Przewlekła choroba nerek (PCHN)

Teresa Bączkowska

- **PCHN 6% - 16% populacji (600 mln na świecie; 4,3 mln w Polsce)**

  Częstość występowania nowych przypadków ESRD zwiększa się o 9% na rok (głównie wśród chorych > 60 roku zycia)

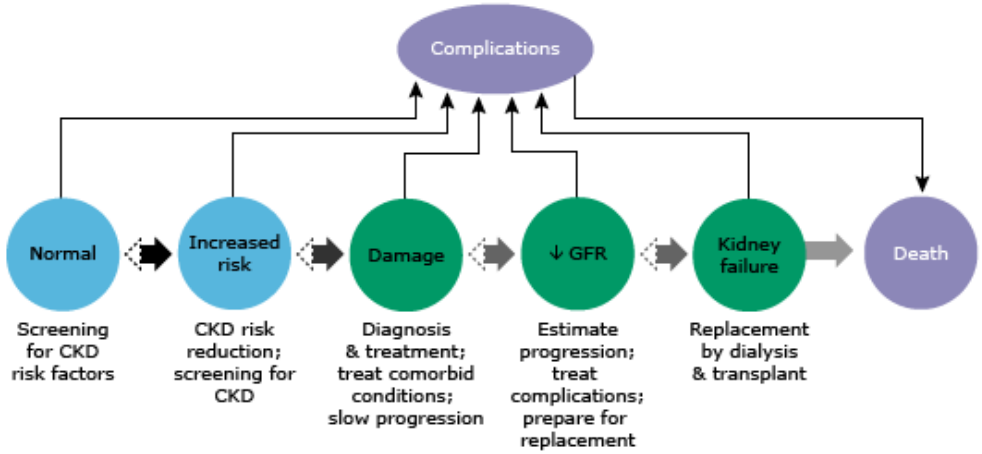
- **Leczenie dializą , przeszczepienie nerki jest uważane jako „naturalny" przebieg PCHN**
-
- **Agresywne leczenie czynników ryzyka sercowo-naczyniowych jest podstawowe (czynniki ryzyka sercowo-naczyniowe – główna przyczyna zgonu chorych z PCHN**

- **Leczenie dializą ekwiwalent około 10 ml/min/1.73 m2 eGFR**

- **Nie wszystkie problemy chorych z PCHN mogą być rozwiązane poprzez dializę**

- **U istotnej części chorych z PCHN można zatrzymać lub co najmniej zwolnić progresję choroby nerek**

Conceptual model for chronic kidney disease



This diagram presents the continuum of development, progression and complications of chronic kidney disease (CKD) and strategies to improve outcomes. Green circles represent stages of CKD; aqua circles represent potential antecedents of CKD, lavender circles represent consequences of CKD; and thick arrows between circles represent the development, progression and remission of CKD. "CKD" is defined as the presence of either kidney damage or decreased kidney function for three or more months, irrespective of cause (underlying illness and pathology). "Complications" refers to all complications of CKD, including complications of decreased GFR, albuminuria and cardiovascular disease. Complications may also arise from adverse effects of interventions to prevent or treat the disease. The horizontal arrows pointing from left to right emphasize the progressive nature of CKD. Dashed arrowheads pointing from right to left signify that remission is less frequent than progression.

Original figure modified for this publication. From: Levey AS, Stevens LA, Coresh J. Conceptual model of CKD: applications and implications. Am J Kidney Dis 2009; 53:S4.

Definicja PCHN

Nieprawidłowości w zakresie czynności nerek lub zaburzeń w budowie nerek trwające co najmniej 3 miesiące, mające wpływ na zdrowie

Kryteria PCHN	
Wskaźniki uszkodzenia nerek (jeden lub więcej)	Albuminuria > 30 mg/24godz; ACR >30 mg/g kreatyniny Nieprawidłowy osad moczu Zaburzenia elektrolitowe spowodowane zaburzeniami czynności cewek nerkowych Nieprawidłowy wynik badania hist-pat Nieprawidłowości wykryte w badaniach obrazowych Stan po transplantacji nerki
Obniżony GFR	GFR < 60 ml/min/1.73m2 (stadium G3a – G%)

Definition and criteria for chronic kidney disease

Definition:

Chronic kidney disease is defined based on the presence of either kidney damage or decreased kidney function for three or more months, irrespective of cause.

Criteria	Comment
Duration ≥3 months, based on documentation or inference	Duration is necessary to distinguish chronic from acute kidney diseases. ▪ Clinical evaluation can often suggest duration ▪ Documentation of duration is usually not available in epidemiologic studies
Glomerular filtration rate (GFR) <60 mL/min/1.73 m^2	GFR is the best overall index of kidney function in health and disease. ▪ The normal GFR in young adults is approximately 125 mL/min/1.73 m^2; GFR <15 mL/min/1.73 m^2 is defined as kidney failure ▪ Decreased GFR can be detected by current estimating equations for GFR based on serum creatinine (estimated GFR) but not by serum creatinine alone ▪ Decreased estimated GFR can be confirmed by measured GFR, measured creatinine clearance, or estimated GFR using cystatin C
Kidney damage, as defined by structural abnormalities or functional abnormalities other than decreased GFR	Pathologic abnormalities (examples). Cause is based on underlying illness and pathology. Markers of kidney damage may reflect pathology. ▪ Glomerular diseases (diabetes, autoimmune diseases, systemic infections, drugs, neoplasia) ▪ Vascular diseases (atherosclerosis, hypertension, ischemia, vasculitis, thrombotic microangiopathy) ▪ Tubulointerstitial diseases (urinary tract infections, stones, obstruction, drug toxicity) ▪ Cystic disease (polycystic kidney disease)
	History of kidney transplantation. In addition to pathologic abnormalities observed in native kidneys, common pathologic abnormalities include the following: ▪ Chronic allograft nephropathy (non-specific findings of tubular atrophy, interstitial fibrosis, vascular and glomerular sclerosis) ▪ Rejection ▪ Drug toxicity (calcineurin inhibitors) ▪ BK virus nephropathy ▪ Recurrent disease (glomerular disease, oxalosis, Fabry disease)
	Albuminuria as a marker of kidney damage (increased glomerular permeability, urine albumin-to-creatinine ratio [ACR] >30 mg/g).* ▪ The normal urine ACR in young adults is <10 mg/g. Urine ACR categories 10-29, 30-300 and >300 mg are termed "mildly increased, moderately increased, and severely increased" respectively. Urine ACR >2200 mg/g is accompanied by signs and symptoms of nephrotic syndrome (low serum albumin, edema and high serum cholesterol). ▪ Threshold value corresponds approximately to urine dipstick values of trace or 1+, depending on urine concentration ▪ High urine ACR can be confirmed by urine albumin excretion in a timed urine collection
	Urinary sediment abnormalities as markers of kidney damage, for example: ▪ RBC casts in proliferative glomerulonephritis ▪ WBC casts in pyelonephritis or interstitial nephritis ▪ Oval fat bodies or fatty casts in diseases with proteinuria ▪ Granular casts and renal tubular epithelial cells in many parenchymal diseases (non-specific)
	Imaging abnormalities as markers of kidney damage (ultrasound, computed tomography and magnetic resonance imaging with or without contrast, isotope scans, angiography). ▪ Polycystic kidneys ▪ Hydronephrosis due to obstruction ▪ Cortical scarring due to infarcts, pyelonephritis or vesicoureteral reflux ▪ Renal masses or enlarged kidneys due to infiltrative diseases ▪ Renal artery stenosis ▪ Small and echogenic kidneys (common in later stages of CKD due to many parenchymal diseases)

* Albumin-to-creatinine ratio (ACR) conversion factor 1.0 mg/g = 0.113 mg/mmol.

Revised chronic kidney disease classification based upon upon glomerular filtration rate and albuminuria

GFR stages	GFR (mL/min/1.73 m^2)	Terms
G1	>90	Normal or high
G2	60 to 89	Mildly decreased
G3a	45 to 59	Mildly to moderately decreased
G3b	30 to 44	Moderately to severely decreased
G4	15 to 29	Severely decreased
G5	<15	Kidney failure (add D if treated by dialysis)
Albuminuria stages	**AER (mg/day)**	**Terms**
A1	<30	Normal to mildly increased (may be subdivided for risk prediction)
A2	30 to 300	Moderately increased
A3	>300	Severely increased (may be subdivided into nephrotic and non-nephrotic for differential diagnosis, management, and risk prediction)

The cause of CKD is also included in the KDIGO revised classification but is not included in this table.

GFR: glomerular filtration rate; AER: albumin excretion rate; CKD: chronic kidney disease; KDIGO: Kidney Disease Improving Global Outcomes.

Data from:

1. *KDIGO. Summary of recommendation statements. Kidney Int 2013; 3 (Suppl):5.*
2. *National Kidney Foundation. K/DOQI clinical practice guidelines for chronic kidney disease: evaluation, classification, and stratification. Am J Kidney Dis 2002; 39 (Suppl 1):S1.*

Categories for albuminuria and proteinuria

	Normal to mildly increased	Moderately increased	Severely increased
AER (mg/day)	<30	30 to 300	>300
PER (mg/day)	<150	150 to 500	>500
ACR (mg/g)	<30	30 to 300	>300
PCR (mg/g)	<150	150 to 500	>500
Protein dipstick	Negative to trace	Trace to 1+	>1+

Normal urine contains small amounts of albumin, low-molecular-weight serum proteins, and proteins derived from renal tubules and the lower urinary tract. Albuminuria and proteinuria can be measured using excretion rates in timed urine collections, ratio of concentrations to creatinine concentration in spot urine samples, and semiquantitative dipsticks in spot urine samples. Relationships among measurement methods within a category are not exact.

Normal albumin and protein excretion rates are <10 mg/day and <50 mg/day, respectively. In most kidney diseases, albumin is the predominant urine protein, comprising approximately 60 to 90 percent of urine protein when protein excretion rate is very high. Urine albumin excretion rate of 30 to 300 and >300 mg/day correspond to moderately increased albuminuria (formerly "microalbuminuria") and severely increased albuminuria (formerly "macroalbuminuria"), respectively. Urine albumin and protein excretion rates of >2200 mg/day and >3500 mg/day are usually accompanied by signs and symptoms of nephrotic syndrome (hypoalbuminemia, hypercholesterolemia, and edema).

Albuminuria and proteinuria may be assessed from ACR and PCR. ACR and PCR are best determined by repeated measurement in morning first voided urine. In general, for clinical decision-making, ACR and PCR are sufficient, but AER and PER can be measured as a confirmatory test. Relationships between AER and ACR and between PER and PCR are based on the assumption that average creatinine excretion rate is 1 g/day. Creatinine excretion varies with age, sex, race and diet; therefore, the relationship among these categories is approximate only. ACR <10 mg/g (<1.1 mg/mmol) is considered normal; ACR 10 to 29 mg/g (1.1 to 3.3 mg/mmol) is considered "mildly increased."

Proteinuria may be assessed from semiquantitative urine dipsticks. The relationship between urine dipstick results and other measures depends upon urine concentration. In particular, a "trace" result can correspond to the "normal to mildly increased" category or low range of the "moderately increased" category. Positive dipstick tests can be confirmed by ACR, PCR, AER, or PER.

For ACR and PCR, to convert from mg/g creatinine to mg/mmol of creatinine, multiply by 0.113.

AER: albumin excretion rate; PER: protein excretion rate; ACR: albumin/creatinine ratio; PCR: protein/creatinine ratio.

Data from: KDIGO. Summary of recommendation statements. Kidney Int 2013; 3(Suppl):5.

Relative risks of major complications of chronic kidney disease based upon categorical meta-analysis

Ranking of adjusted relative risk

- Rank numbers 1-8
- Rank numbers 9-14
- Rank numbers 15-21
- Rank numbers 22-28

Absolute risk can be computed by multiplying the RRs in each cell by the incidence rate in the reference cell.

All-cause mortality

	ACR <10	ACR 10-29	ACR 30-299	ACR ≥300
eGFR >105	1.1	1.5	2.2	5.0
eGFR 90-105	Ref	1.4	1.5	3.1
eGFR 75-90	1.0	1.3	1.7	2.3
eGFR 60-75	1.0	1.4	1.8	2.7
eGFR 45-60	1.3	1.7	2.2	3.6
eGFR 30-45	1.9	2.3	3.3	4.9
eGFR 15-30	5.3	3.6	4.7	6.6

Cardiovascular mortality

	ACR <10	ACR 10-29	ACR 30-299	ACR ≥300
eGFR >105	0.9	1.3	2.3	2.1
eGFR 90-105	Ref	1.5	1.7	3.7
eGFR 75-90	1.0	1.3	1.6	3.7
eGFR 60-75	1.1	1.4	2.0	4.1
eGFR 45-60	1.5	2.2	2.8	4.3
eGFR 30-45	2.2	2.7	3.4	5.2
eGFR 15-30	14	7.9	4.8	8.1

Kidney failure (ESRD)

	ACR <10	ACR 10-29	ACR 30-299	ACR ≥300
eGFR >105	Ref	Ref	7.8	18
eGFR 90-105	Ref	Ref	11	20
eGFR 75-90	Ref	Ref	3.8	48
eGFR 60-75	Ref	Ref	7.4	67
eGFR 45-60	5.2	22	40	147
eGFR 30-45	56	74	294	763
eGFR 15-30	433	1044	1056	2286

Acute kidney injury (AKI)

	ACR <10	ACR 10-29	ACR 30-299	ACR ≥300
eGFR >105	Ref	Ref	2.7	8.4
eGFR 90-105	Ref	Ref	2.4	5.8
eGFR 75-90	Ref	Ref	2.5	4.1
eGFR 60-75	Ref	Ref	3.3	6.4
eGFR 45-60	2.2	4.9	6.4	5.9
eGFR 30-45	7.3	10	12	20
eGFR 15-30	17	17	21	29

Progressive CKD

	ACR <10	ACR 10-29	ACR 30-299	ACR ≥300
eGFR >105	Ref	Ref	0.4	3.0
eGFR 90-105	Ref	Ref	0.9	3.3
eGFR 75-90	Ref	Ref	1.9	5.0
eGFR 60-75	Ref	Ref	3.2	8.1
eGFR 45-60	3.1	4.0	9.4	57
eGFR 30-45	3.0	19	15	22
eGFR 15-30	4.0	12	21	7.7

Summary of categorical meta-analysis (adjusted relative risk) for general population cohorts with ACR. Mortality is reported for general population cohorts assessing albuminuria as urine ACR. Kidney outcomes are reported for general population cohorts assessing albuminuria as either urine ACR or dipstick. eGFR and albuminuria are expressed as categorical variables. All results are adjusted for covariates and compared with the Ref. Each cell represents a pooled RR from a meta-analysis; bold numbers indicate statistical significance at $p<0.05$. Incidence rates per 1000 person-years for the reference cells are 7.0 for all-cause mortality, 4.5 for CVD mortality, 0.04 for kidney failure, 0.98 for AKI, and 2.02 for kidney disease progression. Absolute risk can be computed by multiplying the RRs in each cell by the incidence rate in the reference cell. Colors reflect the ranking of adjusted RR. The point estimates for each cell were ranked from 1 to 28 (the lowest RR having rank number 1, and the highest number 28). The categories with rank numbers 1 through 8 are green; rank numbers 9 through 14 are yellow; rank numbers 15 through 21 are orange; and trank numbers 22 through 28 are colored red. (For the outcome of kidney disease progression, two cells with RR of 1.0 are also green, leaving fewer cells as orange.)

RR: relative risk; ACR: albumin creatinine ratio; eGFR: estimated glomerular filtration rate; Ref: reference cell; ESRD: end-stage renal disease; AKI: acute kidney injury; CKD: chronic kidney disease; CVD: cardiovascular disease.

* Dipstick included (-, ±, +, ≥++).

Table 1. Inventory of Possible Approaches to Estimating and Reporting GFR, Attributes, and Challenges

Approach	Acronym	Race Included[a]	Challenges by Attribute[b]					
			1	2	3	4	5	6
Creatinine used as biomarker								
1. CKD-EPI eGFRcr (age, sex, race)[6]	CKD-EPIcr	✓CR	●	●	●	●	○	○
2. MDRD Study (age, sex, race)[7]	MDRDcr	✓CR	●	●	○	●	○	○
3. eGFRcr (CKD-EPI) (age, sex, race) with "Black" estimate reported as "high muscle mass" and non-Black estimate reported as "low muscle mass"	CKD-EPIcr_MM	✓C	●	○	●	●	●	●
4. eGFRcr (CKD-EPI) (age, sex, race) with "Black" estimate reported as "high value" and non-Black reported as "low value"	CKD-EPIcr_H/L	✓C	●	○	●	○	●	○
5. eGFRcr (CKD-EPI) (age, sex, race) with the Black coefficient removed and eGFR value for non-Black reported for all	CKD-EPIcr_NB	✓C	●	●	●	○	◑	○
6. eGFRcr (CKD-EPI) (age, sex, race), with the Black coefficient used and eGFR value for Black individuals reported for all	CKD-EPIcr_B	✓C	●	●	●	○	◑	○
7. Blended eGFRcr (CKD-EPI) (age, sex, race), using single coefficient weighted for percentage of Black individuals in specific population, reported for all	CKD-EPIcr_blend	✓C	●	●	●	●	●	●
8. CG estimated creatinine clearance (age, sex, weight)[8]	CG_Clcr		●	●	●	●	●	●
9. eGFRcr (FAS) (age, sex, population-specific Scr/Q)[43]	FAScr		●	●	●	●	●	●
10. eGFRcr (EKFC) (age, sex, population-specific Scr/Q)[27]	EKFCcr		●	●	●	●	●	●
11. eGFR (LM) (age, sex)[44]	LMcr		●	○	●	●	●	●
12. eGFRcr (CKD-EPI) refit without race variable[38]	CKD-EPIcr_R		●	●	●	●	●	●
13. eGFRcr (CKD-EPI) refit with height and weight without race variable[45]	CKD-EPI_R_HW		●	●	●	●	●	●

Creatinine in combination with cystatin C or other markers								
14. eGFRcr-cys (CKD-EPI) with race coefficient (age, sex, race)[46]	CKD-EPIcr-cys	✓CR	○	●	●	●	●	●
15. eGFRcr-cys (CKD-EPI) (age, sex, race) with "Black" estimate reported as "high muscle mass" and non-Black estimate reported as "low muscle mass"	CKD-EPIcr-cys_MM	✓C	○	○	●	●	●	●
16. eGFRcr-cys (CKD-EPI) (age, sex, race) with "Black" estimate reported as "high value" and non-Black estimate reported as "low value"	CKD-EPIcr-cys_H/L	✓C	○	○	●	●	●	●
17. eGFRcr-cys (CKD-EPI) (age, sex, race) with the Black coefficient removed and value for non-Black estimate reported for all	CKD-EPIcr-cys_NB	✓C	○	●	●	●	○	○
18. eGFRcr-cys (CKD-EPI) (age, sex, race) with Black coefficient used and value for Black individuals reported for all	CKD-EPIcr-cys_B	✓C	○	●	●	○	○	○
19. Blended eGFRcr-cys (CKD-EPI) (age, sex, race), using a single coefficient weighted for percentage of Black patients in the specific population, reported for all	CKD-EPIcr-cys_blend	✓C	○	●	●	●	●	●
20. eGFRcr-cys (CKD-EPI) refit without race variable[38]	CKD-EPIcr-cys_R		○	●	●	●	●	●
21. eGFRcr-cys (FAS) (age, sex, population-specific Q)[47]	FAScr-cys		○	●	●	●	●	●
22. eGFRcr-cys-B2M-BTP (age, sex)[48]	CKD-EPI_4M		●	●	●	○	○	○

Recommendation 1

The Task Force recommends for US adults (>85% of whom have normal kidney function) that the CKD-EPIcr_R equation that was developed without the use of the race variable be implemented immediately, including in all laboratories. In addition to not including race in the calculation and reporting, it included diversity in its development, is immediately available to all laboratories in the United States, and has acceptable performance

Recommendation 2

The Task Force recommends national efforts to facilitate increased, routine, and timely use of cystatin C, especially to confirm eGFR in adults who are at risk for or have CKD. Combining filtration markers (creatinine and cystatin C) is more accurate and would support better clinical decisions than either marker alone. Thus, if ongoing evidence supports acceptable performance, the CKD-EPIcys and CKD-EPIcr-cys_R without the race variable should be adopted to provide more accurate first-line or confirmatory testing, as appropriate for the clinical setting.

PCHN

Miejsce pierwotnego uszkodzenia nerek może być widoczne klinicznie i może wskazywać typ uszkodzenia:

- **zespół nerczycowy może wskazywać na pierwotne lub wtórne kłębuszkowe zapalenie nerek,**

- **podczas gdy zaburzenia w zagęszczaniu moczu mogą sugerować kompartment cewkowo-śródmiąższowy jako pierwotne miejsce uszkodzenia nerek**

The stages of glomerulosclerosis

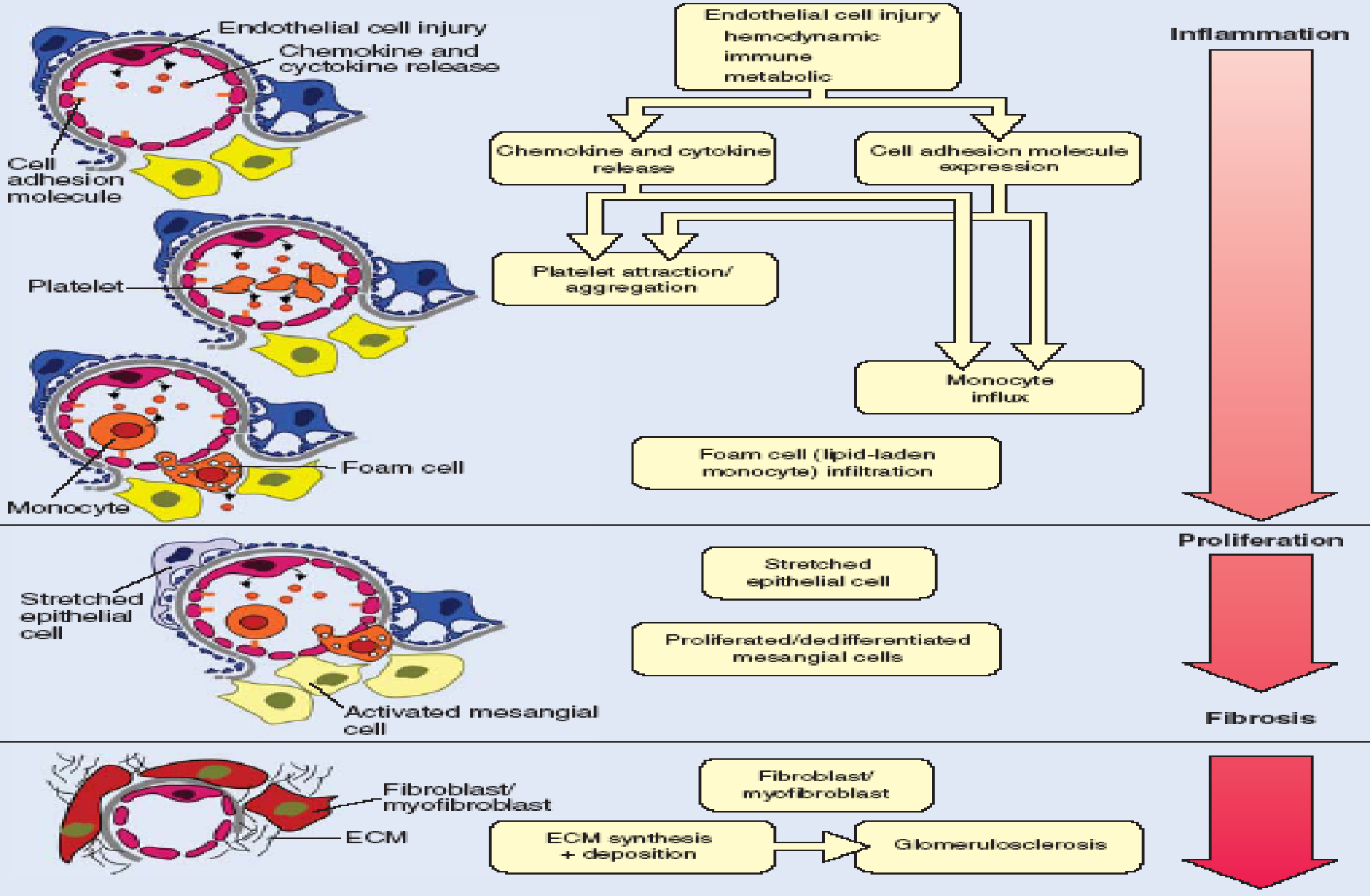


Figure 68.9 The stages of glomerulosclerosis. ECM, extracellular matrix.

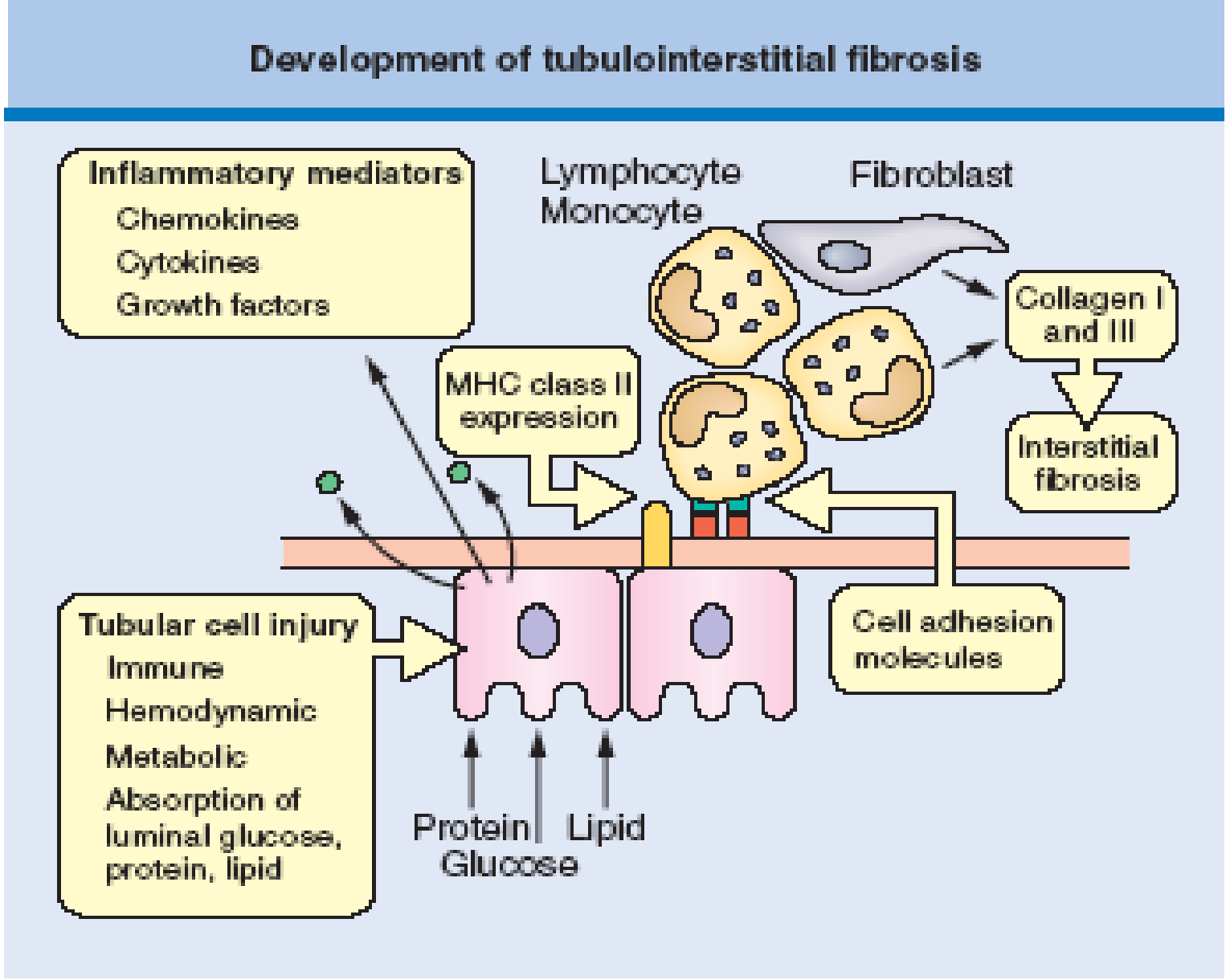


Figure 68.11 Development of tubulointerstitial fibrosis. MHC, major histocompatibility complex.

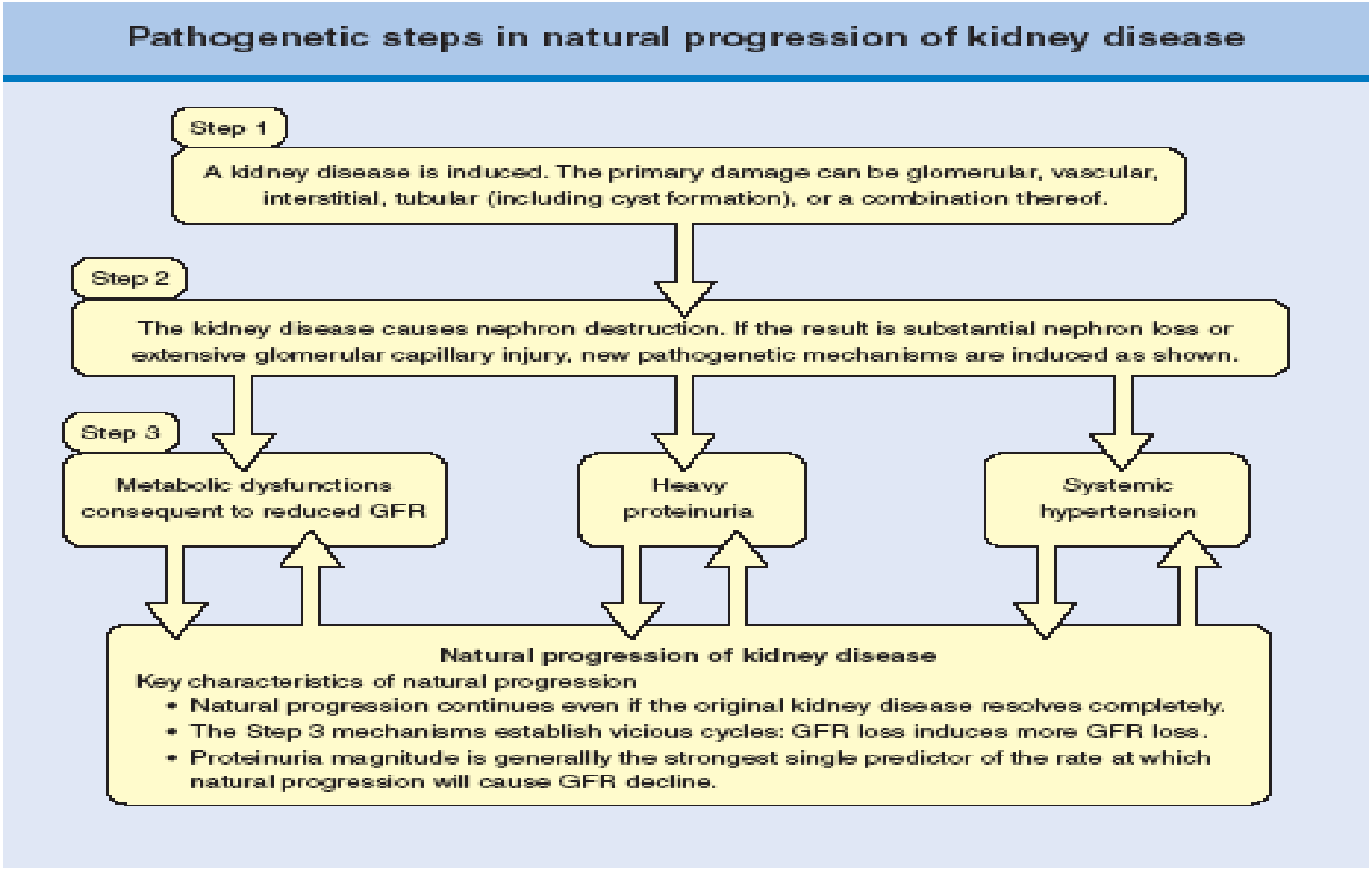


Figure 69.1 Pathogenetic steps in natural progression of kidney disease. The mechanisms of natural progression are arbitrarily categorized as those induced by decreased glomerular filtration rate (GFR), proteinuria, and systemic hypertension.

Wydalanie wody

- **Osmolarność krwi: 285-295 mOsm/kgH20**
- **PCHN – uposledzenie zdolnośći zagęszczania moczu (50-1200 mOsm/kg H20)**
- **W zaawansowanej PCHN osmolarność moczu zbliża się do osmolarności krwi**
- **Zwiększone obligatoryjne wydalanie moczu u chorych z PCHN może prowadzić do polyurii and nycturii**

Wydalanie sodu

- **Frakcjonowane wydalanie sodu z moczem zwiększa się i pozanerkowa kontrola bilansu sodowego jest zachowana do późnych stadiów PCHN**
- **Objętość pozakomórkowa jest relatywnie dobrze zachowana**
- **W celu utrzymania bilansu sodowego należy ograniczyć podaż sodu w diecie**
- **U 1-2% chorych obserwujemy nadmierna utratę sodu przez nerki („ urine sodium leak”), co powoduje hiponatremię przy stosowaniu diety „normalnosodowej”. W celu uniknięcia niedoboru sodu należy zwiększyć jego podaż w diecie (torbielowatość rdzenia, nefropatia analgetyczna, wielotorbielowatość nerek, przewlekłe choroby cewkowo-śródmiąższowe).**

Wydalanie potasu

- **Prawidłowo około 90% - 95% przyjętego potasu jest wydalane przez nerki**
- **U chorych z PCHN około 20% - 50% potasu wydalane jest przez przewód pokarmowy**
- **U chorych z PCHN - istotne zwiększenie wydalania potasu/nefron**
- **Prawidłowe stężenie potasu utrzymywane jest do późnych faz PCHN , aż GFR obniża się < GFR 10 ml/min**
- **Bilans potasu zależy od jego cewkowego wydalania – aldosteron zwiększa wydalanie K w cewce dystalnej – ostrożnie z przepisywaniem iACE – zmniejszają stężenie aldosteronu.**
- **Stężenie potasu może wzrastać jako wyraz redystrybucji u chorych z PCHN pomiędzy przestrzenią wewnatrz i zewnątrzkomórkową (kwasica, stosownie b-blokerów)**
- **U chorych z zaawansowaną PCHN pozostaje mała rezerwa w odpowiedzi na nagle zmiany w przyjmowaniu potasu (kwasica metaboliczna, stany kataboliczne mogą powodować zagrażającą życiu hiperpotasemię).**

Bilans kwasowo-zasadowy

- **W wyniku kompensacyjnej adaptacji i zwiększonego wydalania H/nefron chorzy nie wykazują cech kwasicy do późncyh stadiów PCHN (pojawia się zazwyczaj, gdy GFR około 25% prawidłowej wartości.**

- **Inne bufory, jako węglany uwalniane z kości są wykorzystywane jako bufory u chorych z retencja H.**

- **U chorych z PCHN występują 2 typy kwasicy**

  1)kwasica hiperchloremiczna (prawidłowa luka anionowa);

  2) kwasica metaboliczna ze zwiększoną luka anionową: akumulacja fosforanów, siarczanów.

Magnez

- **Większość chorych z PCHN maja prawidłowe lub niewielkie podwyższenie stężenia Mg**
- **Stężenie Mg wzrasta w wyniku kwasicy, suplementacji wit D3**
- **U chorych z hipermagnezemią mogą wystąpić: osłabienie siły mięśniowej, u chorych z bardzo wysokimi stężeniami Mg paraliż mięśni, niewydolność oddechowa**

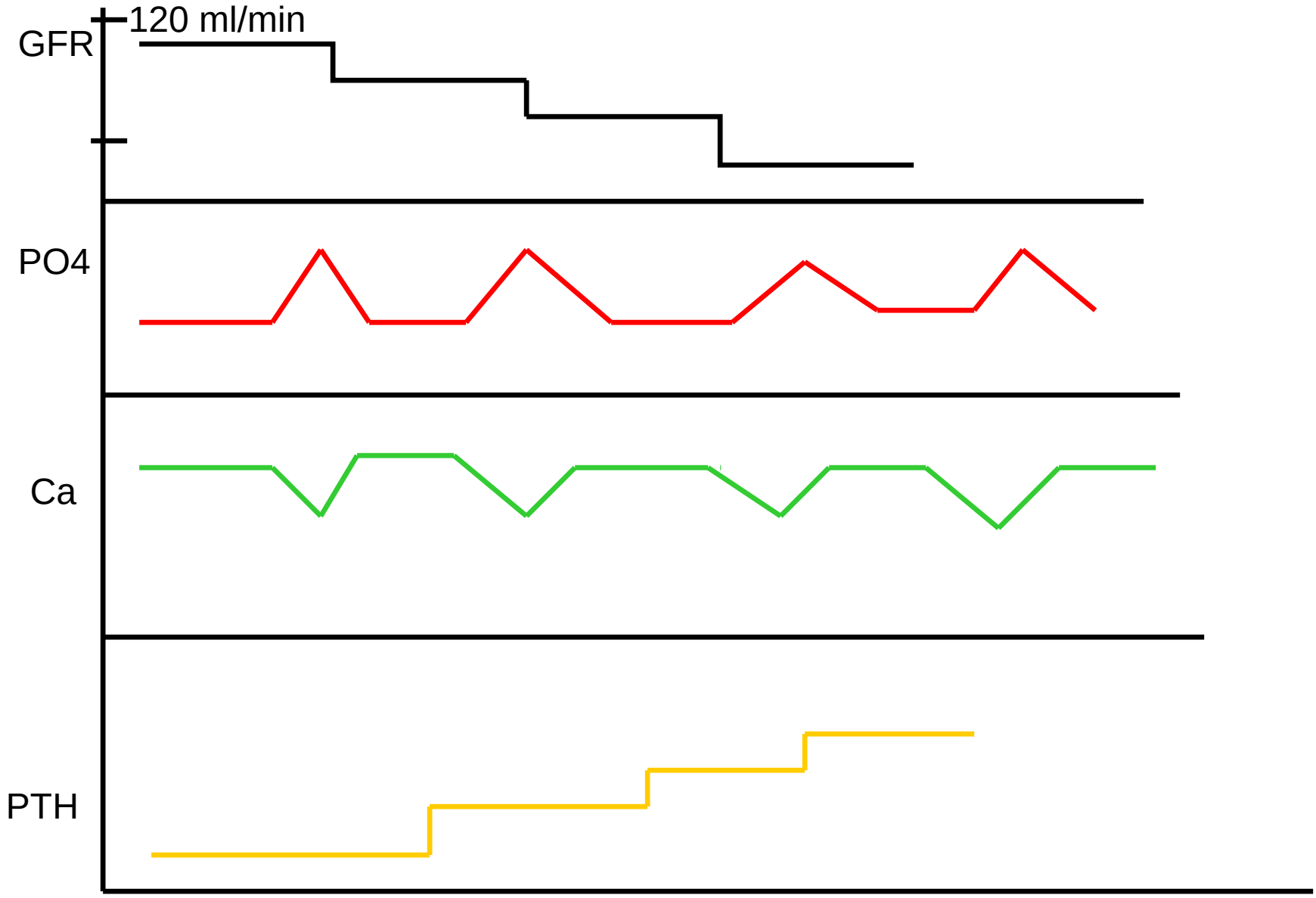
CaxP04 w PCHN

- **Hyperfosfatemia jest obserwowana zazwyczaj, gdy GFR < 25 ml/min, nierestrykcyjna dieta**

- **Hypokalcemia jest wynikiem:**
  - **odpowiedzi na hiperfosfatemię,**
  - **zmniejszonego stężenia wit D3,**
  - **zmniejszonego wchłaniania z przewodu pokarmowego**
  - **zmniejszona zdolność uwalniania Ca z kości w odpowiedzi na PTH**

- **Kwasica metaboliczna zwiększa frakcje zjonizowanego Ca i zabezpiecza przed klinicznymi konsekwencjami hipokalcemii.**

- **Gwałtowne wyrównywanie kwasicy może prowadzic do spadku zjonizowanego Ca i klinicznej manifestacji hipokalcemii (napad tężyczki, drgawki)**


120 ml/min
GFR
PO4
Ca
PTH

Mocznica

- **Mocznik sam w sobie jest relatywnie mało toksyczny, ale pomiarjego stężenia jest czynnikiem, który relatywnie dobrze odzwierciedla zagrożenia kliniczne związane z mocznicą.**
  (odzwierciedla akumulacje produktów przemiany białkowej)

- **Akumulacja „toksyn”**
  a/ niskocząsteczkowych (mocznik, moczany, fosforany, siarczany)

  b/ fenole, niskocząsetczkowe peptydy

  c/ zaburzenia elektrolitowe, kwasowo-zasadowe

  d/ akumulacja hormonów: upośledzona nerkowa degradacja
  (GH, insulin, glucagon); PTH, czynnik natriuretyczny

  e/ upośledzona synteza hormonów (erythropetyna, 1(0H)2 wit D3)

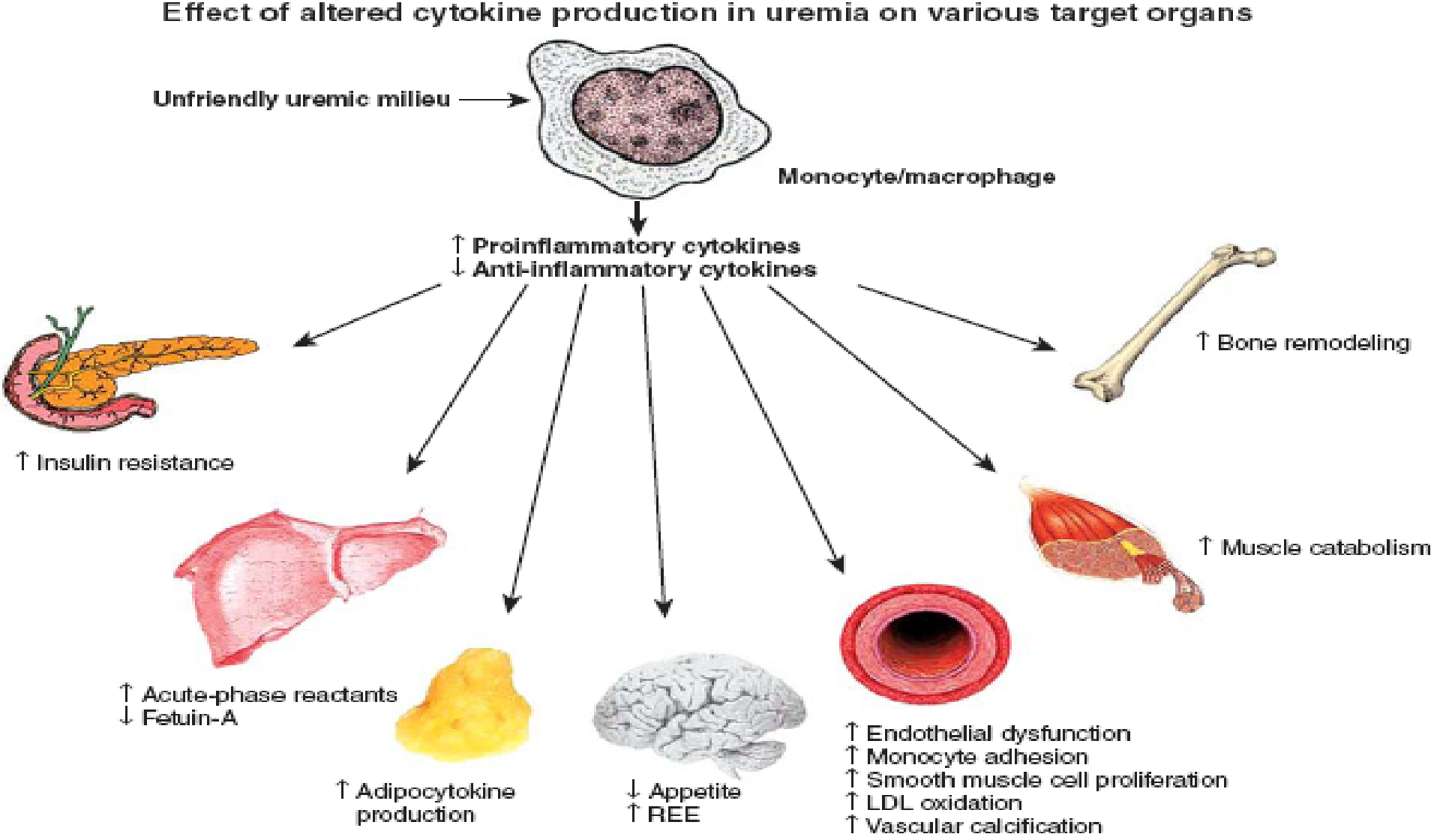


Figure 71.8 Effect of altered cytokine production in uremia on various target organs. Potential mechanisms by which altered circulating levels of proinflammatory and anti-inflammatory cytokines may promote accelerated atherosclerosis, other uremic complications, and wasting. LDL, low-density lipoprotein; REE, resting energy expenditure.

(Adapted from Stenvinkel P, Ketteler M, Johnson RJ, et al: Interleukin-10, IL-6 and TNF-α: Important factors in the altered cytokine network of end-stage renal disease—the good, the bad and the ugly. Kidney Int 2005;67:1216–1233.)

Przyczyny ESRD

- **Cukrzycowa choroba nerek**
- **Nadciśnienie tętnicze**
- **Kłębuszkowe zapalenia nerek**
- **Choroby cewkowo-śródmiąższowe nerek**
- **Wrodzone ***
- **Choroby tkanki łącznej z zajęciem nerek**
- **Nieznane**

- ***** głównie wielotorbielowatość nerek**

PCHN

- **Wszyscy chorzy z PCHN powinni mieć konsultację nefrologiczną**

- **Należy pamiętać, że fizjologicznie z wiekiem obserwujemy redukcje GFR, w wieku 85-90 lat GFR jest zazwyczaj zredukowane do około 50%. Spadek ten nie musi być związany ze wzrostem kreatyniny – zmniejszenie masy mięśniowej.**

Różnicowanie pomiędzy AKI i PCHN

- **U większości chorych z PCHN obserwujemy progresję PCHN**
- **Większość chorych z AKI powraca do prawidłowej czynności nerek**
- **Ocena jest podobna, ale musi być wykonana szybciej u chorych z AKI**

Różnicowanie AKI vs PCHN

Wywiad	Zazwyczaj długi okres
Osteodystrofia nerkowa	Radiologiczne cechy osteodystrofii nerkowej, osteomalacji
Wielkość nerek (length) małe nerki (<9 cm) Prawidłowe lub powiększone (10-12 cm)	 PCHN AKI PCHN: HIV nephropatia Nefropatia cukrzycowa Amyloidoza
Powiększone (>12 cm)	Wielotorbielowatość nerek
Biopsja nerki	Różnicowanie hist-pat

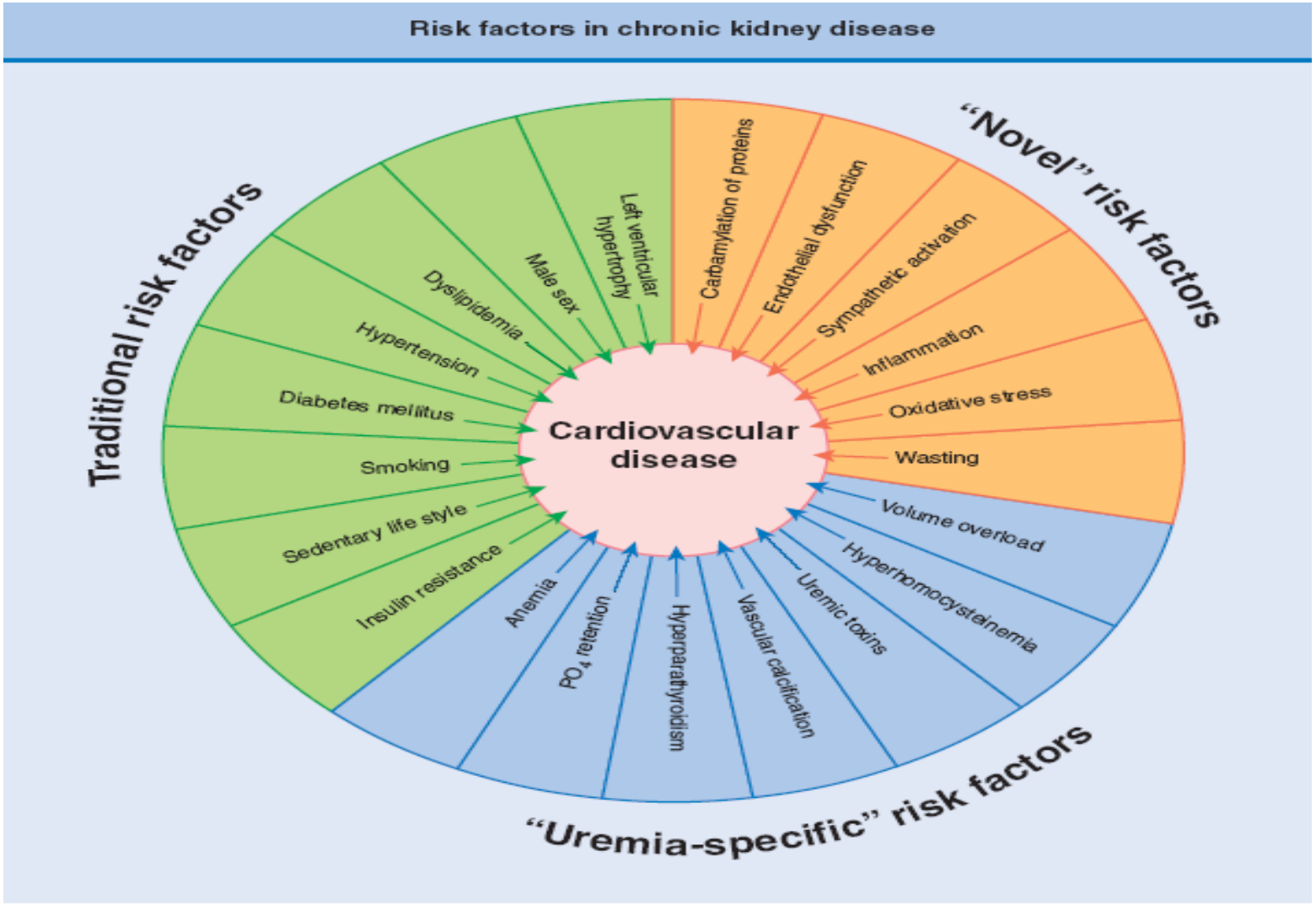


Figure 71.4 Risk factors for cardiovascular disease. Schematic overview of traditional (i.e., Framingham) risk factors (*green*), "novel" risk factors (*orange*), and more or less "uremia-specific" risk factors (*blue*).

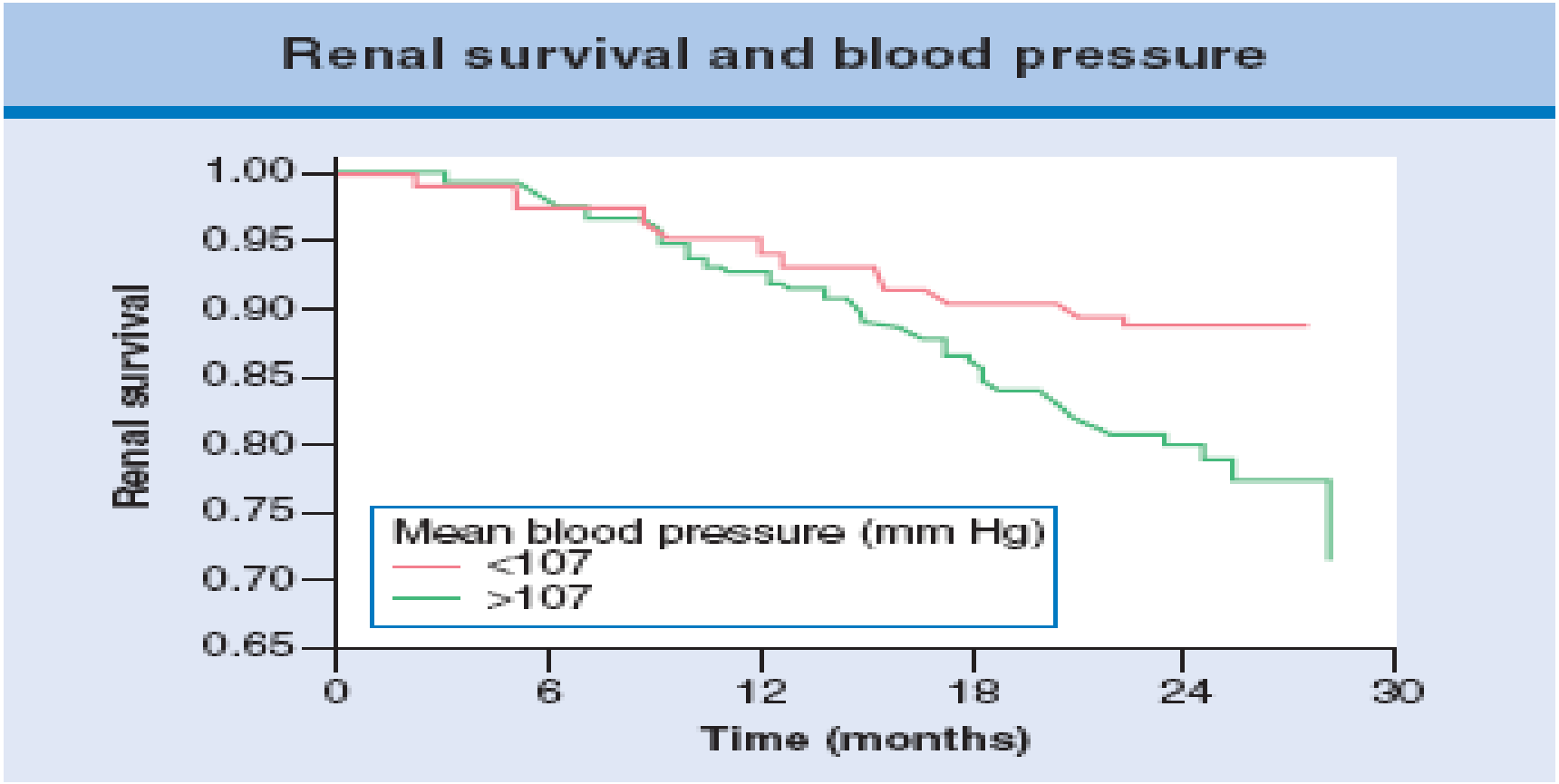


Figure 68.4 Actuarial renal survival in relation to blood pressure.

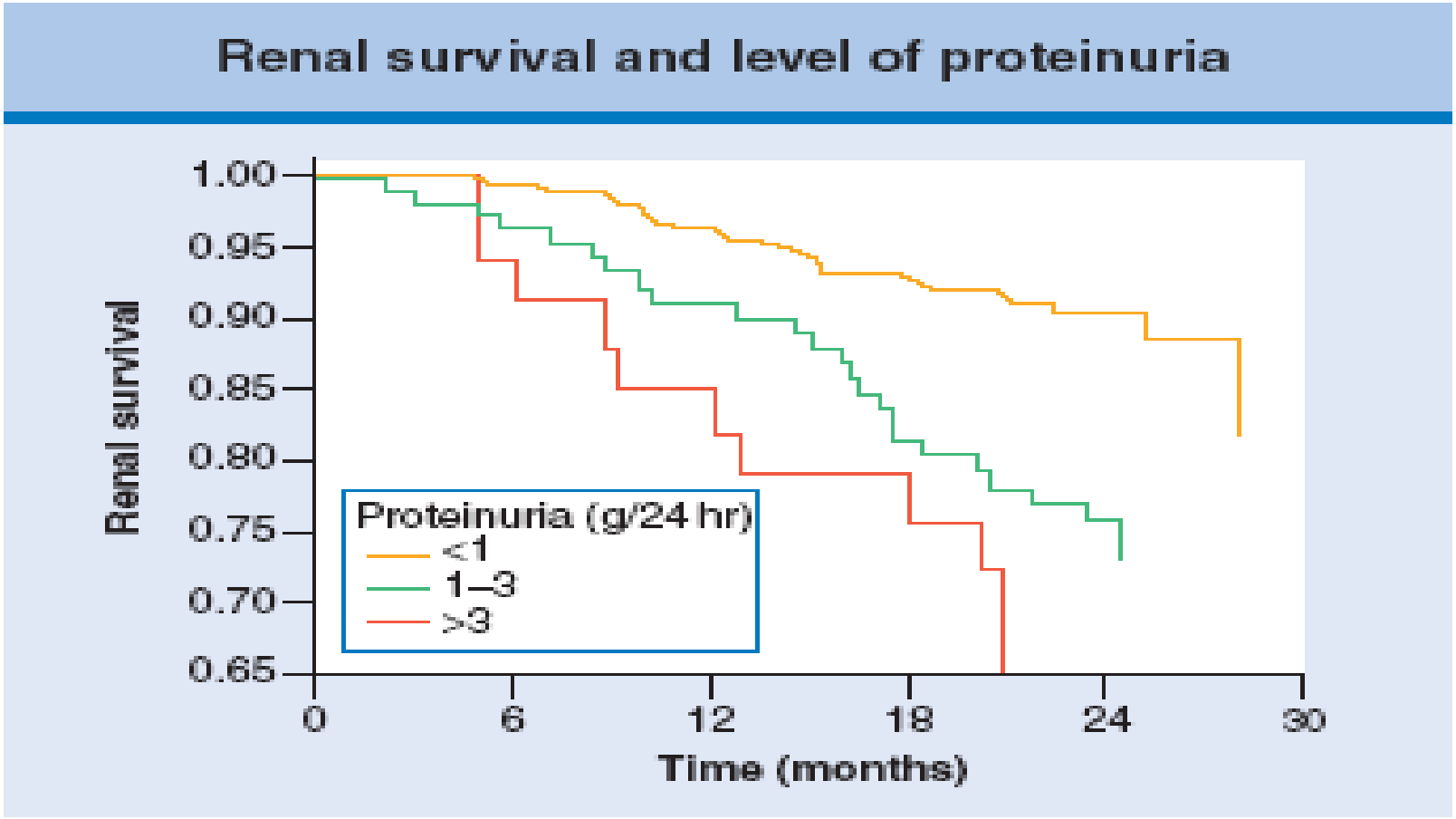


Figure 68.7 Actuarial renal survival in relation to proteinuria.

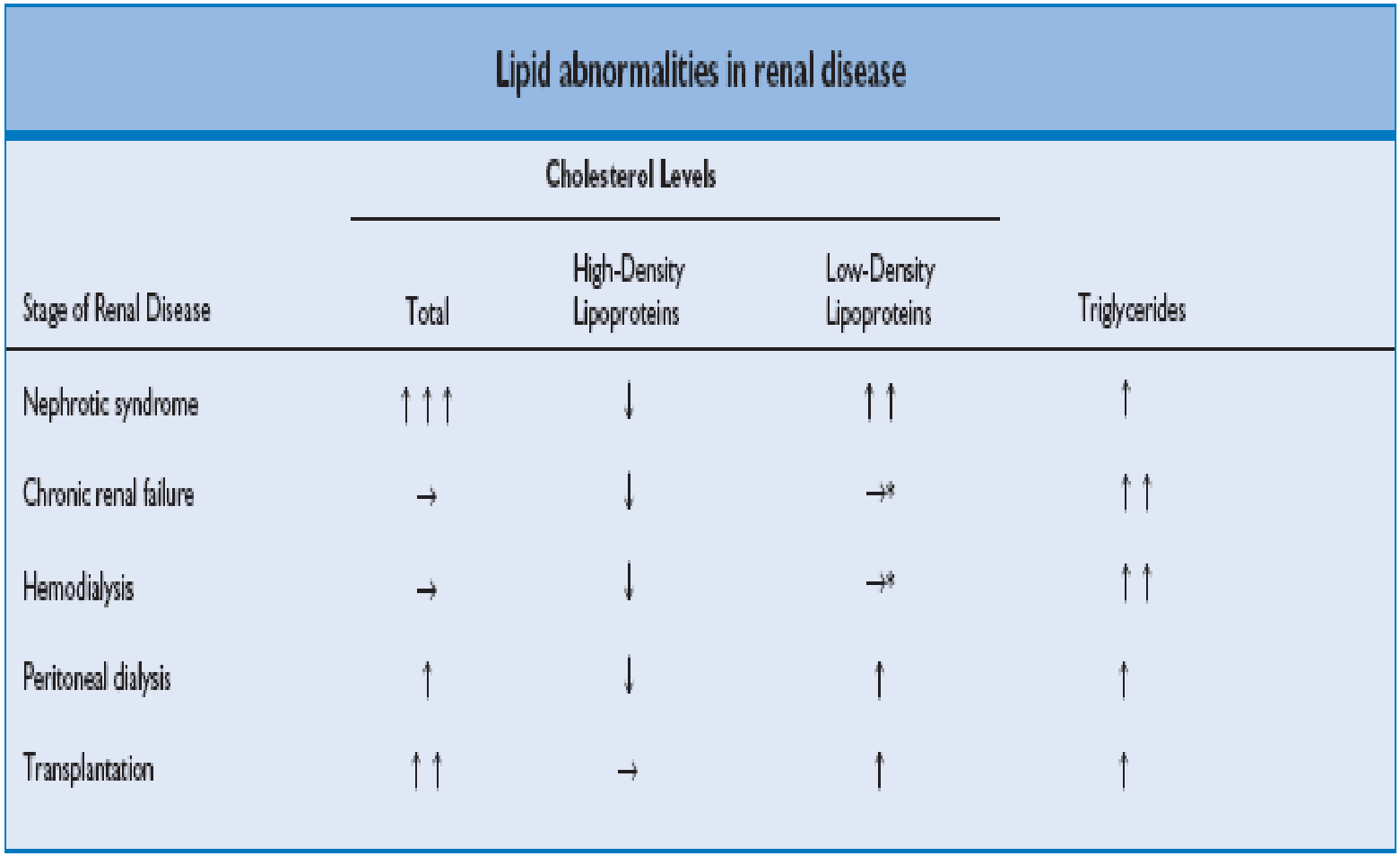


Figure 71.6 Lipid abnormalities in renal disease. Common patterns of hyperlipidemia in different stages of renal disease.
*Composition altered.

PCHN

- **Może być asymptomatyczna przez wiele lat**
- **Wczesne rozpoznanie, ustalenie przyczyny, odpowiednie leczenie – kluczowe**
- **Wywiad, badanie przedmiotowe, badania laboratoryjne, testy genetyczne?**
- **Badania obrazowe: usg – dostępne, nieinwazyje, powtarzalne, tanie, TK (nefropatia pokontrastowa), MRI (nie przy GFR <30 ml/min – włóknienie systemowe)**
- **Biopsja „gold standard”, przeciwwskazania**

PCHN

Brak specyficznego testu krwi, moczu różnicującego definitywnie

AKI vs PCHN

np: wysokie stężenie mocznika, kreatyniny lub bardzo niskie stężenie Hgb mogą być obecne u chorych z AKI

Również ↑PTH, hyperfosfatemia, hipokalcemia nie są wykładnikami przewlekłości choroby nerek

Kliniczny przebieg PCHN

- **Asymptomatycznie**

Nadciśneinie tętnicze

Białkomocz

Krwinkomocz

Nieprawidłowe wyniki badań obrazowych

Prezenatcja kliniczna PCHN

- **Objawowa**
- **Ogólne**
  zmięczenie
  osłabienie
- **Sercowo-naczyniowe**
  Nadciśnienie tętnicze
- **Płucne**
  kaszel
  duszność
  krwioplucie
- **Neurologiczne**
  encefalopatia
  drgawki
  obwodowa neuropatia
- **Uklad moczowo-płciowy**
  krwiomocz
  dysuria

- **Przewód pokarmowy**
  anorexia
  nudności
  wymioty
  ból brzucha
  krwawienie
- **Mięśsniowo-szkiletowe**
  osłabienie mięśni
  bole stawów
  bóle kości
- **Skórne**
  pruritis
  martwica
  siniaki

Badanie ogólne moczu

- **Nie różnicuje AKI vs PCHN**
- **Pyuria, hematuria, proteinuria mogą być obecne w AKI i PCHN**
- **Zespół nerczycowy, erytrocyty dysmorficzne przemawiają za kzn ,**
- **Kryształy szczawianów mogą być widoczne u chorych z wrodzonymi lub nabytymi oksalozami powodującymi PCHN.**
- **Obecność fosforanów wapnia lub kryształów moczanów mogą przemawiać za wcześniejszą kamicą jako przyczyną PCHN.**

3.1: PREVENTION OF CKD PROGRESSION

BP and RAAS interruption

3.1.1: Individualize BP targets and agents according to age, coexistent cardiovascular disease and other comorbidities, risk of progression of CKD, presence or absence of retinopathy (in CKD patients with diabetes), and tolerance of treatment as described in the KDIGO 2012 Blood Pressure Guideline. (*Not Graded*)

3.1.2: Inquire about postural dizziness and check for postural hypotension regularly when treating CKD patients with BP-lowering drugs. (*Not Graded*)

3.1.3: Tailor BP treatment regimens in elderly patients with CKD by carefully considering age, comorbidities 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. (*Not Graded*)

3.1.4: We recommend that in both diabetic and non-diabetic adults with CKD and urine albumin excretion <30 mg/24 hours (or equivalent*) whose office BP is consistently >140 mm Hg systolic or >90 mm Hg diastolic be treated with BP-lowering drugs to maintain a BP that is consistently ≤ 140 mm Hg systolic and ≤ 90 mm Hg diastolic. *(1B)*

3.1.5: We suggest that in both diabetic and non-diabetic adults with CKD and with urine albumin excretion of ≥ 30 mg/24 hours (or equivalent*) whose office BP is consistently >130 mm Hg systolic or >80 mm Hg diastolic be treated with BP-lowering drugs to maintain a BP that is consistently ≤ 130 mm Hg systolic and ≤ 80 mm Hg diastolic. *(2D)*

3.1.6: We suggest that an ARB or ACE-I be used in diabetic adults with CKD and urine albumin excretion 30–300 mg/24 hours (or equivalent*). (*2D*)

3.1.7: We recommend that an ARB or ACE-I be used in both diabetic and non-diabetic adults with CKD and urine albumin excretion >300 mg/24 hours (or equivalent*). (*1B*)

3.1.8: There is insufficient evidence to recommend combining an ACE-I with ARBs to prevent progression of CKD. (*Not Graded*)

SGLT2 inhibitors – Patients who have proteinuric CKD (with or without diabetes) may benefit from treatment with SGLT2 inhibitors. While the majority of trials demonstrating kidney protective benefits have been performed in proteinuric patients with diabetic kidney disease, there are data to suggest that these benefits also extend to nondiabetic proteinuric patients

CKD and risk of AKI

3.1.12: We recommend that all people with CKD are considered to be at increased risk of AKI. (*1A*)

3.1.12.1: In people with CKD, the recommendations detailed in the KDIGO AKI Guideline should be followed for management of those at risk of AKI during intercurrent illness, or when undergoing investigation and procedures that are likely to increase the risk of AKI. (*Not Graded*)

Protein intake

3.1.13: We suggest lowering protein intake to 0.8 g/kg/day in adults with diabetes (*2C*) or without diabetes (*2B*) and GFR <30 ml/min/ 1.73 m^2 (GFR categories G4-G5), with appropriate education.

3.1.14: We suggest avoiding high protein intake (>1.3 g/kg/day) in adults with CKD at risk of progression. (*2C*)

Glycemic control

3.1.15: We recommend a target hemoglobin A_{1c} (HbA_{1c}) of ~7.0% (53 mmol/mol) to prevent or delay progression of the microvascular complications of diabetes, including diabetic kidney disease. (*1A*)

3.1.16: We recommend not treating to an HbA_{1c} target of <7.0% (<53 mmol/mol) in patients at risk of hypoglycemia. (*1B*)

3.1.17: We suggest that target HbA_{1c} be extended above 7.0% (53 mmol/mol) in individuals with comorbidities or limited life expectancy and risk of hypoglycemia. (*2C*)

3.1.18: In people with CKD and diabetes, glycemic control should be part of a multifactorial intervention strategy addressing blood pressure control and cardiovascular risk, promoting the use of angiotensin-converting enzyme inhibition or angiotensin receptor blockade, statins, and antiplatelet therapy where clinically indicated. (*Not Graded*)

Salt intake

3.1.19: We recommend lowering salt intake to <90 mmol (<2 g) per day of sodium (corresponding to 5 g of sodium chloride) in adults, unless contraindicated (see rationale). (*1C*)

3.1.19.1: We recommend restriction of sodium intake for children with CKD who have hypertension (systolic and/or diastolic blood pressure >95th percentile) or prehypertension (systolic and/or diastolic blood pressure >90th percentile and <95th percentile), following the age-based Recommended Daily Intake. (*1C*)

3.1.19.2: We recommend supplemental free water and sodium supplements for children with CKD and polyuria to avoid chronic intravascular depletion and to promote optimal growth. (*1C*)

Lifestyle

3.1.21: We recommend that people with CKD be encouraged to undertake physical activity compatible with cardiovascular health and tolerance (aiming for at least 30 minutes 5 times per week), achieve a healthy weight (BMI 20 to 25, according to country specific demographics), and stop smoking. (*1D*)

Additional dietary advice

3.1.22: We recommend that individuals with CKD receive expert dietary advice and information in the context of an education program, tailored to severity of CKD and the need to intervene on salt, phosphate, potassium, and protein intake where indicated. (*1B*)

3.2: COMPLICATIONS ASSOCIATED WITH LOSS OF KIDNEY FUNCTION

Definition and identification of anemia in CKD

3.2.1: Diagnose anemia in adults and children >15 years with CKD when the Hb concentration is <13.0 g/dl (<130 g/l) in males and <12.0 g/dl (<120 g/l) in females. (*Not Graded*)

3.2.2: Diagnose anemia in children with CKD if Hb concentration is <11.0 g/dl (<110 g/l) in children 0.5–5 years, <11.5 g/dl (115 g/l) in children 5–12 years, and <12.0 g/dl (120 g/l) in children 12-15 years. (*Not Graded*)

3.3: CKD METABOLIC BONE DISEASE INCLUDING LABORATORY ABNORMALITIES

3.3.1: We recommend measuring serum levels of calcium, phosphate, PTH, and alkaline phosphatase activity at least once in adults with GFR <45 ml/min/1.73 m^2 (GFR categories G3b-G5) in order to determine baseline values and inform prediction equations if used. (*1C*)

3.3.2: We suggest not to perform bone mineral density testing routinely in those with eGFR <45 ml/min/1.73 m^2 (GFR categories G3b-G5), as information may be misleading or unhelpful. (*2B*)

3.3.3: In people with GFR <45 ml/min/1.73 m^2 (GFR categories G3b-G5), we suggest maintaining serum phosphate concentrations in the normal range according to local laboratory reference values. (*2C*)

3.3.4: In people with GFR <45 ml/min/1.73 m^2 (GFR categories G3b-G5) the optimal PTH level is not known. We suggest that people with levels of intact PTH above the upper normal limit of the assay are first evaluated for hyperphosphatemia, hypocalcemia, and vitamin D deficiency. (*2C*)

3.4: ACIDOSIS

3.4.1: We suggest that in people with CKD and serum bicarbonate concentrations <22 mmol/l treatment with oral bicarbonate supplementation be given to maintain serum bicarbonate within the normal range, unless contraindicated. (*2B*)

4.1:CKD AND CVD

4.1.1: We recommend that all people with CKD be considered at increased risk for cardiovascular disease. (*1A*)

4.1.2: We recommend that the level of care for ischemic heart disease offered to people with CKD should not be prejudiced by their CKD. (*1A*)

4.1.3: We suggest that adults with CKD at risk for atherosclerotic events be offered treatment with antiplatelet agents unless there is an increased bleeding risk that needs to be balanced against the possible cardiovascular benefits. (*2B*)

4.1.4: We suggest that the level of care for heart failure offered to people with CKD should be the same as is offered to those without CKD. (*2A*)

4.1.5: In people with CKD and heart failure, any escalation in therapy and/or clinical deterioration should prompt monitoring of eGFR and serum potassium concentration. (*Not Graded*)

4.2: CAVEATS WHEN INTERPRETING TESTS FOR CVD IN PEOPLE WITH CKD

BNP/N-terminal-proBNP (NT-proBNP)

4.2.1: In people with GFR <60 ml/min/1.73 m^2 (GFR categories G3a-G5), we recommend that serum concentrations of BNP/NT-proBNP be interpreted with caution and in relation to GFR with respect to diagnosis of heart failure and assessment of volume status. (*1B*)

Troponins

4.2.2: In people with GFR <60 ml/min/1.73 m^2 (GFR categories G3a-G5), we recommend that serum concentrations of troponin be interpreted with caution with respect to diagnosis of acute coronary syndrome. (*1B*)

Non-invasive testing

4.2.3: We recommend that people with CKD presenting with chest pain should be investigated for underlying cardiac disease and other disorders according to the same local practice for people without CKD (and subsequent treatment should be initiated similarly). (*1B*)

4.2.4: We suggest that clinicians are familiar with the limitations of non-invasive cardiac tests (e.g., exercise electrocardiography [ECG], nuclear imaging, echocardiography, etc.) in adults with CKD and interpret the results accordingly. (*2B*)

4.4: MEDICATION MANAGEMENT AND PATIENT SAFETY IN CKD

4.4.1: We recommend that prescribers should take GFR into account when drug dosing. (*1A*)

4.4.2: Where precision is required for dosing (due to narrow therapeutic or toxic range) and/or estimates may be unreliable (e.g., due to low muscle mass), we recommend methods based upon cystatin C or direct measurement of GFR. (*1C*)

4.4.3: We recommend temporary discontinuation of potentially nephrotoxic and renally excreted drugs in people with a GFR <60 ml/min/1.73 m^2 (GFR categories G3a-G5) who have serious intercurrent illness that increases the risk of AKI. These agents include, but are not limited to: RAAS blockers (including ACE-Is, ARBs, aldosterone inhibitors, direct renin inhibitors), diuretics, NSAIDs, metformin, lithium, and digoxin. (*1C*)

4.4.4: We recommend that adults with CKD seek medical or pharmacist advice before using over-the-counter medicines or nutritional protein supplements. (*1B*)

4.4.5: We recommend not using herbal remedies in people with CKD. (*1B*)

4.4.6: We recommend that metformin be continued in people with GFR $\geq$45 ml/min/1.73 m^2 (GFR categories G1-G3a); its use should be reviewed in those with GFR 30–44 ml/min/1.73 m^2 (GFR category G3b); and it should be discontinued in people with GFR $<$30 ml/min/1.73 m^2 (GFR categories G4-G5). (*1C*)

4.4.7: We recommend that all people taking potentially nephrotoxic agents such as lithium and calcineurin inhibitors should have their GFR, electrolytes and drug levels regularly monitored. (*1A*)

4.4.8: People with CKD should not be denied therapies for other conditions such as cancer but there should be appropriate dose adjustment of cytotoxic drugs according to knowledge of GFR. (*Not Graded*)

4.5: IMAGING STUDIES

4.5.1: Balance the risk of acute impairment in kidney function due to contrast agent use against the diagnostic value and therapeutic implications of the investigation. (*Not Graded*)

Radiocontrast

4.5.2: We recommend that all people with GFR <60 ml/min/1.73 m^2 (GFR categories G3a-G5) undergoing elective investigation involving the intravascular administration of iodinated radiocontrast media should be managed according to the *KDIGO Clinical Practice Guideline for AKI* including:

- **Avoidance of high osmolar agents (*1B*);**
- **Use of lowest possible radiocontrast dose (*Not Graded*);**
- **Withdrawal of potentially nephrotoxic agents before and after the procedure (*1C*);**
- **Adequate hydration with saline before, during, and after the procedure (*1A*);**
- **Measurement of GFR 48–96 hours after the procedure (*1C*).**

Gadolinium-based contrast media

4.5.3: We recommend not using gadolinium-containing contrast media in people with GFR <15 ml/min/1.73 m^2 (GFR category G5) unless there is no alternative appropriate test. (*1B*)

4.5.4: We suggest that people with a GFR <30 ml/min/1.73 m^2 (GFR categories G4-G5) who require gadolinium-containing contrast media are preferentially offered a macrocyclic chelate preparation. (*2B*)

Bowel preparation

4.5.5: We recommend not to use oral phosphate-containing bowel preparations in people with a GFR <60 ml/min/1.73 m^2 (GFR categories G3a-G5) or in those known to be at risk of phosphate nephropathy. (*1A*)

CKD and risk of infections

4.6.1: We recommend that all adults with CKD are offered annual vaccination with influenza vaccine, unless contraindicated. (*1B*)

4.6.2: We recommend that all adults with eGFR <30 ml/min/1.73 m^2 (GFR categories G4-G5) and those at high risk of pneumococcal infection (e.g., nephrotic syndrome, diabetes, or those receiving immunosuppression) receive vaccination with polyvalent pneumococcal vaccine unless contraindicated. (*1B*)

4.6.3: We recommend that all adults with CKD who have received pneumococcal vaccination are offered revaccination within 5 years. (*1B*)

4.6.4: We recommend that all adults who are at high risk of progression of CKD and have GFR <30 ml/min/1.73 m^2 (GFR categories G4-G5) be immunized against hepatitis B and the response confirmed by appropriate serological testing. (*1B*)

4.6.5: Consideration of live vaccine should include an appreciation of the patient's immune status and should be in line with recommendations from official or governmental bodies. (*Not Graded*)

4.6.6: Pediatric immunization schedules should be followed according to official international and regional recommedations for children with CKD. (*Not Graded*)

CKD and risk of AKI

4.6.7: We recommend that all people with CKD are considered to be at increased risk of AKI. (*1A*)

4.6.7.1: In people with CKD, the recommendations detailed in the KDIGO AKI Guideline should be followed for management of those at risk of AKI during intercurrent illness, or when undergoing investigation and procedures that are likely to increase the risk of AKI. (*Not Graded*)

5.1: REFERRAL TO SPECIALIST SERVICES

5.1.1: We recommend referral to specialist kidney care services for people with CKD in the following circumstances (*1B*):

- AKI or abrupt sustained fall in GFR;
- GFR <30 ml/min/1.73 m^2 (GFR categories G4-G5)*;
- a consistent finding of significant albuminuria (ACR ≥ 300 mg/g [≥ 30 mg/mmol] or AER ≥ 300 mg/24 hours, approximately equivalent to PCR ≥ 500 mg/g [≥ 50 mg/mmol] or PER ≥ 500 mg/24 hours);
- progression of CKD (see Recommendation 2.1.3 for definition);
- urinary red cell casts, RBC >20 per high power field sustained and not readily explained;
- CKD and hypertension refractory to treatment with 4 or more antihypertensive agents;
- persistent abnormalities of serum potassium;
- recurrent or extensive nephrolithiasis;
- hereditary kidney disease.

5.1.2: We recommend timely referral for planning renal replacement therapy (RRT) in people with progressive CKD in whom the risk of kidney failure within 1 year is 10–20% or higher[†], as determined by validated risk prediction tools. ***(1B)***

5.2: CARE OF THE PATIENT WITH PROGRESSIVE CKD

5.2.1: We suggest that people with progressive CKD should be managed in a multidisciplinary care setting. (*2B*)

5.2.2: The multidisciplinary team should include or have access to dietary counseling, education and counseling about different RRT modalities, transplant options, vascular access surgery, and ethical, psychological, and social care. (*Not Graded*)

5.3: TIMING THE INITIATION OF RRT

5.3.1: We suggest that dialysis be initiated when one or more of the following are present: symptoms or signs attributable to kidney failure (serositis, acid-base or electrolyte abnormalities, pruritus); inability to control volume status or blood pressure; a progressive deterioration in nutritional status refractory to dietary intervention; or cognitive impairment. This often but not invariably occurs in the GFR range between 5 and 10 ml/min/1.73 m^2. (*2B*)

5.3.2: Living donor preemptive renal transplantation in adults should be considered when the GFR is <20 ml/min/1.73 m^2, and there is evidence of progressive and irreversible CKD over the preceding 6–12 months. (*Not Graded*)

5.4: STRUCTURE AND PROCESS OF COMPREHENSIVE CONSERVATIVE MANAGEMENT

5.4.1: Conservative management should be an option in people who choose not to pursue RRT and this should be supported by a comprehensive management program. (*Not Graded*)

5.4.2: All CKD programs and care providers should be able to deliver advance care planning for people with a recognized need for end-of-life care, including those people undergoing conservative kidney care. (*Not Graded*)

5.4.3: Coordinated end-of-life care should be available to people and families through either primary care or specialist care as local circumstances dictate. (*Not Graded*)

5.4.4: The comprehensive conservative management program should include protocols for symptom and pain management, psychological care, spiritual care, and culturally sensitive care for the dying patient and their family (whether at home, in a hospice or a hospital setting), followed by the provision of culturally appropriate bereavement support. (*Not Graded*)

Recommended dietary intake for chronic kidney and end-stage renal disease patients*

	Chronic kidney disease¶	Maintenance hemodialysis
Protein	0.8 to 1.0 g/kg/day$^{\Delta}$ of high biological value protein	>1.2 to 1.3 g/kg/day
Energy	≥35 kcal/kg/day; if the body weight is greater than 120 percent of normal or the patient is greater than 60 years of age a lower amount may be prescribed	
Fat, percent of total energy intake	30 to 40	30 to 40
Polyunsaturated-to-saturated ratio (fatty acid ratio)	1.0:1.0	1.0:1.0
Carbohydrate	Balance of nonprotein calories	
Total fiber, g/day	20 to 25	20 to 25
Minerals, range of intake		
Sodium, mg/day	<2000	<2000
Potassium, meq/day	40 to 70	40 to 70
Phosphorus, mg/day	600 to 800◇	600 to 800◇
Calcium, mg/day	1400 to 1600	1400 to 1600
Magnesium, mg/day	200 to 300	200 to 300
Iron, mg/day	≥10 to 18§	≥10 to 18§
Zinc, mg/day	15	15
Water, mL/day	Up to 3000 as tolerated	Usually 750 to 1500

* The nutritional intake is adjusted based upon individual needs. This is particularly important for the carbohydrate, lipid, and mineral contents of the diet.
¶ GFR <70 mL/min/1.73 m2 with evidence for progression.
Δ Some recommend 0.56 to 0.75 g/kg/day, with 0.35 g/kg/day of high biological value protein. The protein intake is increased by 1.0 g/day of high biological value protein for each gram per day of urinary protein loss. This is performed under close supervision and dietary counseling.
◇ Phosphate binders often are also needed to maintain normal serum phosphorus levels.
§ 10 mg/day for males and nonmenstruating females, 18 mg/day for menstruating females.

Data from:

1. *Ahmed, K, Kopple, J. Nutritional management of renal disease. In: Primer on Kidney Diseases, Greenberg, A (Ed). Academic Press, San Diego, CA, 1994, p. 289.*
2. *Ikizler, IA. Nutrition and kidney disease. In: Primer on Kidney Diseases, Greenberg, A (Ed). Elsevier, Philadelphia, 2005, p. 496.*

Management plan for chronic kidney disease patients, according to stage

K/DOQI Class	GFR (ml/min)	Typical Serum Creatinine in a 65-kg Subject	Consequences	Action
3	30–59	2 mg/dl (170 µmol/l)	Hypertension, secondary hyperparathyroidism	Treat hypertension Start phosphate restriction and phosphate binders Start vitamin D analogue Immunize against hepatitis B
4	15–29	4 mg/dl (354 µmol/l)	+ Anemia	Restrict dietary potassium to 60 mmol/day Advise moderate protein restriction Plan renal replacement therapy, including vascular access
5	<15	8 mg/dl (707 µmol/l)	+ Sodium and water retention, anorexia, vomiting, reduced higher mental function	Plan elective start of dialysis or pre-emptive renal transplantation
5 (uremic emergency)	<5	17 mg/dl (1503 µmol/l)	+ Pulmonary edema coma, fits, metabolic acidosis, hyperkalemia, death	Start dialysis or provide palliative care

Figure 70.2 Management plan for patients with chronic kidney disease (CKD), according to stage. The table gives a rough guide to the level of blood creatinine corresponding to each stage of CKD in a typical 65-kg subject and shows the approximate timing of the anticipated clinical problems and interventions required as CKD progresses. At each stage, the action plan for the previous CKD stage should be followed if not already initiated.