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Disclosures

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Managing Adult with Chronic Kidney Disease

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Making Waves

Objectives

- Review epidemiological data of CKD
- Discuss risk factors and diagnosing CKD
- Describe best practices for co-management of CKD with primary care

Making Waves

Defining Chronic Kidney Disease

- **Kidney damage for ≥ 3 months, defined by structural or functional abnormalities of the kidney, with or without decreased GFR, manifest by either**
  - **Pathologic abnormalities, or**
  - **Markers of kidney damage, such as abnormalities of the blood or urine, or in imaging tests**
  - **GFR < 60 mL/min/1.73 m^2 for ≥ 3 months with or without kidney damage.**

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Kidney Disease Outcomes and Quality Improvement (KDOQI) CKD Staging Guidelines

CKD Stage	Description	GFR (ml/min/1.73 m^2)
1	Kidney damage with normal or ↑ GFR	>90
2	Kidney damage with mild ↓ in GFR	60-89
3	Moderate ↓ in GFR	30-59
4	Severe ↓ in GFR	15-29
5	Kidney failure	<15 (or dialysis)

Data Source: National Health and Nutrition Examination Survey (NHANES), 2001-2004, 2005-2008, 2009-2012 & 2013–2016participants aged 20 & older. Whisker lines indicate 95% confidence intervals. Abbreviation: CKD, chronic kidney disease.

ICD-9-CM and ICD-10-CM codes for Chronic Kidney Disease (CKD) stages

ICD-9-CM code[a]	ICD-10-CM code[a]	Stage
585.1	N18.1	CKD, Stage 1
585.2	N18.2	CKD, Stage 2 (mild)
585.3	N18.3	CKD, Stage 3 (moderate)
585.4	N18.4	CKD, Stage 4 (severe)
585.5	N18.5	CKD, Stage 5 (excludes 585.6: Stage 5, requiring chronic dialysis[b])
CKD Stage-unspecified	CKD Stage-unspecified	For these analyses, identified by multiple codes including 585.9, 250.4x, 403.9x & others for ICD-9-CM and A18.xx, E08.xx, E11.xx and other for ICD-10-CM.

[a]For analyses in this chapter, CKD stage estimates require at least one occurrence of a stage-specific code, and the last available CKD stage in a given year is used. [b]In USRDS analyses, patients with ICD-9-CM code 585.6 or ICD-10-CM code N 18.6 & with no ESRD 2728 form or other indication of end-stage renal disease (ESRD) are considered to have code 585.5 or N 18.5.

Albuminuria Categories in CKD

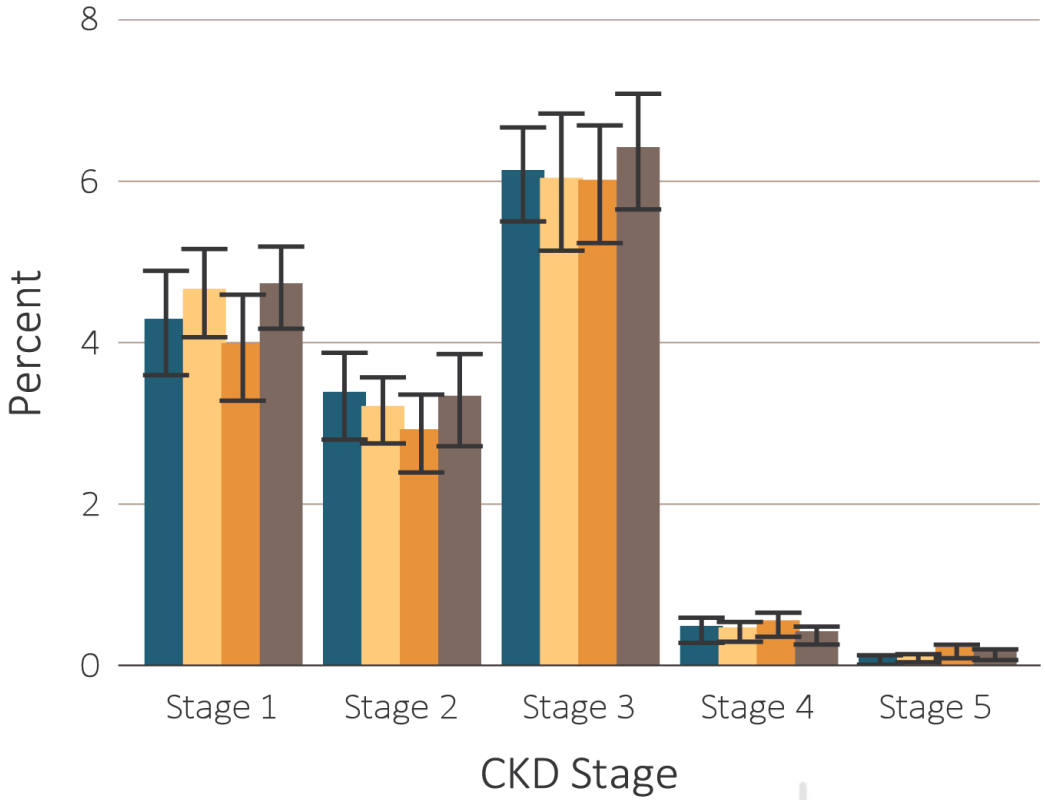
Category	AER (Mg/24 hrs)	ACR (mg/mmol) (mg/g)		Terms
A1	< 30	< 3	<30	Normal to mildly increased
A2	30-300	3-30	30-300	Moderately increased *
A3	>300	>30	> 300	Severely increased **

Percentage of NHANES 2013-2016 participants, in the various CKD (eGFR and albuminuria) risk categories (KDIGO 2012)

GFR categories (ml/min/1.73 m²)				Albuminuria categories			Total
				A1	A2	A3	
				Normal to mildly increased	Moderately increased	Severely increased	
				<30 mg/g <3 mg/mmol	30-300 mg/g 3-30 mg/mmol	>300 mg/g >30 mg/mmol	
	G1	Normal to high	≥90	54.9	4.2	0.5	59.6
	G2	Mildly decreased	60-89	30.2	2.9	0.3	33.5
	G3a	Mildly to moderately decreased	45-59	3.6	0.8	0.3	4.7
	G3b	Moderately to severely decreased	30-44	1.0	0.4	0.2	1.7
	G4	Severely decreased	15-29	0.13	0.10	0.15	0.37
	G5	Kidney failure	<15	0.01	0.04	0.09	0.13
			Total	89.9	8.5	1.6	100

Data source: National Health and Nutrition Examination Survey (NHANES), 2001-2004, 2005-2008, 2009-2012 & 2013-2016 participants aged 20 and older. Single-sample estimates of eGFR and ACR; eGFR calculated using the CKD-EPI equation. Low risk: eGFR ≥60 ml/min/1.73 m² and ACR <30 mg/g; moderately high risk: eGFR 45-59 ml/min/1.73 m² or eGFR ≥60 ml/min/1.73 m² and ACR 30-300 mg/g; high risk: eGFR 30-44 ml/min/1.73 m² or eGFR 45-59 ml/min/1.73 m² and ACR 30-300 mg/g or eGFR ≥60 ml/min/1.73 m² and ACR >300 mg/g; very high risk: eGFR <30 ml/min/1.73 m² or eGFR 30-44 ml/min/1.73 m² and ACR 30-300 mg/g or eGFR ≥60 ml/min/1.73 m² and ACR >300 mg/g. Abbreviations: ACR, urine albumin/creatinine ratio; CKD, chronic kidney disease; eGFR, estimated glomerular filtration rate; GFR, glomerular filtration rate; KDIGO, Kidney Disease: Improving Global Outcomes CKD Work Group.

Prevalence of CKD by stage among NHANES participants, 2001-2016



Prevalence of CKD

	Stages 1-5	Stages 3-5
2001-2004	14.2 (13.2-15.1)	6.6 (6.0-7.2)
2005-2008	14.3 (13.0-15.5)	6.5 (5.6-7.4)
2009-2012	13.5 (12.5-14.4)	6.6 (5.9-7.4)
2013-2016	14.8 (13.6-16.1)	6.9 (6.2-7.6)

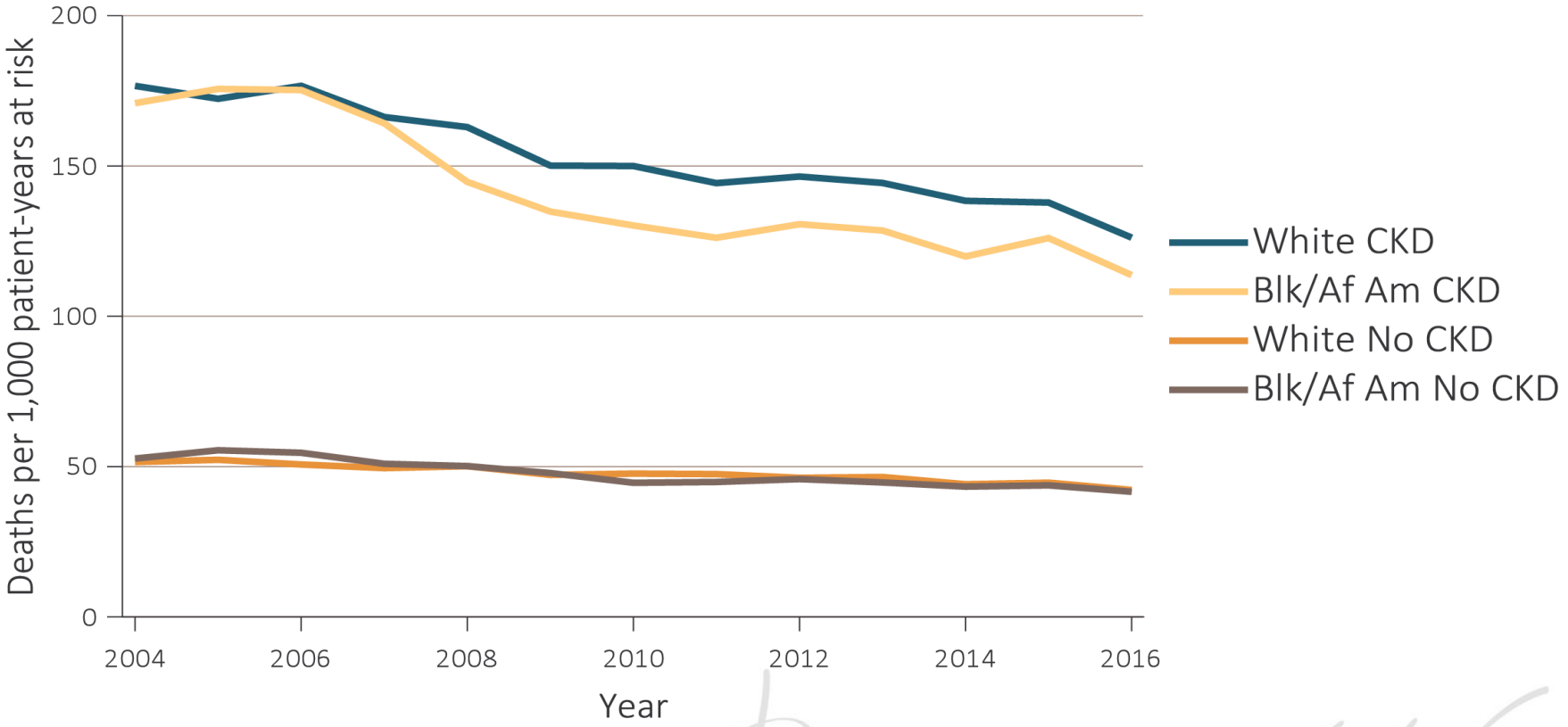
Data Source: National Health and Nutrition Examination Survey (NHANES), 2001-2004, 2005-2008, 2009-2012 & 2013–2016participants aged 20 & older. Whisker lines indicate 95% confidence intervals.
Abbreviation: CKD, chronic kidney disease.

The patient with early stage CKD is 5 to 10 times more likely to die from a cardiovascular event than progress to ESRD

What can we do about it?

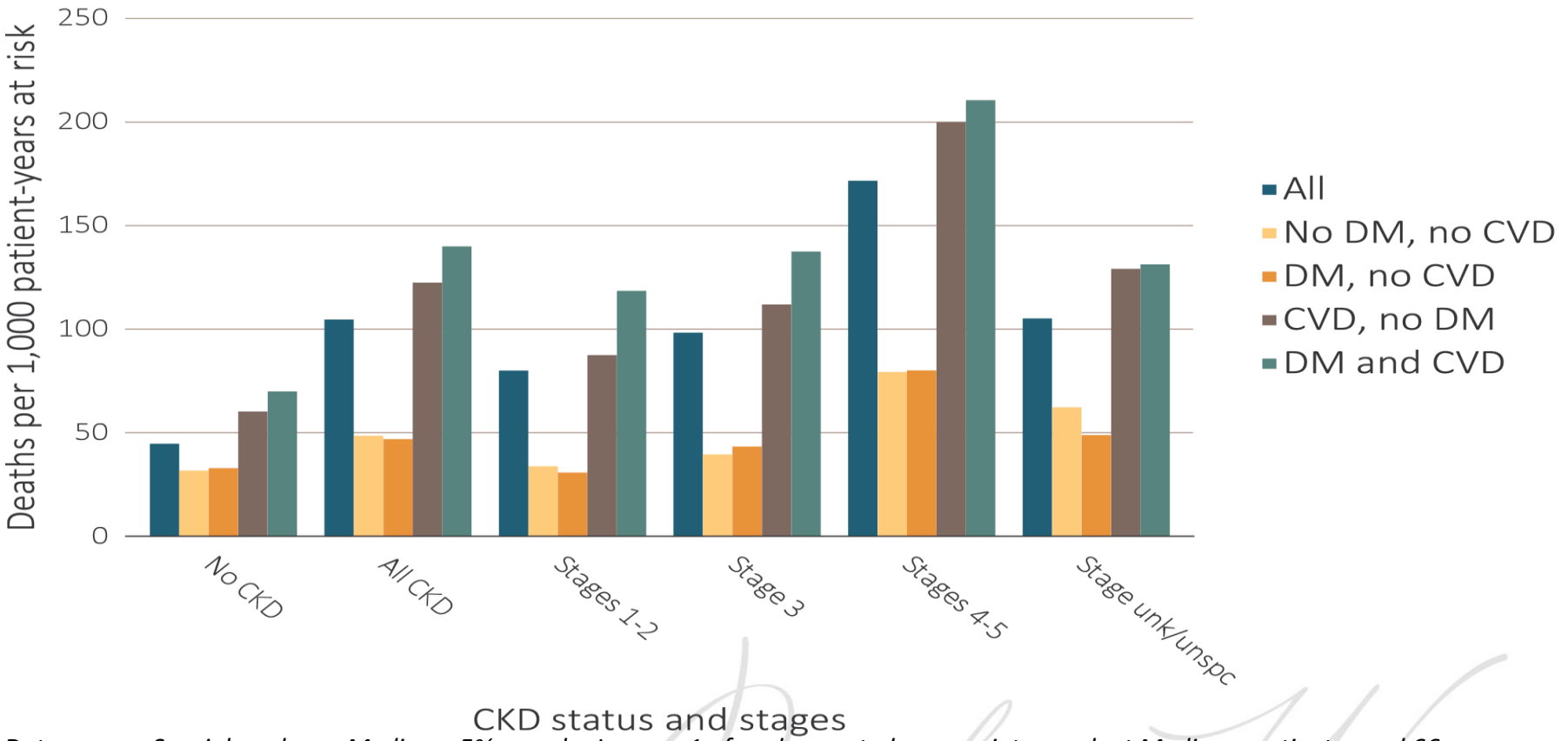
Foley RN, Murray AM, Li S, Herzog CA, McBean AM, Eggers PW, Collins AJ. Chronic kidney disease and the risk for cardiovascular disease, renal replacement, and death in the United States Medicare population, 1998 to 1999. J Am Soc Nephrol 2005; 16:489-95.

Unadjusted and adjusted all-cause mortality rates per 1,000 patient-years at risk for Medicare patients aged 66 and older, by CKD status and year, 2004-2016



Data source: Special analyses, Medicare 5% sample. January 1 of each reported year, point prevalent Medicare patients aged 66 and older. 1.b adjusted for age/sex/race and 1.c adjusted for age/sex/race/comorbidities. 1.e adjusted for age/sex and 1.f adjusted for age/sex/comorbidities. Standard population: Medicare 2011 patients. Abbreviation: CKD, chronic kidney disease.

Adjusted all-cause mortality rates per 1,000 patient-years at risk for Medicare patients aged 66 and older, by cardiovascular disease and diabetes mellitus, CKD status, and stage, 2016



Data source: Special analyses, Medicare 5% sample. January 1 of each reported year, point prevalent Medicare patients aged 66 and older. Adjusted for age/sex/race. Standard population: Medicare 2016 patients. Abbreviations: CKD, chronic kidney disease; CVD, cardiovascular disease; DM, diabetes mellitus; unk/unspc, CKD stage unidentified.

Primary Care Professionals: Critical to CKD Care

- **Many of care issues overlap with those of diabetes and hypertension**
- **Identifying and intervening early lead to improve patient outcomes**
  - **Slowing progression and addressing CV risk factors**
  - **Co-manage with nephrology experts**

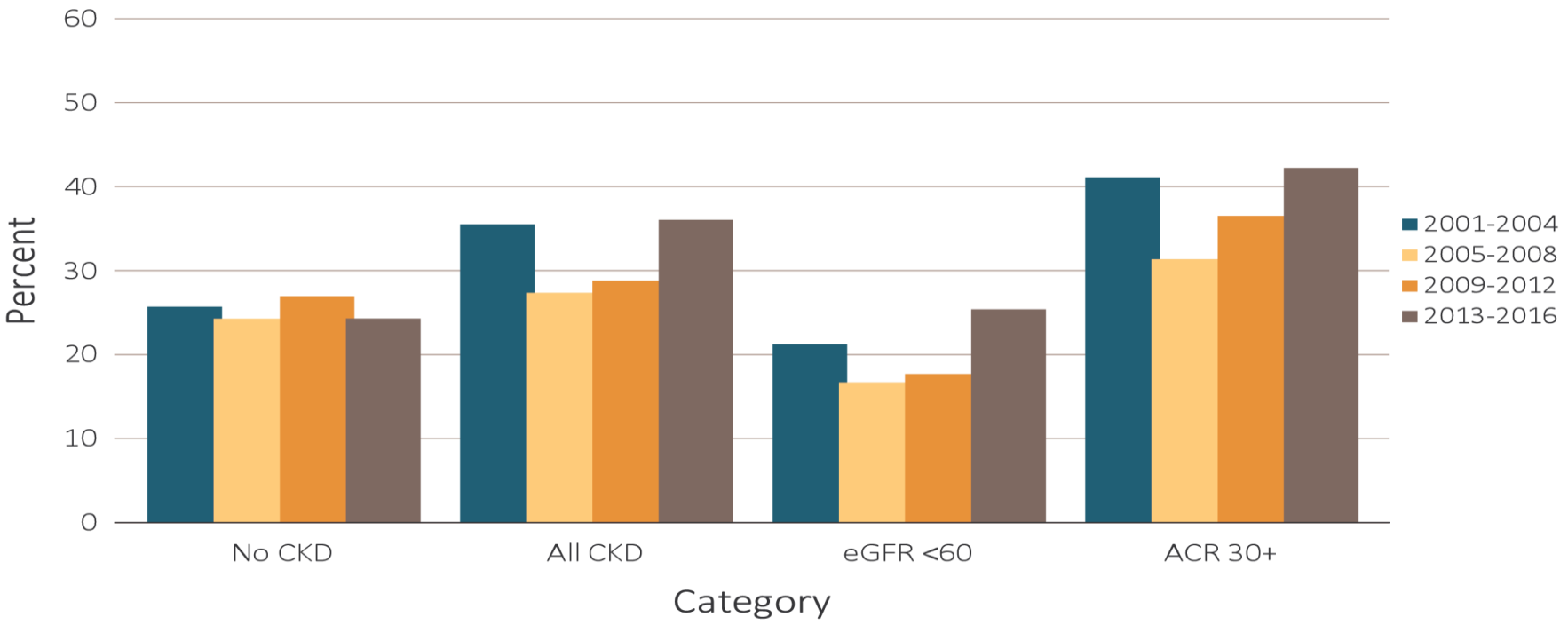
Making Waves

The Key Issues in Managing CKD

- **Identify those at risk**
- **Ensuring correct etiology**
- **Implementing appropriate therapy**
- **Monitoring patient**
- **Screening for CKD complications**
- **Educating patient**
  - **Assure patient understands has CKD**
  - **Stage 4 Medicare benefit for education**
- **Care coordination**
  - **Care management**

Making Waves

Time trends of individuals with CKD aware of their kidney disease, NHANES 2001-2016



Data Source: National Health and Nutrition Examination Survey (NHANES), 2001-2016 participants aged 20 & older. Abbreviations: ACR, urine albumin/creatinine ratio; CKD, chronic kidney disease; DM, diabetes mellitus; eGFR, estimated glomerular filtration rate; HTN, hypertension.

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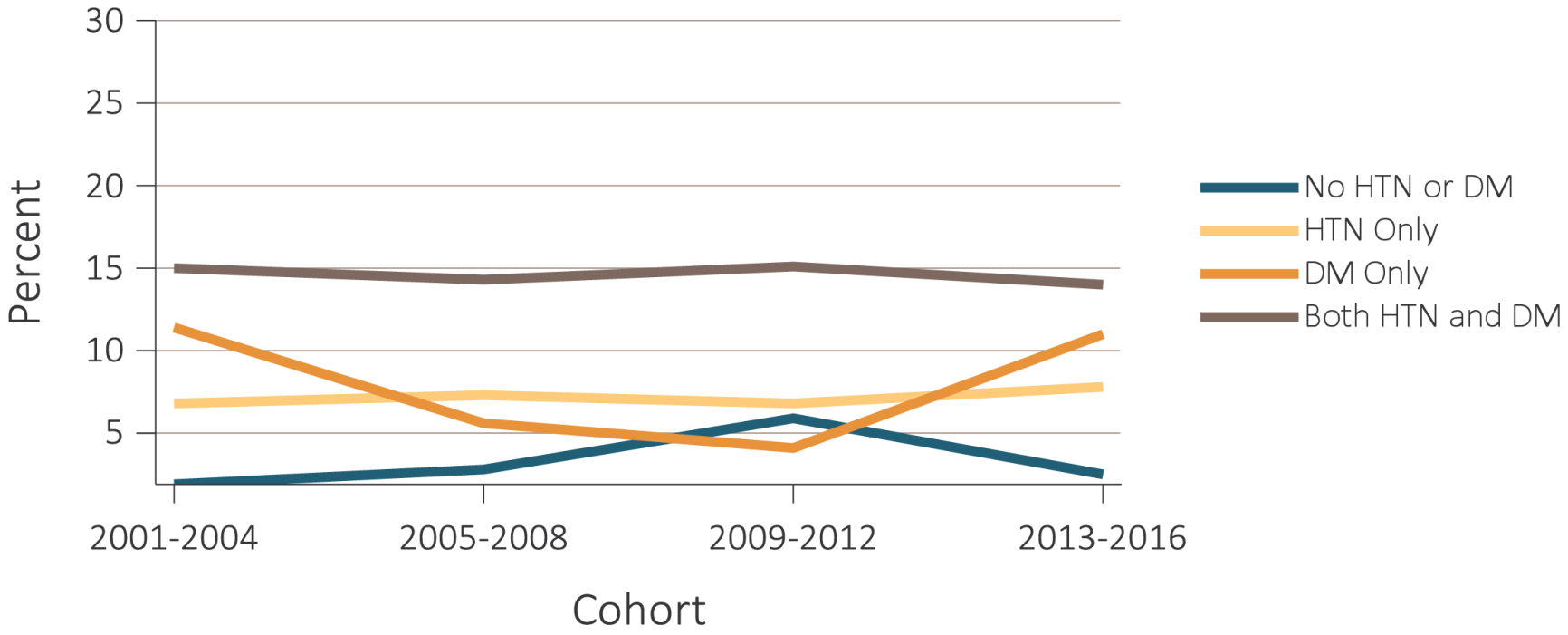

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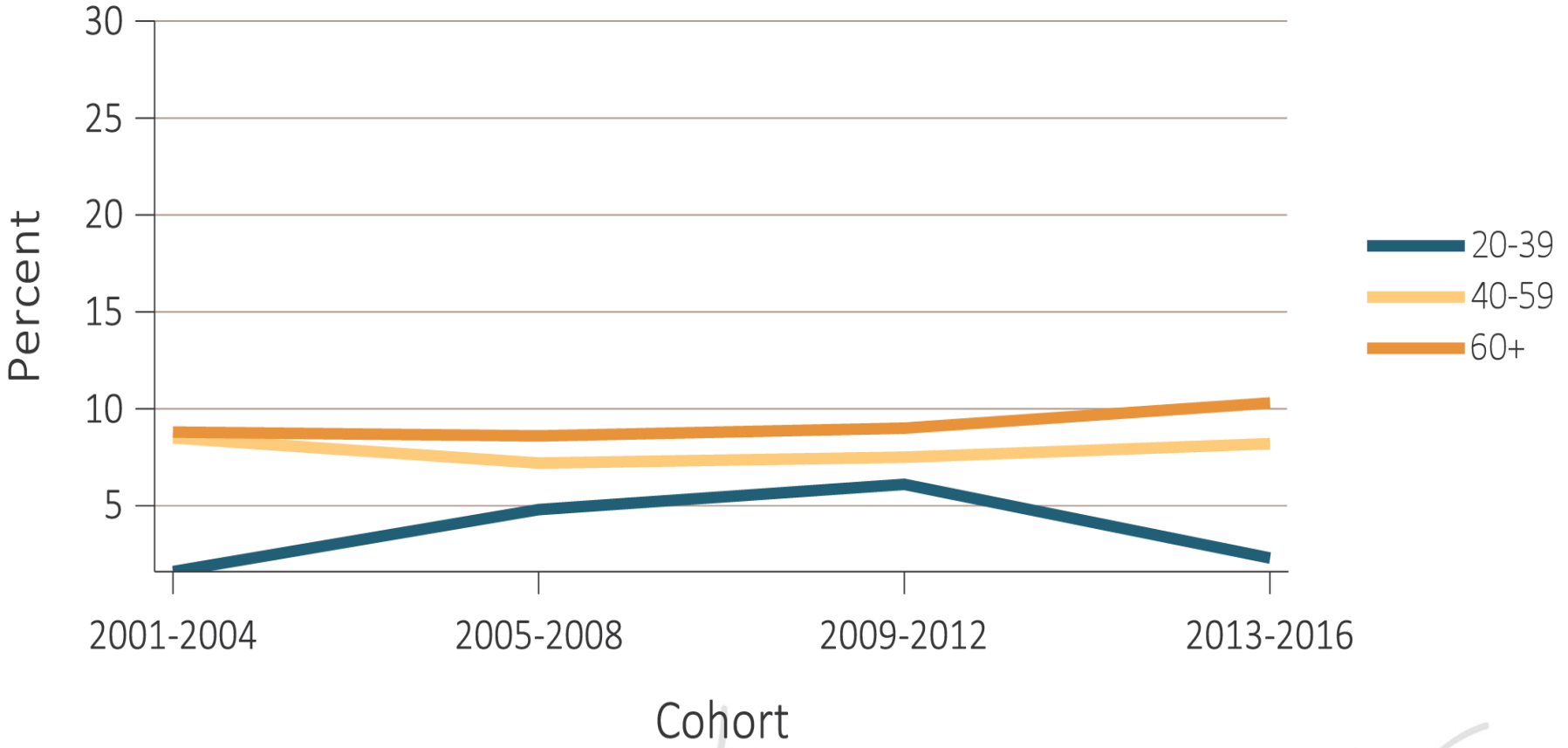
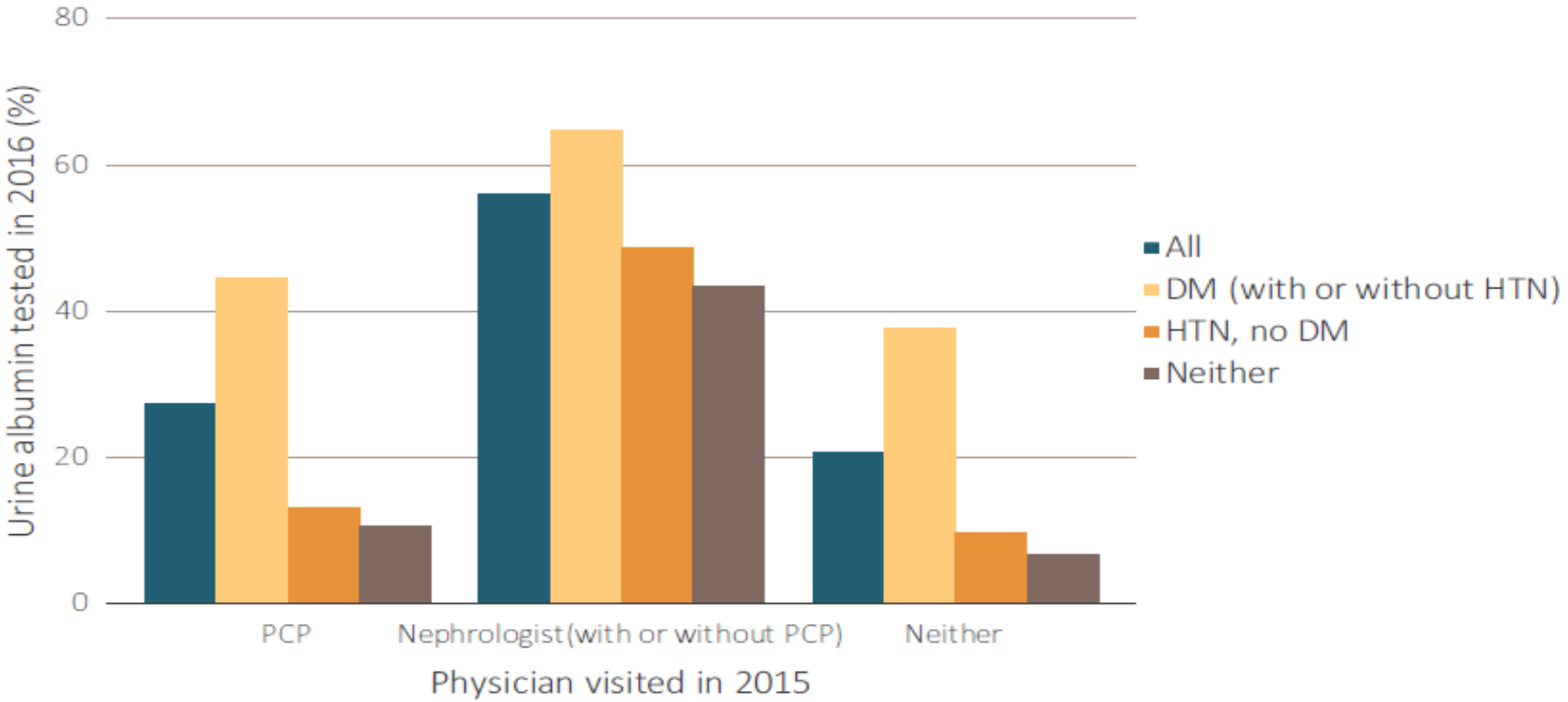


Data Source: National Health and Nutrition Examination Survey (NHANES), 2001-2016 participants aged 20 & older. Abbreviations: ACR, urine albumin/creatinine ratio; CKD, chronic kidney disease; DM, diabetes mellitus; eGFR, estimated glomerular filtration rate; HTN, hypertension.

Percent of CKD patients in 2015 with physician visit (nephrologist, primary care provider, both, and neither), with laboratory testing in the following year (2016), by comorbidity

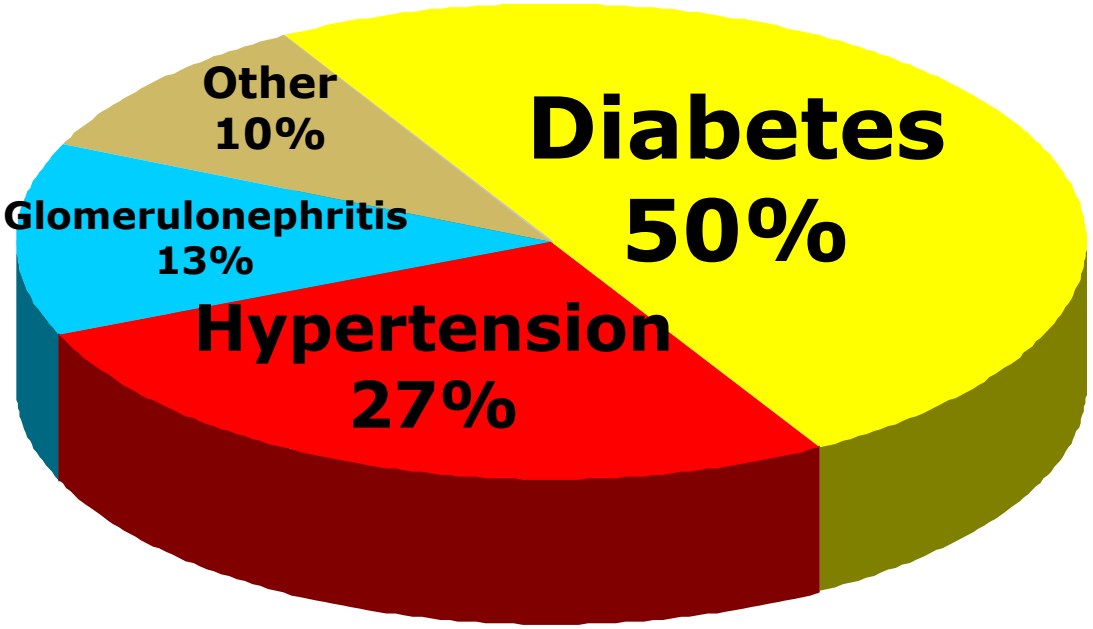


Data Source: Special analyses, Medicare 5% sample aged 65 and older alive & eligible for all of 2016, with a CKD diagnosis claim based on ICD-9 diagnostic codes and a physician visit in 2015. Patient visits with both PCP and nephrologists are classified as nephrologist. Abbreviations: CKD, chronic kidney disease; DM, diabetes mellitus; HTN, hypertension; PCP, primary care physician.

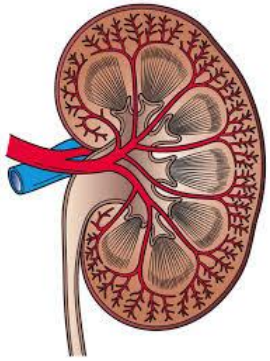
What's the most common sign or symptom of early kidney disease?

Making Waves

Primary diagnosis at time of starting dialysis



Making Waves

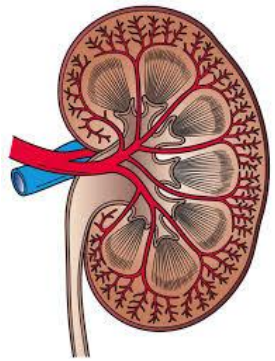


Risk Factors for CKD Early Detection

- Diabetes
- Hypertension
- Autoimmune Diseases
- Systemic Infections
- UTI
- Lower urinary tract obstruction
- Family history
- Recovery from AKI
- Reduction in kidney mass
- High-protein diet
- Atherosclerosis
- Obesity
- Exposure to nephrotoxic drugs
  - NSAIDS, Cox 2
  - Contrast dye

Making Waves

Socio-demographic



- **Aging**
- **Low income/education**
- **Racial-ethnic background**
  - **African American, Native American, Asian-American, Pacific Islander, Latin American, Hispanic)**

Making Waves

Decline in kidney function in older adult

Function	Mechanisms	Clinical significance
Glomerular filtration rate (GFR)	Numerous	↑ susceptibility to acute and chronic kidney disease
Sodium conservation	↓ in distal tubular sodium reabsorption, renin levels and activity, and aldosterone levels	↑ susceptibility to hyponatremia from salt loss caused by excessive diaphoresis, GI losses, etc
Sodium excretion	↓ in GFR and response to atrial natriuretic peptide	↑ percentage of nocturnal sodium load excretion contributing to nocturia, and susceptibility to hypernatremia

Decline in kidney function in older adults

Function	Mechanisms	Clinical significance
Renal concentrating capacity	↓ in tubular water transport in response to arginine vasopressin release	↓ response to hyperosmolar and volume-deprived conditions
Renal diluting capacity	Unclear; may be due to ↓ in GFR	↓ response to hyperosmolar and volume-overloaded conditions
Acid and ammonium excretion	↓ in GFR and renal mass	↑ susceptibility to metabolic acidosis

Who should be screened?

- USPSTF does not recommend screening in asymptomatic adults unless have risk factors such as hypertension and diabetes
- American Diabetes Association recommends screening all individuals with diabetes
- Joint National Committee on Prevention, Detection, Evaluating, and Treatment of High Blood pressure recommends screening all those with hypertension

Making Waves

Table 138. Clinical Evaluation of Patients at Increased Risk of Chronic Kidney Disease

All Patients

Measurement of blood pressure

→ Serum creatinine to estimate GFR

→ Protein-to-creatinine ratio or albumin-to-creatinine ratio in a first-

→ morning or random untimed "spot" urine specimen

Examination of the urine sediment or dipstick for red blood cells and white blood cells

Selected Patients, Depending on Risk Factors

Utrasound imaging (for example, in patients with symptoms of urinary tract obstruction, infection or stone, or family history of polycystic kidney disease)

Serum electrolytes (sodium, potassium, chloride and bicarbonate)

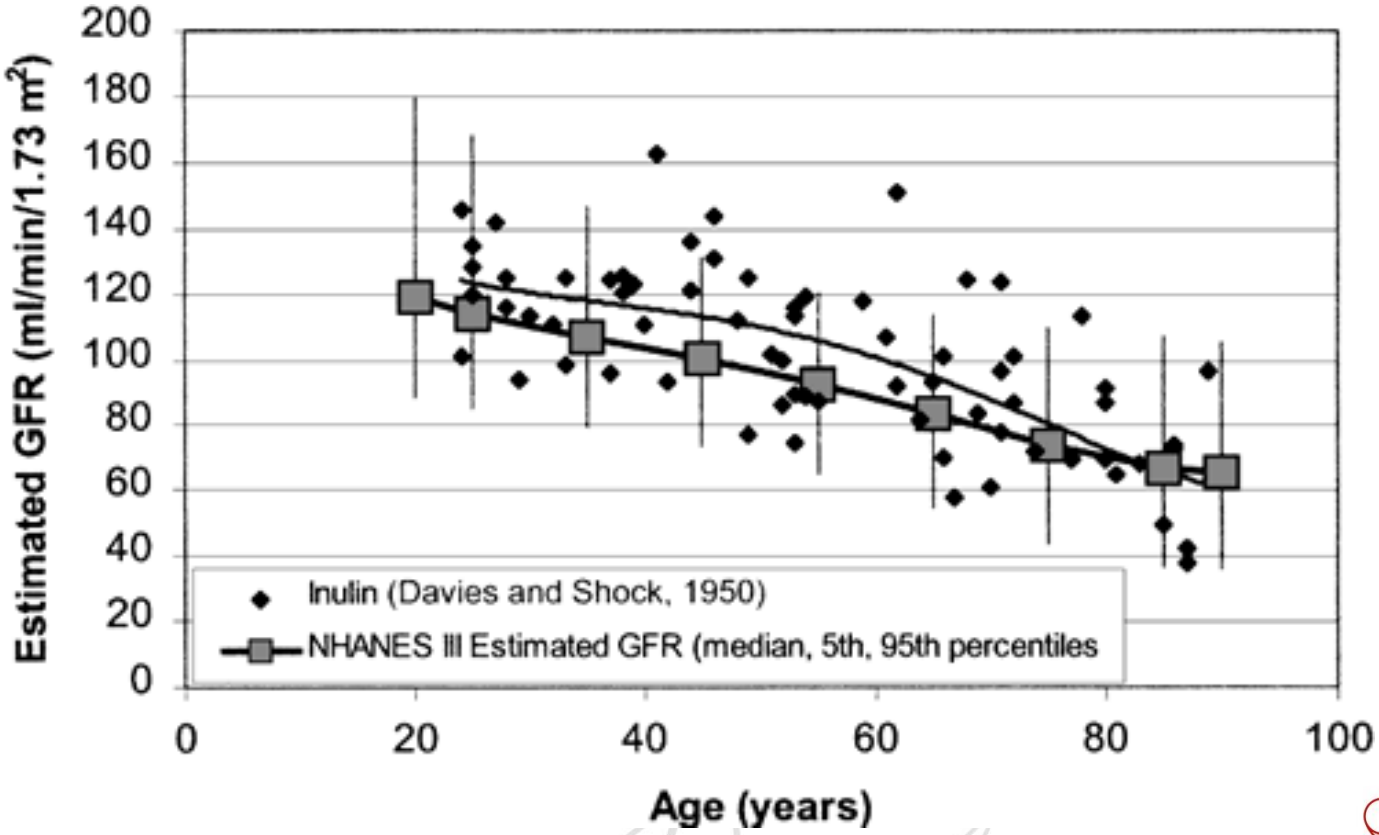
Urinary concentration or dilution (specific gravity or osmolality)

Urinary acidification (pH)

Factors Affecting Serum Creatinine Concentration

Increase	Decrease
• Kidney Disease • Ketoacidosis • Ingestion of cooked meat • Drugs: – Trimethoprim – Cimetidine – Flucytosine – Some cephalosporins	• Reduced Muscle Mass • Malnutrition

Remember….
GFR normally decreases with age!



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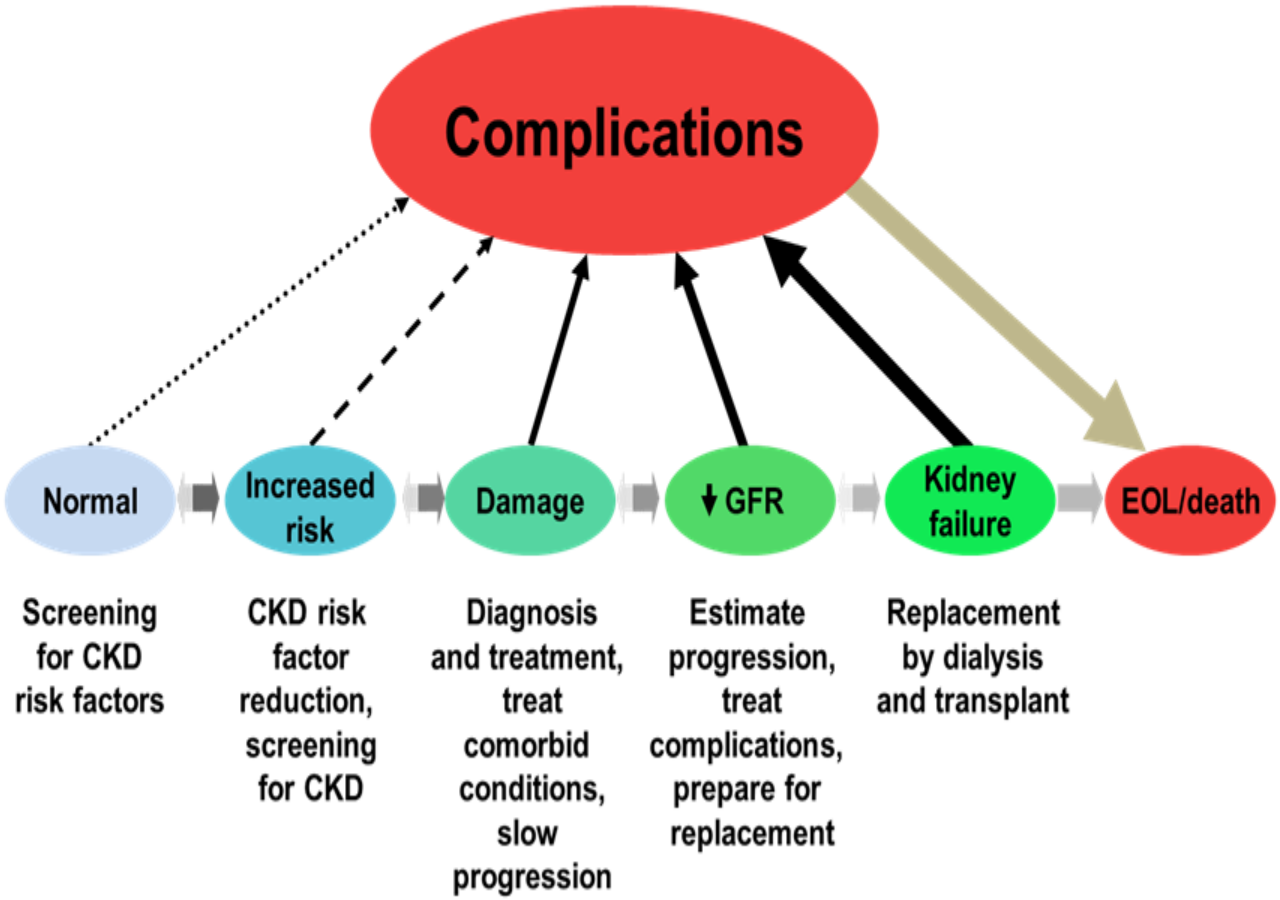
Conceptual Model of CKD



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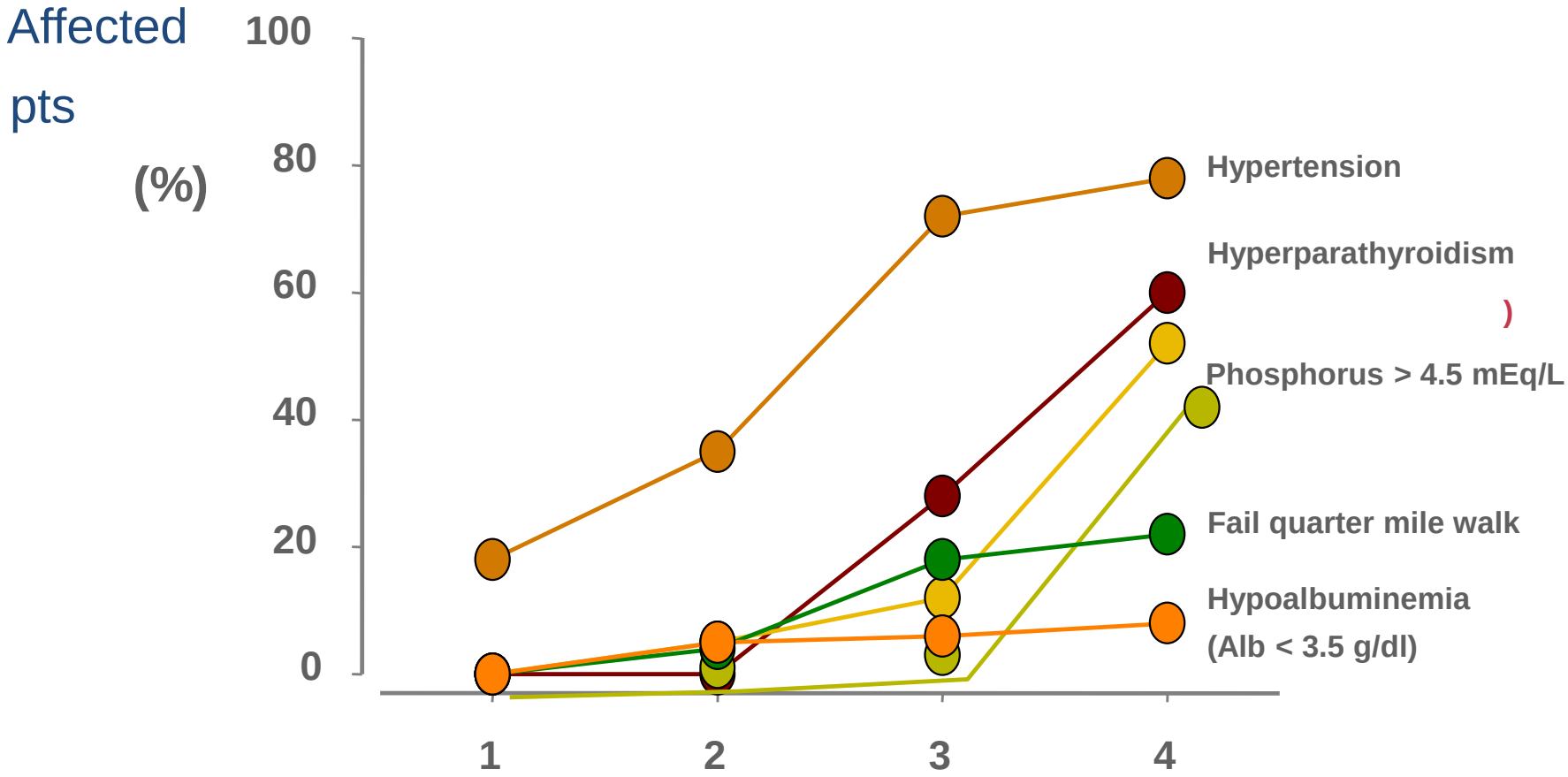
Adapted with permission from the NKF. Levey AS, et. al. AJKD 2009; 53: S4-16.

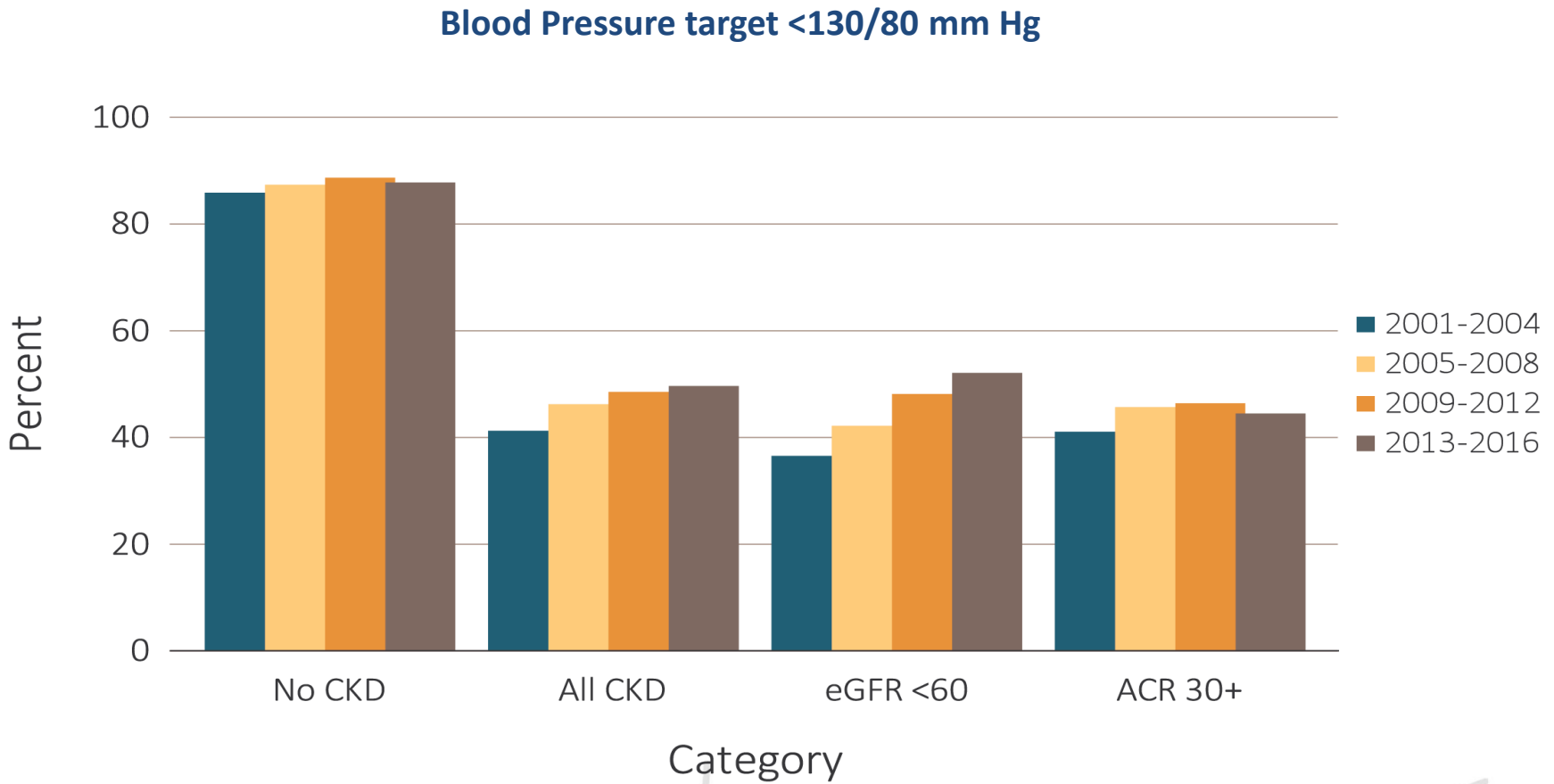
CKD Complications

Evolution and Acceleration by Stage



BP Control

Time Trends of NHANES participants with and without CKD at target blood pressure, 2001-2016



Data Source: National Health and Nutrition Examination Survey (NHANES), 2001-2004, 2005-2008, 2009-2012 & 2013-2016 participants aged 20 & older. Single-sample estimates of eGFR & ACR; eGFR calculated using the CKD-EPI equation. Figure represents all hypertensive participants including those who were at target blood pressure, probably due to medication. Abbreviations: ACR, urine albumin/creatinine ratio; CKD, chronic kidney disease; eGFR, estimated glomerular filtration rate.

Hypertension

- Leading cause of CV mortality and morbidity
  - If BP > 115/75 increased risk for every increase in 20 mmHg SBP and 10 mmHg in DBP
- Second leading cause of CKD in US
- HTN can be a consequence of CKD

Making Waves

Ambulatory BP monitoring and office measurement

- Office measurements can be variable
- Home BP monitoring can be stronger predictor of HTN and adherence to medication
- Ambulatory BP monitoring

Making Waves

Indications for Ambulatory BP measurements

- White coat hypertension
- Evaluation of apparent drug resistance
- Hypotensive symptoms
- Autonomic dysfunction
- Episodic hypertension
- Evaluation of nocturnal decreases
- Safety withdrawal from antihypertensive
- Borderline hypertension
- Pacemaker syndrome

Elliot & Lawton, 2019

Making Waves

Goal

- Individualize BP targets and agents according to
  - coexistent CVD and other co-morbid conditions, presence or absence pf retinopathy (in CKD with diabetes) and tolerance of treatment
  - Postural dizziness and check postural hypotension
  - Tailor BP treatment regimens in elderly population with CKD (KDIGO, 2012)
    - co-morbidities and other therapies, with gradual escalation of treatment and close attention to adverse events related to BP treatment, including electrolyte disorders, acute deterioration in kidney function, orthostatic hypotension and drug side effects

Making Waves

Lifestyle Modifications

- Weight reduction
  - Reduction in urinary protein excretion
- Salt reduction (< 2 grams per day)
  - Alterations in salt handing are most likely play key role in HTN in CKD
  - Some forms of CKD associated with salt wasting from the kidney
    - Higher risk of volume depletion
- Exercise (30 minutes 5 times a week)

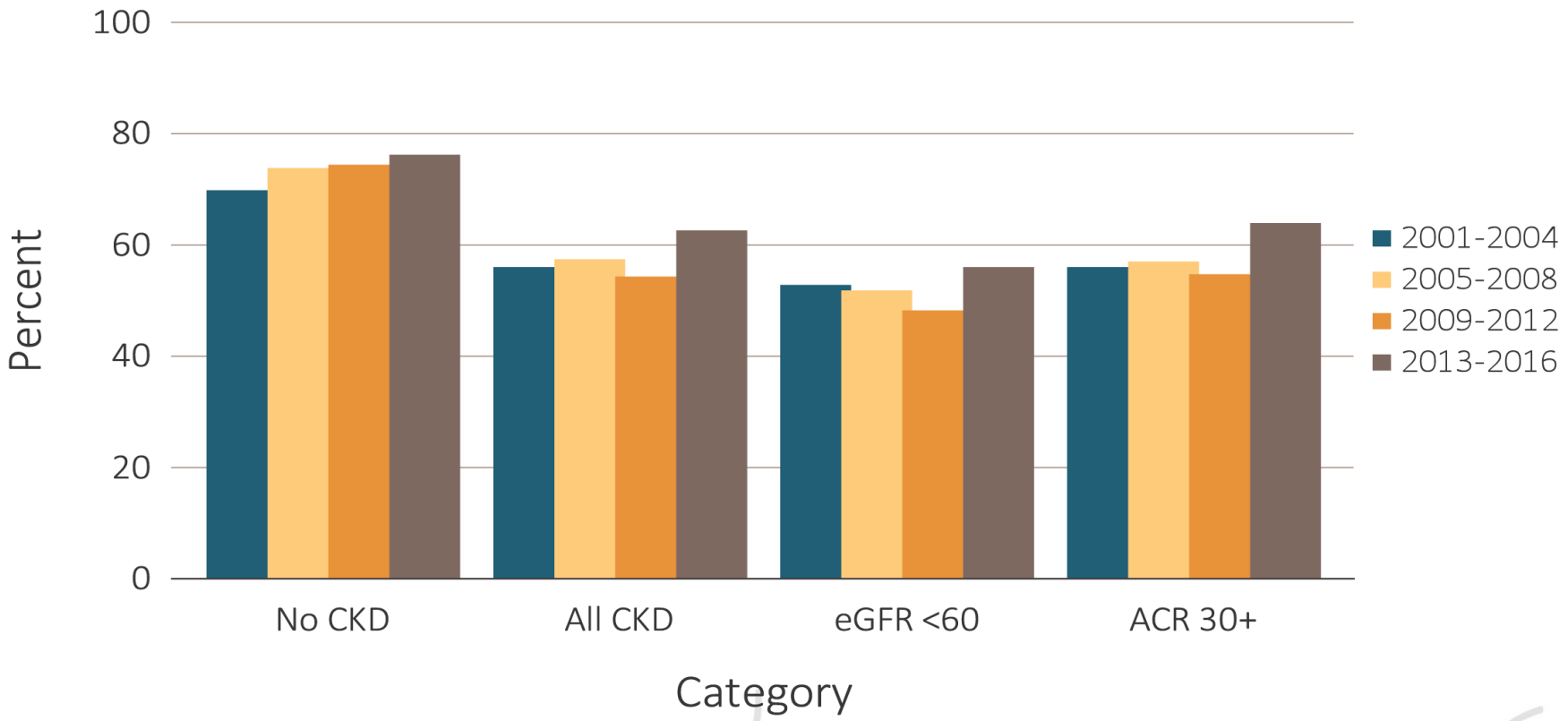
Making Waves

Lifestyle Modifications

- Alcohol: limit to no more than 2 standard drinks per day
- Cigarette smoking and exposure to environmental tobacco
- Dietary supplements
  - Potassium supplementation has shown positive effects on BP
    - Risk of hyperkalemia
  - Magnesium
  - Fish oil

Making Waves

NHANES participants physically active, 2001-2016



Data Source: National Health and Nutrition Examination Survey (NHANES), 2001-2004, 2005-2008, 2009-2012 & 2013-2016 participants aged 20 & older. Single-sample estimates of eGFR & ACR; eGFR calculated using the CKD-EPI equation. Abbreviations: ACR, urine albumin/creatinine ratio; CKD, chronic kidney disease; eGFR, estimated glomerular filtration rate.

Optimizing BP

- Both diabetic and non-diabetic adults with CKD and urine albumin excretion < 30 mg/24 hours whose BP is consistently > 140 mmHg systolic or >90 mmHg diastolic treat with BP-lowering drugs to maintain a BP ≤ 140/90
  - Urine albumin ≥ 30 mg.24 hours BP goal is ≤130/80
  - Recommend ARB or ACE-I for diabetes with CKD with albumin excretion 30-300 mg/24 hours
    - > Urine albumin excretion > 300 mg/24 hours ARB or ACE-I regardless diabetes status

Making Waves

BP-Lowering Agents

- Most people with CKD require two or more agents
- With the exception of ARBs or ACE-Is individuals with high levels of urinary albumin or protein excretion, no strong evidence supporting particular agent
- Tailor
  - Presence or absence of urinary protein
  - Co-morbidities
  - Concomitant medications
  - Adverse effects
  - Availability of agents

Making Waves

Renin-angiotensin-aldosterone system blockers

- Pivotal role in regulation of BP
- ACE-Is and ARBs
  - Block conversion of angiotensin I to angiotensin II and the degradation of bradykinin
  - Indicated if urinary albumin excretion is elevated

- Hyperkalemia
  - Dietary
  - Reduce dose
  - Switching fosinopril or trandolapril or adding potassium lowering agent
  - Potassium lowering agents

Making Waves

Potassium Lowering Agents

- Sodium Polystyrene
- Patiromer
- Sodium Zirconium Cyclosilicate

Monitoring GFR w/ BP meds

NKF-K/DOQI guidelines

Table 136. Recommended Intervals for Monitoring GFR According to Baseline GFR

	Baseline GFR (mL/min/1.73 m²)		
	GFR ≥60	GFR 30-59	GFR <30
After initiation or changes in dose of antihypertensive therapy	4-12 weeks	2-4 weeks	≤2 weeks
After blood pressure is at goal and dose is stable	6-12 months	3-6 months	1-3 months

Making Waves

ACE/ARB monitoring intervals

NKF-K/DOQI guidelines

Table 130. Summary of Recommended Intervals to Monitor for Side Effects of ACE Inhibitor or ARB Therapy after Blood Pressure Is at Goal and Dose Is Stable, According to Baseline Values

Baseline Value				
	SBP (mm Hg)	120-129	110-119	<110
	GFR (mL/min/1.73 m^2)	≥60	30-59	<30
	Early GFR Decline (%)	<15	<15	≥15
	Potassium (mEq/L)	≤4.5	4.6-5.0	>5.0
Interval (Months)		6-12	3-6	1-3

Clinicians are advised to evaluate each parameter and select the follow-up interval for the parameter that requires the earliest follow-up.

Making Waves

Aldosterone antagonists

- Spironlactone
  - Reduced dose (12.5 to 50 mg/day)
- Eplerenone, a mineralocorticoid receptor blocker with estrogen-like side effects has been develop
- Studies show benefit in patients with heart failure, including HF with MI
  - Risk hyperkalemia and reduction in GFR

Making Waves

Diuretics

- Salt and water retention are major factors contributing to high BP in CKD and to morbidity and mortality through systemic or pulmonary edema
- Thiazides: risk of hyperuricemia and hyperglycemia
- Loop diuretic
- Potassium-sparing

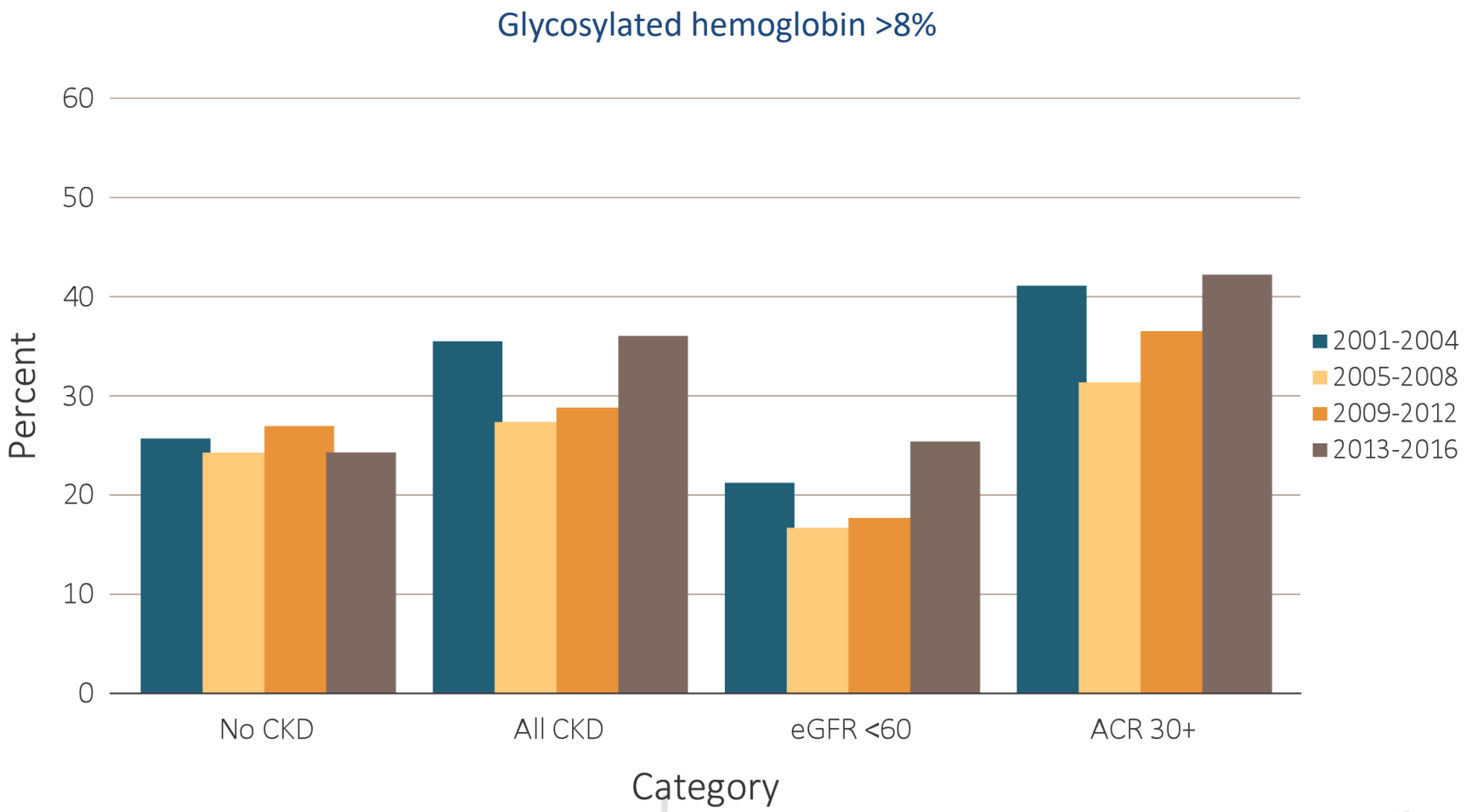
Making Waves

Recognizing Renal Vascular Disease

- Suspect renal artery stenosis in cases of:
  - New-onset diastolic hypertension (HTN)
  - HTN despite maximal doses of 3 antihypertensive agents
  - Abruptly worsening HTN that was previously stable
  - Azotemia induced by treatment with an ACE inhibitor or ARB
  - HTN accompanied by widespread vascular disease
- Diagnostic test options: renal artery duplex ultrasonography, CT angiography, or magnetic resonance angiography

Glycemic Control

Time trends of diabetic NHANES participants with and without CKD with respect to glycemic control, 2001-2016



Data Source: National Health and Nutrition Examination Survey (NHANES), 2001-2004, 2005-2008, 2009-2012 & 2013-2016 participants aged 20 & older. Single-sample estimates of eGFR & ACR; eGFR calculated using the CKD-EPI equation. Abbreviations: ACR, urine albumin/creatinine ratio; CKD, chronic kidney disease; eGFR, estimated glomerular filtration rate.

Diabetic Kidney Disease

- Normoalbuminuria with elevated GFR- usually occurs within 5-10 years
  - Associated with glomerular and tubular hypertrophy and enlarged kidneys on ultrasound evaluation
  - Hyperfiltration –maladaptive and my be a risk factor for progression to CKD
- Microalbuminuria
- Macroalbuminuria

Making Waves

Glycemic Control

- NKF and Clinical Practice Guidelines for DM and CKD recommends target hemoglobin A1c of ~7.0% to prevent or delay the progression of microvascular complications of diabetes, including diabetic kidney disease

Making Waves

Other recommendations

- Not lower A1c below 7.0% for those at risk for hypoglycemia
  - Consider life expectancy and other co-morbidities and risk of hypoglycemia
  - A1c > 8% may be appropriate for some individuals
- More stringent A1c < 7.0% (< 6.5) for selected individuals without significant risk of hypoglycemia

Making Waves

Anemia

Anemia in CKD

Stage	GFR	% Anemia
1	≥ 90–120 mL/min/1.73 m^2	stage 1 and 2 about 26.7%
2	60–89 mL/min/1.73 m^2	
3	30–59 mL/min/1.73 m^2	41.6%
4	15–29 mL/min/1.73 m^2	53.6%
5	< 15 mL/min/1.73 m^2 or dialysis	75.5%

* National Kidney Foundation. *Am J Kidney Dis.* 2002;39(suppl 1):S1-S266.

Risks Associated with Anemia

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Increased morbidity

- Decreased mobility in community-dwelling
- Decreased quality of life
- Increased risk of fatigue, depression, dementia, delirium, hospitalization, and falls

Increased mortality

- Community-dwelling
- Nursing home residents
- Persons with preexisting heart or kidney disease
- Persons undergoing non-cardiac surgery

Bross, Soch, & Smith-Knuppel, 2010

Making Waves

Factors Cause or Contribute to Anemia in CKD

- Insufficient production of endogenous erythropoietin
- Iron deficiency
- Acute and chronic inflammatory conditions
- Severe hyperparathyroidism
- Aluminum toxicity
- Folate deficiency
- Decreased survival of red blood cell

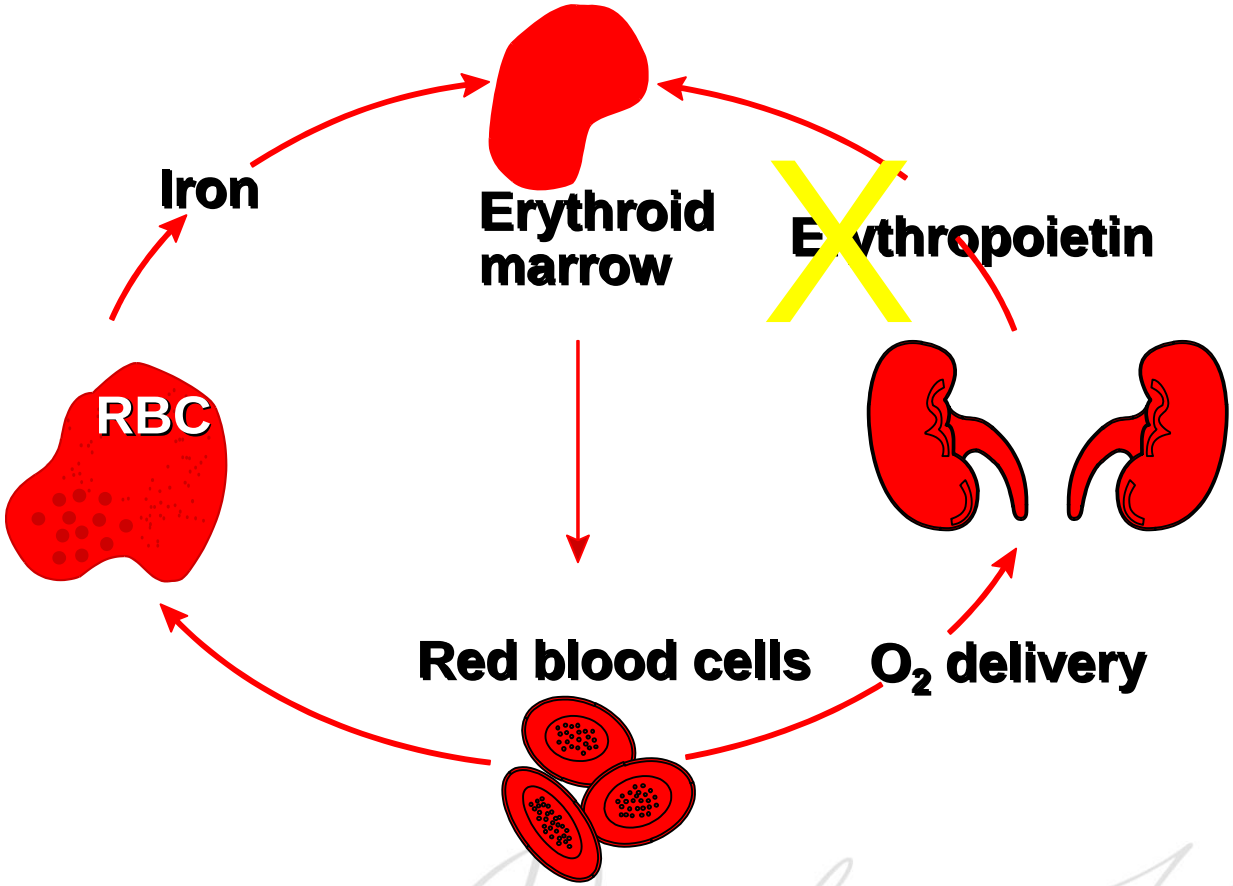
Making Waves

Erythropoietin

- Key regulator of erythropoiesis
- Kidney major site (90%) Liver (10%)
  - Peritubular interstitial fibroblasts
- Acts in the bone marrow to increase red blood cell mass
- Hypoxia is the major stimulus for EPO production

Making Waves

Erythropoiesis in CKD



Making Waves

Decreased lifespan of RBC

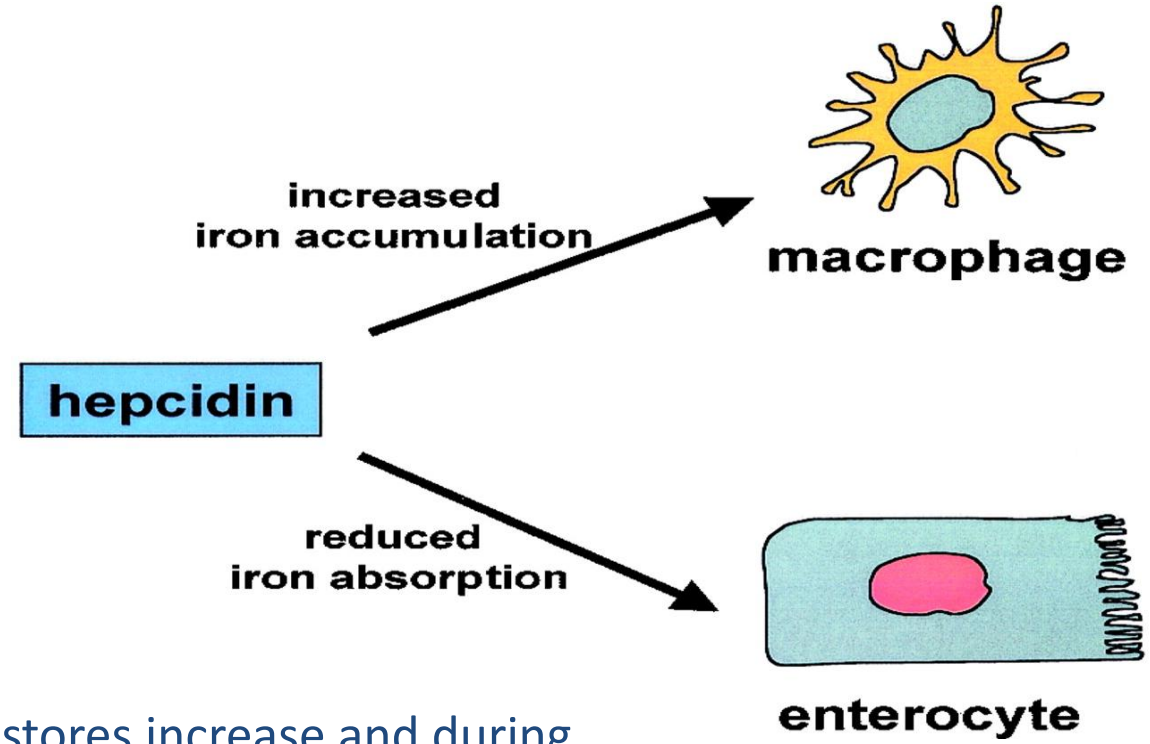
- In people with CKD
  - 60-90 days (compared to 120 days in those without CKD)
- RBC trauma due to microvascular disease
- Resistance to oxidative stress

Making Waves

Circulating protein made by the liver, binds to ferroportin and internalizes it

- Effectively limiting the iron absorption and release of iron from the RES

Hepcidin



Hepcidin increases when iron stores increase and during inflammation. Increased hepcidin during inflammation impairs the efficacy of oral iron to treat iron-deficiency anemia in people with CKD, especially those undergoing dialysis

Making Waves

Iron Deficiency in CKD

- Critical mineral for RBC production
  - Incorporated into heme at the erythroblast stage of red cell development
- Normal
  - Human body contains about 4-5 g of iron
  - 20-30% stored in hepatocytes and in macrophages
  - Health person absorbs 1-2 g from diet
- Negative iron balance
  - Increased iron losses
    - Blood loss
  - Reduced intestinal iron absorption in **CKD**

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Specific to CKD

- Symptoms tend to occur when Hb < 10 g/dL and more severe at lower Hb
- Cardiac
  - Decreased myocardial oxygen delivery
    - Exacerbation of angina
  - Decreased peripheral oxygen delivery
    - Peripheral vasodilation, increased sympathetic nervous system activity, increased heart rate, stoke volume ultimately to LVH
  - LVH correlates to
    - Hospitalization and mortality

Making Waves

IV Iron

- Clinical trials have demonstrated that IV iron can at least partially bypass hepcidin-mediated iron blockade and treat iron-deficiency anemia in the setting of inflammation

Making Waves

Laboratory evaluation: KDIGO guidelines

- Patients with CKD and anemia regardless of the stage of CKD initial evaluation includes:
  - CBC including red cell indices, WBC with differential, and platelet, absolute reticulocyte count, serum ferritin, and transferrin saturation (TSAT) & vitamin B12 and folate
    - Anemia d/t insufficient erythropoietin stimulation is hypoproliferative and generally normocytic normochromic
    - Microcytic is suggestive of iron deficiency but can be seen in thalassemia
    - Macrocytic is suggestive of vitamin B12 or folate deficiency

Making Waves

Frequency of testing for anemia: Hb

- CKD without anemia
  - Stage 3 annually
  - Stage 4-5ND twice per year
- CKD with anemia
  - Stage 3-5ND every three months

KDIGO,2012

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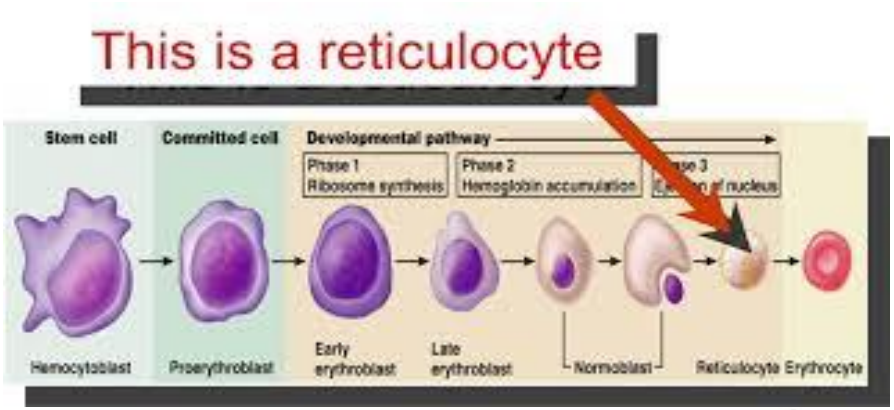
Lab Tests of Iron Deficiency of Increased Severity

	Normal	Fe deficiency without anemia	Fe deficiency with mild anemia	Fe deficiency with severe anemia
Serum iron	60-150	60-150	< 60	< 40
Iron binding capacity	300-360	300-390	350-400	> 410
Saturation	20-50	30	< 15	< 10
Hb	Nomal	Normal	9-12	6-7
Serum Ferritin	40-200	< 20	< 10	0-10

Source: Chmielewski at American Nephrology Nurses' Association 45th Symposium 2014

Reticulocytes

- Immature RBC
- Reticulocytes develop and mature in the red bone marrow
- Circulate for about a day in the blood stream before developing into mature RBC
- Normal 0.5 to 1.5%
- < 1%
  - Inadequate production
- >1%
  - Increased product**ion**



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Other

Chronic Kidney Disease: Mineral and Bone Disease (CKD-MBD)

- All patients with GFR < 60 should be regularly screened for calcium, phosphorus, and PTH abnormalities
- Maintain phosphorus concentrations between 2.7 and 4.6 mg/dL in patients with stage 3 or 4 CKD
  - Start dietary phosphorus restriction if PTH is increased, even if serum phosphorus is normal
  - Use phosphorus binders as soon as PTH starts to increase

Making Waves

NUTRITION AND CKD

- Dietary requirements for patients with CKD are complex
  - Intake of protein, phosphorus, and potassium all need to be controlled while maintaining adequate energy intake
- Once a patient reaches stage 4 CKD, an experienced renal dietician should be involved in the patient's nutritional management

Making Waves

Avoid NSAIDS

- When renal function normal NSAIDS have an insignificant effect on renal hemodynamics
- However when renal blood flow is compromised, compensatory afferent arteriolar vasodilation by prostaglandins plays a key role in maintaining glomerular perfusion
- NSAIDs block prostaglandins

Making Waves

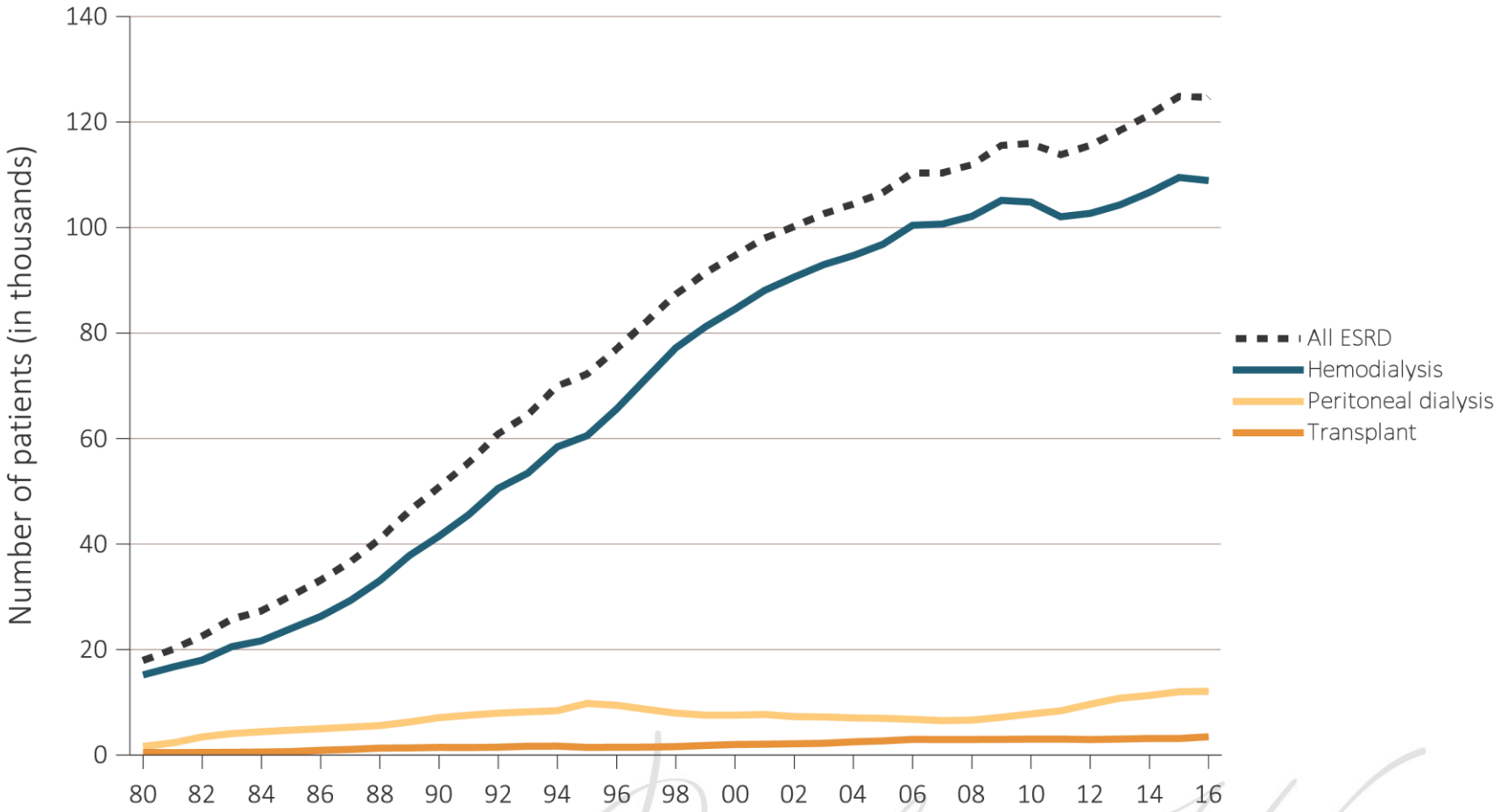
ESKD

ESKD: DIALYSIS

- **Age should not be the sole exclusion criterion**
- **Early referral to a nephrologist ensures adequate time for discussing options and for creating adequate access (creation of a native arteriovenous fistula can require up to 6 months)**
- **Hemodialysis and continuous ambulatory peritoneal dialysis appear to be equally effective in older adults, so the choice between them can be individualized**
- **Dialysis to patients with dementia**

Making Waves

Trends in the annual number of ESRD incident cases, by modality, in the U.S. population, 1980-2016



Data Source: Reference Table D.1 and special analyses, USRDS ESRD Database. Persons with "Uncertain Dialysis" were included in the "All ESRD" total, but are not represented separately. Abbreviation: ESRD, end-stage renal disease.

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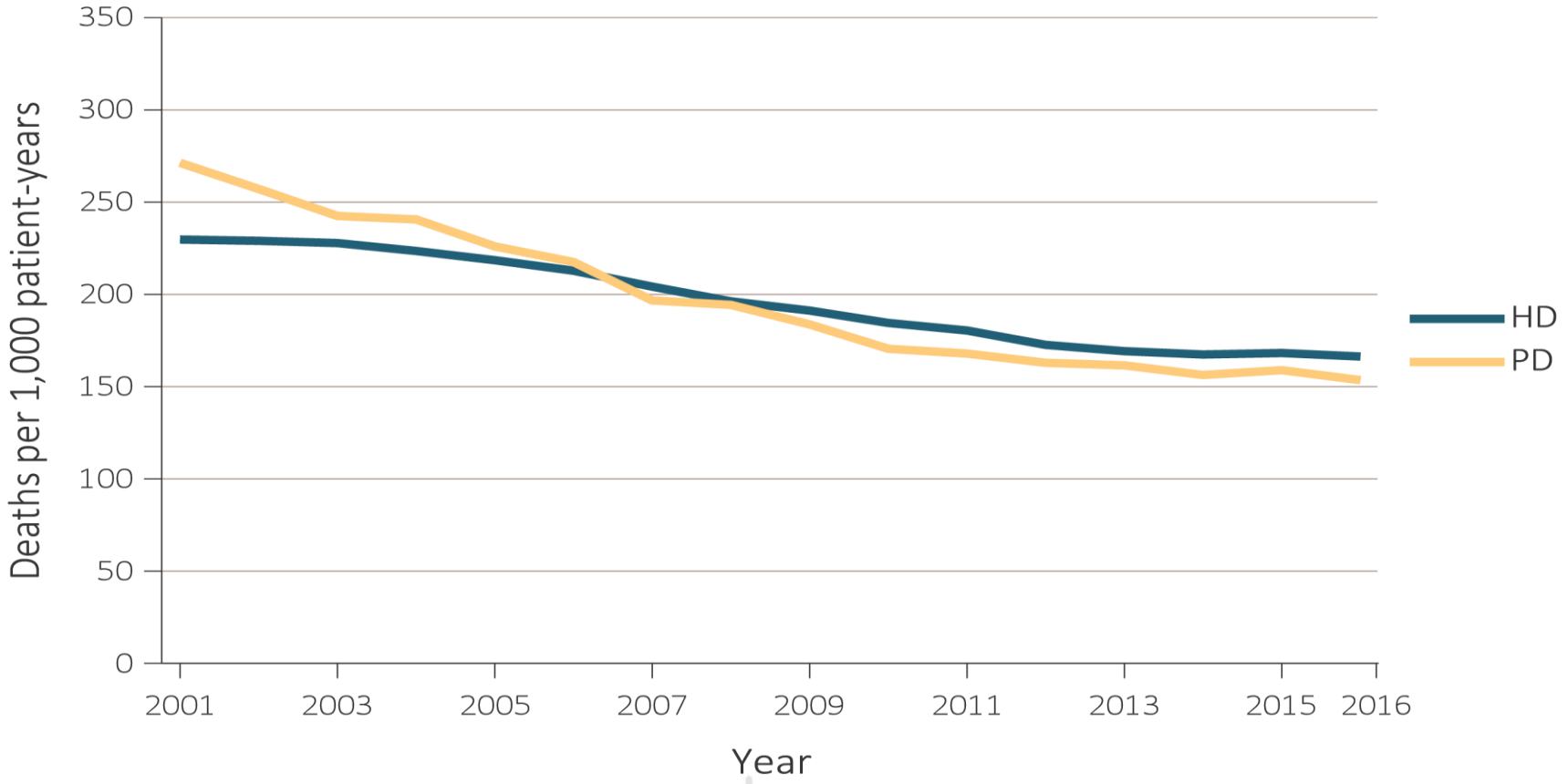
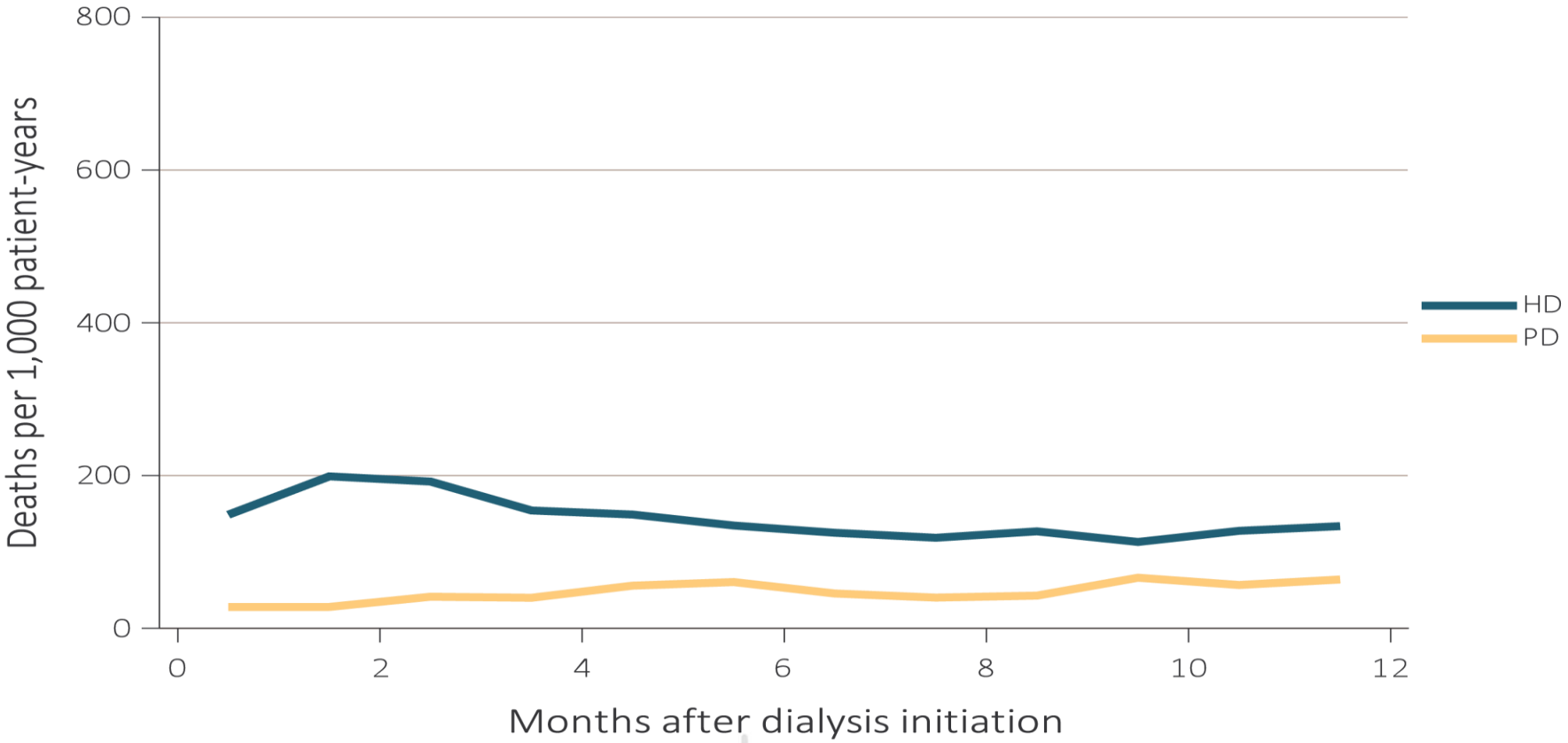
Adjusted all-cause mortality by treatment modality 2001-2016



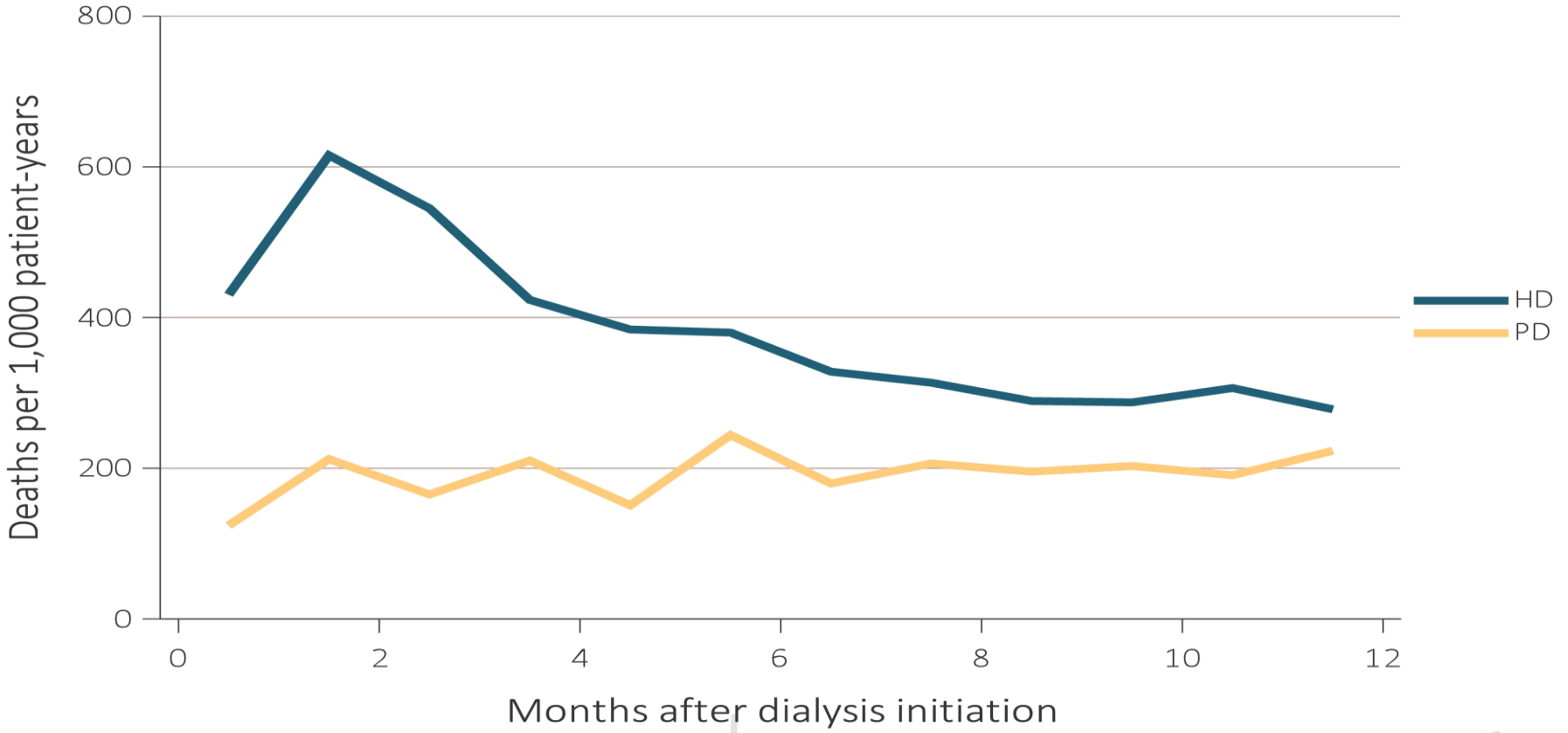
Data Source: Reference Tables H.2_adj, H.4_adj, H.8_adj, H.9_adj, and H.10_adj; and special analyses, USRDS ESRD Database. Adjusted for age, sex, race, ethnicity, primary diagnosis and vintage. Reference population: period prevalent ESRD patients, 2011. Abbreviations: ESRD, end-stage renal disease; HD, hemodialysis; PD, peritoneal dialysis.

Adjusted mortality by treatment modality and number of months after treatment initiation among ESRD patients < aged 65



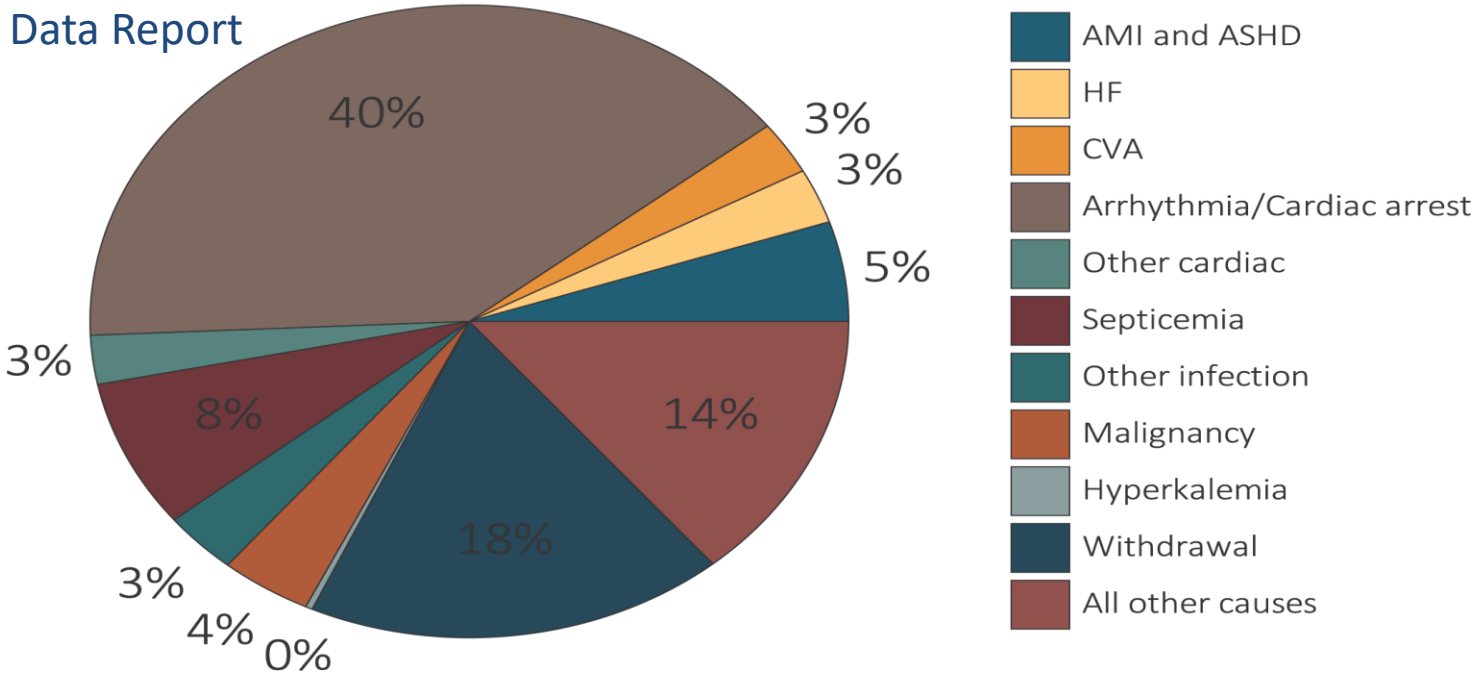
Data Source: Special analyses, USRDS ESRD Database. Adjusted (age, race, sex, ethnicity, and primary diagnosis) mortality among 2015 incident ESRD patients during the first year of therapy. Reference population: incident ESRD patients, 2011. Abbreviations: ESRD, end-stage renal disease; HD, hemodialysis; PD, peritoneal dialysis.

Adjusted mortality by treatment modality and number of months after treatment initiation among ESRD patients aged 65 and over



Data Source: Special analyses, USRDS ESRD Database. Adjusted (age, race, sex, ethnicity, and primary diagnosis) mortality among 2015 incident ESRD patients during the first year of therapy. Reference population: incident ESRD patients, 2011. Abbreviations: ESRD, end-stage renal disease; HD, hemodialysis; PD, peritoneal dialysis.

Unadjusted percentages of deaths in 2015 by cause, with and without missing data, by modality among dialysis patients



Data Source: Special analysis using Reference Table H.12_Dialysis and H.12_Tx. Mortality among 2015 prevalent patients. (a) Dialysis patients, denominator excludes missing/unknown causes of death. (b) Transplant recipients, denominator excludes missing/unknown causes of death. (c) Dialysis patients, denominator includes missing/unknown causes of death. (d) Transplant recipients, denominator includes missing/unknown causes of death. Abbreviations: AMI, acute myocardial infarction; ASHD, atherosclerotic heart disease; CHF, congestive heart failure; CVA, cerebrovascular accident.

KIDNEY TRANSPLANTATION

- As in younger patients, mortality rates in older patients with kidney transplants are considerably less than in those maintained on dialysis
- Older kidney recipients demonstrate lower acute rejection rates and lower incidence of chronic rejection and greater survival probability than patients remaining on dialysis, even when corrected for levels of comorbidity
- Older patients and their families should explore the option of transplantation as soon as the need for renal replacement therapy arises

Making Waves

HOSPICE

- In almost half of cases, failure to thrive is the driving reason for withdrawal from dialysis
- Most people who withdraw from dialysis are >65 yr
- About 20% of the dialysis cohort withdraws in any given year
- Specialist such as geriatricians and AGNP have a unique role in educating nephrologists and patients about the value of hospice

Making Waves

Shared decision making

Medicare Educational Benefits

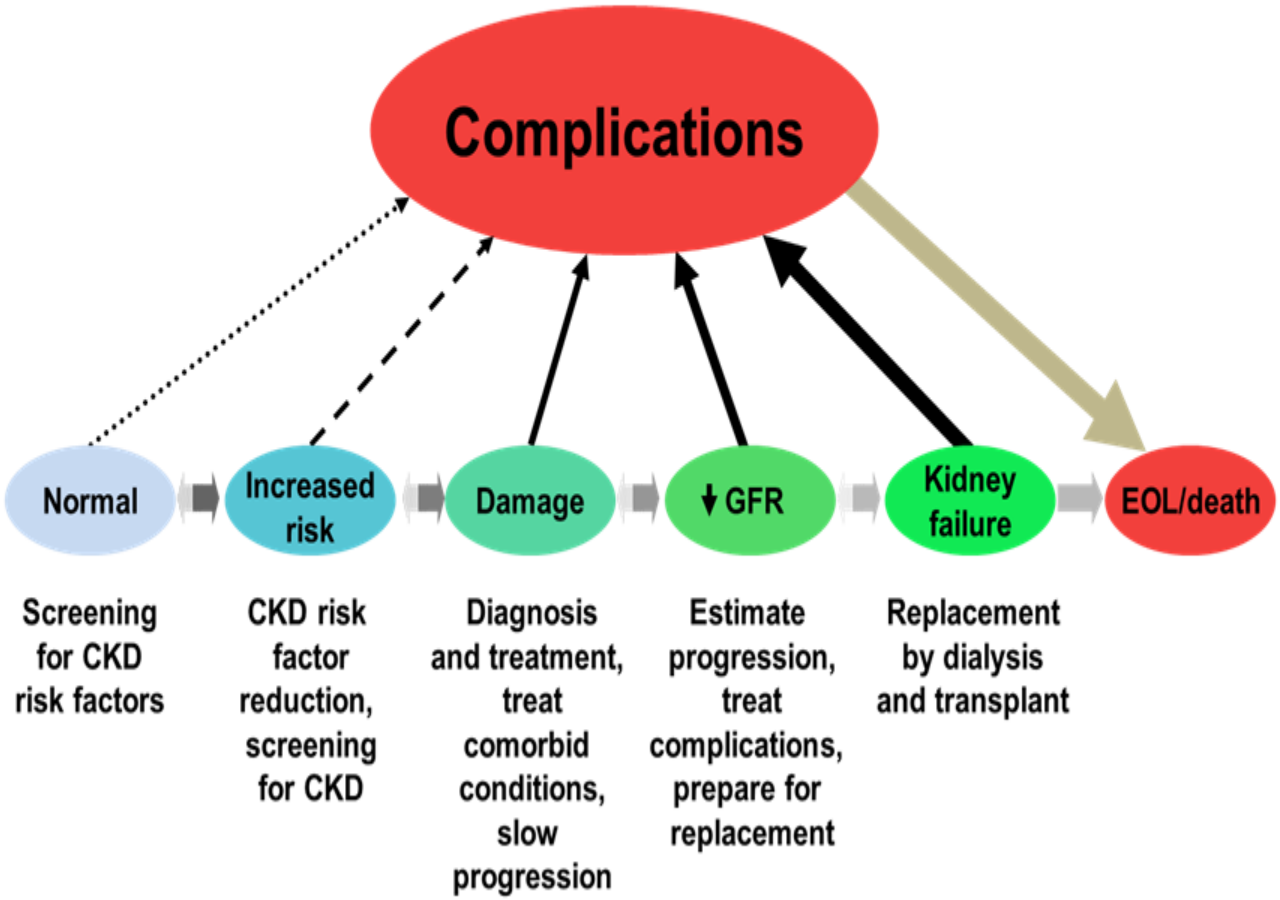
- **Consult diabetic educator for Diabetes Self-Management**
  - **Annual diabetes self-management training is covered under Medicare Part B**
- **Consult dietician**
  - **MNT is a Medicare benefit for people with CKD before they receive kidney replacement therapy**

When to refer

- AKI or abrupt sustained fall in GFR
- GFR < 30 ml/min.1.73m
- Consistent finding of albuminuria
- Progression of CKD
- CKD and HTN refractory to treatment with 4 or more antihypertensive agents
- Persistent abnormalities of serum potassium
- Recurrent or extensive nephrolithiasis
- Hereditary KD
- Urinary red cell casts, RBC > 20 per high power filed sustained and not readily explained

Making Waves

Conceptual Model of CKD



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Adapted with permission from the NKF. Levey AS, et. al. AJKD 2009; 53: S4-16.

Thank you!

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