



University of California  
San Francisco

# Osher Mini Medical School for the Public

## Personalized Medicine Powered By Precision Imaging

Prostate Health: Risk, Detection, and Optimizing Personalized Treatment

Antonio C. Westphalen, MD PhD

Associate Professor, Radiology and Biomedical Imaging, and Urology

# Outline

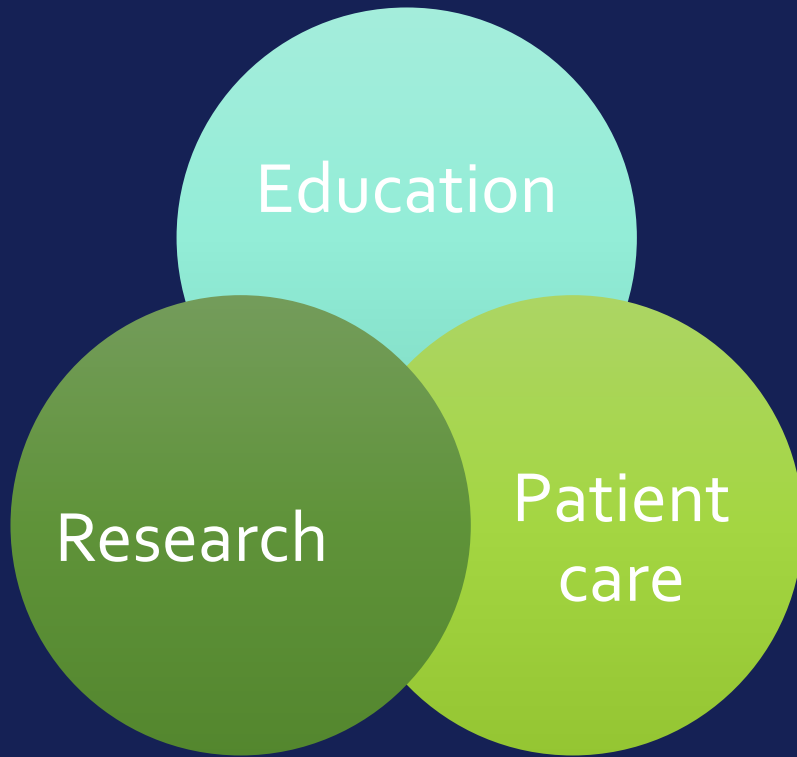
- What are we doing at UCSF? How? Why?
- What is the role of radiologists in this process?
  
- Matthew Cooperberg
- John Kurhanewicz
  
- Questions and Answers



# UCSF Mission

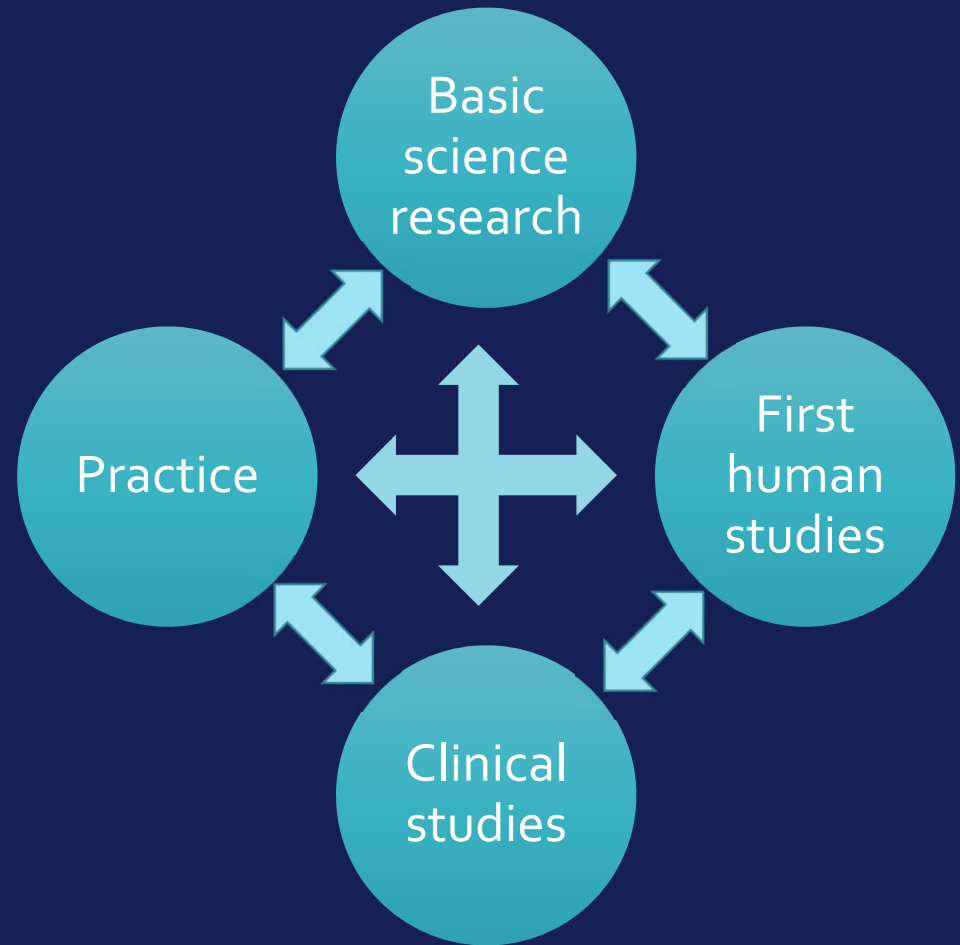
- *“advancing health worldwide through preeminent biomedical research, graduate-level education in the life sciences and health professions, and excellence in patient care.”*

# UCSF Mission

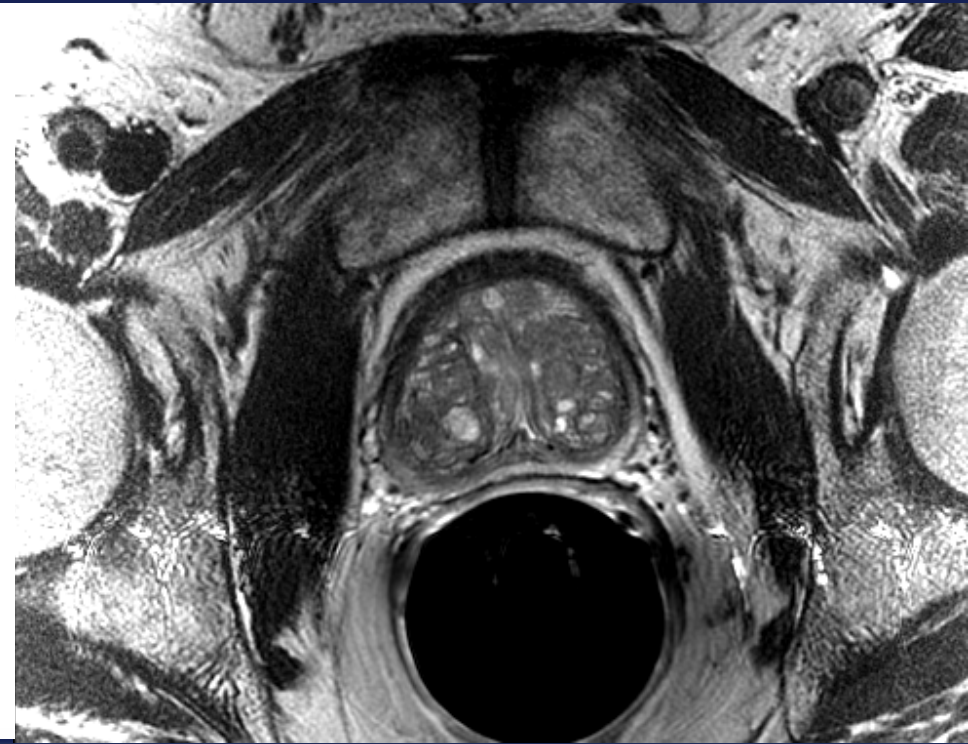
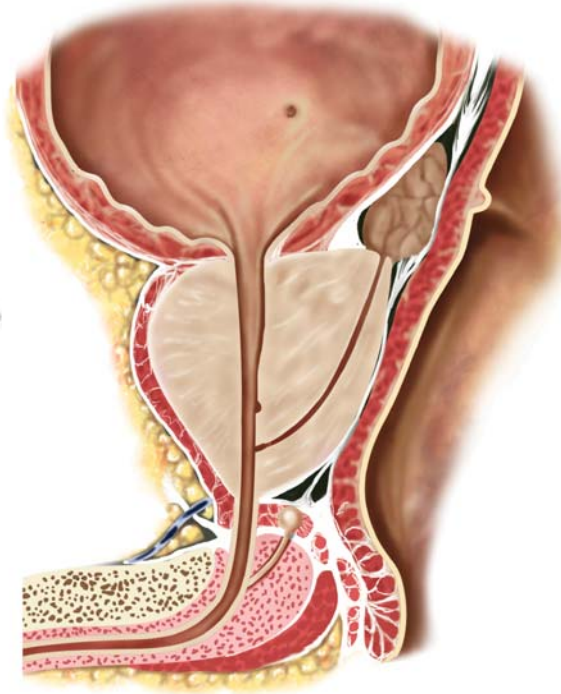
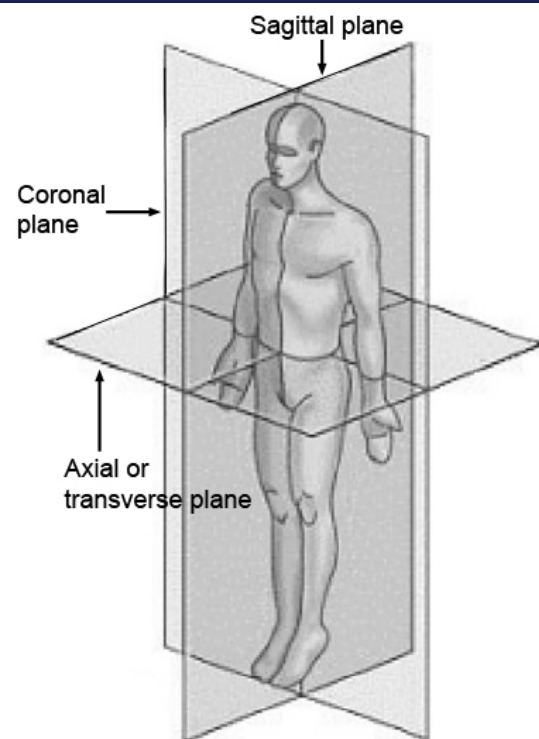




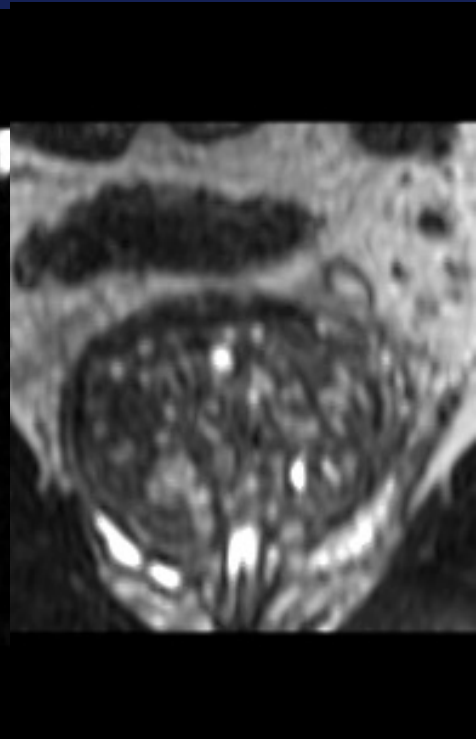
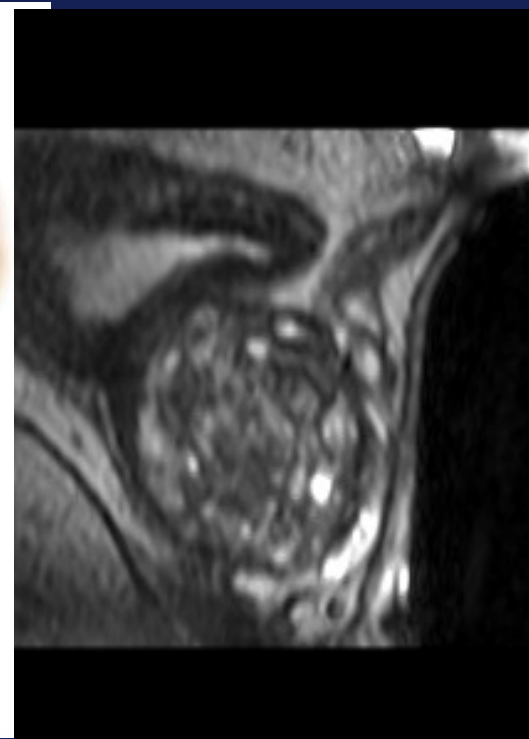
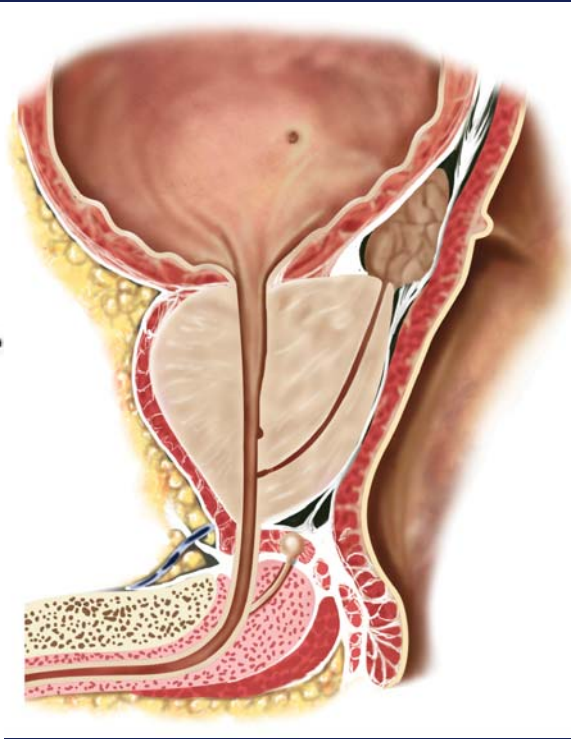
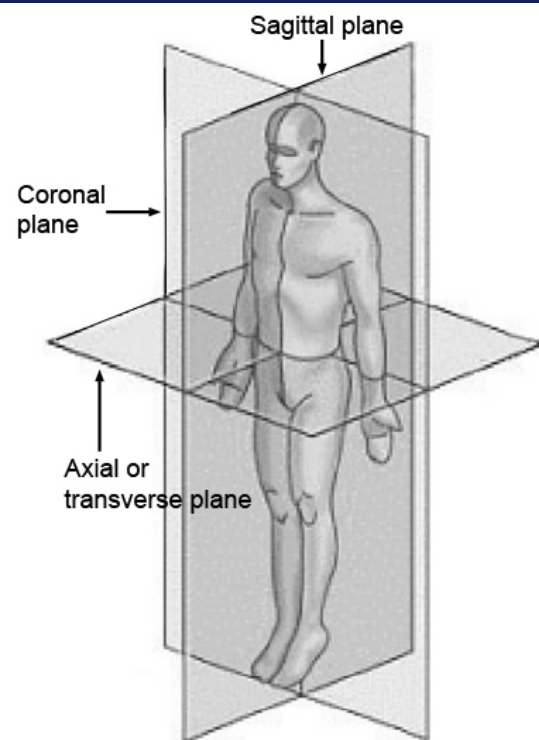
# UCSF Mission




# Prostate and Prostate Cancer!



# Prostate and Prostate Cancer!





**Cancer Statistics Center** [By State](#) [By Cancer Type](#) [Analysis Tool](#) [About](#) [Publications](#)

In 2017 in the U.S., there will be an estimated  
**1,688,780 new cancer cases** and  
**600,920 cancer deaths.**

**EVERY DAY** ▼

THAT'S APPROXIMATELY

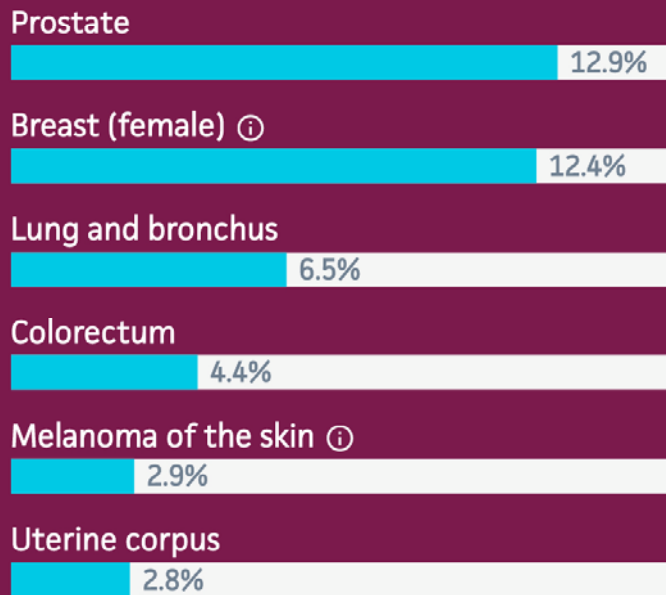
<b>4,630</b> NEW CASES	<b>1,650</b> DEATHS
---------------------------	------------------------

EXPLORE CANCER STATISTICS

▼

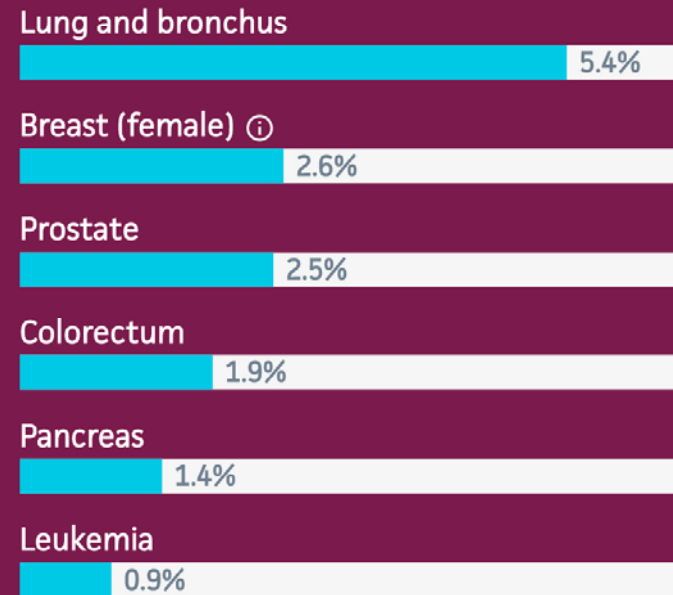
### Probability of developing cancer, 2011-2013

By cancer type



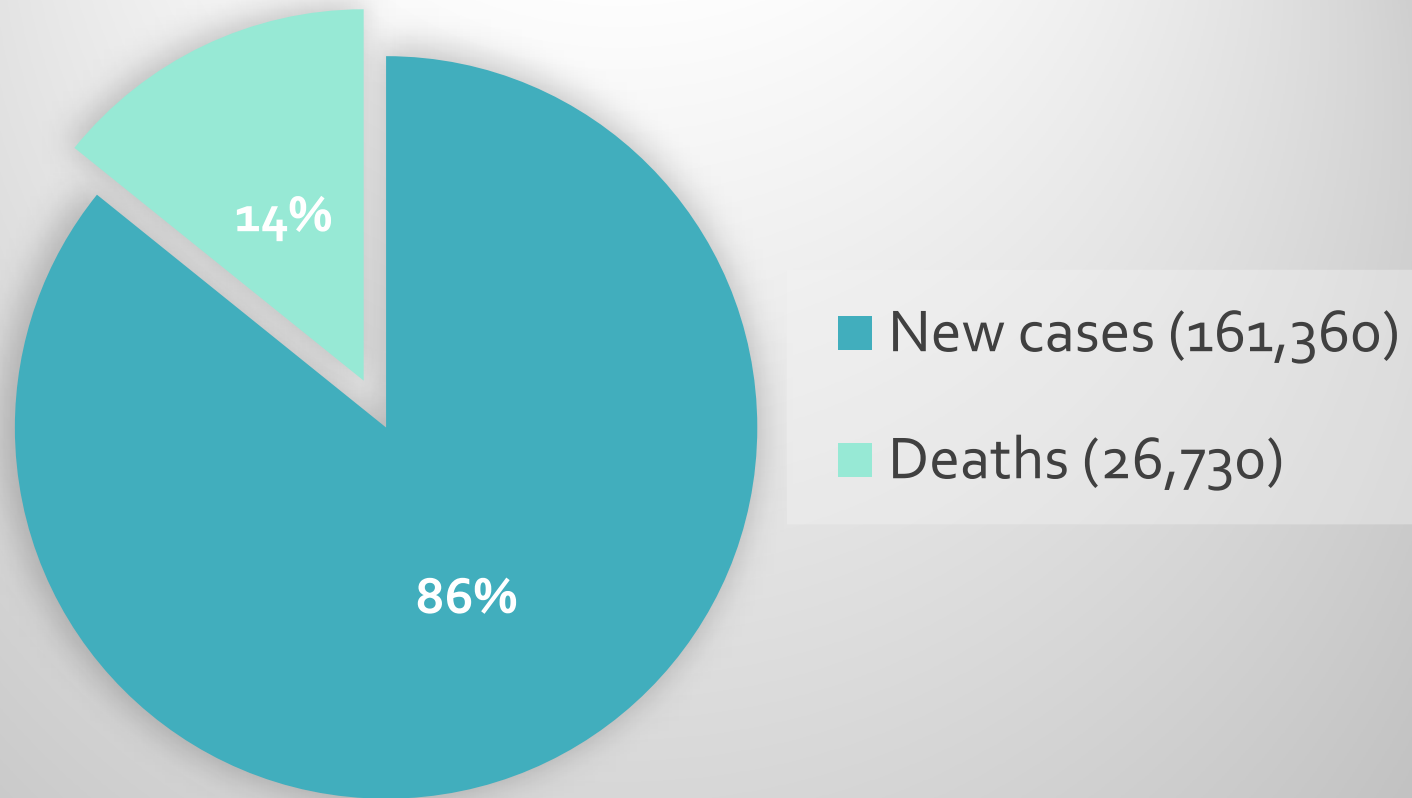
### Probability of dying from cancer, 2011-2013

By cancer type



*Lifetime risk*

## Prostate Cancer (2017)

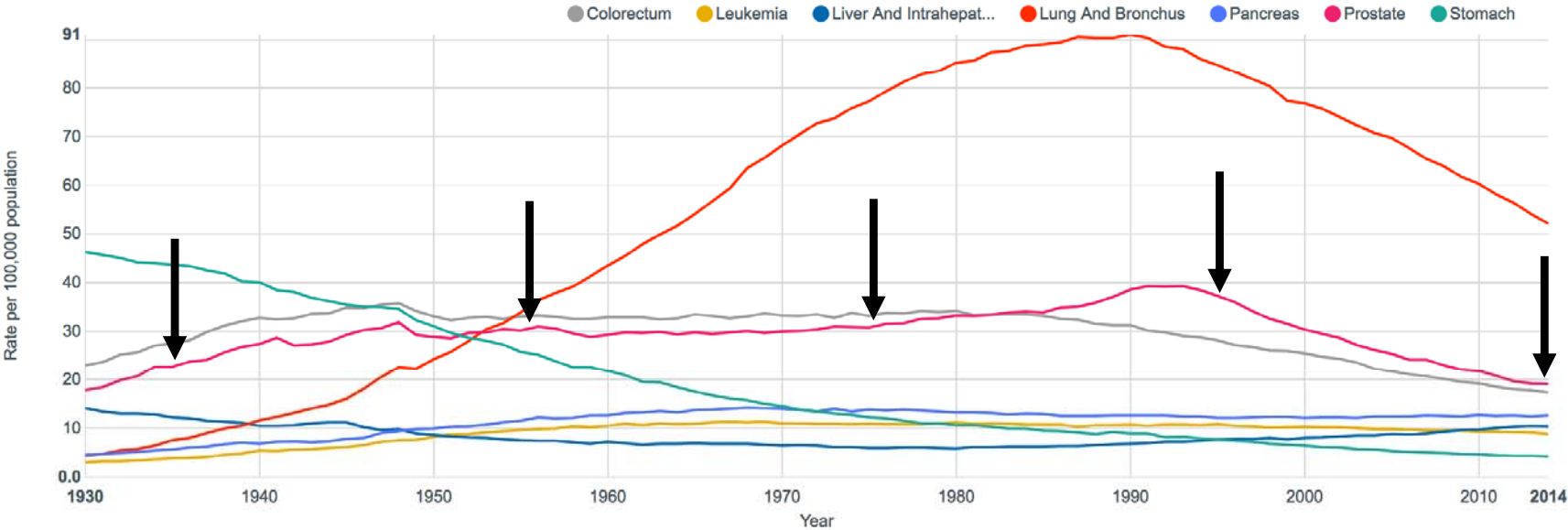






### Trends in death rates, 1930-2014

Males



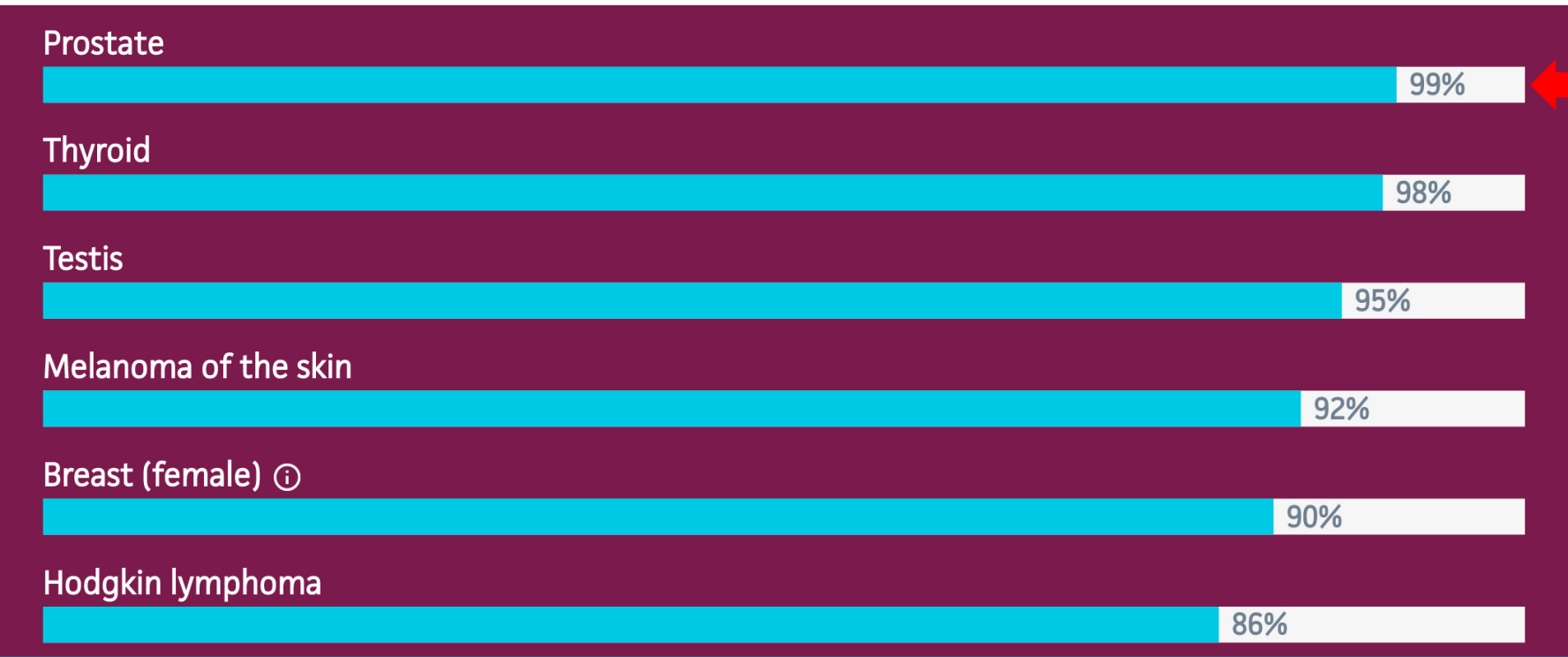
Per 100,000, age adjusted to the 2000 US standard population.

Data sources: National Center for Health Statistics (NCHS), Centers for Disease Control and Prevention, 2016

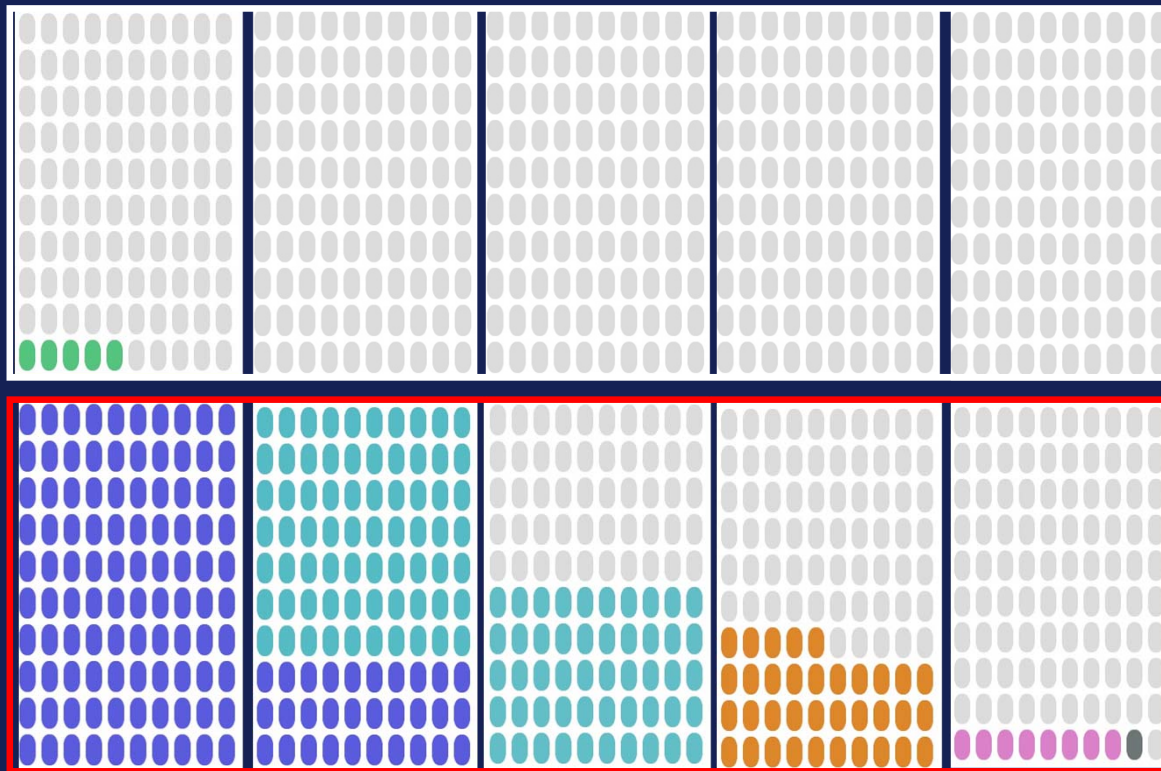


### 5-year relative survival, 2006-2012

By cancer type



# PSA Screening in 1000 US men



## Benefits

5 fewer Pca deaths

## Harms

130 negative biopsies

120 positive biopsies

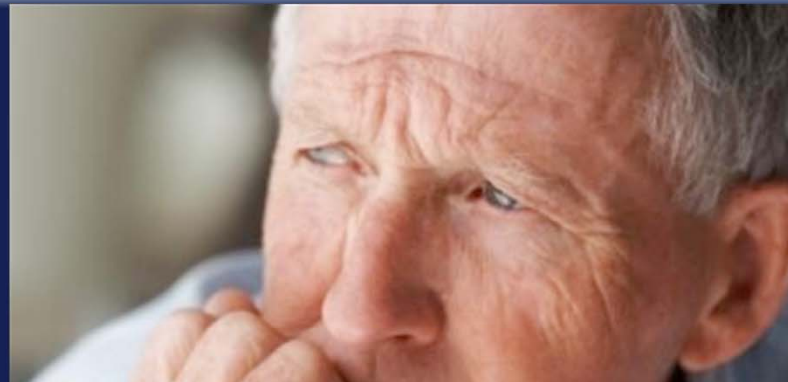
35 develop bladder, bowel or sexual side effects

8 complications of biopsy or treatment (i.e. sepsis, wound infection, DVT, MI, etc.)

<1 death due to treatment

We *overdiagnose* prostate cancer, i.e. we diagnose tumors that will not have an impact on patients life.

We *overtreat* prostate cancer, i.e. we treat tumors tumors that will not have an impact on patients life.



Do I have cancer?  
Is my cancer bad?



# What do we want?

- *We want ...*

- ... to diagnose only prostate cancers that do need treatment  
because they will impact the patient's life*

- ... to improve treatment/management decisions*

- ... to minimize the risks, i.e. complications, of treatments*



# And when cure is not possible

- *We want ...*

*... to detect spreading of disease early to maximize the control of cancer and maintain life expectancy*

Radiologists play a key role!



After abnormal PSA  
Before diagnosis, i.e. biopsy

After diagnosis, i.e. biopsy  
Before treatment



After treatment

Treatment



After abnormal PSA  
Before diagnosis, i.e. biopsy  
MRI



After diagnosis, i.e. biopsy  
Before treatment  
MRI / CT / bone scan / PET

**We play a role at all stages of patient care!**

After treatment  
PET



Treatment  
CT / bone scan / PET

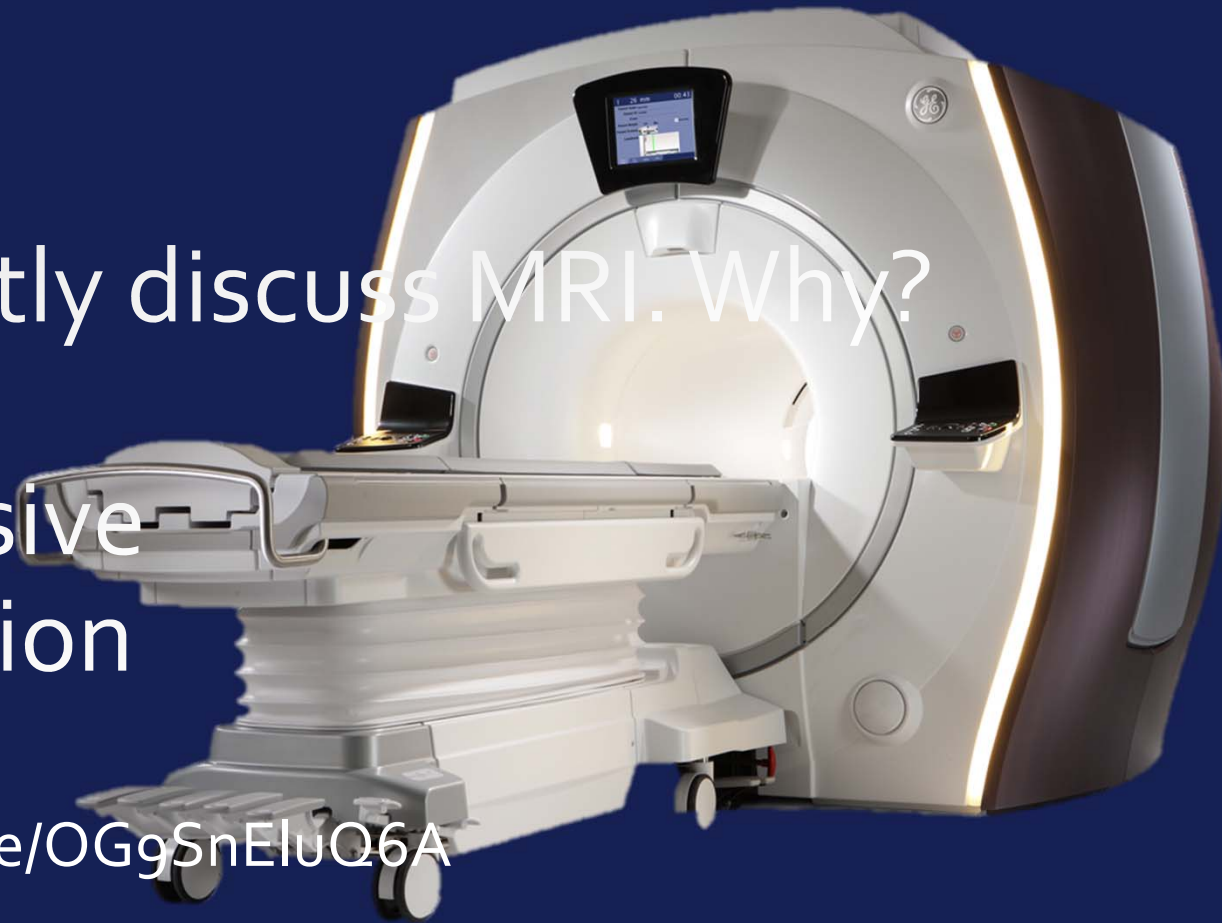
I will mostly discuss MRI.



I will mostly discuss MRI. Why?

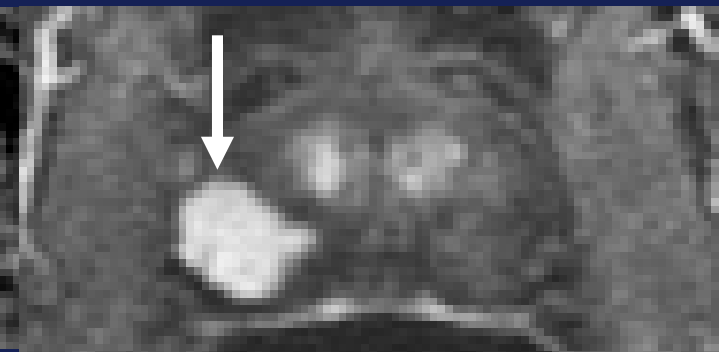
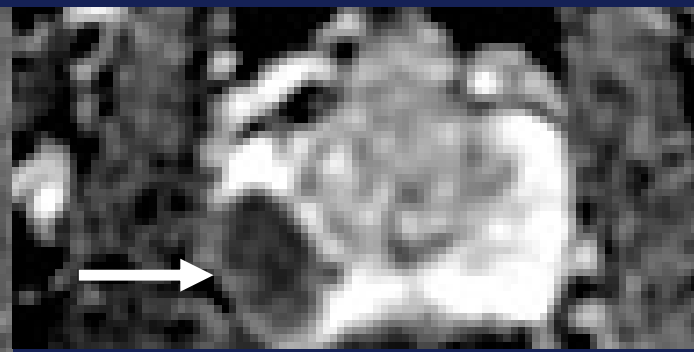
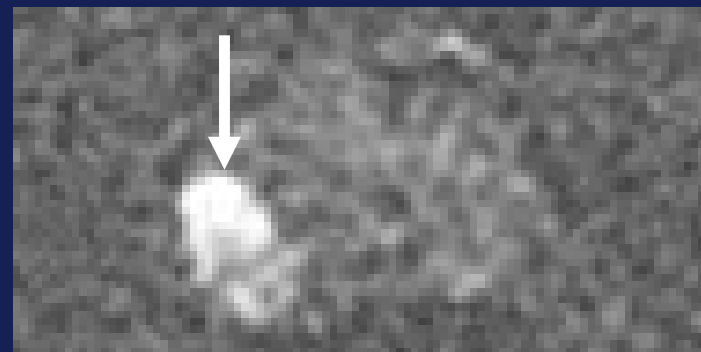
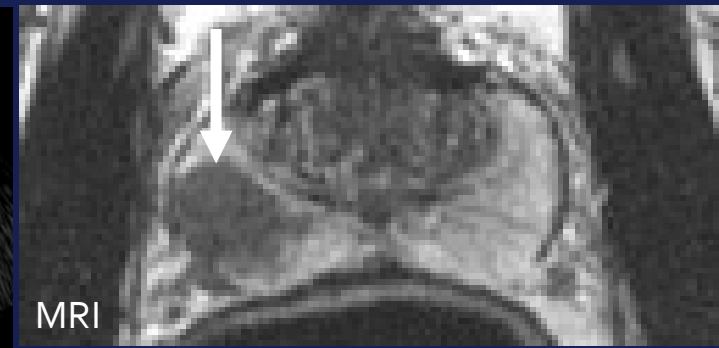
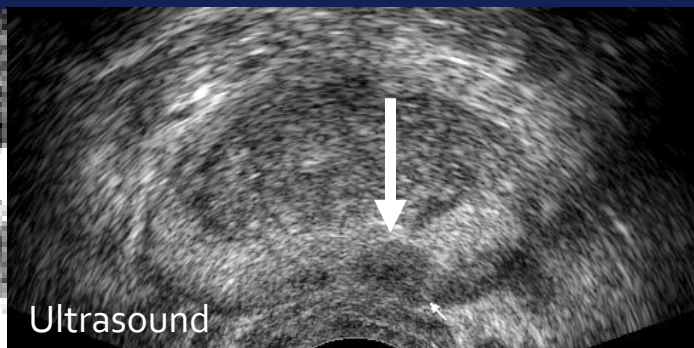
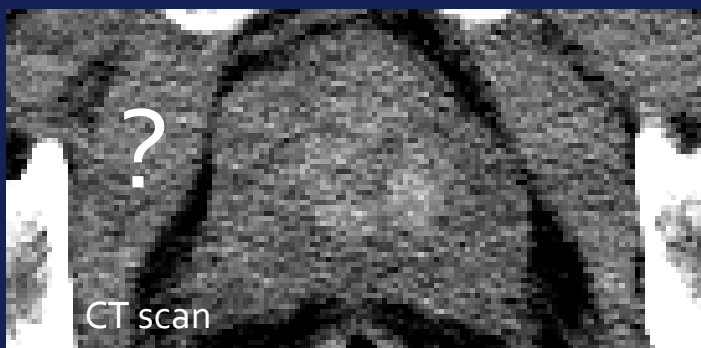
Non invasive  
No radiation

<https://youtu.be/OGgSnEluQ6A>

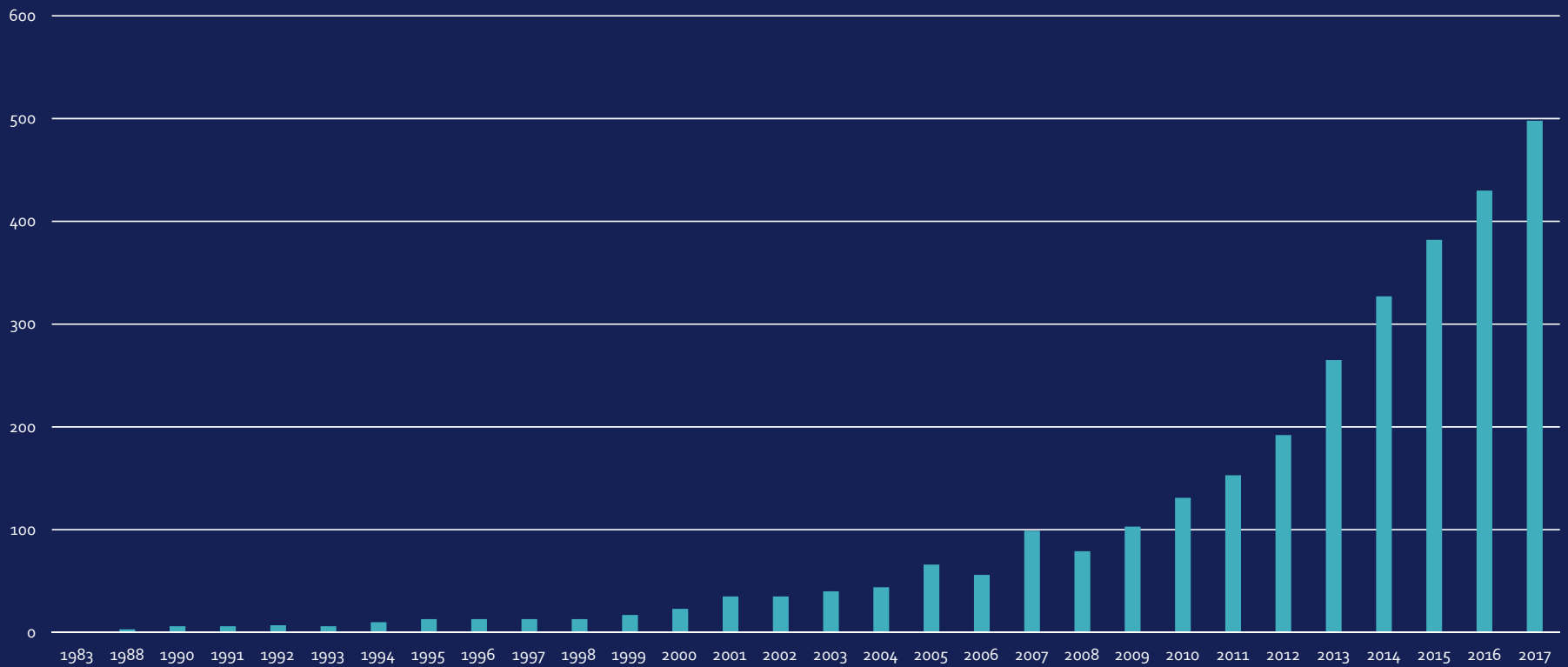


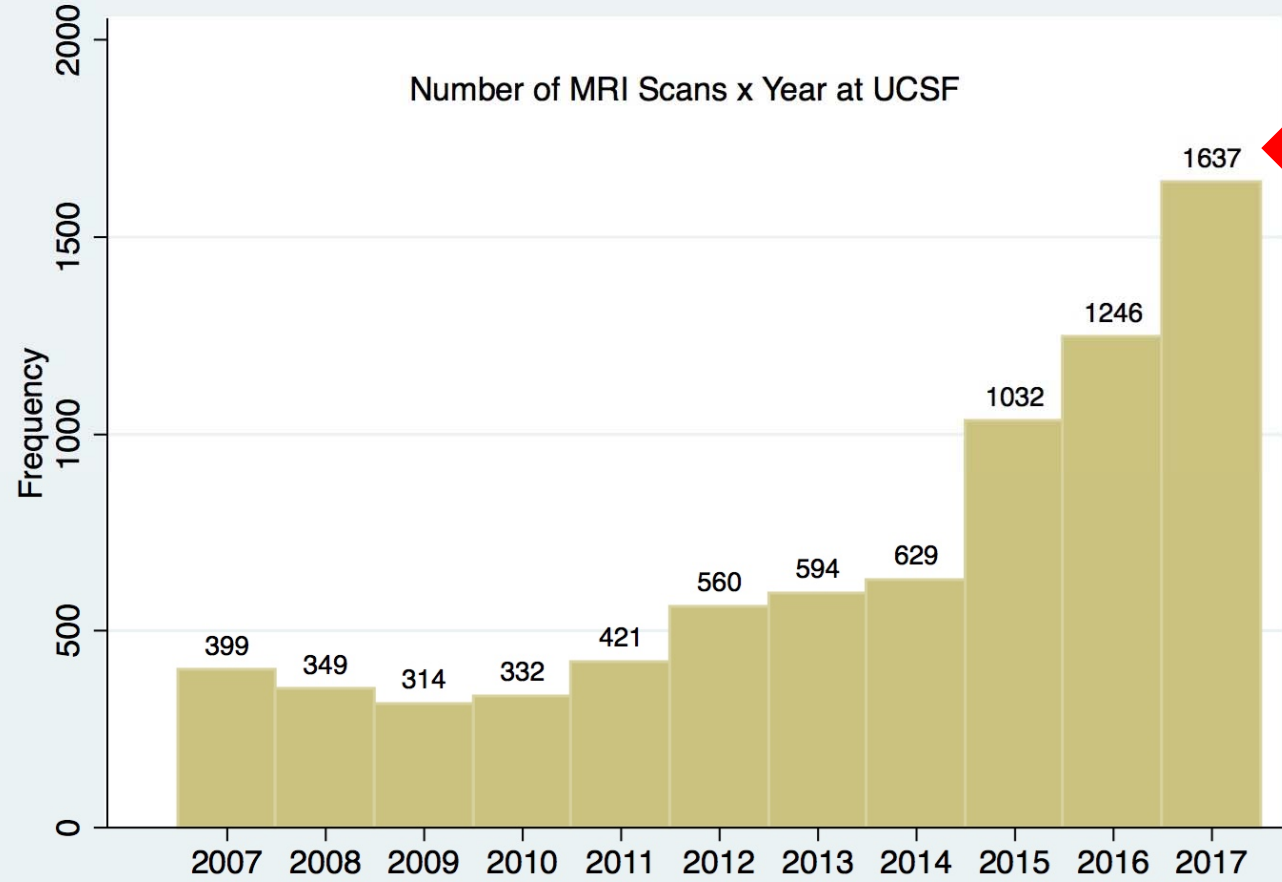


# I will mostly discuss MRI



# Prostate MRI PubMed publications





09/31/2017

### Endorectal MRI of Prostate Cancer: Incremental Prognostic Importance of Gross Locally Advanced Disease

Valdair F. Muglia<sup>1</sup>  
Antonio C. Westphalen<sup>2</sup>  
Zhen J. Wang<sup>2</sup>  
John Kurhanewicz<sup>2</sup>  
Peter R. Carroll<sup>3</sup>  
Fergus V. Coakley<sup>2</sup>

**OBJE**  
prognos  
with pre  
**MAT**  
tients wi  
6-year p  
gross lo  
cal semi  
trol gro  
**RES**  
1085 (C

**Prostate Imaging and Data System Reflections on Ear With a Standardiz Scheme for Multip Prostate MRI**

Abdominal Imaging

© Springer Science+Business Media New York 2014  
Published online: 17 April 2014

Abdom Imaging (2014) 39:1027–1035  
DOI: 10.1007/s00261-014-0136-7

**Abnormal findings on multiparametric prostate magnetic resonance imaging predict subsequent biopsy upgrade in patients with low risk prostate cancer managed with active surveillance**

Robert R. Flavell, Antonio C. Westphalen, Carmin Liang, Christopher C. Sotro, Susan M. Noworolski, Daniel B. Vigneron, Zhen J. Wang, John Kurhanewicz

ng and Version 2:

Our group has over 200 publications focused on MRI of prostate cancer!



CLINICAL INVESTIGATION

#### PRETREATMENT MAGNETIC RESONANCE IMAGING AS PREDICTOR OF CLINICAL OUTCOME IN PROSTATE CANCER

TIM JOSEPH, M.D.  
Clinical Urology

International Braz J Urol

#### T2-Weighted Endorectal MRI of Prostate Cancer after External Beam Radiation Therapy

Antonio C. Westphalen, Shoujun Zhao, Fergus V. Coakley

John M. Neuhaus, PhD  
Ralph T. Marcus, MD  
John Kurhanewicz, PhD  
Rebecca Smith-Bindman, MD

Munish Chitkara, Antonio Westphalen, Galen and Antonio C. Westphalen,

Antonio C. Westphalen, MD  
Fergus V. Coakley, MD  
Mack Roach III, MD  
Charles E. McCulloch, PhD  
John Kurhanewicz, PhD

Antonio C. Westphalen<sup>1</sup>  
Fergus V. Coakley<sup>1</sup>  
John Kurhanewicz<sup>1</sup>  
Galen Reed<sup>1</sup>  
Zhen J. Wang<sup>1</sup>  
Jeffery P. Simko<sup>2</sup>

Adam J. Jung MD, PhD, Antonio C. Westphalen MD,

Adam J. Jung<sup>a,\*</sup>, Fergus V. Coakley<sup>a</sup>, Katsuto Shinohara<sup>a</sup>, John Kurhanewicz<sup>a</sup>, Janet E. Cowan<sup>b</sup>, Antonio C. Westphalen, MD,<sup>\*</sup> Galen D. Reed, BS, Phillip P. Sotro, BS, Daniel B. Vigneron, PhD, and John K

#### Clinical Investigation: Genitourinary Cancer

### Does Local Recurrence of Prostate Cancer Therapy Occur at the Site of Primary Tumor of a Longitudinal MRI and MRSI Study

Elnasif Arrayeh, M.D.,\* Antonio C. Westphalen, M.D.,\* John Kurhanewicz, M.D.,\* Adam J. Jung, M.D., Ph.D.,\* Peter R. Carroll, M.D.,\* and Fergus V. Coakley, M.D.,\*§

Mekhail Anwar<sup>a,\*</sup>, Antonio C. Westphalen<sup>b</sup>, Adam J. Jung<sup>b</sup>, Susan M. Noworolski<sup>b,c,f,g</sup>, Jeffrey P. Simko<sup>c,e</sup>, John Kurhanewicz<sup>b,c,f,g</sup>, Mack Roach III<sup>a,c</sup>, Peter R. Carroll<sup>d,e</sup>, Fergus V. Coakley<sup>b,d,e</sup>

#### Original Article

### Prostate cancer with a pseudocapsule at MR imaging: a marker of high grade and stage disease?\*

Apurva A. Bonde<sup>a</sup>, Elena K. Korngold<sup>a</sup>, Bryan R. Foster<sup>a</sup>, Antonio C. Westphalen<sup>c</sup>, David R. Pettersson<sup>a</sup>, Megan L. Troxell<sup>b</sup>, Jeffrey P. Simko<sup>d</sup>, Fergus V. Coakley<sup>a,\*</sup>

Adam J. Jung, MD, PhD,<sup>1</sup> Antonio C. Westphalen, MD,<sup>1</sup> John Kurhanewicz, PhD,<sup>1</sup> Zhen J. Wang, MD,<sup>1</sup> Peter R. Carroll, MD, MPH,<sup>2</sup> Jeffrey P. Simko, MD, PhD,<sup>3</sup> and Fergus V. Coakley, MD<sup>1,\*</sup>

Antonio C. Westphalen<sup>1</sup>  
Susan M. Noworolski<sup>1</sup>  
Mukesh Harisinghani<sup>2</sup>  
Kartik S. Jhaveri<sup>3</sup>  
Steve S. Raman<sup>4</sup>  
Andrew B. Rosenkrantz<sup>5</sup>  
Zhen J. Wang<sup>1</sup>  
Ronald J. Zagoria<sup>1</sup>  
John Kurhanewicz<sup>1</sup>

**OBJECTIVE.** The goal of this study was to compare the perceived quality of 3-T axial T2-weighted high-resolution 2D and high-resolution 3D fast spin-echo (FSE) endorectal MR images of the prostate.  
**MATERIALS AND METHODS.** Six radiologists independently reviewed paired 3-T axial T2-weighted high-resolution 2D and 3D FSE endorectal MR images of the prostates of 85 men in two sessions. In the first session (n = 85), each reader selected his or her preferred images; in the second session (n = 28), they determined their confidence in tumor identification and compared the depiction of the prostatic anatomy, tumor conspicuity, and subjective intrinsic image quality of images. A meta-analysis using a random-effects model, logistic regression, and the paired Wilcoxon rank-sum test were used for statistical analyses.

potential challenges associated with the use of PI-RADS v2, and to compare its performance to its earlier version and will determine if the use of PI-RADS v2 remains on the basis of earlier studies. PI-RADS v2 are noted. Continued use of PI-RADS v2 will be invaluable for PI-RADS v2



*We want ...*

*... to diagnose only prostate cancers that do need treatment  
because they will impact the patient's life*

When the MRI is negative it is unlikely the patient has a bad/aggressive prostate cancer, i.e. tumor with Gleason pattern 4

## *We want ...*

*... to diagnose only prostate cancers that do need treatment  
because they will impact the patient's life*

When the MRI is negative it is unlikely the patient has a bad/aggressive prostate cancer, i.e. tumor with Gleason pattern 4

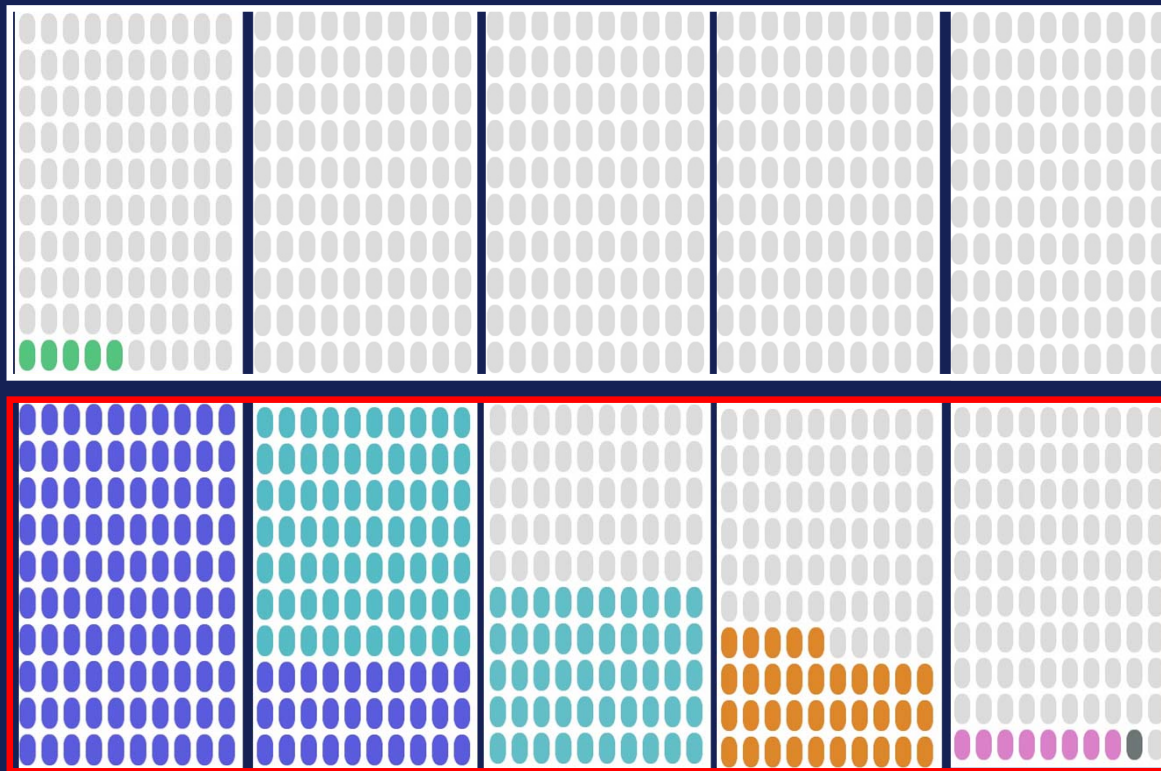
### Questions:

Do men with a negative MRI need a biopsy?

Do men with known cancer and negative MRI need immediate treatment?



# PSA Screening in 1000 US men



## Benefits

5 fewer Pca deaths

## Harms

130 negative biopsies

120 positive biopsies

35 develop bladder, bowel or sexual side effects

8 complications of biopsy or treatment (i.e. sepsis, wound infection, DVT, MI, etc.)

<1 death due to treatment

## *We want ...*

*... to diagnose only prostate cancers that do need treatment  
because they will impact the patient's life*

When the MRI is negative it is unlikely the patient has a bad/aggressive prostate cancer, i.e. tumor with Gleason pattern 4

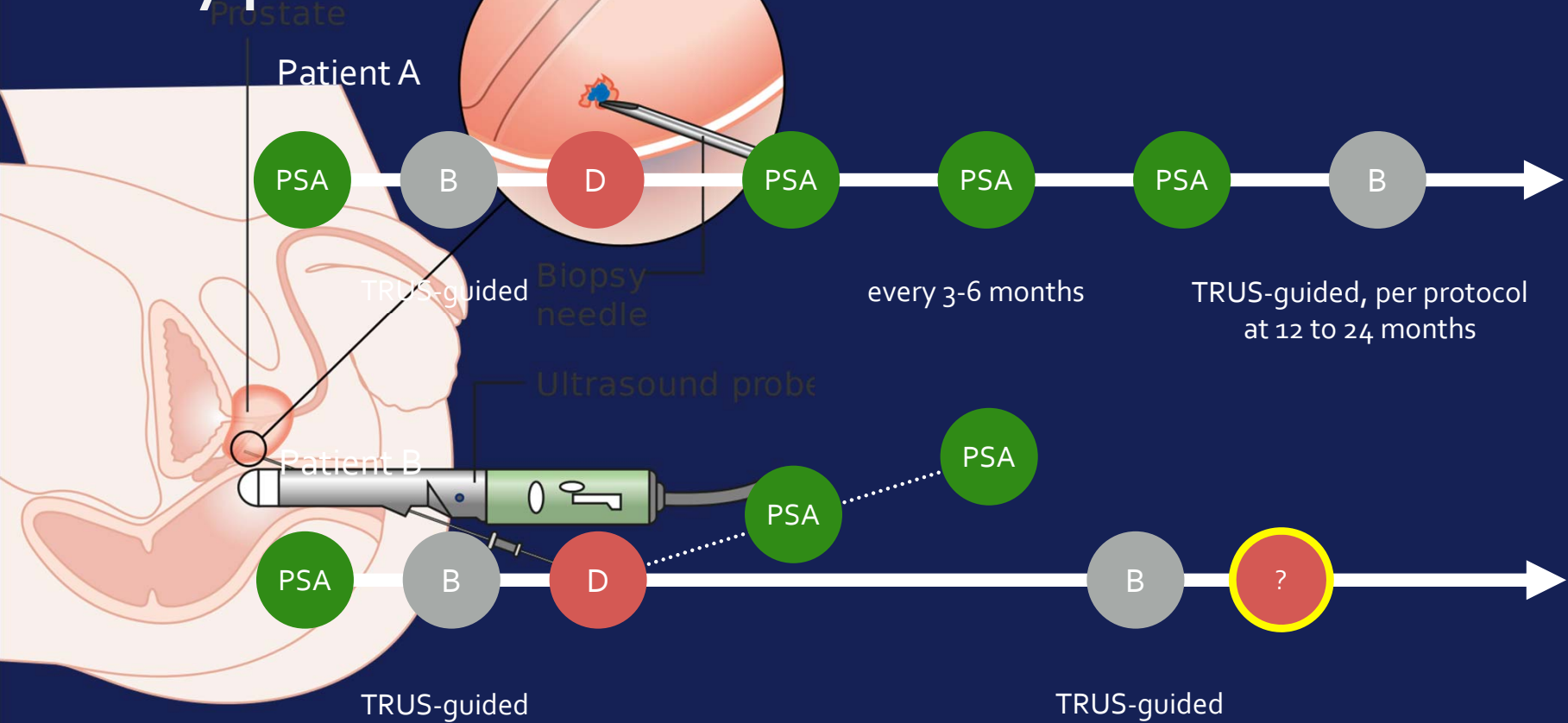
Problem:

Between 5 a

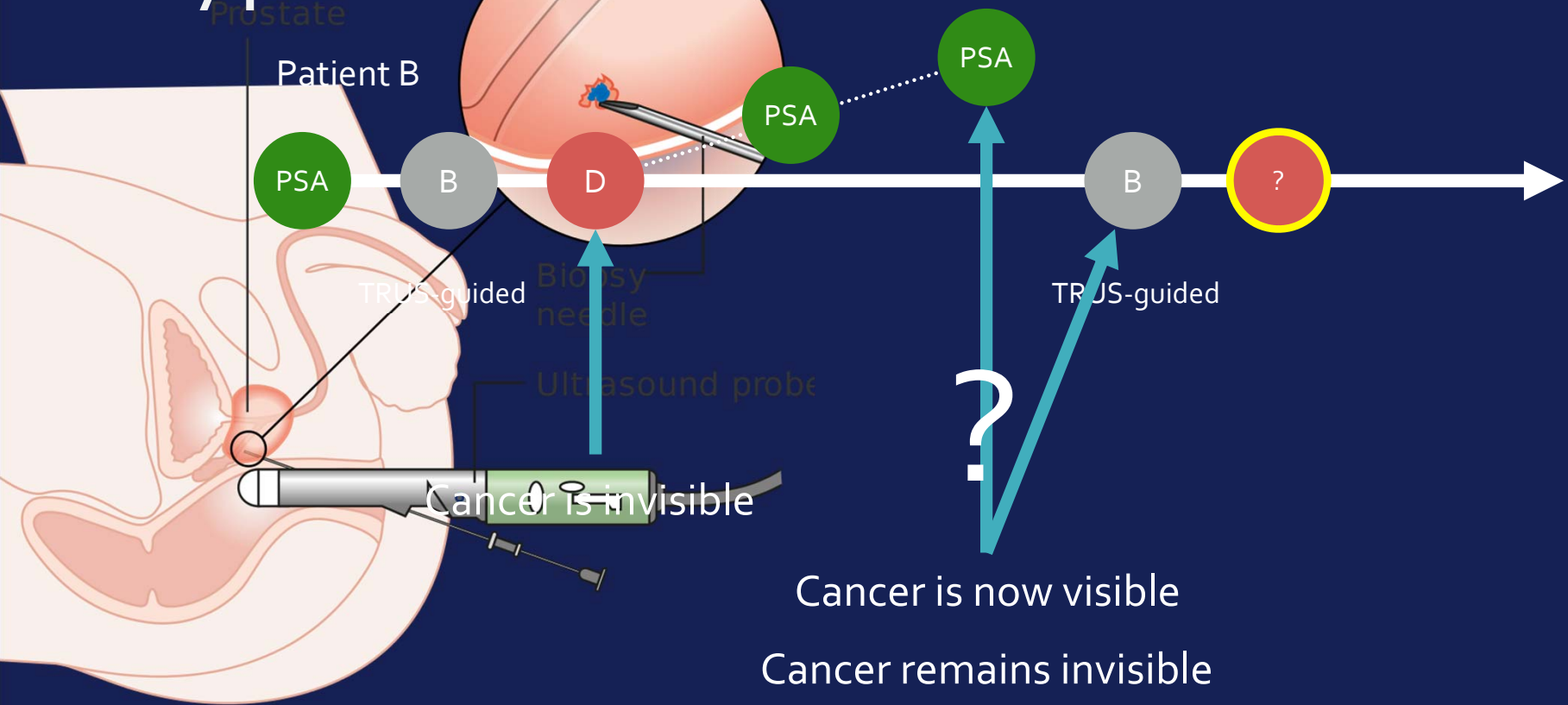
Do invisible tumors impact patients' lives?

Can these tumors be followed until visible?

# Typical AS Protocol



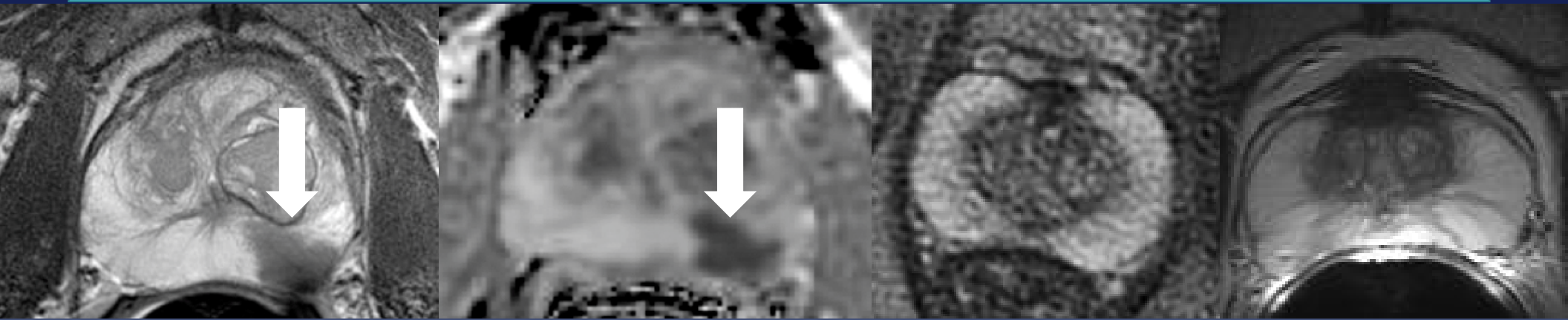
# Typical AS Protocol



# *We want ...*

*... to diagnose only prostate cancers that do need treatment  
because they will impact the patient's life*

Flipside – bad tumors are usually very positive! PI-RADS scores



## *We want ...*

*... to diagnose only prostate cancers that do need treatment  
because they will impact the patient's life*

Flipside – bad tumors are usually very positive! PI-RADS scores

Questions:

– Can we target these areas on biopsy to diagnose the bad cancer?

– Can we target only these areas?

– Can we treat only these areas?

# MRI-TRUS fusion biopsy technique

© UC Regents

UCSF Radiology Proton MRS Study

Image File : pc7390\_E970S4\_div.int2  
Image Series : 400  
Image FOV : 35.16 X 35.16  
CSI File : pc7390\_8\_cor\_rephased.ompr  
CSI Slice No. : 9  
CSI Slice Pos. : 5.86 mm

Selected Region : 45.14 cc  
Size : 50.0 RL 30.0 AP 30.1 SI mm  
Center: 2.8 RL -2.6 AP 2.9 SI mm

CSI Resolution : 0.04 cc  
Size : 5.4 RL 2.7 AP 2.7 SI mm  
Center: 5.5 RL -1.0 AP 1.8 SI mm

Metabolites displayed:

1=Def Nor  
2=Prob Nor  
3=Equivocal  
4=Prob Abnor  
5=Def Abnor  
A=Atrophy  
U=Un-usable  
B=Biop Art  
MENU OFF

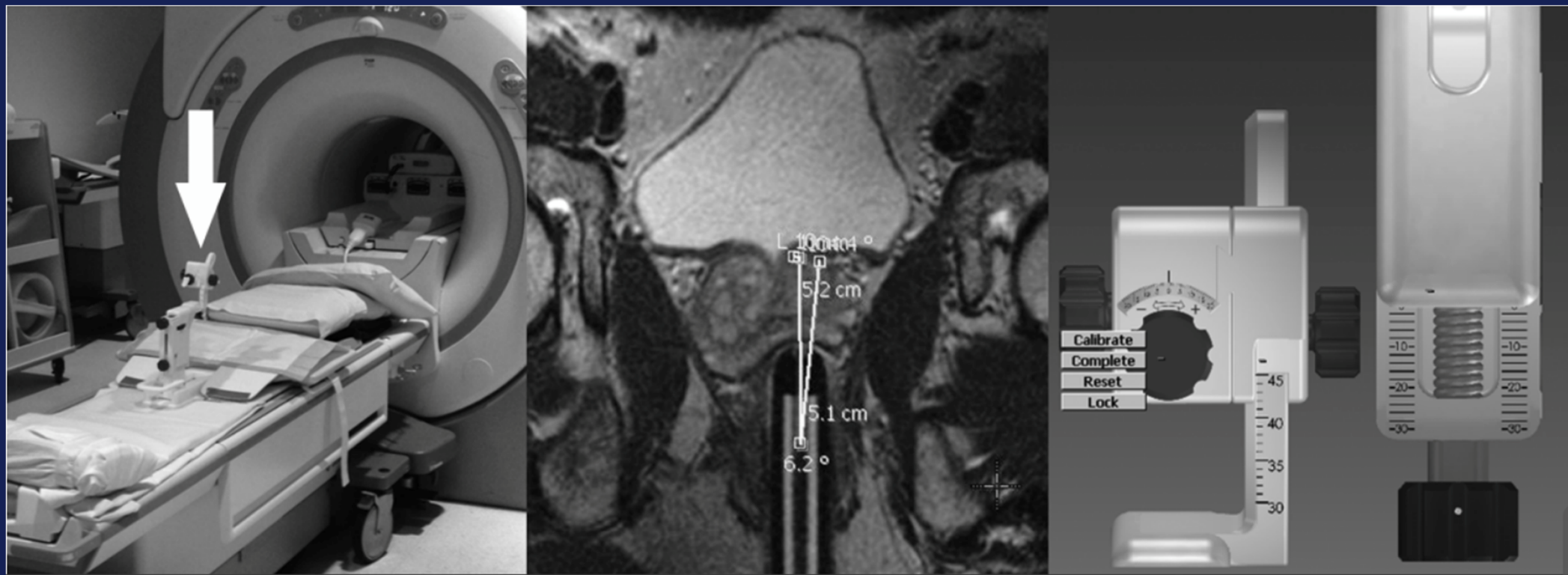
Depth: 6.9  
Dreg: 6 mm

C 10427  
W20855  
Depth: 6.9

3D



# In-bore biopsy technique





## *We want ...*

*... to diagnose only prostate cancers that do need treatment  
because they will impact the patient's life*

Flipside – bad tumors are usually very positive! PI-RADS scores

### Questions:

- Can we target these areas on biopsy to diagnose the bad cancer?
- Can we target only these areas?

## *We want ...*

*... to diagnose only prostate cancers that do need treatment  
because they will impact the patient's life*

Flipside – bad tumors are usually very positive! PI-RADS scores

### Questions:

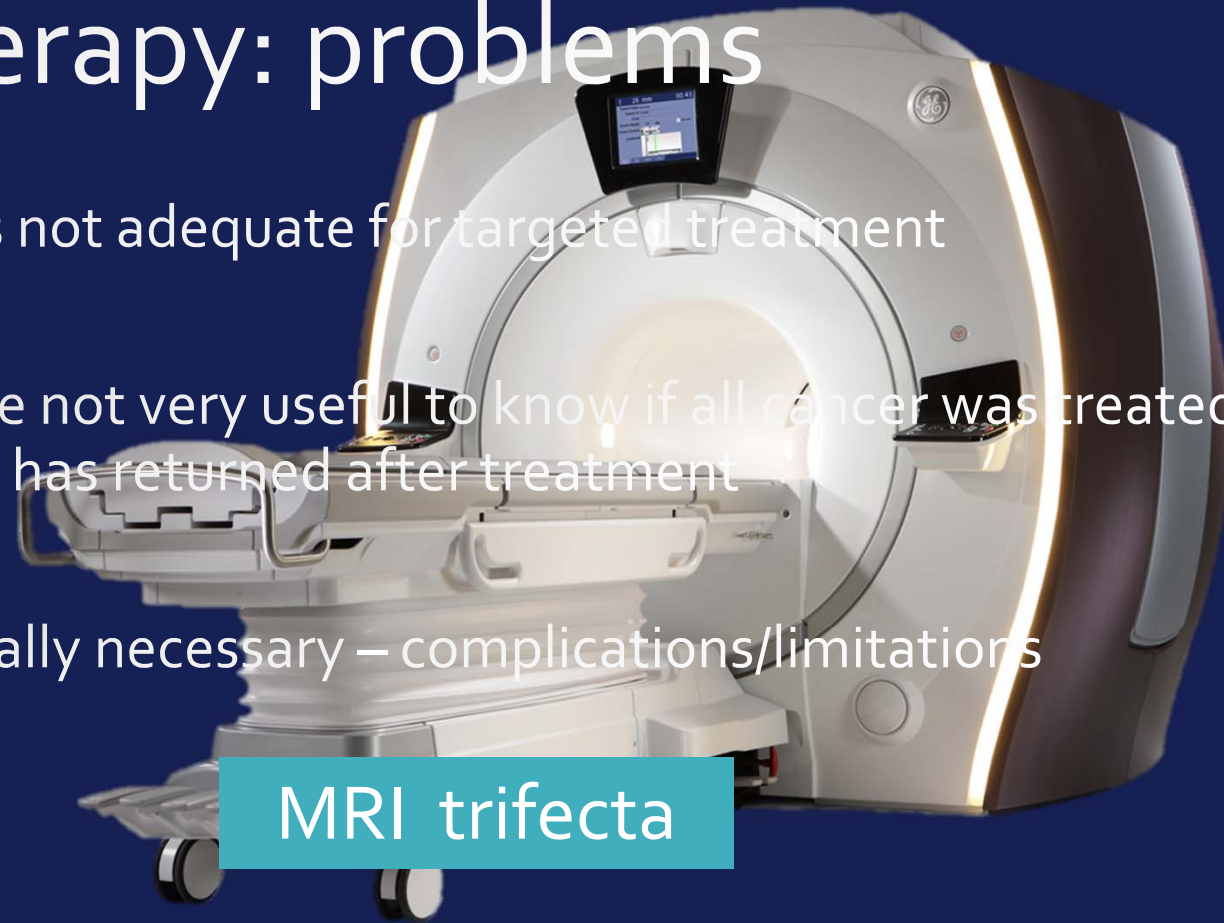
- Can we target these areas on biopsy to diagnose the bad cancer?
- Can we target only these areas?
- Can we treat only these areas?

# Focal therapy

- Rationale: control of cancer with fewer complications
- Analogy: breast cancer
  - 1900 radical mastectomy (Halsted)
  - 1960 – 1970 need for the procedure is challenged
  - 1974 – simple mastectomy +/- radiation therapy
  - today – lumpectomy

# Focal therapy: problems

- Ultrasound is not adequate for targeted treatment
- PSA levels are not very useful to know if all cancer was treated or to decide if it has returned after treatment
- Biopsy is usually necessary – complications/limitations



MRI trifecta

## *We want ...*

*... to diagnose only prostate cancers that do need treatment  
because they will impact the patient's life*

Flipside – bad tumors are usually very positive! PI-RADS scores

Problem:

We are planning a study to investigate MRI-guided focal therapy

*We want ...*

*... to improve treatment/management decisions*

Biopsy

Active surveillance

Focal therapy

We can also help patients and our physician colleagues to decide for definitive therapy (surgery or radiation)!

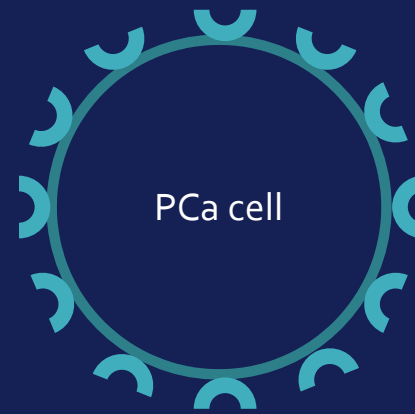
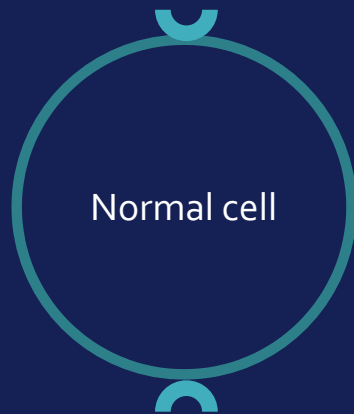
## *We want ...*

*... to detect spreading of disease early to maximize the control of cancer and maintain life expectancy*

- Molecular imaging!
- Previously discussed by Dr. Hope and Dr. Flavell
- PSMA PET scan (PET/CT or PET/MRI)

# PSMA imaging agents

- The prostate-specific membrane antigen (PSMA) is present in excess (i.e. overexpressed) in the majority of prostate cancers.



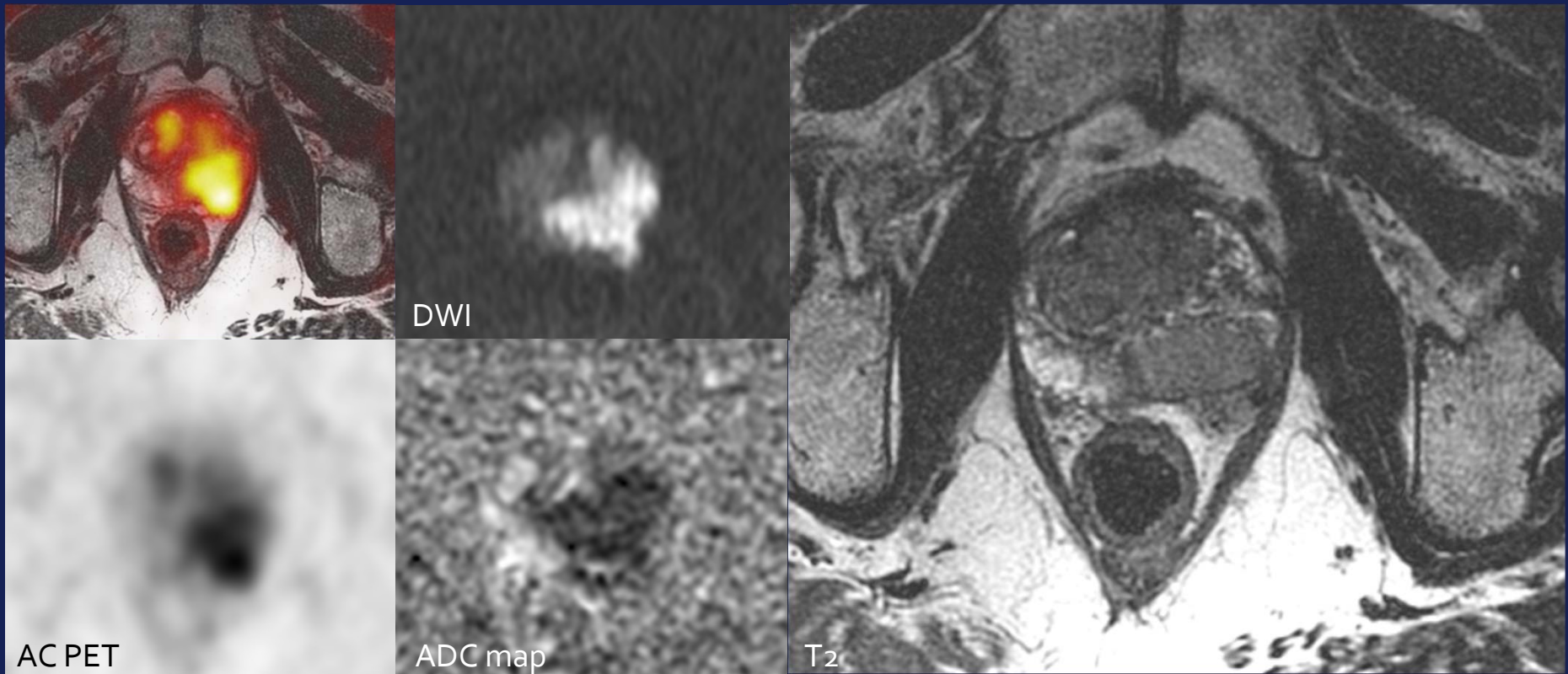


# PSMA imaging agents

- Several radionuclides can be ligated to PSMA protein and used for imaging. These include  $^{68}\text{Ga}$ -PSMA-11, and indium ( $^{111}\text{In}$ ) and fluorinated ( $^{18}\text{F}$ ) agents.



# 72 years old, Gleason 4+4



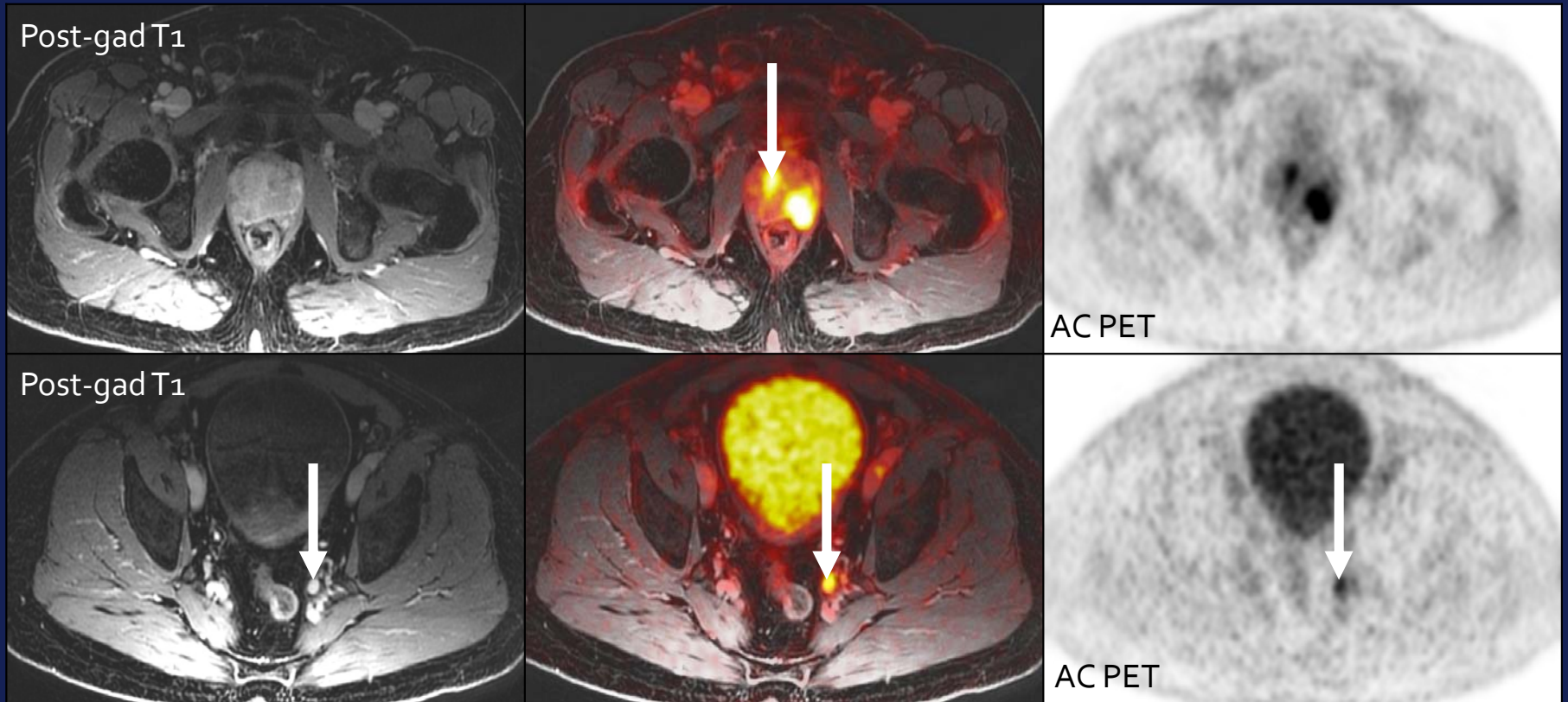
DWI

AC PET

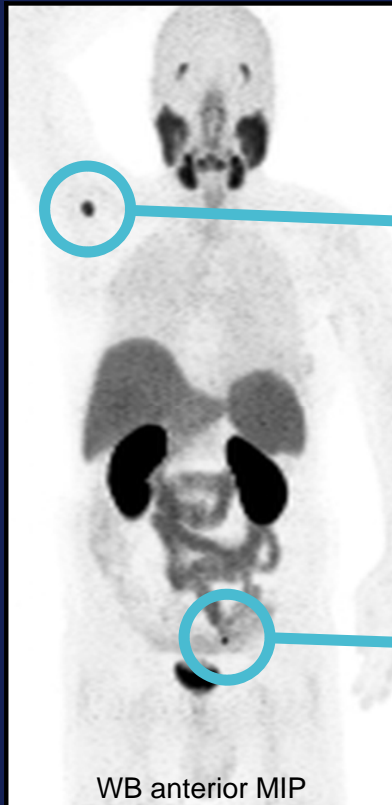
ADC map

T<sub>2</sub>

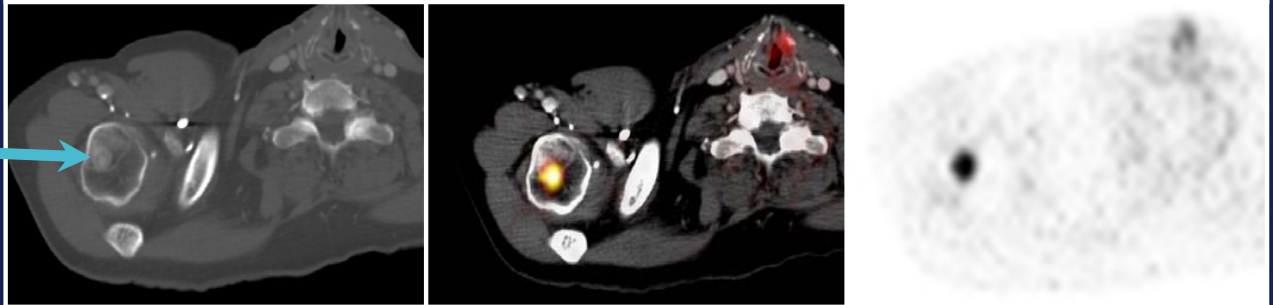
# 72 years old, Gleason 4+4



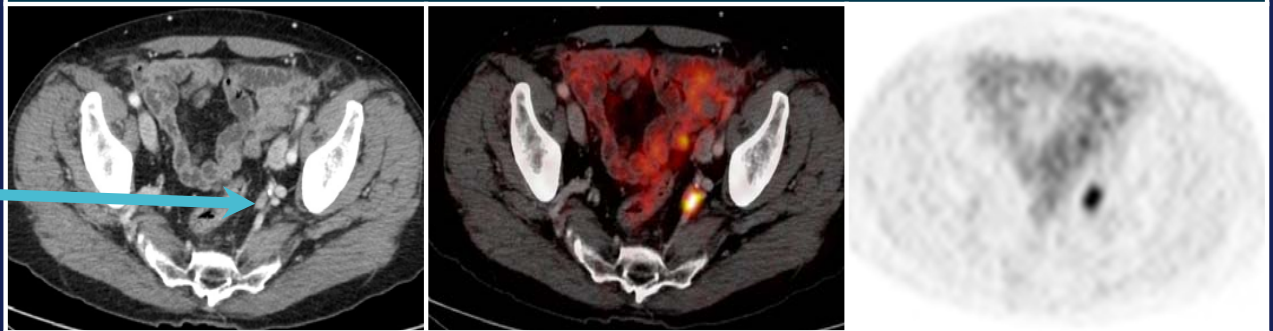
69 years old, **S/P RP**, PSA = 0.67 ng/ml



Disease site 1: right humerus



Disease site 2: left internal iliac node

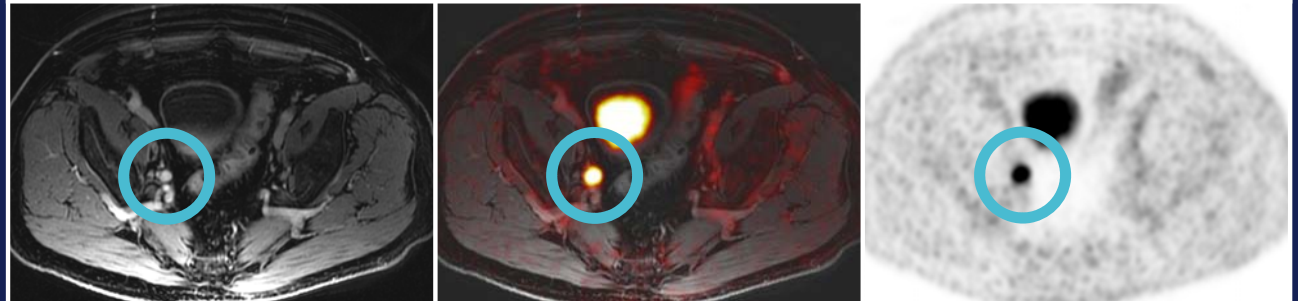




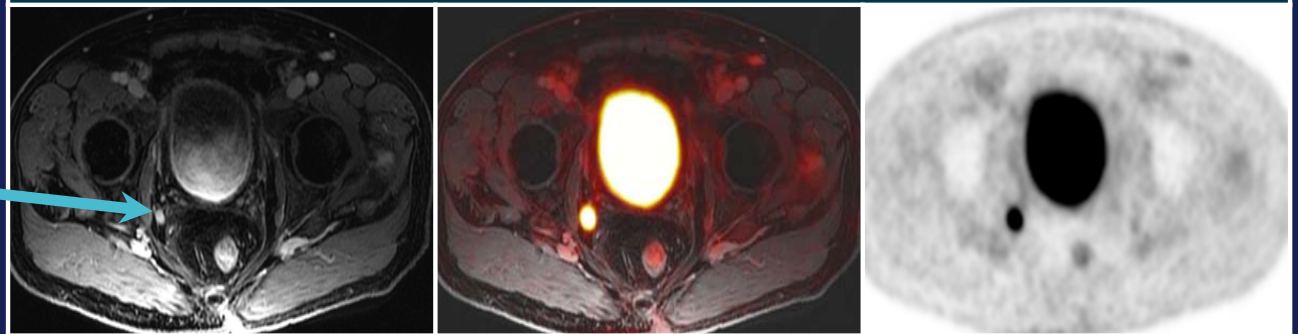
71 years old, S/P RP, PSA = 0.9 ng/ml



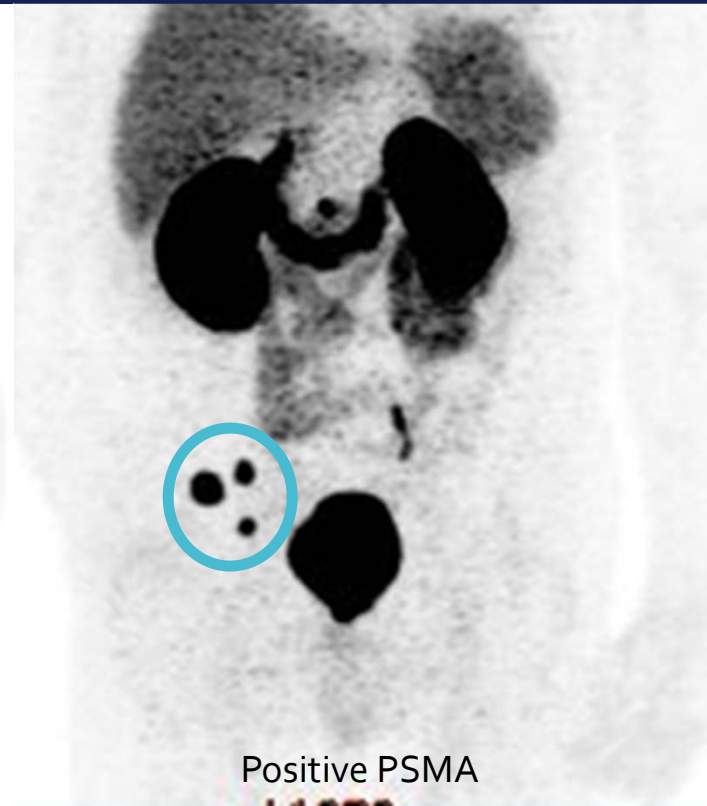
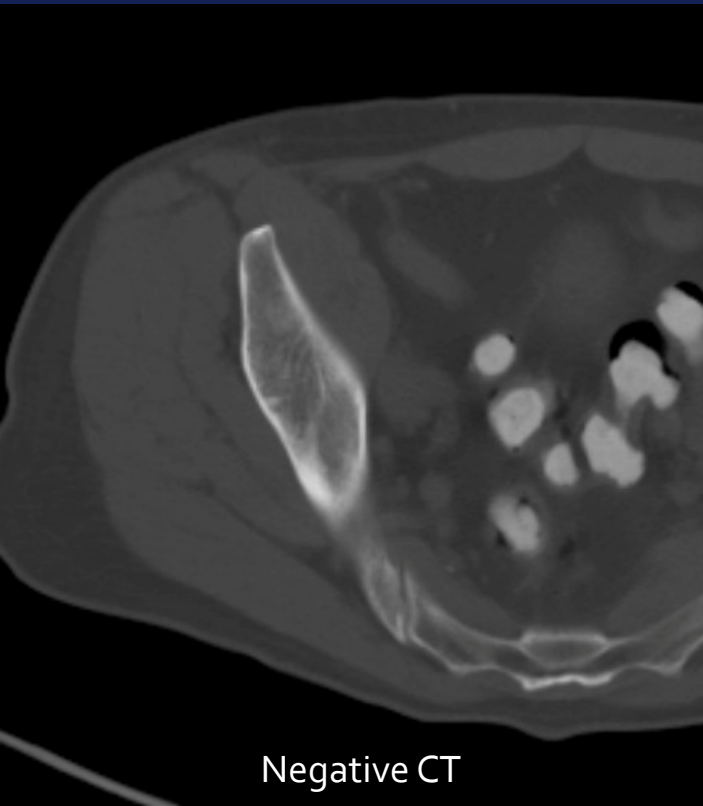
Disease site 1: right pelvic side wall node 1



Disease site 2: right pelvic side wall node 2



69 year old, S/P RP, PSA = 3.5 ng/ml



# Closing comments

- UCSF radiologists are active members of a multidisciplinary team.
- UCSF radiologists are involved in all stages of care of men with known or suspected prostate cancer.
- UCSF radiologists are leading cutting edge research in the field of prostate MRI.
- UCSF radiologists are heavily engaged in the education/training of future generations of physicians, radiologists or not.



University of California  
San Francisco

# Osher Mini Medical School for the Public

Thank you!

