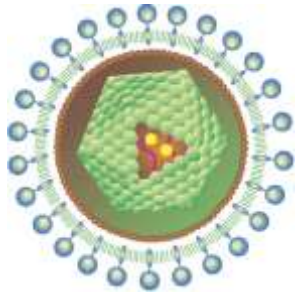
Beth Israel Deaconess Medical Center

Harvard Medical School Teaching Affiliate



Renal issues in the patient with HIV

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Renal disease in the context of HIV

- HIV associated nephropathy (collapsing FSGS)
- IgA nephropathy
- Lupus-like glomerulonephritis
- Thrombotic microangiopathy (TTP/HUS)
- Membranous nephropathy
- Membranoproliferative GN
- Rhabdomyolysis with AKI (statins, newer ARV, cocaine)
- Nephropathy assoc with concurrent infections (hep B,C)
- Acute interstitial nephritis
- Acute kidney injury (AKI) from prerenal azotemia or ATN
- Crystal induced nephropathy
- Renal failure and Fanconi's syndrome
- Infiltrative diseases (lymphoma or KS)
- Chronic kidney disease

Adapted from Balow KI 2005

- Routine monitoring of renal function
- Medications
  - Tenofovir and other antiretroviral agents
- HIV nephropathy
- CKD and ESKD

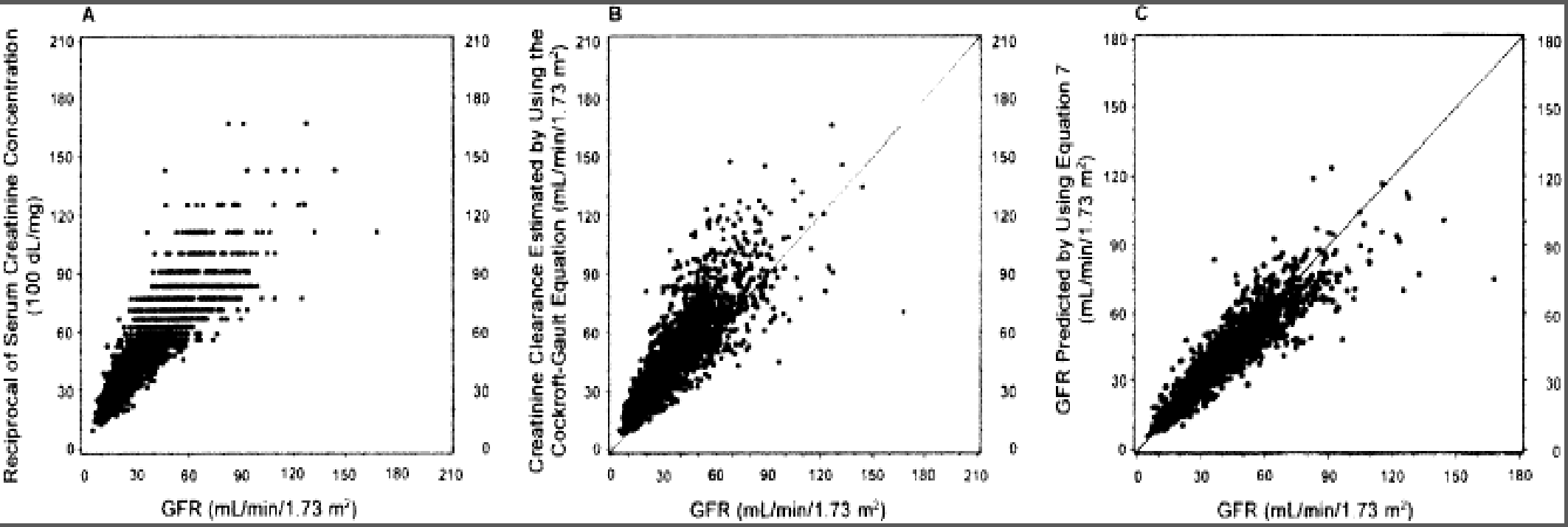
Routine monitoring of pt with HIV

	Basic chemistry	urinalysis	other
Entry to care	✔	✔	
Q 6 months			
Initiation of ART	✔	✔	
2-8 weeks after initiation or modification	✔		
Q 3-6 months	✔	(on TDF) (annual if other)	Serum phosphate on TDF?

Guidelines for use of antiretroviral agents in HIV-1-infected adults and adolescents, revised 5/1/14

1.All formulas for eGFR perform poorly when renal function is close to normal

2. All formulas are meant for the steady state, not AKI



1/creat vs GFR

CG vs GFR

MDRD vs. GFR

Ann Int Med 1999; 130

MEASUREMENT OF URINARY PROTEIN

- Dipstick Method
- 24 hour urine collections
- Urinary "ratios"
  - Protein to creatinine ratio
  - Microalbuminuria (albumin to creatinine ratio)

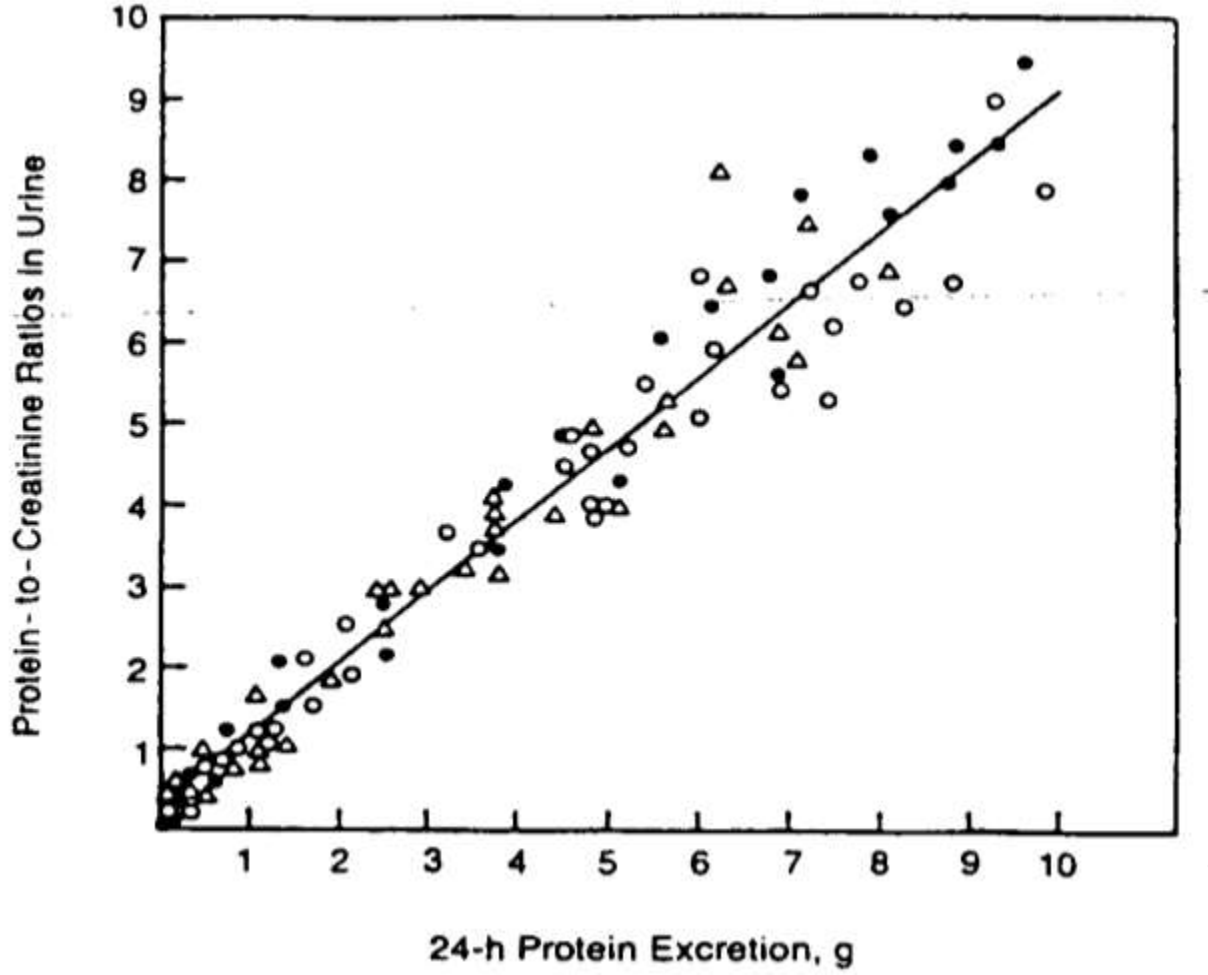
URINARY PROTEIN:CREATININE RATIO

- ALIQUOT OF RANDOM SPECIMEN
- USES SSA (DETECTS ALL PROTEINS)
- IN STEADY STATE, CORRELATES WITH

24 HR URINARY PROTEIN EXCRETION

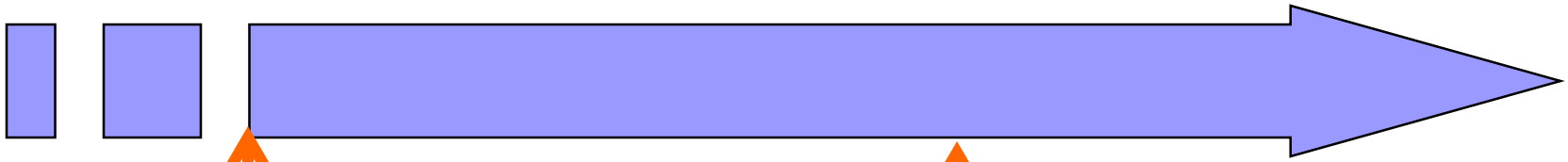
- NORMAL RATIO IS <0.2

Correlation of protein: creatinine ratio and 24 hour urine protein



Schwab Arch Int Med 1987

Increasing albuminuria



NORMAL

MICROALBUMINURIA

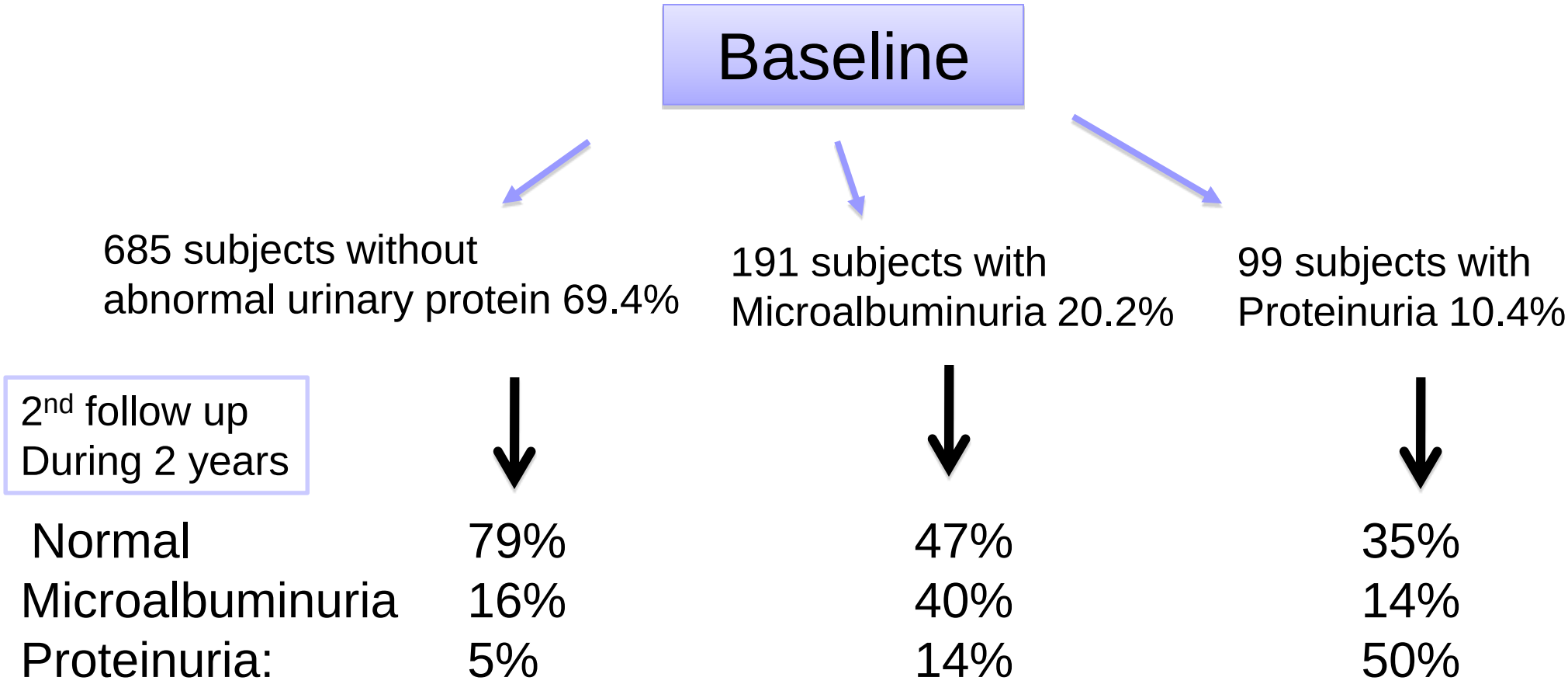
OVERT PROTEINURIA

<30 mcg alb / mg creat

30-300 mcg alb / mg creat

NEPHROTIC RANGE >3000

Presence of microalbuminuria in HIV may predict future proteinuria



Szczech L et al. HIV Medicine 2010: 11 419-426

Staging HIV+ patients by eGFR AND proteinuria provides risk stratification

		Proteinuria		
		0 mg/dL	30-100 mg/dL	300-1,000 mg/dL
STAGE I/II	**eGFR ≥60 ml/min/1.73m²**			
	Number of Patients at Risk	15,348	2,390	185
	ESRD Rate per 1,000 Person-Years	1.0	6.6	35.4
	Hazard Ratio (95% CI)†	Reference	6.3 (4.6-8.6)	24.6 (16.0-37.7)
STAGEIII	**eGFR 30-59 ml/min/1.73m²**			
	Number of Patients at Risk	484	350	85
	ESRD Rate per 1,000 Person-Years	5.5	31.1	115.6
	Hazard Ratio (95% CI)†	7.4 (4.0-13.8)	37.1 (25.3-54.6)	88.7 (56.0-140.5)
STAGE IV/V	**eGFR <30 ml/min/1.73m²**			
	Number of Patients at Risk	38	106	60
	ESRD Rate per 1,000 Person-Years	46.1	111.1	192.9
	Hazard Ratio (95% CI)†	42.6 (18.3-99.4)	132.8 (87.1-202.5)	523.0 (323.6-845.4)

Jotwani V et al. AJKD 2012 59(5): 628

Which protein should we measure?

- Urinary albumin to creatinine ratio (ACR) for low levels of proteinuria in DIABETES MELLITUS
- Urinary protein to creatinine ratio for overt (dipstick +) and heavy proteinuria
- Other proteins measured can reflect tubular damage including retinol binding protein and β2 microglobulin but the role of these tests in monitoring patients has not yet been defined

Case

Case

- 45 year old man with well controlled HIV referred for discolored urine
- Undetectable HIV viral load, CD4 446
- Began ARV in 1996 indinivir and AZT and then with atazanavir (liver disease),

  current regimen since 2009
- Meds: omeprazole, rosuvastatin
  - Darunavir 400 mg
  - Emtricitabine-tenofovir (Truvada) 200-300mg

Initial visit:

- BP 113/81 HR 69
- Serum creatinine 0.8-1.1 from 1999 to 2010,

  then

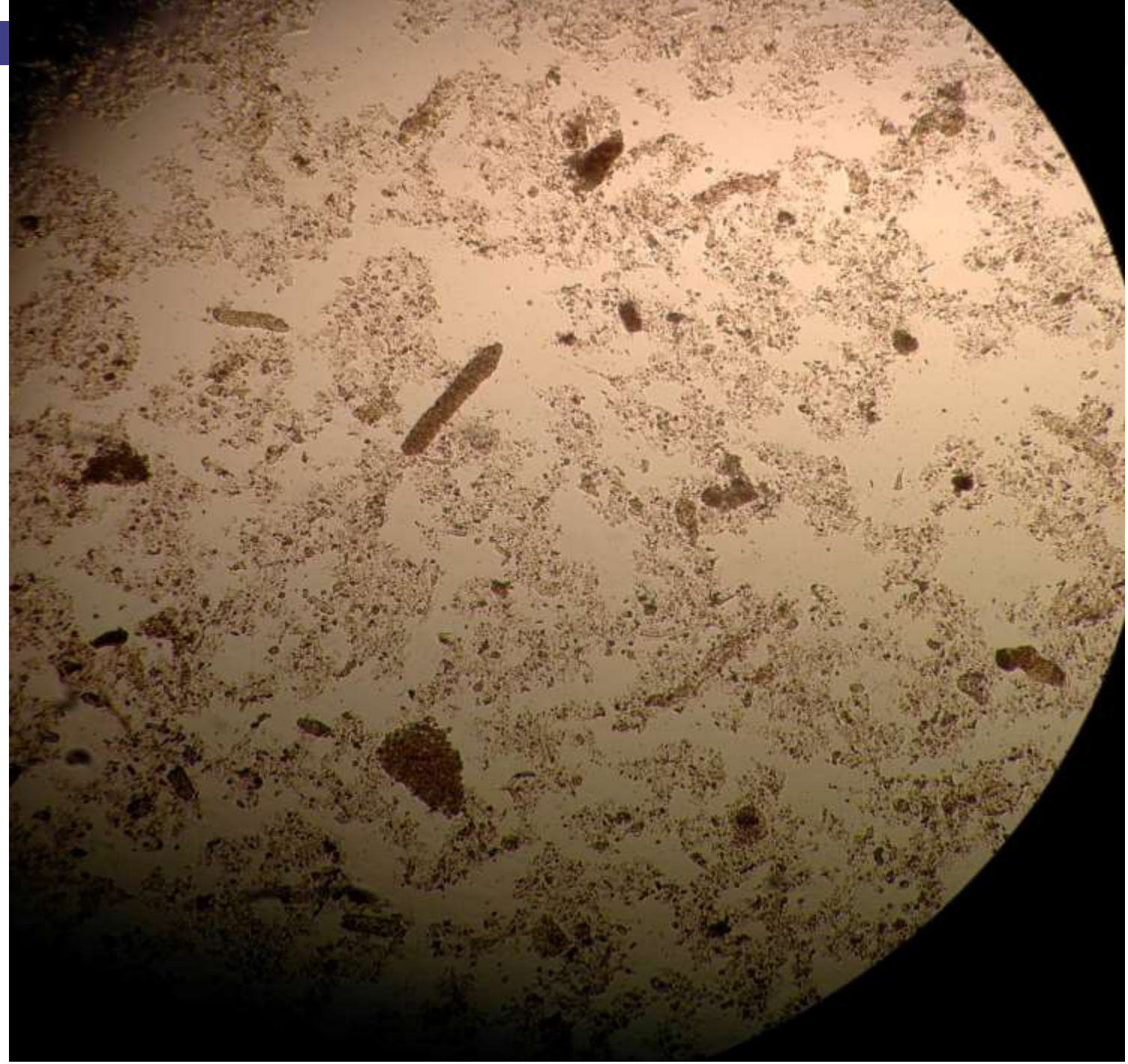
3/2012	1.2
5/2012	1.3
8/2012	1.5
9/2012	1.6

urine protein to creatinine ratio 0.9 g/g (nl <0.2)

Urine albumin: creatinine ratio 229 mcg/mg

Serum

- Na^+ 138 mEq/L
- Cl^- 114 mEq/L
- K^+ 4.3 mEq/L
- HCO_3^- 26 mEq/L
- BUN 28 mg/dL
- creat 1.6 mg/dL
- glucose 109 mg/dL
- Phos 2.3 (2.7-4.5 mg/dL)
- Uric acid 1.9 mg/dL (nl 3.4-7.0)



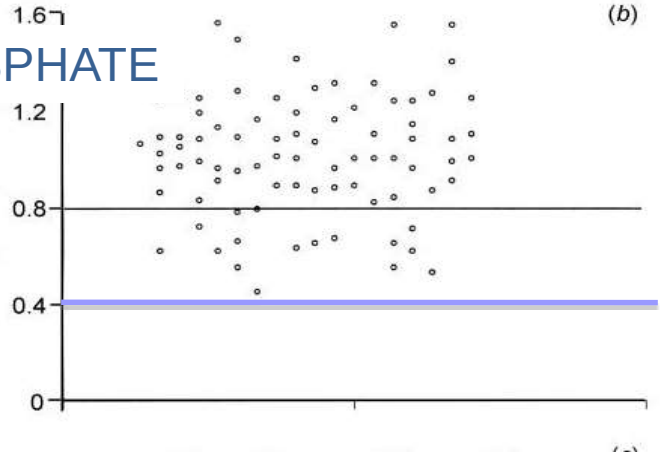
Causes of low serum phosphate?

Routine biochemistry in vitamin D deficiency
Peacey SR J R Soc Med 2004; 97; 322-325

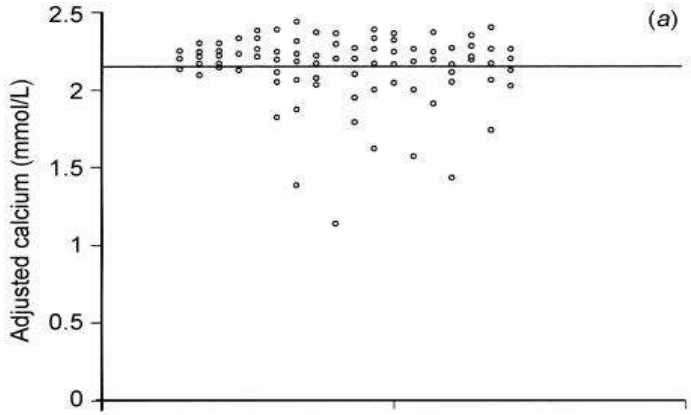
SERUM PHOSPHATE

2.47 mg/dl

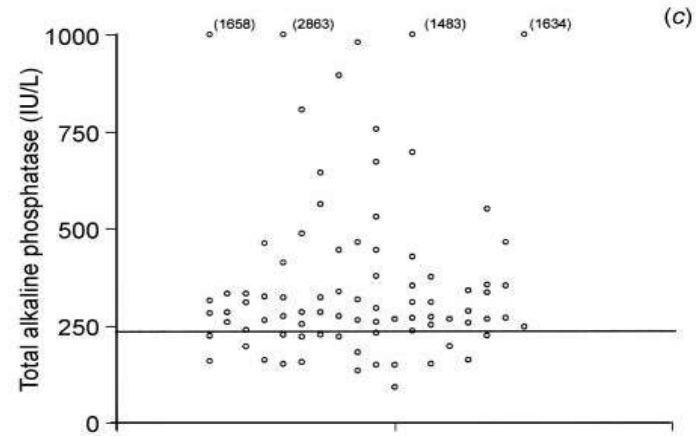
1.24 mg/dl



SERUM CALCIUM



ALKALINE PHOSPHATASE



Urine

- Urine dipstick: glu 100, “protein” 100, pH 6.5
- Alb/creat 229 mcg/mg creat
- prot/creat 0.9 mg/mg
- Urine Phos 144 mg/dL
- Urine creatinine 445 mg/dL

FE PO_4: % filtered load Phosphate excreted

$$= \frac{\mathbf{U_{phos}}\ \mathbf{P_{creat}}}{\mathbf{P_{phos}}\ \mathbf{U_{creat}}} \times 100 = \frac{144 \times 1.6}{2.3 \times 445}$$

$$= 23\ \%$$

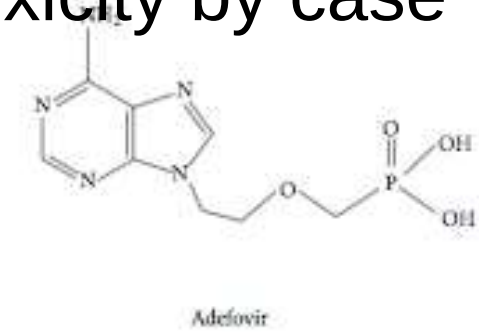
(normal is <<15% if serum PO_4 low and kidney normal)

Some use fractional tubular reabsorption or [1-$FEPO_4$]

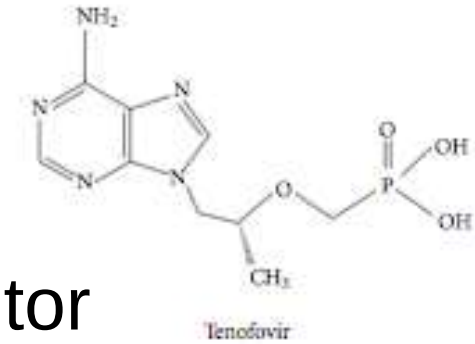
(normal is >>85%)*

Tenofovir nucleotide analogue RTI

- Renally cleared by filtration and tubular secretion
- In initial large scale trials for efficacy and safety, tenofovir did not cause significant renal disease
- Post FDA approval has identified nephrotoxicity by case reports and cohort studies :
  - Acute tubular necrosis
  - Fanconi's syndrome
    (glycosuria, PO_4 wasting +/- ↓ renal function)
  - Nephrogenic diabetes insipidus
  - Proteinuria and chronic kidney disease
- Increased risk in patients with underlying renal disease or boosted with protease inhibitor

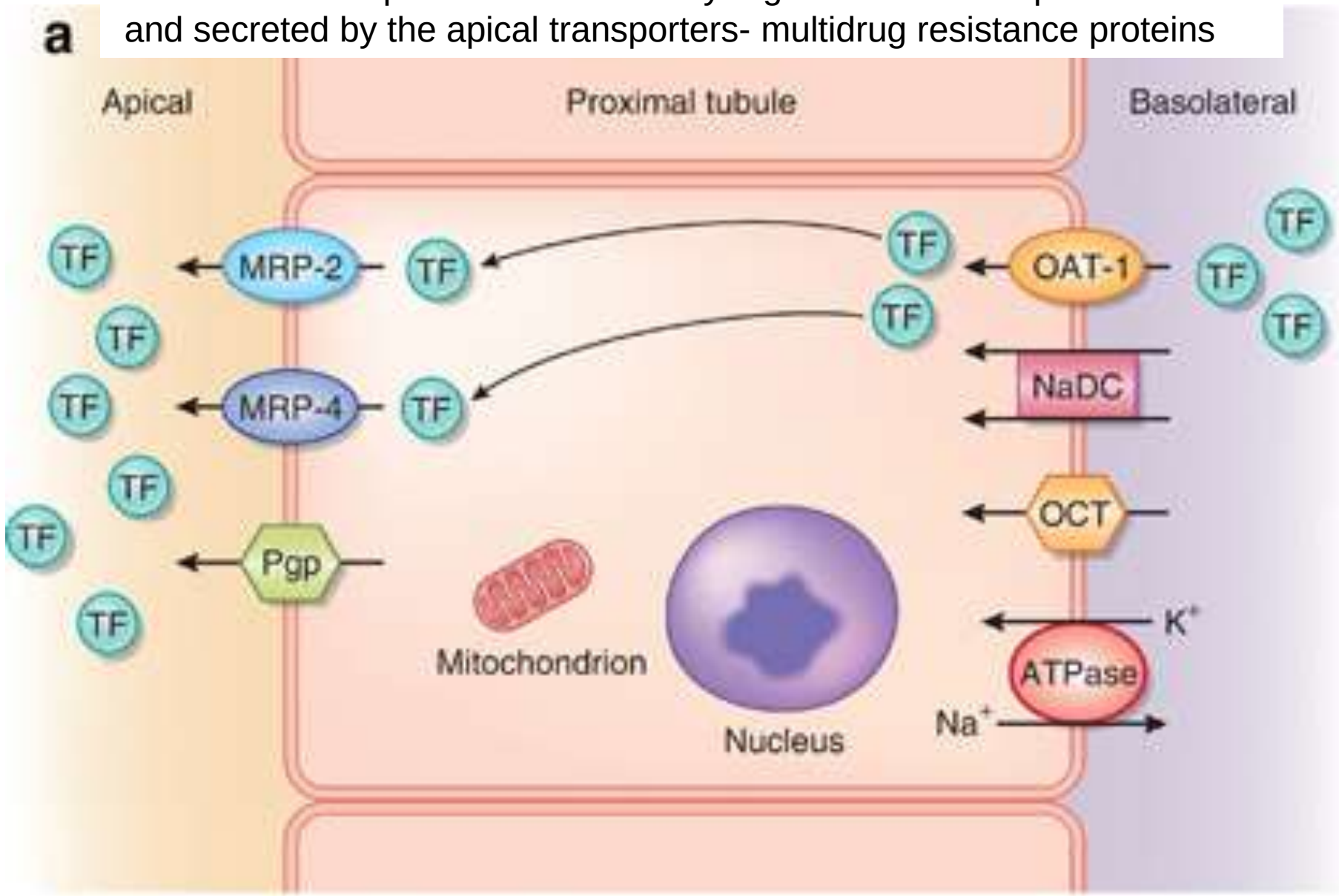


Adefovir



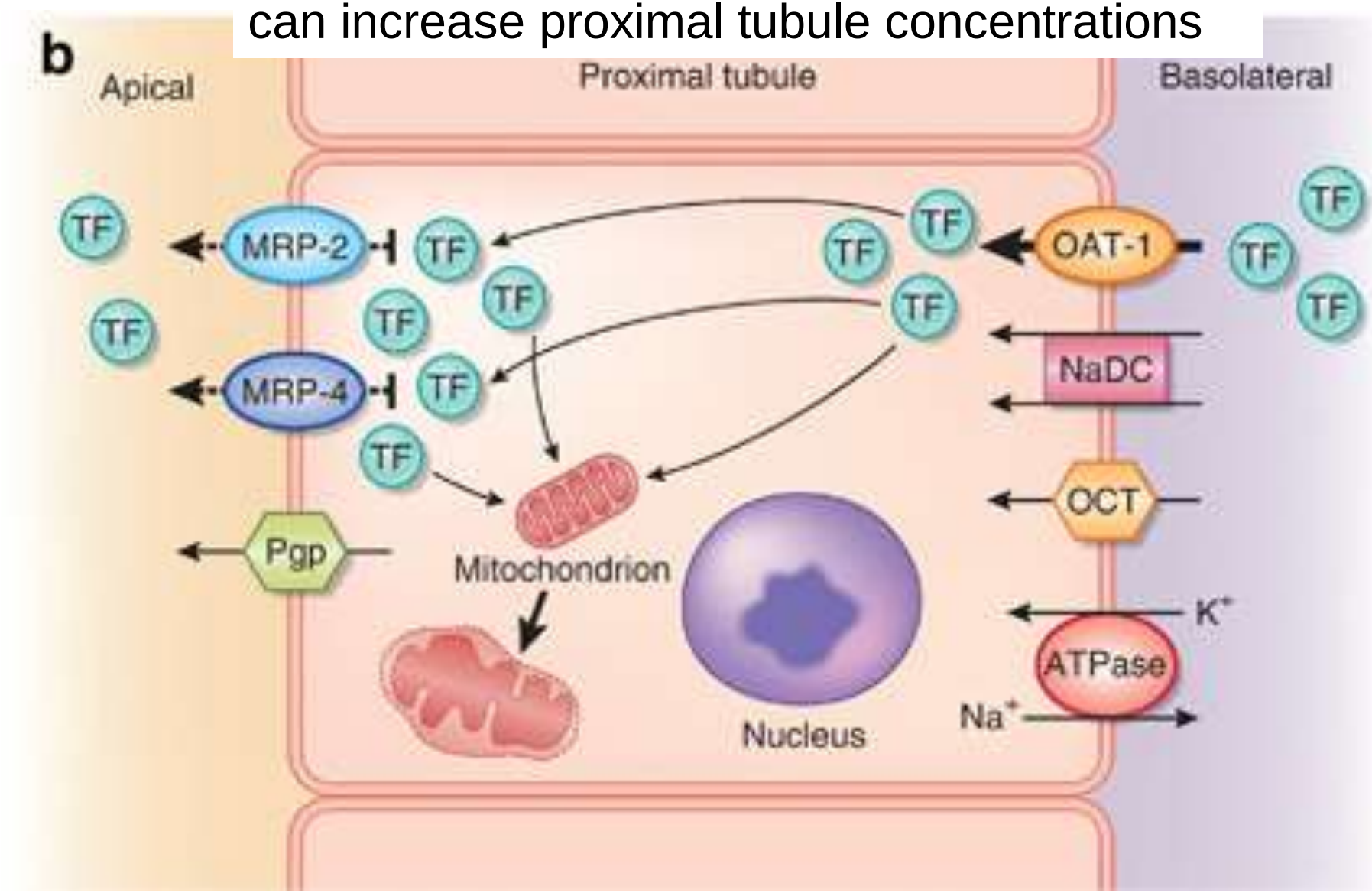
Tenofovir

Tenofovir is transported into the cell by organic anion transporters and secreted by the apical transporters- multidrug resistance proteins

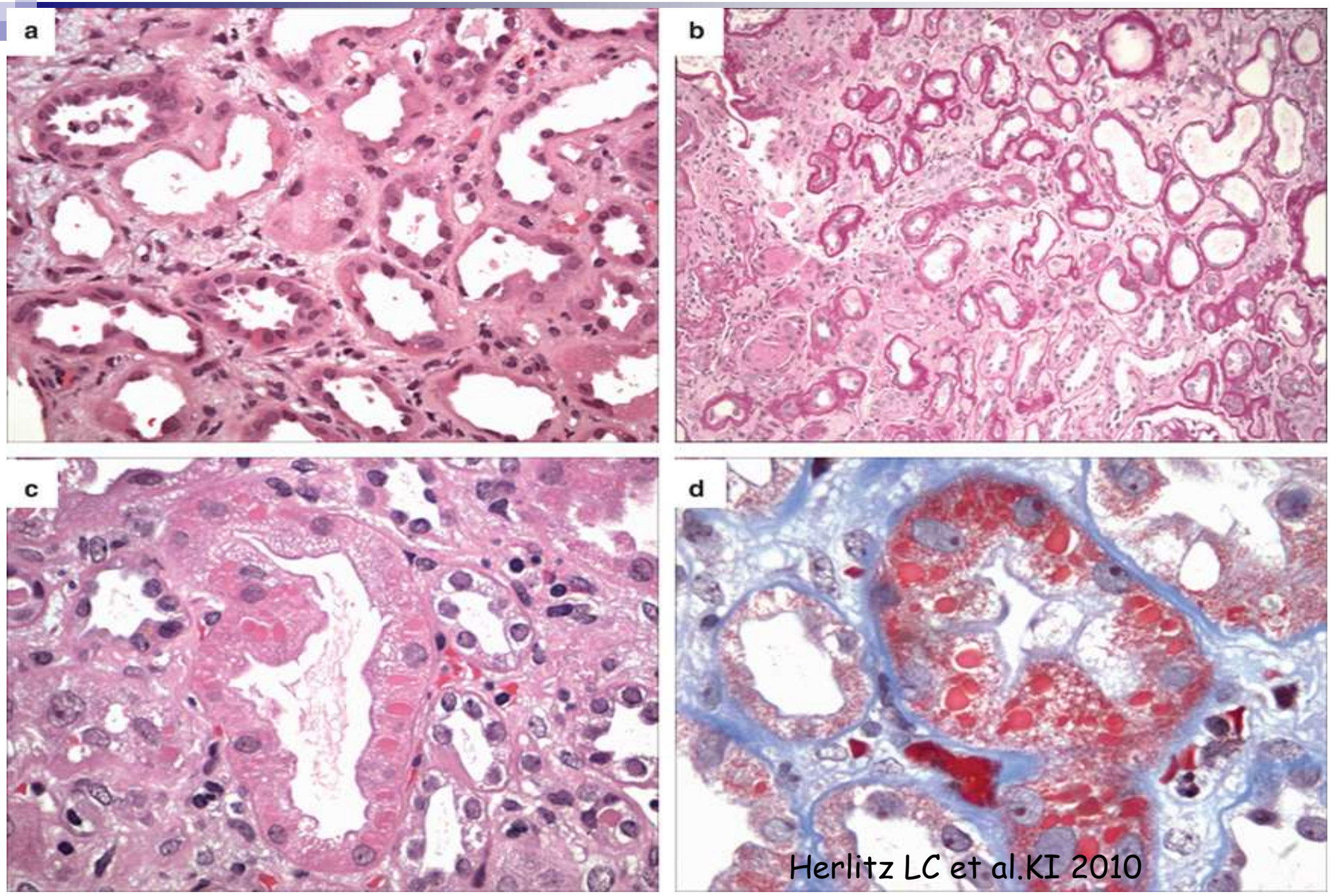


Perazella M KI 2010 78

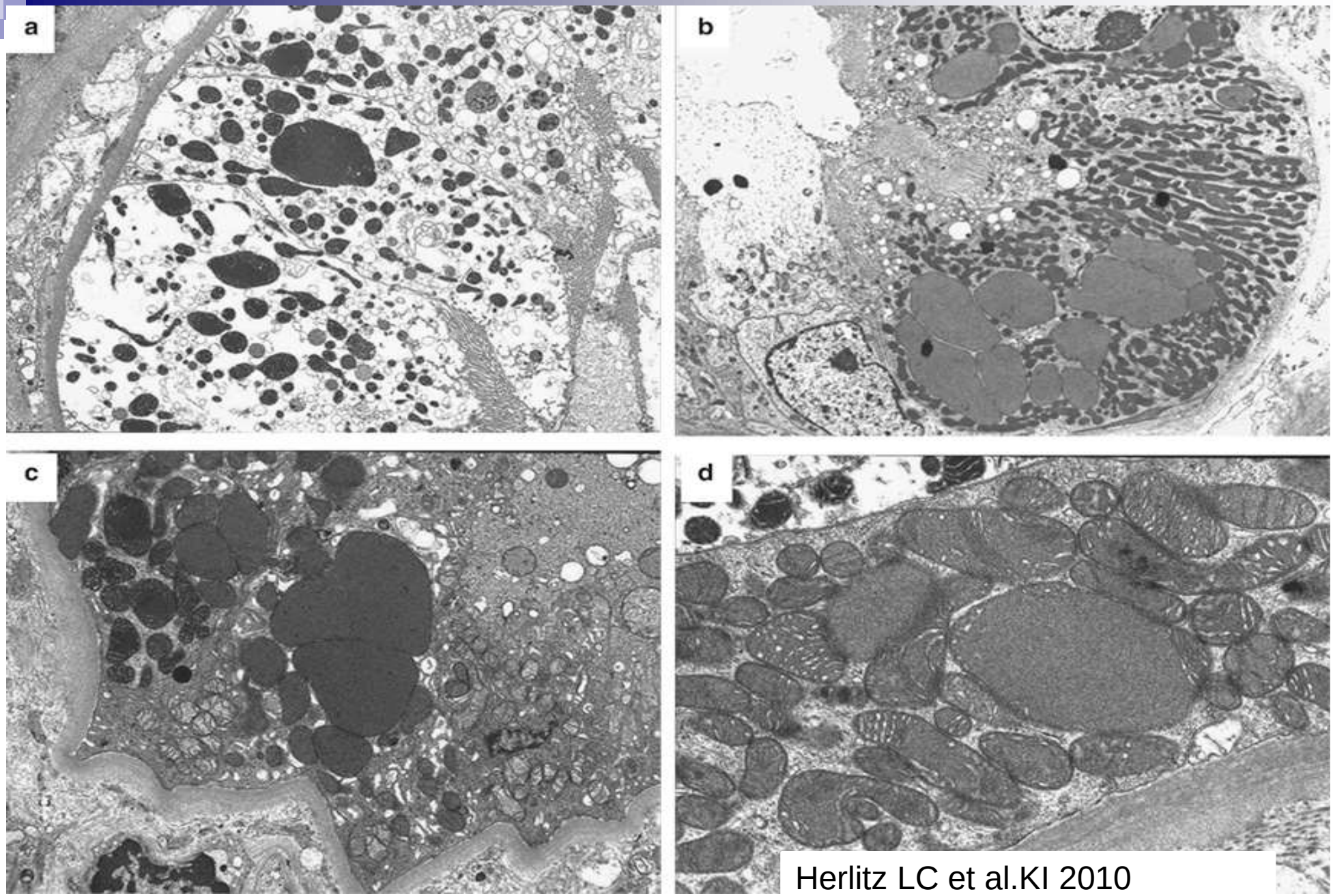
An increase in OAT or decreased MRP can increase proximal tubule concentrations



Perazella M KI 2010 78

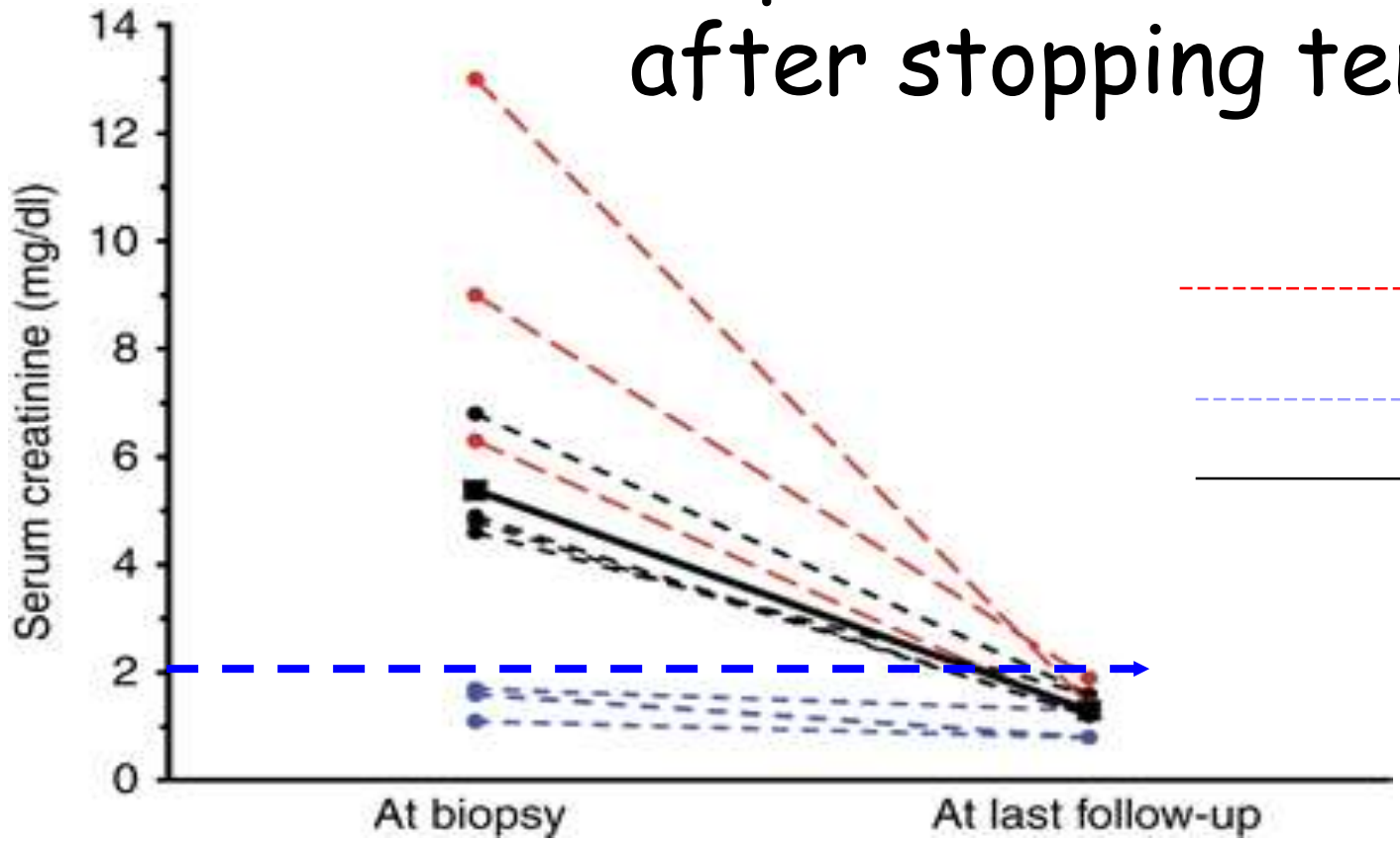


Herlitz LC et al.KI 2010



Herlitz LC et al.KI 2010

Improvement in creatinine after stopping tenofovir

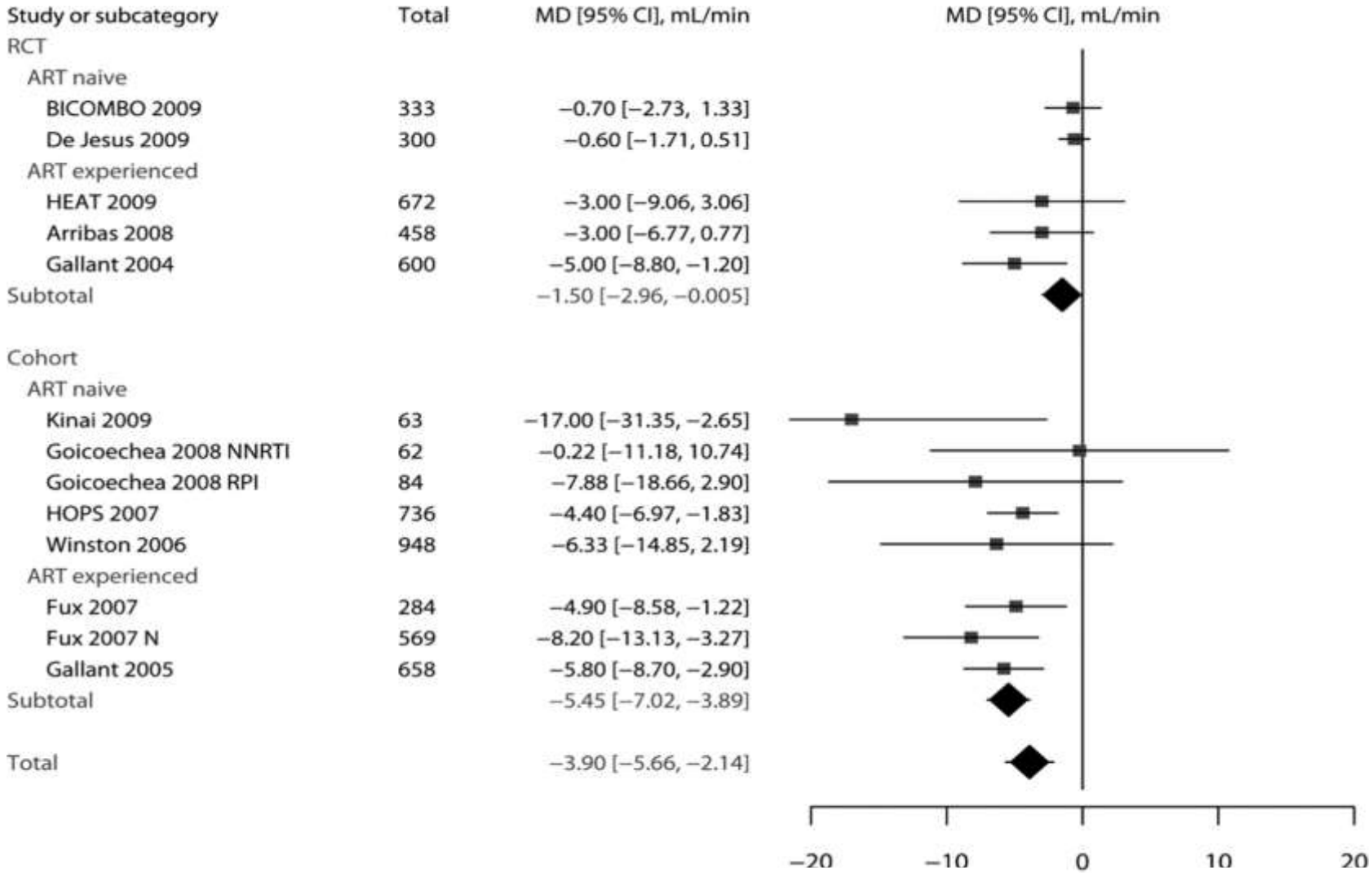


Mean creatinine 5.7mg/dL
(1.1 to 13 range)

Mean baseline creatinine 1.3 (range 0.8 to 1.8) mg/dL

Herlitz LC et al.KI 2010

Metanalysis on change in GFR (by CG) +/-TDF.



Cooper R D et al. Clin Infect Dis. 2010;51:496-505

Recommendations for use of tenofovir

- Monitor patients on TDF for tubular toxicity (serum creatinine and serum phosphate,

urinary protein:creatinine ratio vs. albuminuria? phosphaturia, uricosuria, glycosuria) q 6 months (or 3?)

- If hypophosphatemia, r/o vitamin D deficiency
- When there are clear proximal tubular defects, the medication must be discontinued
- Dose reduce TDF for CKD and avoid combination therapy with GFR <30 ml/min

1. Tenofovir
2. Emtricitabine
3. Elvitegravir

(new integrase inhibitor)

4. Novel “boosting” agent, cobicistat --inhibits P450 (CY3A) and “boosts elvitegravir levels

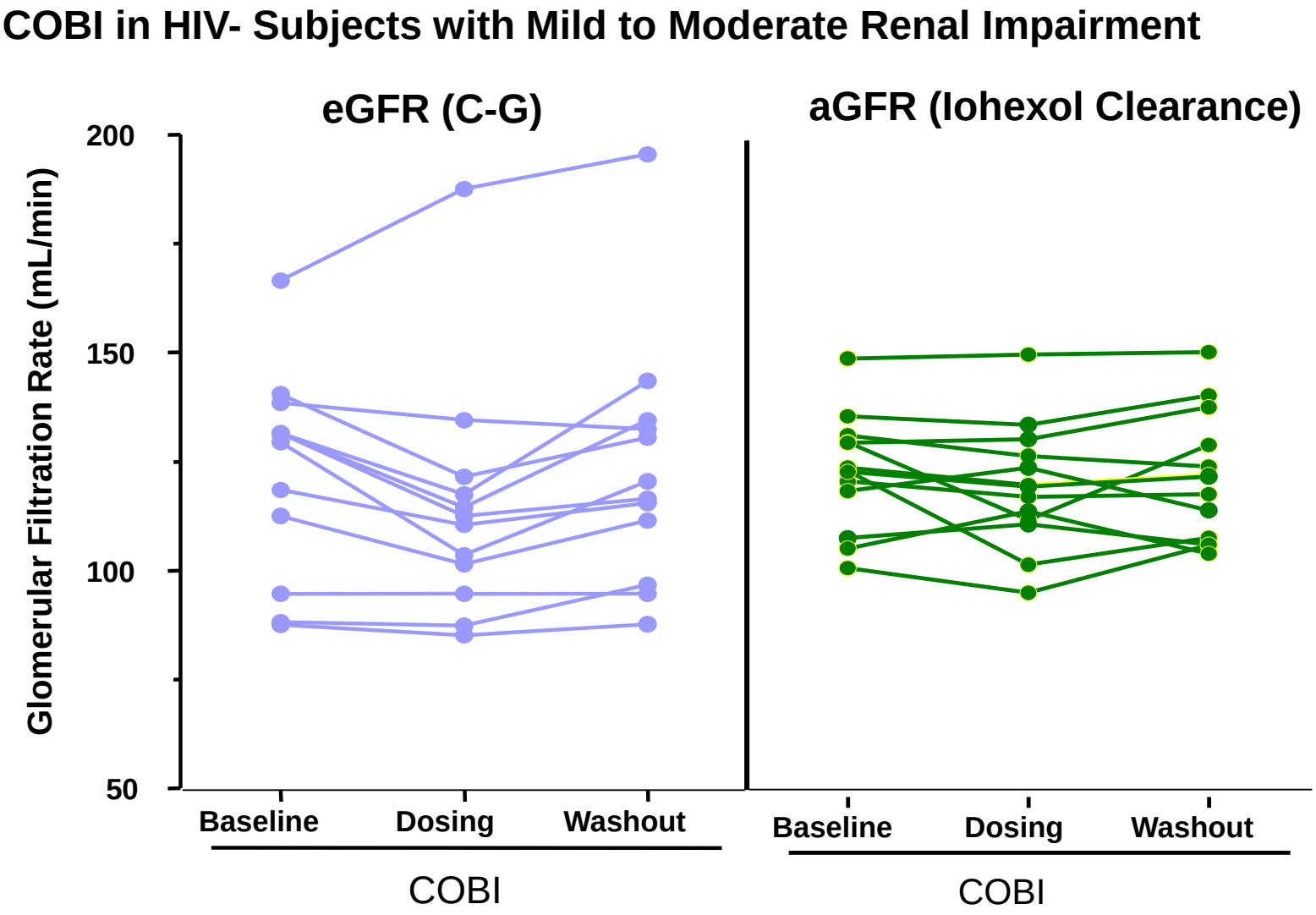
STRIBILD™

ATRIPLA

1. Tenofovir
2. Emtricitabine
3. Efavirenz

AIDS 25 (6):F7-12

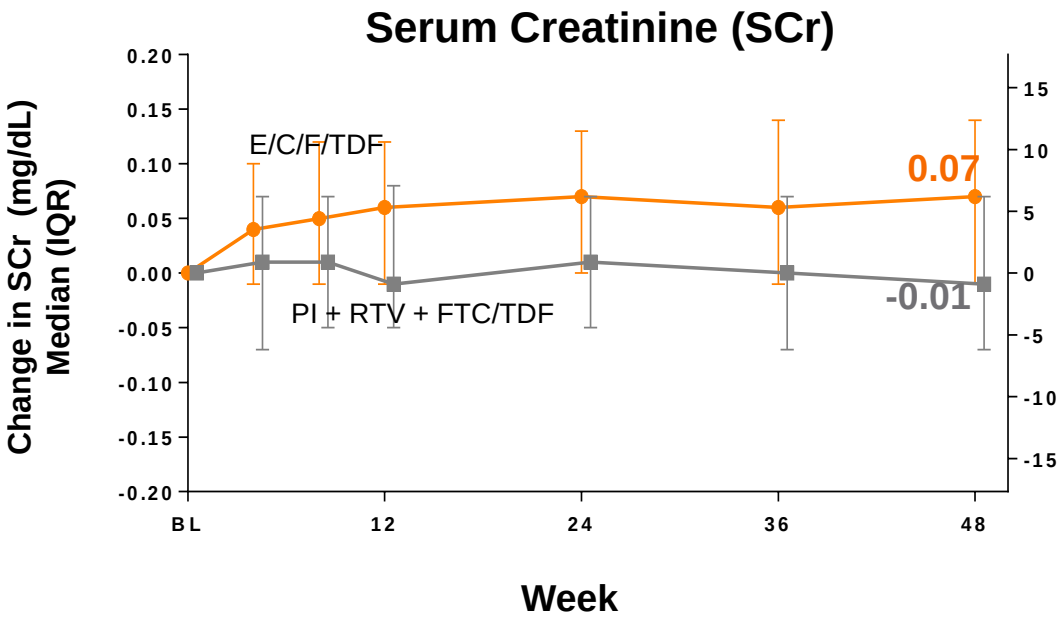
Cobicistat effects serum creatinine not the GFR

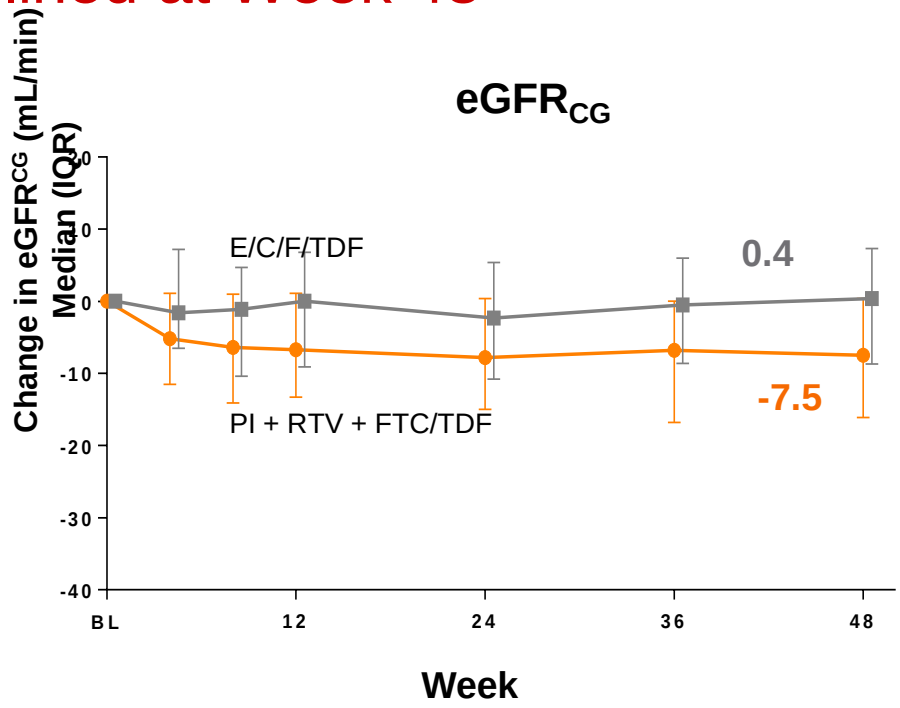


German P, et al. ICAAC 2011; Chicago. #H2-804 → J Acquir Immune Defic Syndr. 2012 Sep 1;61(1):32-40.

Cobicistat effect seen in STRATEGY study (single tablet regimens for virologically suppressed patients)

SCr rose and eGFR declined at Week 48

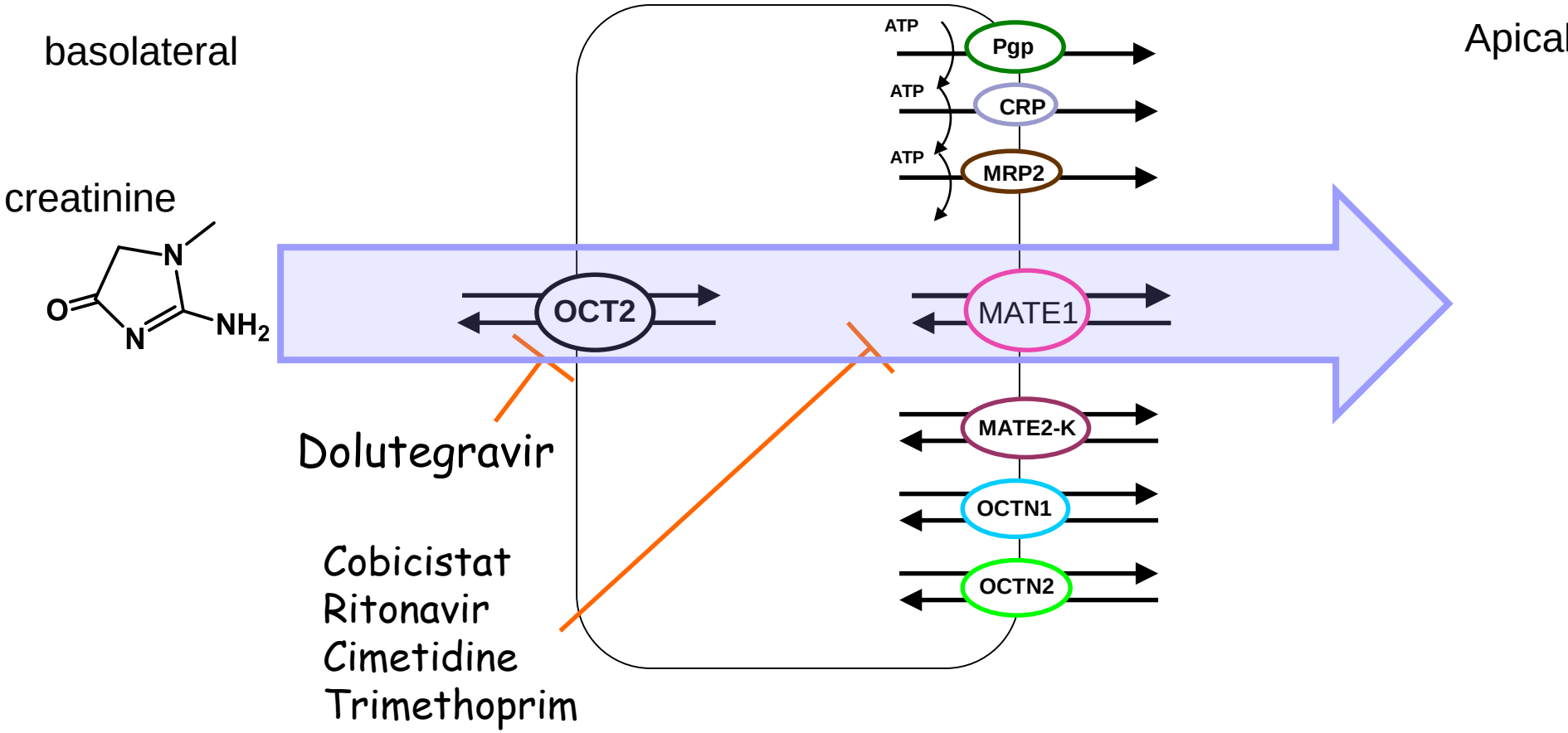




Median change from baseline in SCr at week 48: E/C/F/TDF, 6.19 µmol/L vs. PI + RTV + FTC/TDF, -0.88 µmol/L

Arribas J, et al. CROI 2014; Boston. #551LB

Cobicistat may ↑ serum creatinine



Bloomber

HOME QUICK NEWS SUS

ViiV's HIV
FDA Priori

By Makiko Kitamura - Feb 15

ViiV Healthcare Ltd. said its experimental HIV m Drug Administration.

A regulatory decis ec. 17, the London-base iority review status, wh provement over existing ther

Dolutegravir

Brand Name: Tivicay

Other Names: DTG

Drug Class: Integrase Inhibitors

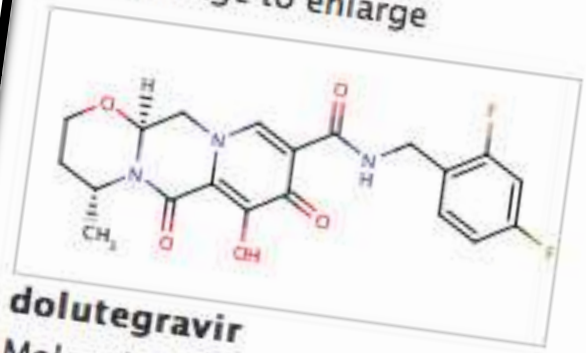
Approved Use: Treatment of HIV Infection

Drug Image:

Click image to enlarge

Chemical Image:

Click image to enlarge



dolutegravir

Molecular Weight: 419.3821

- Abacavir
- Dolutegravir
- lamivudine

New prodrug tenofovir alafenamide (TAF) may lead to less renal exposure to drug

The New York Times
Saturday, April 20, 2013

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Gilead Initiates Phase 3 Clinical Program for Tenofovir Alafenamide, a Novel Low-Dose Prodrug for the Treatment of HIV

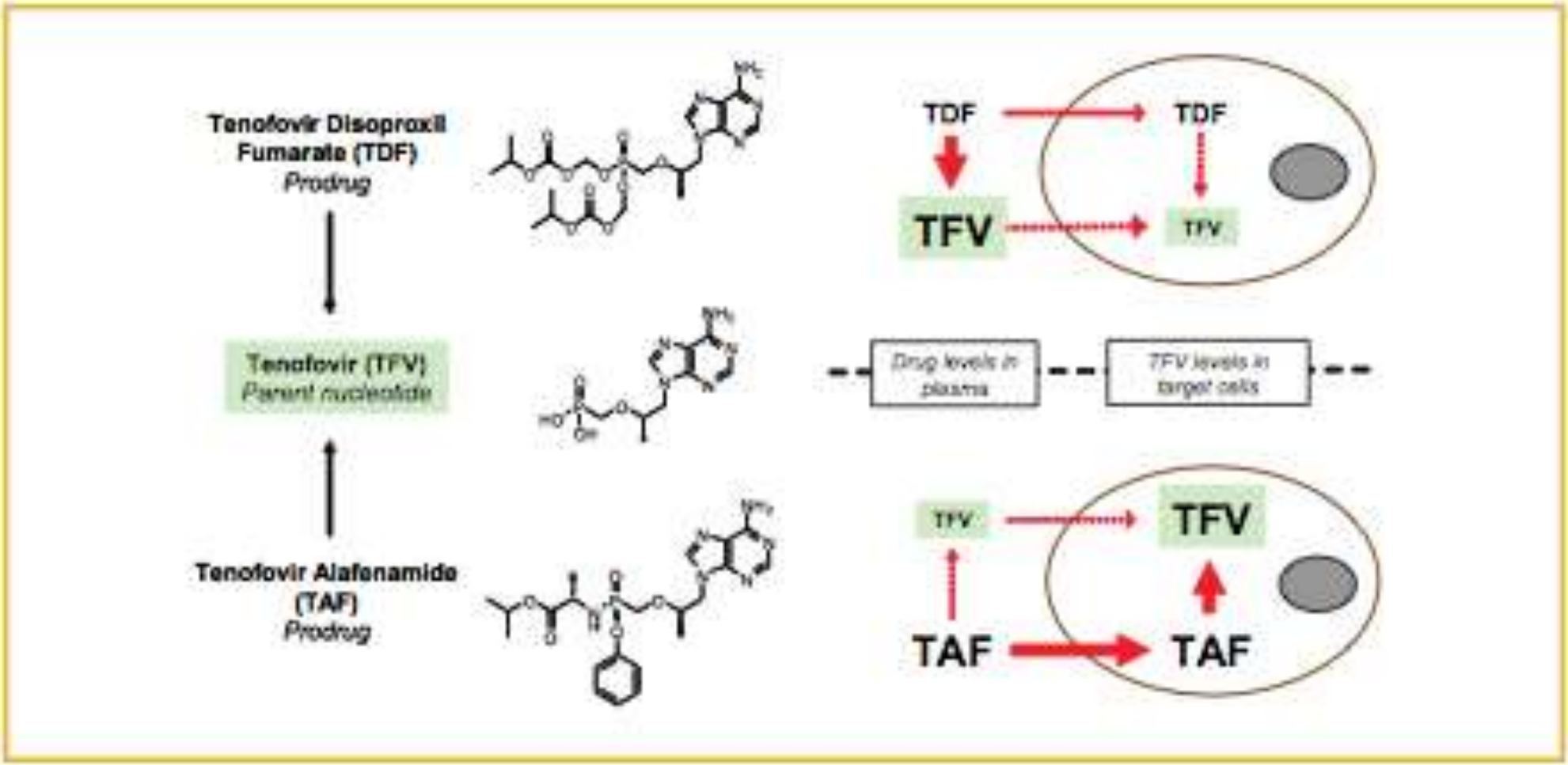
Published: January 24, 2013

-- Two Studies Will Compare a Tenofovir Alafenamide-Based Single Tablet Regimen to Gilead's Stribild® --

FOSTER CITY, Calif.--(BUSINESS WIRE)--Jan. 24, 2013-- Gilead Sciences, Inc. (Nasdaq: GILD) today announced the initiation of the first of two Phase 3 clinical trials (Study 104) evaluating a single tablet regimen containing tenofovir alafenamide (TAF) for the treatment of HIV-1 infection in treatment-naïve adults. TAF is a novel prodrug of

→ TAF does not appear to be a substrate for OAT

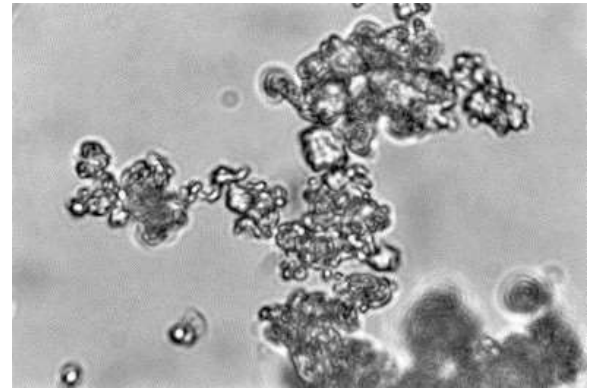
Figure 1. Tenofovir Prodrugs TDF and TAF: Delivery of Parent Tenofovir to Target CD4 Cells



Tenofovir Alafenamide is not a substrate for renal organic anion transporter 1 and does not exhibit OAT dependent cytotoxicity Bam RA, Yant SR and Cihlar T CROI 2013; 540

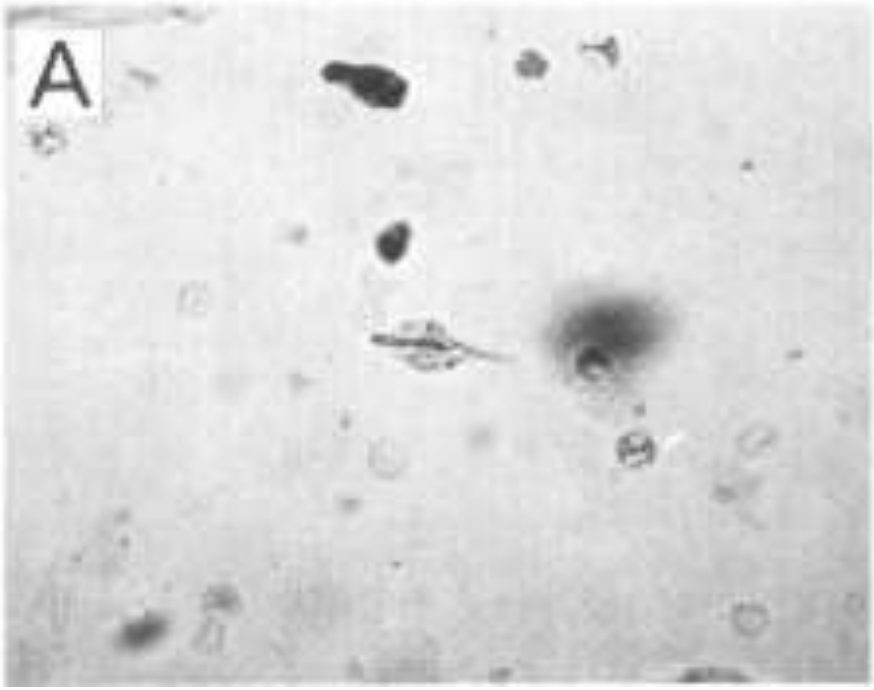
Crystal induced renal disease

- Protease inhibitors
  - Indinivir (insoluble in acid pH)
  - Atazanavir (Reyataz) insoluble in alkaline pH
  - Nelfinivir
  - amprenavir
- NRTI Efavirenz
- Other medications
  - Acyclovir
  - foscarnet



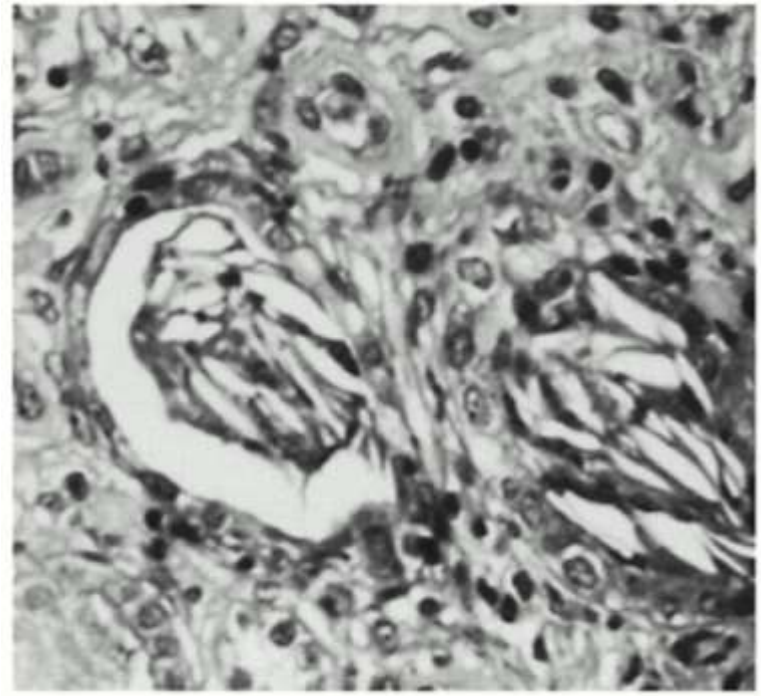
Nelfinivir crystals

Crystal induced renal disease



Urine with crystals from acyclovir

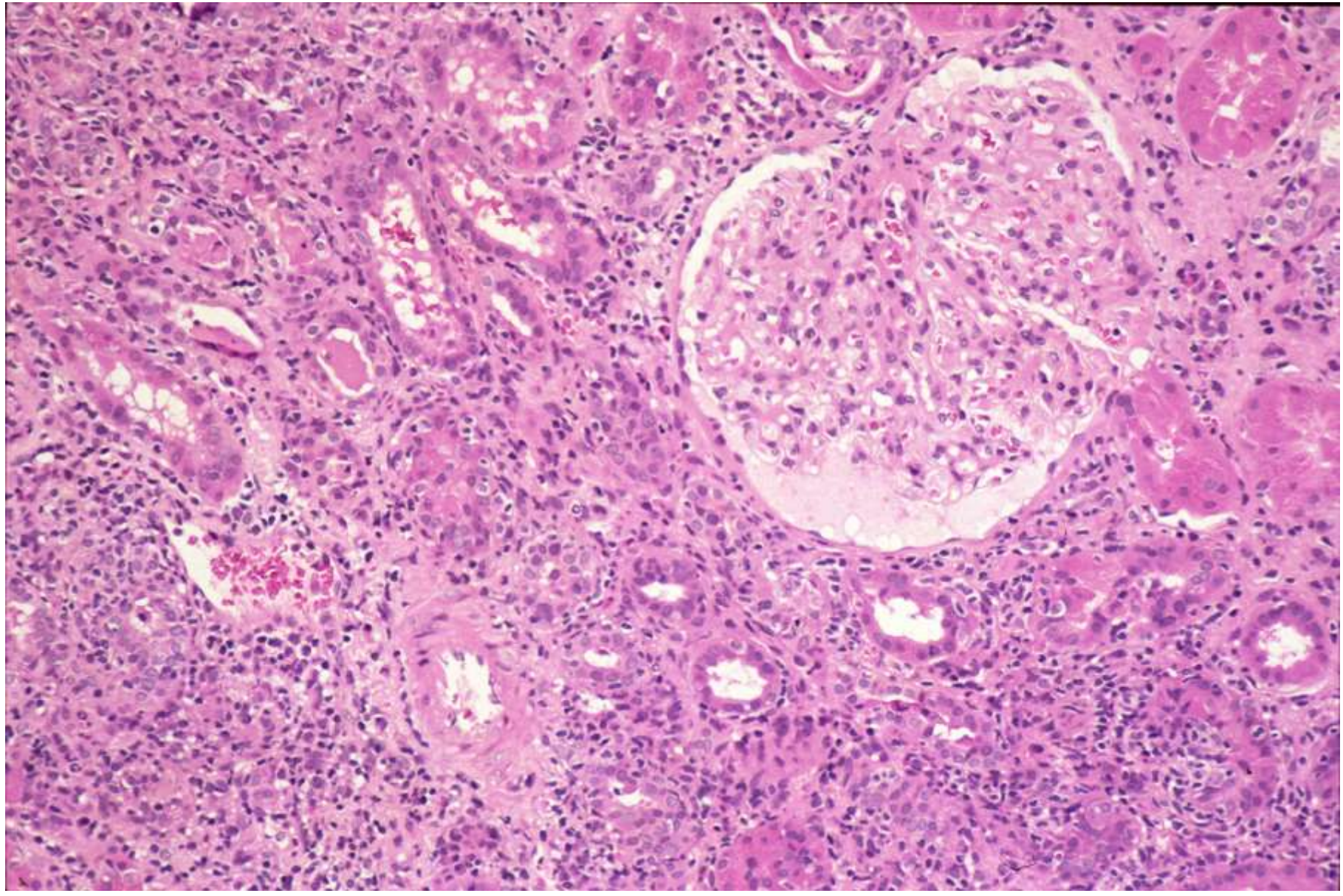
Sawyer MH AmJ Med 1988 84(6) 1002



Renal Tissue in an HIV+ patient Treated with Indinavir

Tashima, K. T. N Engl J Med 1997;336:138

Acute interstitial nephritis



Drugs that may cause AIN

- Antibiotics
  - β lactam antibiotics
  - Sulfonamides (tmp/smz, dapsone)
  - Quinolones
  - rifampin
- Proton pump inhibitors***
- NSAIDS
- Allopurinol
- ARV: Abacavir, ritonovir, atazanavir, indinivir,
  - efavirenz * (hypersensitivity RXN)
- cocaine
- HIV, BK virus and other infectious agents

Review in CJASN 2010 5(5): 798

Renal dosing of ARV

- Dose reduction for nucleoside/tide reverse transcriptase inhibitors
- Caution with combination pills
- Some PI need dose alteration
- NNRTI extensive hepatic metabolism
- Newer agents (darunavir, etravirine, raltegravir, maraviroc) primarily hepatic metabolism but not extensively tested in patients with CKD
- Reports of inadequate treatment in many patients with CKD or ESKD

Double check at http://www.aidsinfo.nih.gov/

New table

Table 15. Antiretroviral Therapy-Associated Adverse Events That Can Be Managed with Substitution of Alternative Antiretroviral Agent (page 3 of 3)

Adverse Event	ARV Agent(s)/Drug Class		Comments
	Switch from	Switch to	
Renal Effects Including proximal renal tubulopathy, elevated creatinine	TDF[a]	ABC[b]	Phosphate wasting as a consequence of TDF nephrotoxicity may lead to osteomalacia.
	ATV/r, LPV/r	DTG, RAL, or NNRTI	cobi and DTG, and to a lesser extent RTV, RPV, and RAL, can increase SCr soon after treatment initiation because of inhibition of tubular secretion of creatinine. This effect does not affect glomerular filtration. However, assess for renal dysfunction, especially if SCr increases by >0.4 mg/dL.
Stones Nephrolithiasis and cholelithiasis	ATV, ATV/r	DRV/r, INSTI, or NNRTI	Nephrolithiasis (a frequent complication of IDV) has been observed with ATV. Cholelithiasis is also reported with ATV.

[a] For patients with chronic active HBV infection, another agent active against HBV should be added to substitute for TDF.

[b] ABC should be used only in patients known to be HLA-B*5701 negative.

[c] TDF reduces ATV levels; therefore, unboosted ATV should not be co-administered with TDF. Long term data for unboosted ATV are unavailable.

Key to Abbreviations: ABC = abacavir; ART = antiretroviral therapy; ARV = antiretroviral; ATV = atazanavir; ATV/r = ritonavir-boosted atazanavir; BMD = bone mineral density; CNS = central nervous system; cobi = cobicistat; d4T = stavudine; ddI = didanosine; DRV/r = ritonavir-boosted darunavir; DTG = dolutegravir; EFV = efavirenz; ETR = etravirine; EVG = elvitegravir; FPV/r = ritonavir-boosted

Guidelines for use of antiretroviral agents in HIV-1-infected adults and adolescents, revised 5/1/14

Renal disease in the context of HIV

- HIV associated nephropathy (collapsing FSGS)
- IgA nephropathy
- Lupus-like glomerulonephritis
- Thrombotic microangiopathy (TTP/HUS)
- Membranous nephropathy
- Membranoproliferative GN
- Rhabdomyolysis with AKI (with statin use)
- Nephropathy assoc with concurrent infections (hep B,C)
- Acute interstitial nephritis
- Acute kidney injury (AKI) from prerenal azotemia or ATN
- Crystal induced nephropathy
- Renal failure and Fanconi's syndrome
- Infiltrative diseases (lymphoma or KS)
- Chronic kidney disease

Adapted from Balow KI 2005

Table 1. Clinical Data on 11 Patients with AIDS and Renal Disease.

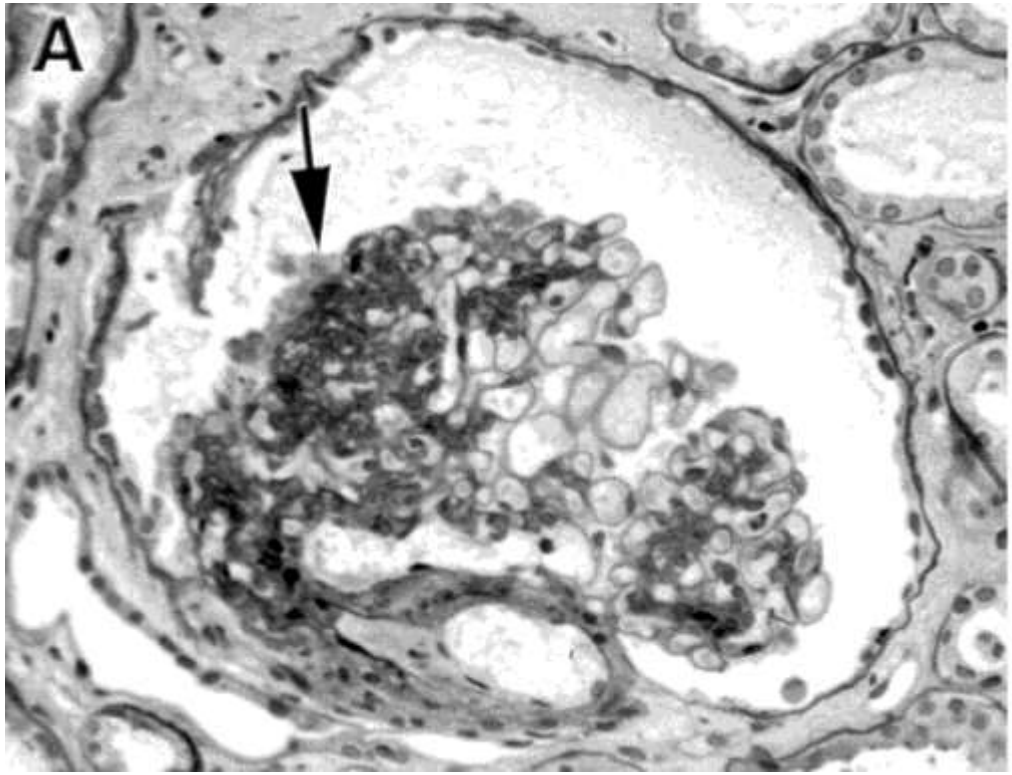
Patient	Age/ Race/Sex	Risk Factor	Renal Manifestation	Renal Histology *	Initial C_{cr} †	Time to Severe Uremia	Current
					ml/min	*wk*	
28/B/F		Heroin	Nephrotic syn.	FSGS	90		
38/B/M		Heroin, homosexual	Nephrotic syn.	FSGS (A)	(1.4)	8–10	
27/B/M		Heroin	Nephrotic syn.	FSGS	75	16	
33/B/M		Heroin	Nephrotic syn.	FSGS (A)	90	12	
8	26/B/M	Homosexual	Nephrotic syn.	FSGS	(1.3)	16	Dead (RF)
9	46/B/M	Haitian	Azotemia, proteinuria	Mesangial increase	50	—	Dead (cr, 3.5)
10	36/B/M	Homosexual	Nephrotic syn.	FSGS (A)	(1.2)	8–10	Dead (RF)
11	22/B/F	Haitian	Nephrotic syn.	FSGS	70	8	On dialysis

Rao TK et al. N Engl J Med 1984;310:669-673.

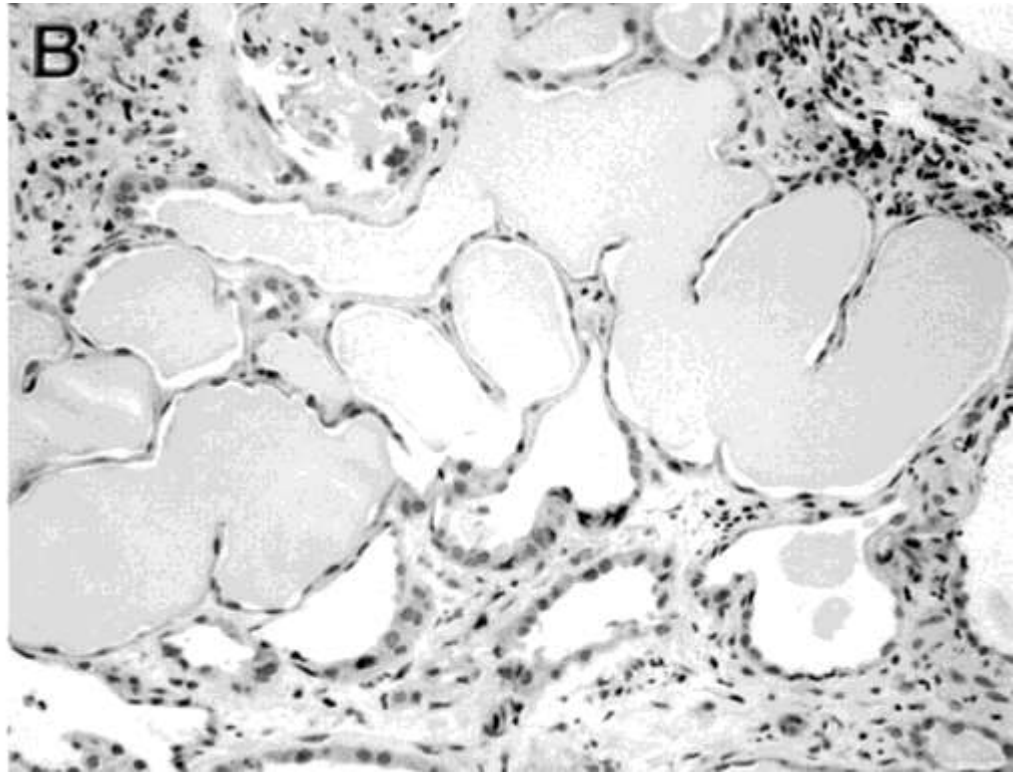
HIV nephropathy/ HIV associated FSGS

- Classically, presents with nephrotic syndrome
- Typically normotensive
- Ultrasound with enlarged kidneys
- Historically-poor prognosis→ARV therapy has changed the landscape
- Usually late manifestation (can occur throughout course of HIV)
- Presentation with well controlled HIV more subtle, may have mild proteinuria
- Marked predilection for individuals of African ancestry

Typical histopathologic findings in HIVAN



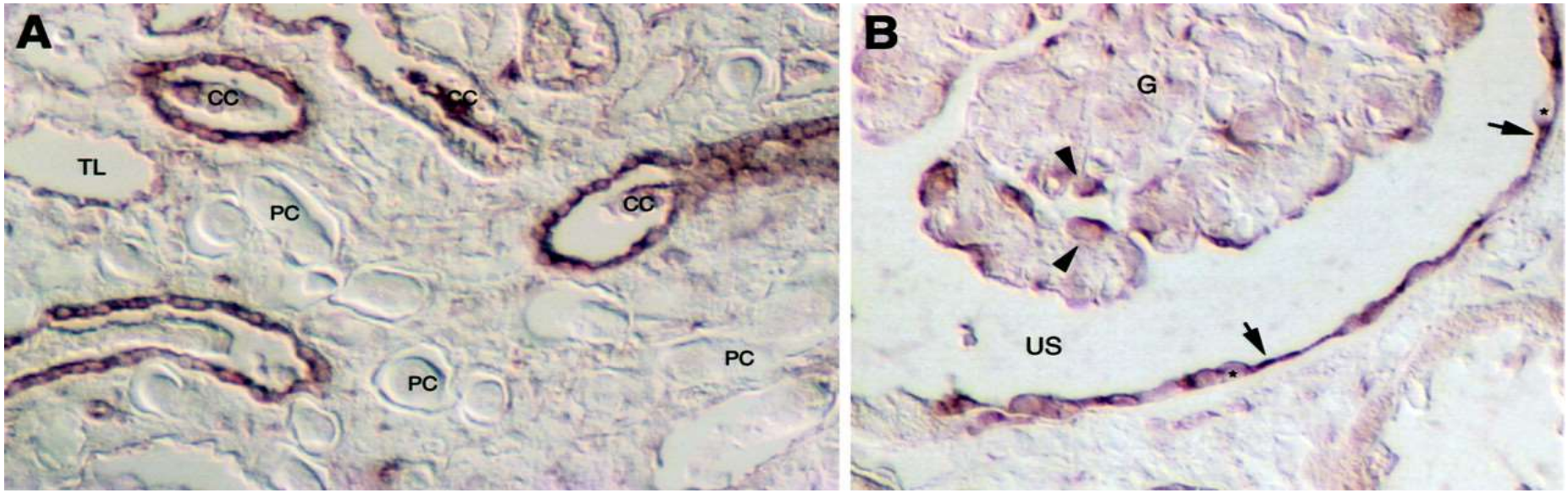
FSGS with segmental collapse



Tubular microcystic changes

Ross JASN 2002; 13:2997

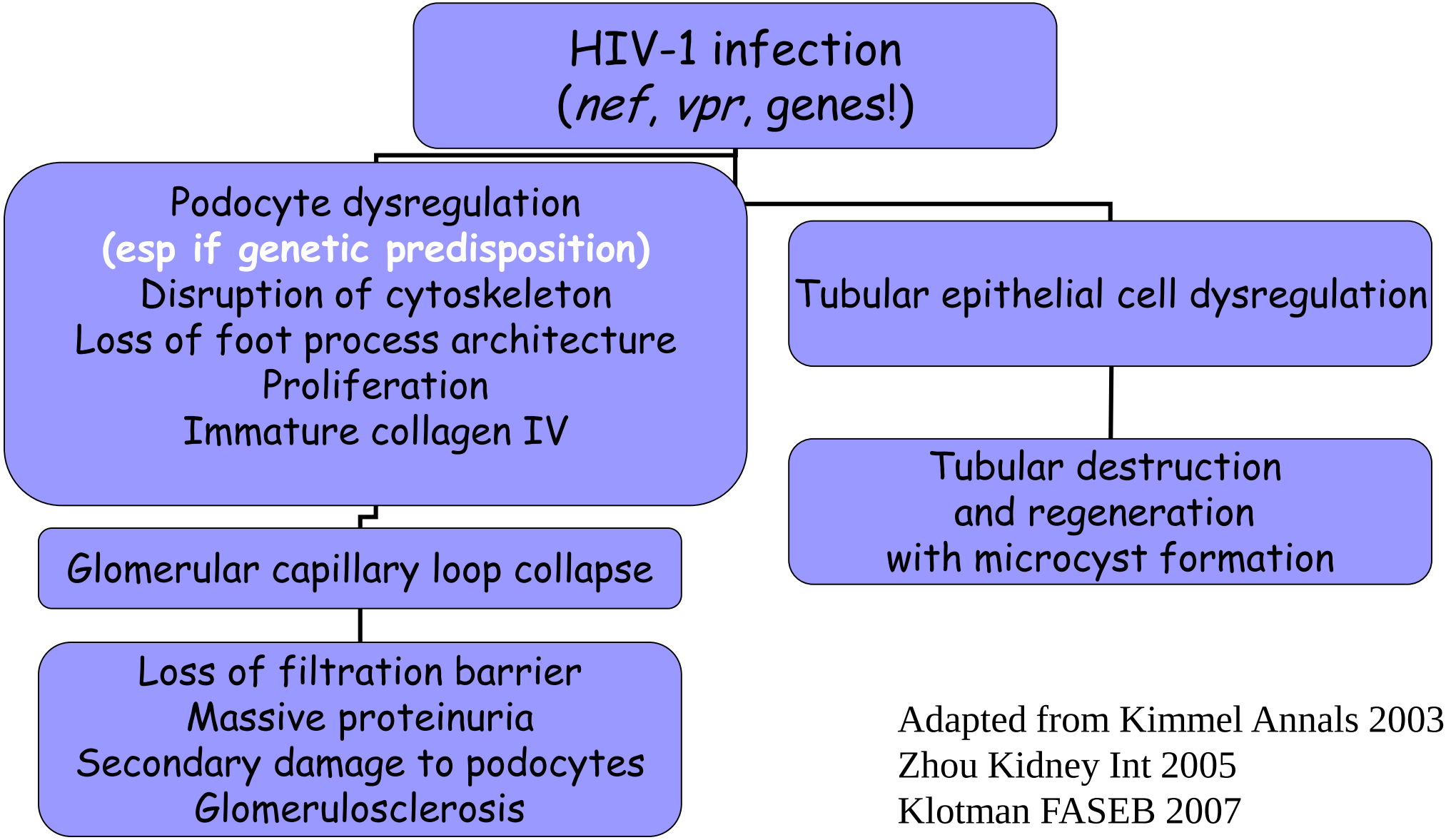
In situ hybridization of HIV mRNA



Ross M J , Klotman P E JASN 2002;13:2997-3004

JASN

Pathogenesis of HIV AN



Adapted from Kimmel Annals 2003
Zhou Kidney Int 2005
Klotman FASEB 2007

Many questions?

- If kidney is a reservoir for HIV, why don't more have this disorder
- What host factors are important in HIVAN
  - MYH9? Apo L1? Others?
- Treatment?

APO L1 alleles G1 and G2 confer risk for HIVAN

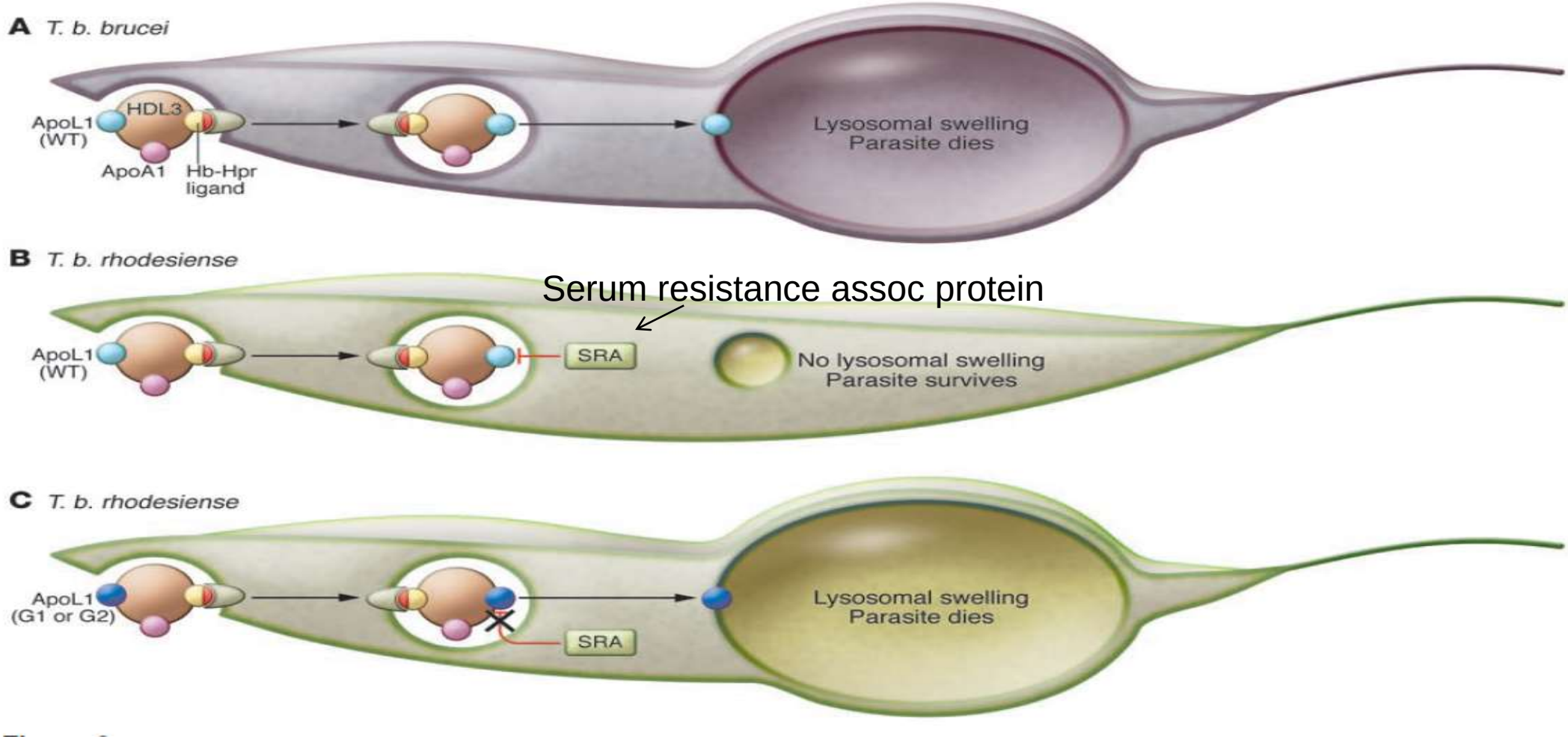
Table 2. Independent effects of the *APOL1* G1 and G2 risk alleles

Risk Allele	Stratum	Number Case/Control	1 vs. 0 Risk Allele		2 vs. 0 Risk Alleles	
			OR (CI)	*P*	OR (CI)	*P*
HIV-associated collapsing glomerulopathy (n = 54) and hyper-normal controls (n = 237)						
G1	No G2	27/180	1.9 (0.5, 8)	0.37	47.4 (11.9, 231.5)	$4.9 \times 10^{-}$
G2	No G1	11/150	1.4 (0.2, 7.5)	0.7	14.4 (1.7, 116.3)	0.007
G1/G2	G1/G2[b]	26/113		—	44.9 (12.9, 192.1)	2.2×10^{-13}
G1 or G2	All	54/237	1.8 (0.5, 6.8)	0.42	40.4 (13.7, 148.4)	4.10×10^{-18}
African American idiopathic FSGS cases (n = 217) and controls (n = 383)						
G1	No G2	125/286	1.9 (1, 3.5)	0.05	23.2 (12, 46.7)	7.3×10^{-29}
G2	No G1	56/234	1.0 (0.4, 2.3)	1.0	25.1 (8.8, 83.3)	7.8×10^{-13}
G1/G2	G1/G2	82/186	—	—	16.7 (8.5, 34)	7.3×10^{-21}
G1 or G2	All	217/383	1.4 (0.8–2.6)	0.26	20.6 (11.8–37)	6.7×10^{-38}

The *APOL1* risk alleles are referred to as follows: G1, S342G mutation; G2, 6 bp deletion (N388del:Y389del). Stratum refers t
lacked the G2 allele or G1 allele). The strata do not add to the total due to overlap between strata. G1/G2 compound heter
were determined by Fisher exact test. As shown, the data best fit a recessive mode of inheritance, with marginal evidence fo

Kopp e al. JASN 2011; 22: 2129

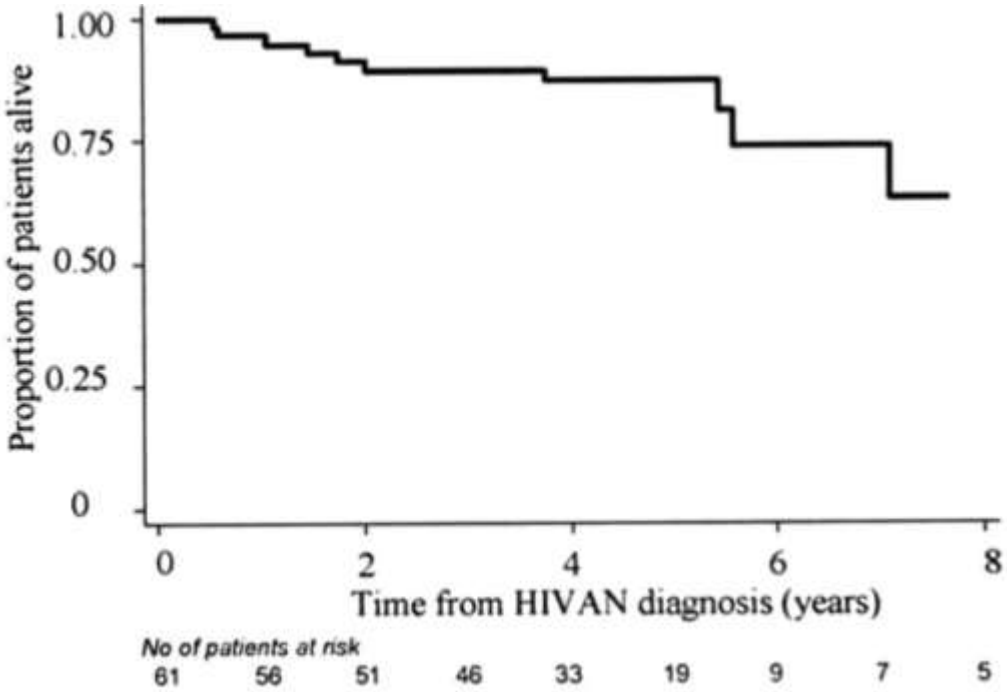
ApolL1 and Trypanosomes



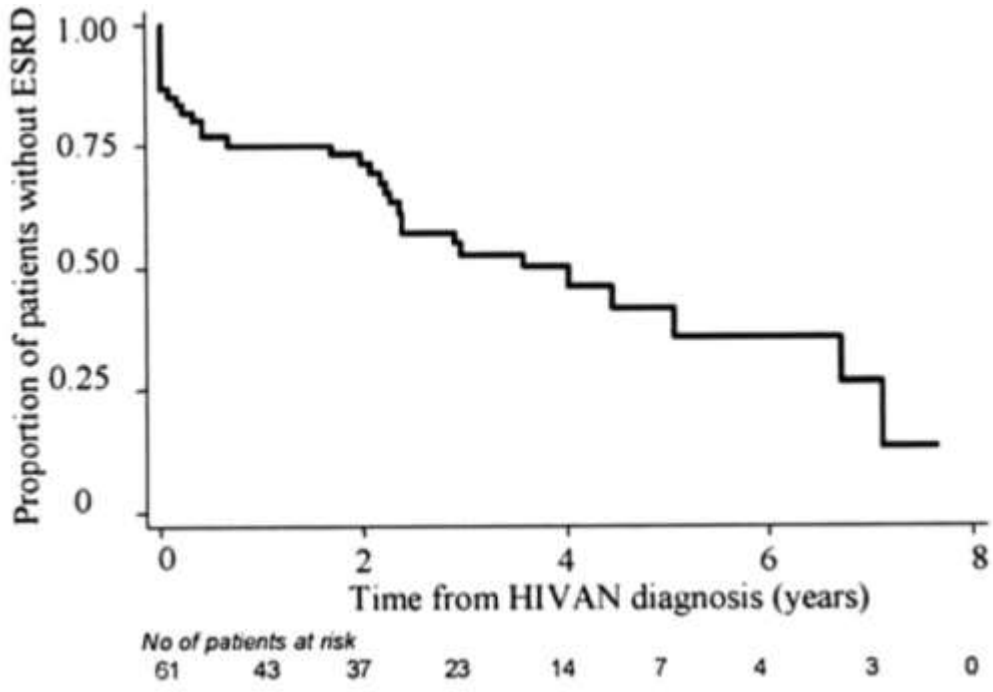
Current opinion in immunology

Patient and renal survival in HIVAN

% alive



% without ESKD



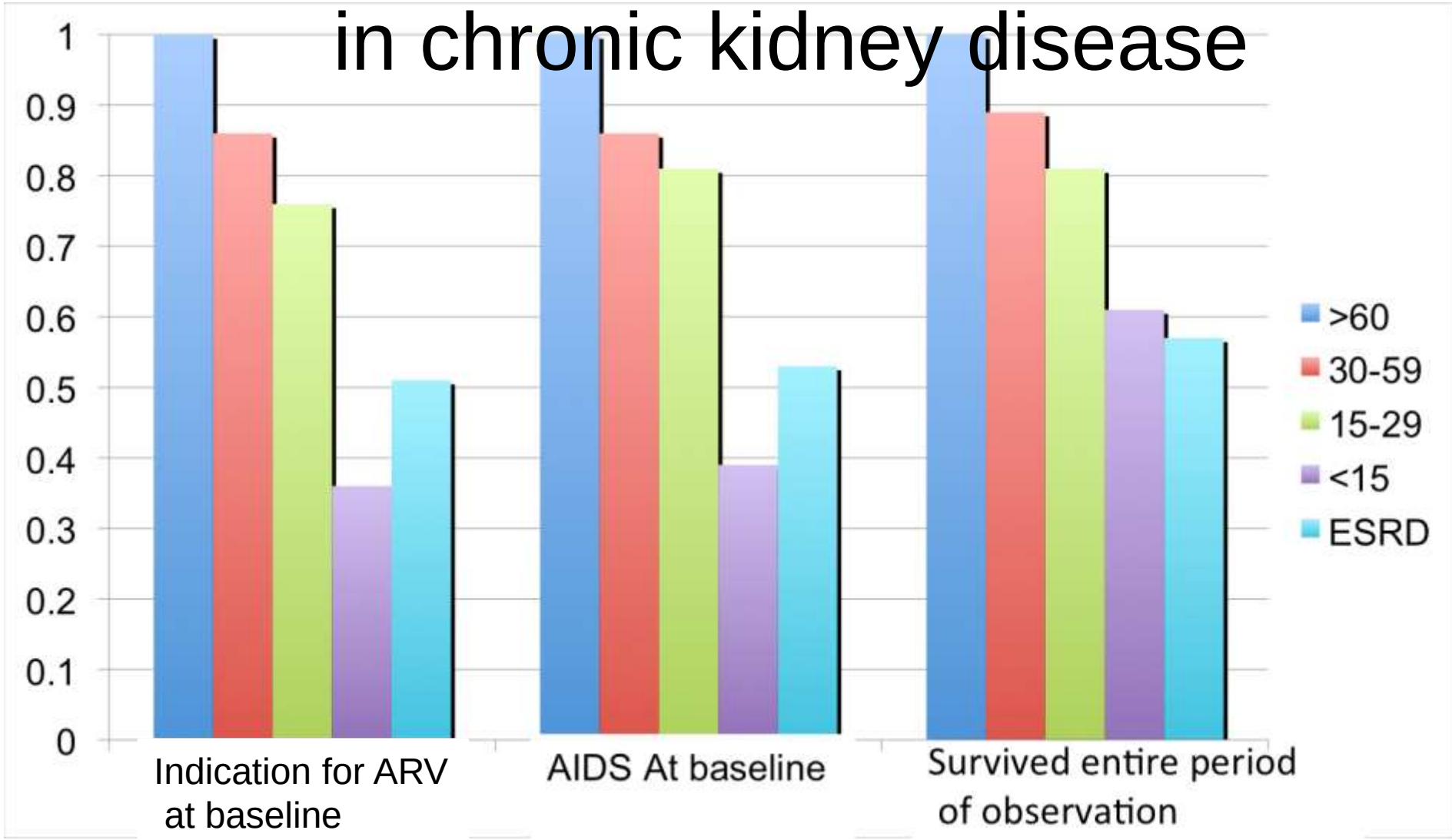
Post F A et al. Clin Infect Dis. 2008;46:1282-1289

Clinical Infectious Diseases

Therapy for HIVAN

- Current era →HAART
  - Case reports of clinical and histological remission from therapy
- Prednisone if HAART does not improve renal function or deterioration is rapid
- Blockade of renin angiotensin aldosterone system
- Epidemiology suggests reduction in incidence of HIVAN but data lags

Relative proportion of patients on ARV in chronic kidney disease



Adapted from Choi AI et al 2007 Clin Inf Dis 45:1633

What about HIV with CKD?

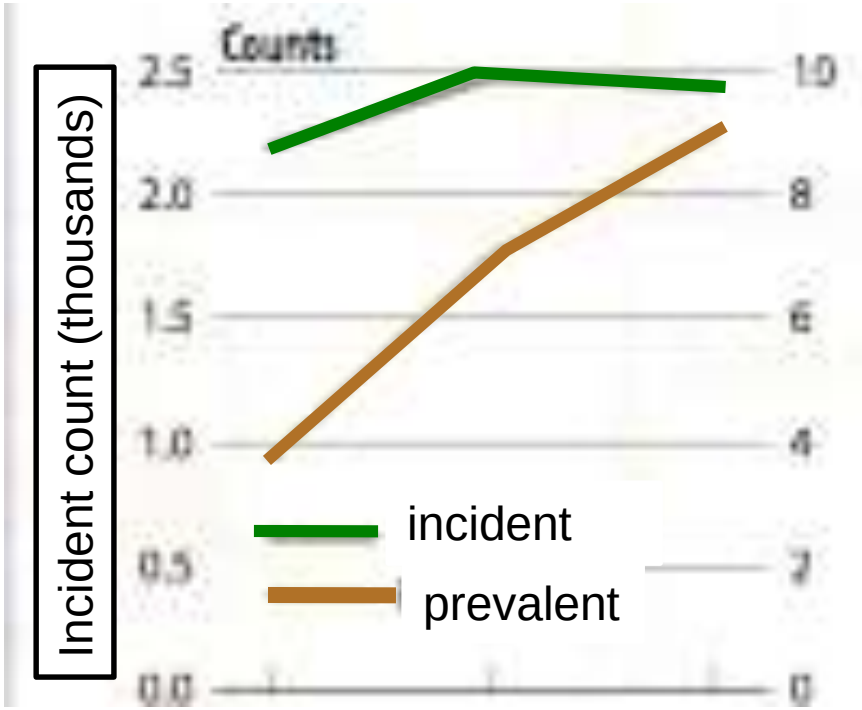
- Address underlying disorders
- Dose medications for reduced GFR
- Address HTN with goal <130/80 if there is proteinuria and preference for ACE I/ARB (if proteinuria)
- Avoid high protein diets
- Management of cardiovascular risk factors
  - hyperlipidemia
  - Glycemic control in diabetes
  - tobacco use!!
- Assess and treat metabolic complications
  - Anemia
  - Metabolic acidosis and hyperkalemia
  - Secondary hyperparathyroidism

ESKD in the HIV positive patient

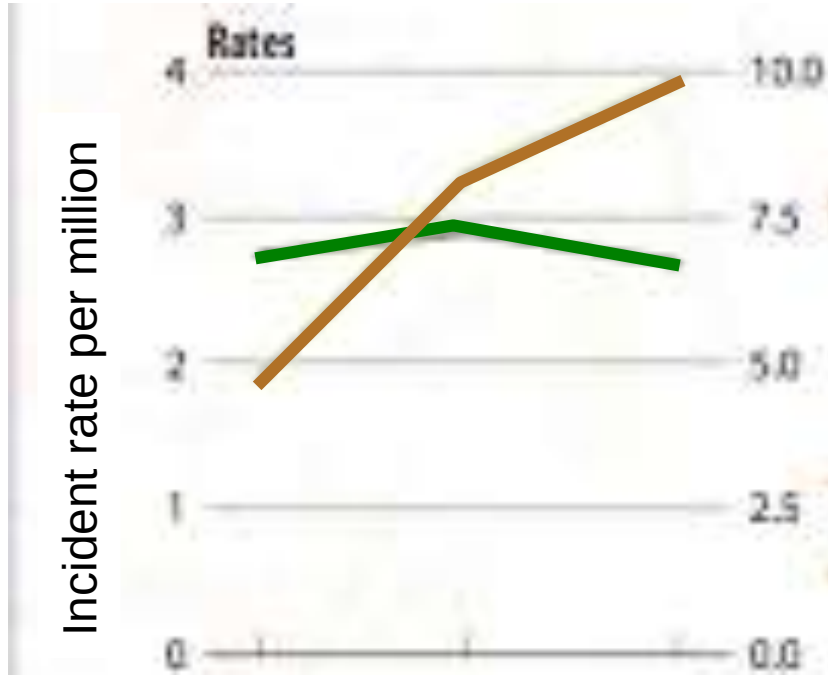
- Hemodialysis
- Peritoneal dialysis
- Renal transplantation
- “Non selection”

Incidence and prevalence of ESKD from AIDS

Counts (in thousands)



Rate (in millions)



http://www.usrds.org/2010/pdf/v2_02.pdf

ESRD Medical Evidence report/MEDICAL Entitlement and or patient registration

2728 1995

*ALL that apply currently or during last 10 years) *See instructions

a.	Congestive heart failure	k.	Diabetes, currently on insulin
b.	Ischemic heart disease, CAD*	l.	Chronic obstructive pulmonary disease
c.	Myocardial infarction	m.	Tobacco use (current smoker)
d.	Cardiac arrest	n.	Malignant neoplasm, Cancer
e.	Cardiac dysrhythmia	o.	Alcohol dependence
f.	Pericarditis	p.	Drug dependence*
g.	Cerebrovascular disease, CVA, TIA*	q.	HIV positive status ☐ Can't Disclose
h.	Peripheral vascular disease*	r.	AIDS ☐ Can't Disclose
i.	History of hypertension	s.	Inability to ambulate
j.	Diabetes (primary or contributing)	t.	Inability to transfer

d?

2728 2005

(Check all that apply currently and/or during last 10 years) *See instructions

a.	Congestive heart failure	n.	Malignant neoplasm, Cancer
b.	Atherosclerotic heart disease ASHD	o.	Toxic nephropathy
c.	Other cardiac disease	p.	Alcohol dependence
d.	Cerebrovascular disease, CVA, TIA*	q.	Drug dependence*
e.	Peripheral vascular disease*	r.	Inability to ambulate
f.	History of hypertension	s.	Inability to transfer
g.	Amputation	t.	Needs assistance with daily activities
h.	Diabetes, currently on insulin	u.	Institutionalized
i.	Diabetes, on oral medications		1. Assisted Living
j.	Diabetes, without medications		2. Nursing Home
k.	Diabetic retinopathy		3. Other Institution
l.	Chronic obstructive pulmonary disease	v.	Non-renal congenital abnormality
m.	Tobacco use (current smoker)	w.	None

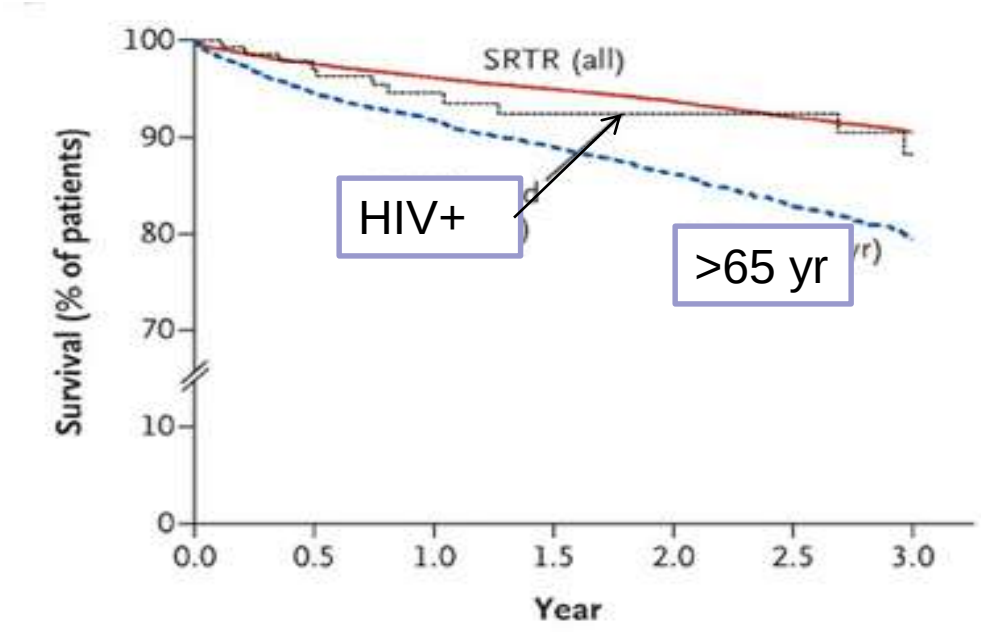
Care of patients with ESKD

- Lifestyle modifications
- Vaccination
- Infection prophylaxis
- Malignancy screening
- Appropriate dosing of ARV
- Anemia management
- Bone and mineral management

From Novak and Szczech ACKD 2010

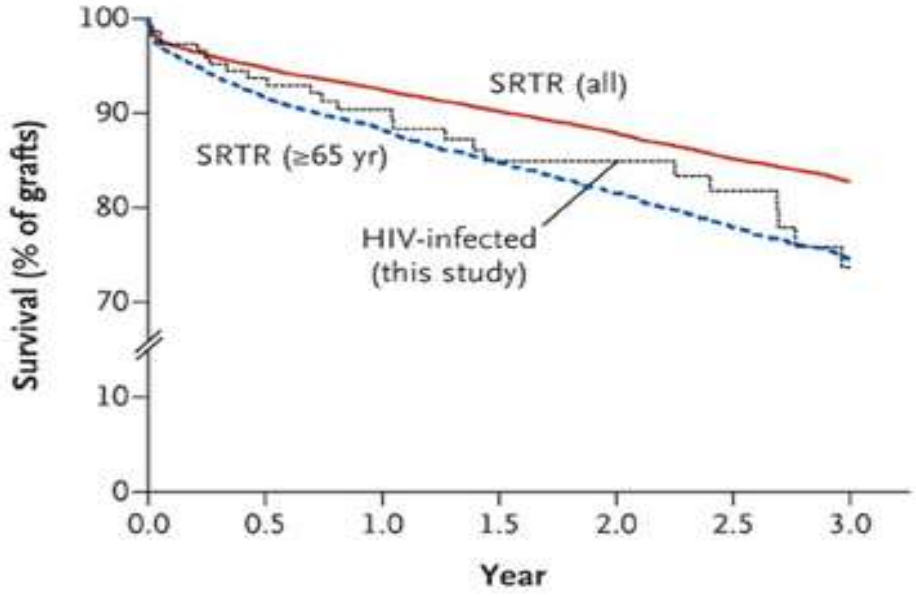
Renal transplantation in recipient with HIV

Patient survival



	29,928	16,792	6508
his study)	96	68	36
	4,226	2,215	836

Graft survival



	29,064	16,114	6215
is study)	93	64	31
	4,103	2,133	807

Stock PG et al. N Engl J Med 2010;363:2004-2014.

The NEW ENGLAND JOURNAL of MEDICINE

HIV and transplantation requires close coordination of care

- **Potential antiretroviral/ immunosuppressive drug-drug interactions**
  - Protease inhibitors affect P450 cytochrome isoenzymes (CYP3A4) which affect metabolism of calcineurin inhibitors
  - Nonnucleoside reverse transcriptors affect metabolism of immunosuppressant agents in more complex manner
- Increased risk of rejection but treatment may result in severe infections
- Transplant team must work closely with infectious disease team

Recommendations:

- Assess renal function and measure proteinuria in all patients at diagnosis of HIV and annually (more frequently with ↑ risk factors for CKD)
- Consider referral for patients with eGFR<<60ml/min, proteinuria and/or hematuria
- Consider a broad differential in assessing kidney disorders
- Dose medications according to eGFR to avoid toxicity AND inadequate treatment
- Attention to modifiable risk factors for CVD in setting of CKD.

Established or hypothesized role of HIV infection or its treatment

- HIV-associated nephropathy (HIVAN)
- Antiretroviral nephrotoxicity
- Tenofovir (proximal tubulopathy)
- Indinavir (interstitial nephritis and crystal deposition)
- Other protease inhibitors?
- HIV-immune complex kidney disease
- IgA nephropathy

- *Hypothesized additive effect of HIV infection or its treatment*
- Diabetic nephropathy
- *Unclear role of HIV infection or its treatment*
- Noncollapsing focal segmental glomerulosclerosis
- Membranoproliferative glomerulonephritis, with or without hepatitis C virus
- Membranous nephropathy, with or without hepatitis B virus
- Arterionephrosclerosis

Mallipatu et al KI 2014

Other resources:

- Guidelines, drug dosing

http://www.aidsinfo.nih.gov

- Monograph on HIV and CKD from NKF:

http://www.kidney.org/professionals/tools

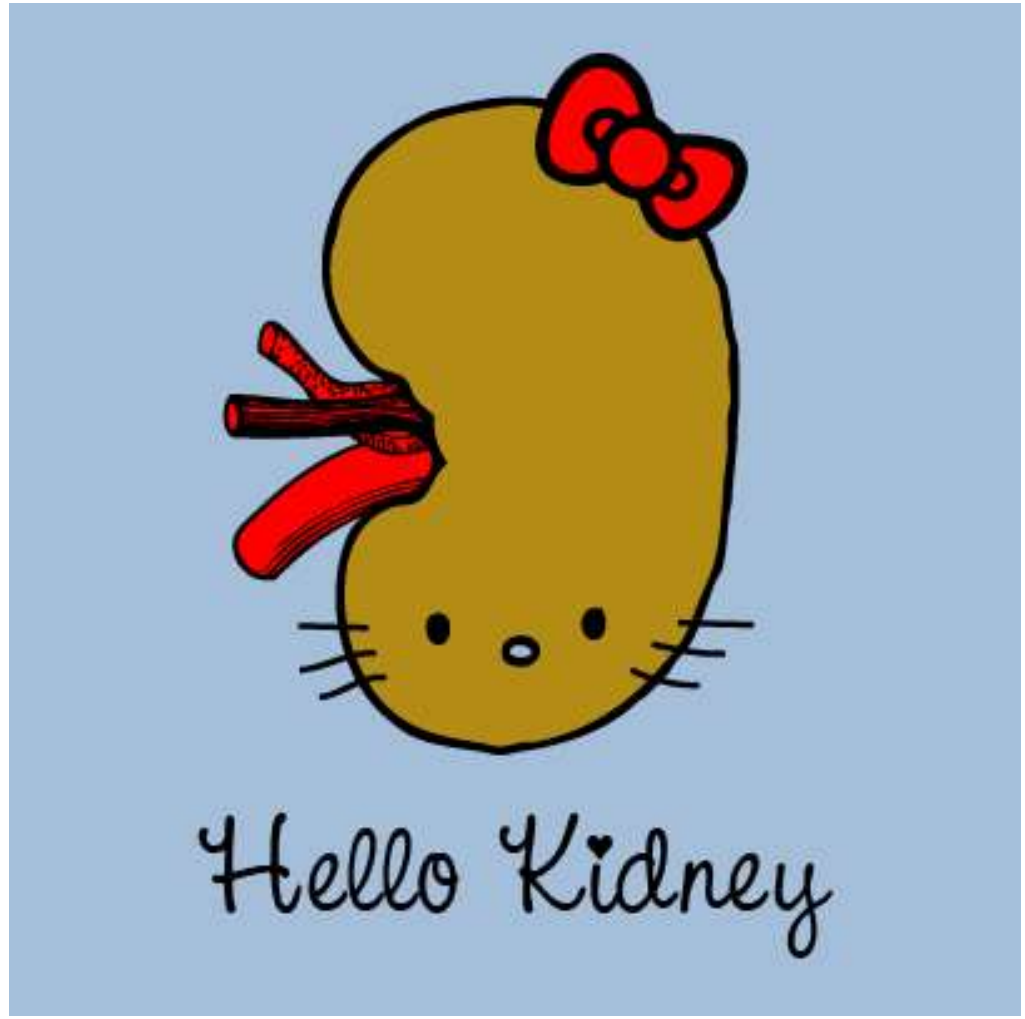
- IDSA CKD in HIV guidelines

(2005 posted, update in 2014)

http://www.idsociety.org

- CROI conference on retroviral and OI has web/podcasts of recent meetings

http://retroconference.org


Hello Kidney