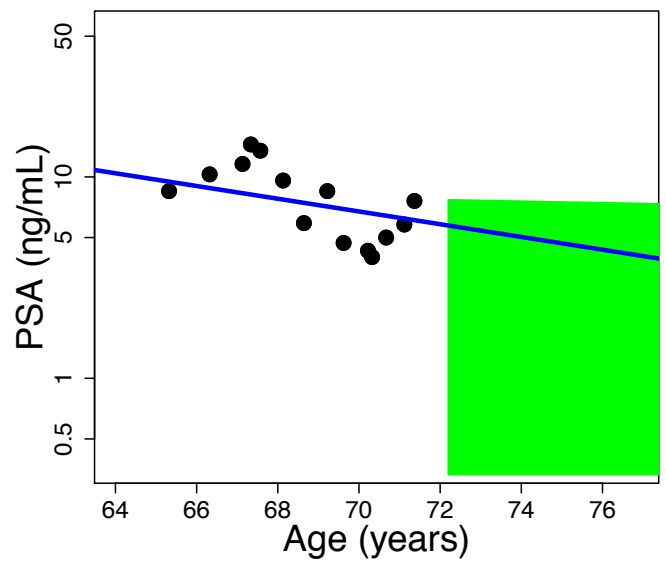
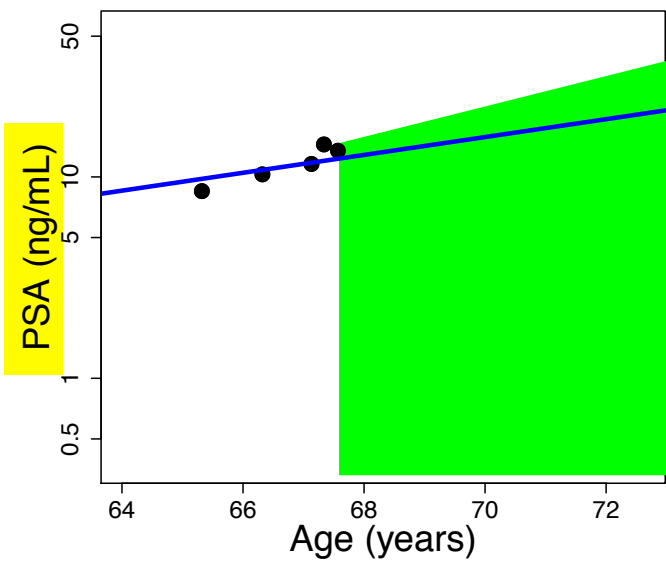
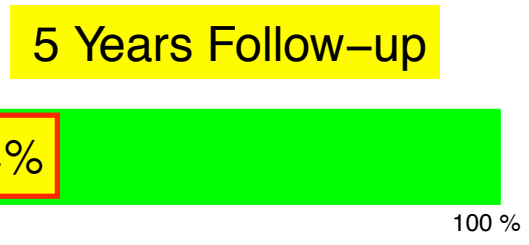
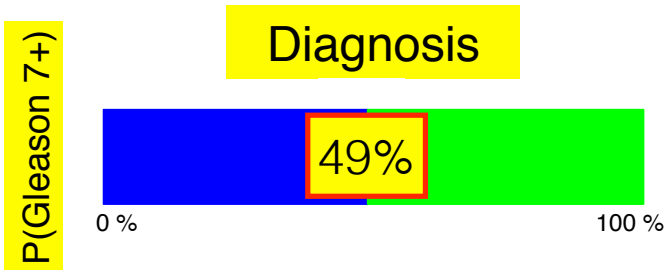


PSA (ng/mL)



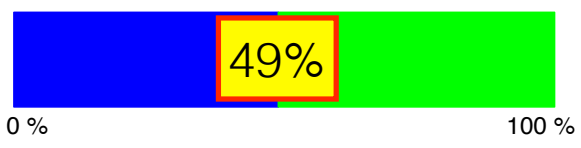
Probability Reclassification





P(Gleason 7+)

Diagnosis



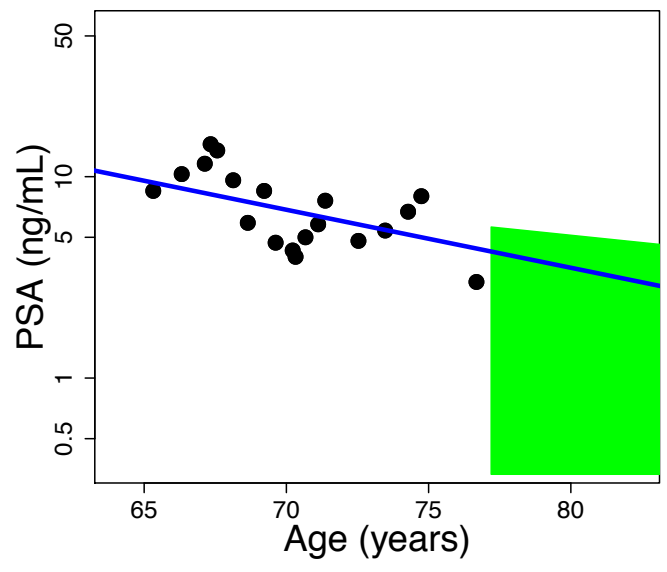
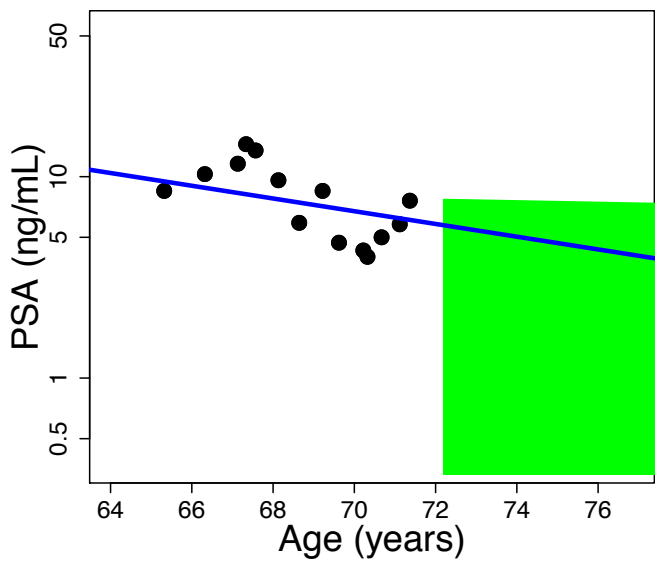
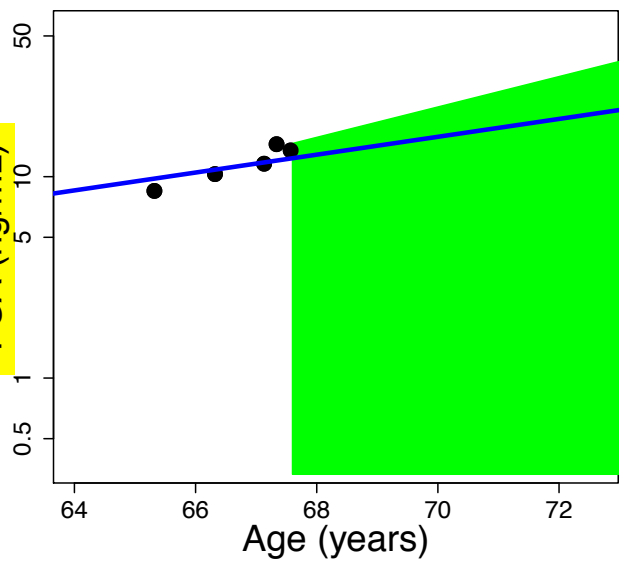
5 Years Follow-up



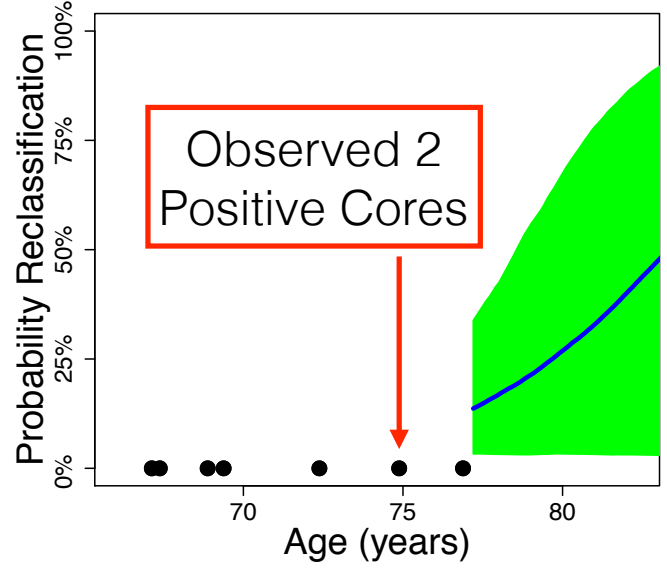
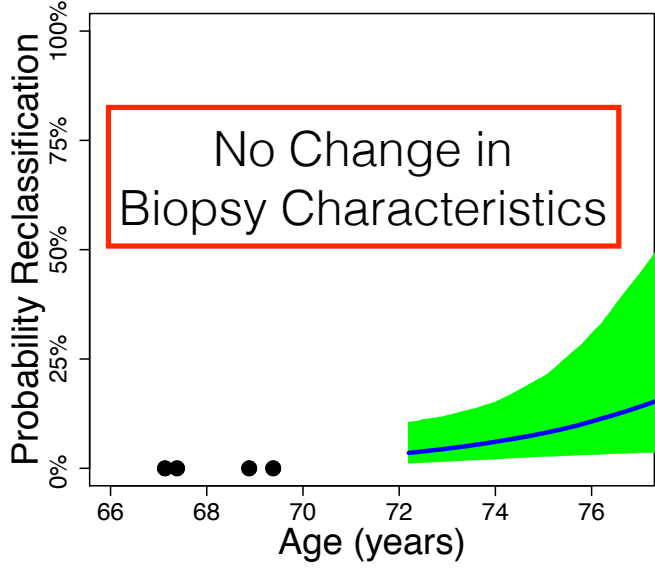
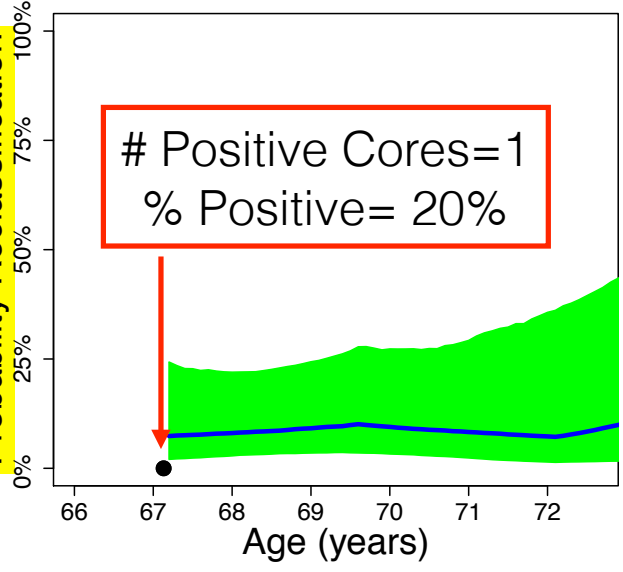
10 Years Follow-up



PSA (ng/mL)

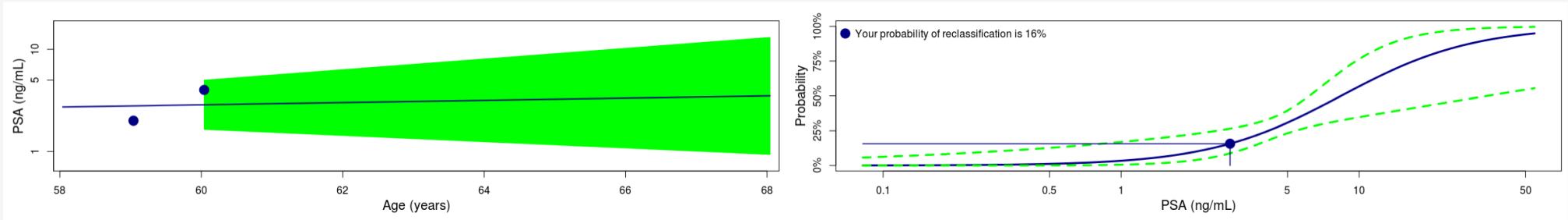


Probability Reclassification



Decision Support Tool

Prognosis for Active Surveillance Patients



These plots show your anticipated PSA trajectory (left) and risk of reclassification (right) based on your diagnostic characteristics. Green bands represent uncertainty in these estimates.

Date of birth
1940-01-01

Date of diagnosis
2000-01-01

Diagnostic biopsy data

Prostate volume (g)
50

Number positive cores
1

Maximum % positive core
10

Clinical stage T1C

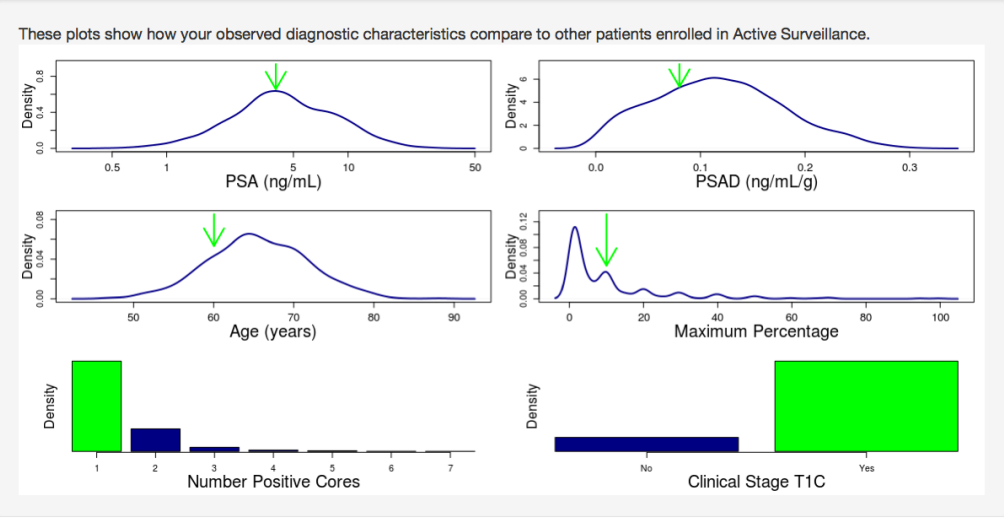
of previous PSA tests
2

(1) PSA (ng/mL)
2

(1) Date of PSA
1999-01-01

(2) PSA (ng/mL)
4

(2) Date of PSA
2000-01-01



<http://rycoley.shinyapps.io/prediction-app>