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Handbook of Nutrition in Kidney Disease

ANITA SAXENA

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Handbook of Nutrition in Kidney Disease

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For the benefit of the readers, Hindi names of food items and preparations have been given alongside the English ones. In addition, for India-specific food preparations, English explanations have been provided.

Foreword

Management of patients with renal disease is complex, as it is not restricted to medical management but also requires teamwork of physician/nephrologist/dietician/counsellor, and other specialists, depending upon comorbid conditions. This syndrome of protein-energy wasting is being increasingly recognised in patients with chronic kidney disease (CKD), especially due to overzealous protein restrictions in predialytic phase of treatment by the treating physicians.



By working closely with the renal healthcare team to improve patient outcomes and quality of life and to decrease comorbid complications, renal dieticians play an integral role in the treatment of individuals with CKD. This role continues to expand, as more emphasis is placed on the importance of medical nutrition therapy (MNT) and management of comorbidities in the field of nephrology. The NKF KDOQI reaffirms the significance of nutrition in the care of individuals with CKD.

This book provides details about basics of nutrition and has individualised the nutritional guidance based on the cause of renal disease, which is a novel concept.

In the book, there are separate sections for diet in acute kidney injury, CKD, and dialysis of patients. It is a very good practical guide for patients as well as dieticians. In addition, the role of dietary management for anaemia renal osteodystrophy and various vitamins supplementation in kidney disease has been highlighted.

At the end, I will summarise that this book is a complete guide for nutrition for patients with kidney disease, renal dieticians, nephrologists, and general physicians.

I sincerely wish Dr Anita Saxena all the best for being the author of such a comprehensive book on renal nutrition, and I am sure this book will be a useful guide on nutrition for all the patients with renal disease.

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Foreword

The science of nutrition has developed along with the progress of humanity. The first recorded dietary advice, carved into a Babylonian stone tablet around 2500 BC, cautioned those with pain inside to avoid eating onions for 3 days. Scurvy, later found to be a vitamin C deficiency, was first described in 1500 BC in the Ebers Papyrus. According to Walter Gratzer, the study of nutrition probably began during the sixth century BC. At that time in India, food was classified as 'hot' (e.g., meat, ginger, and hot spices) and 'cold' (green vegetables), and the imbalance between the intake of these two food groups would result in disease. The seminal Ayurvedic proverb illustrates this elegantly: 'When diet is wrong, medicine is of no use. When diet is correct, medicine is of no need.'



A healthy diet is essential in body homeostasis and plays an important role in the prevention of the major non-communicable diseases of the modern society. The kidney, in normal conditions, is essential for the maintenance of homeostasis, being responsible for fluid, acid-base, and electrolyte balance. Therefore, kidney disease will inherently encompass a number of nutritional alterations that will further aggravate patient outcomes. Before the implementation of chronic renal replacement therapies in the 1990s, dietary management was a cornerstone of kidney disease treatment. Now, in the beginning of the 21st century, the field of nutrition in kidney disease has changed dramatically. Among the key changes in this field is the growth of evidence concerning the importance of inflammatory, oxidative, and carbonyl stress, and the dramatic increase in the prevalence and severity of obesity and its adverse clinical consequences. In parallel, there has been an exponential growth in the information concerning nutritional therapies for retarding progression of chronic kidney disease, including phosphate control, metabolic acidosis, and the fascinating concept of the low-protein diet.

The dietary restrictions of patients with kidney disease are many, and in some cases, they go against our understanding of a healthy diet. Motivation to prescribe (as physician or dietician) and to follow (as patient) these recommendations requires a comprehensive understanding of the mechanisms and rationale behind them. In this book, Dr Anita Saxena illustrates the importance of nutritional management in the progression and complications of kidney diseases in patients. The book exquisitely combines a solid and well-referenced scientific background with the practical advice of patient preferences,

food choices, nutrient composition, and feasibility that can only come from someone with an extensive clinical experience. One of the most interesting aspects of this book, in my opinion, is the specific considerations to paediatric nephrology, kidney stones, and acute kidney injury and the dimensions of the global spectrum of kidney diseases that are seldom covered in this type of compendium. Further, a predominance of western investigators concerned for western dietary realities have usually covered the renal nutritional scientific literature. Thus, another essential aspect of this work is the practical attention to Indian dietary habits and food sources, with careful and thoughtful recommendations in the context of more vegetarian lifestyles. It is my belief that in this comprehensive book the reader will find many tips for healthy 'kidney' eating, applicable not only to the Asian continent but also to the many generations of emigrants who enlarge the Indian and, on a broader sense, the rich Asian culture to the entire world.

I am certain that this book can serve both as a scholarly resource for physicians interested in the many aspects of the field of nutrition and metabolism in renal diseases, and as a practical guide to the management of the clinical manifestations of these disorders. I hope you enjoy reading it as much as I did, and overall, I anticipate the thoughts of Dr Saxena to bring inspiration and motivation for renal nutrition education and management strategies in this vulnerable and fragile patient population.

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Preface

The famous and oft-quoted saying 'we are what we eat' is in fact true. There is increasing evidence that many of the major diseases are in some way related to what we eat. In olden days, when diets were essentially unrefined (more natural) and were made palatable by cooking, there was little risk of excessive intake of a single nutrient. However, today, a large proportion of food we eat is processed to make it look and taste better and easier to cook, which, to a certain extent, is responsible for the rise in the incidence of certain diseases that have direct relation to the food we eat. It is not necessary to give up all the foods one enjoys in order to ensure good health; in fact, all one needs to do is follow some basic principles of healthy eating. A planned diet can pay off dramatically in terms of better health, vitality, and longer life.

Even though malnutrition in chronic kidney disease (CKD) is of prime concern to nephrologists, nutrition remains a neglected area in nephrology. This work is a compilation of thoughts that will assist aspiring and practicing nephrologists, nephrologist, physicians, dieticians, and nurses in clinical practice. Although there is abundance of scientific literature on nutritional deficits in CKD patients, practical ways for correcting these deficits is still missing in textbooks. Hence, this book has been written in a way that makes it complete in terms of scientific text, studies, and practical approach to handling nutritional requirements of patients. Efforts have been made to provide information on 'what to eat and how to eat in renal disease' in order to slow down the progression of disease. Appropriate counselling and timely nutritional intervention can improve patient's quality of life and help them lead a normal life. Information on nutrient composition of foods is tabulated, which is easy to comprehend. For alleviating symptoms through dietary management, nutritional recommendations are based on international guidelines. There are lucid scientific answers to 'why what not to eat'. The chapters in the book address a spectrum of kidney diseases. Some of these chapters are dedicated to individual condition. The book begins with the basics of the disease and its causes before moving on to address nutritional management of the disease; it finally ends with sample diets. This piece of work brings to light alternatives for the renal patient in terms of exchange of food items to make food palatable. Oil-free recipes are also given. Chapter 3 'Counselling a Renal Patient: What Bothers Patient the Most and How to Manage That Concern' is the heart of this book. Chapter 14 'Nephrotoxic Drugs' and Chapter 15, 'Myths and Facts about Kidney Diseases' caution readers on malpractices and misconceptions. The uniqueness of this work lies in the scientific text, which is backed

by practical approach to nutritional management of kidney disease. After reading the book, the reader can test his/her understanding of renal nutrition through 'Review Questions'.

The author's humble pledge to readers is:

'Let not those who suffer from renal disease lose hope,
eating a well-planned diet is what they look for;
few words of advice will nourish their soul,
this is what you will find as the leaves unfold.'

Enjoy Reading!

Acknowledgements

I thank all patients with chronic kidney disease, their families, and nephrology students, who inspired me to blend clinical nephrology with clinical nutrition and come up with a work that has practical approach and scientific backing. I thank my brother-in-law Mr Amit Pradhan and my sister Dr Aparna Pradhan for proofreading the manuscript. I sincerely thank Mr Anil Kumar, the official photographer of my Institute, for helping me with photography of the anthropometric techniques, something that is of immense utility to the readers who are involved in evaluation of nutritional status of patients.

About the author

Dr Anita Saxena, MD (AM), PhD, PhD (Cambridge), works as an Additional Professor in the Department of Nephrology, Sanjay Gandhi Postgraduate Institute of Medical Sciences (SGPGIMS), Lucknow, India. Her achievements include establishing Renal Nutrition not only in SGPGIMS, Lucknow, but also across India. In addition, she created the Society of Renal Nutrition and Metabolism in November 2014, which works for the prevention of malnutrition in chronic kidney disease. As an editor, she started the *Journal of Renal Nutrition and Metabolism*. She was also an associate editor for *Clinical Queries in Nephrology*, a journal published by Elsevier. She is member expert for review panel for The Kidney Disease Outcome Quality Special Initiative (KDOQI). She is recipient of international woman of the year 1999–2000 award conferred by International Biographical Center, Cambridge, UK; member Advisory Council, International Biographical Center, Cambridge, UK; and member of the Research Board of Advisors, American Biographical Institute, USA. She has authored *Textbook of Nutrition and Kidney Disease*, *Nutritional Guide for Renal Patients What Patients Want to Know*, and has co-edited *Manual of Approach to Chronic Kidney Disease: Key to Success* and *Handbook of Medical Genetics ICMR Course on Genetic Counseling*.



Abbreviations*

AA	Amino acid
AAD	Amino acid dialysate
ABCD	Appropriate blood pressure control in diabetes
ABW	Actual body weight
ACE	American College of Endocrinology
ACE	Angiotensin-converting enzyme
ACEi	Angiotensin-converting-enzyme inhibitor
ACR	Albumin-creatinine ratio
AD	Autosomal dominant
ADA	American Diabetes Association
ADAT	Appetite and Diet Assessment Tool
ADH	Antidiuretic hormone
ADPKD	Autosomal dominant polycystic kidney disease
AFP	α -Fetoprotein
AGE	Advanced glycation end product
AGRP	Agouti-related peptide
AHA	American Heart Association
AIDS	Acquired immunodeficiency syndrome
AKI	Acute kidney injury
ALA	Alpha-lipoic acid
ALI	Acute lung injury
ALLHAT	Antihypertensive and Lipid Lowering Treatment to Prevent Heart Attack Trial
AME	Apparent mineral corticoid excess
ANG II	Angiotensin II
ANP	Atrial natriuretic peptide
anti-GBM	Antiglomerular basement membrane
APD	Acute peritoneal dialysis
Apo E	Apolipoprotein E
APR	Acute-phase reactant
APR	Acute-phase response
AR	Autosomal recessive
ARB	Angiotensin II receptor blocker
ARC	Arcuate nucleus
ARDS	Acute respiratory distress syndrome
ARPKD	Autosomal recessive polycystic kidney disease
ATN	Acute tubular necrosis
ATP III	Adult Treatment Panel III

*The list consolidates abbreviations used in the book. There might be instances of duplication of an abbreviation by virtue of a difference in its full form. Readers are recommended to refer to the list contextually.

ATP	Adenosine triphosphate
ATT	Antituberculosis treatment
AVP	Arginine vasopressin
BCAA	Branched-chain amino acids
BCG	Bromocresol green
BCM	Body cell mass
BDNF	Brain-derived neurotrophic factor
BEE	Basal energy expenditure
BIA	Bioelectrical impedance analysis
BMI	Body mass index
BMR	Basal metabolic rate
BN	Nitrogen balance
BNF	Brain-derived neurotrophic factor
BP	Blood pressure
BUN	Blood urea nitrogen
b.w.	Body weight
CAD	Coronary artery disease
cAMP	Cyclic adenosine monophosphate
CAN	Chronic allograft nephropathy
CANUSA study	Canada–United States of America study
CAPD	Continuous ambulatory peritoneal dialysis
CARDS	Collaborative Atorvastatin Diabetes Study
CART	Cocaine and amphetamine-regulated transcript
CASR	Calcium-sensing receptor
Cbfa1	Core binding factor alpha 1
CCD	Clinical cardiac disease
CCF	Chronic cardiac failure
CDC	Centers for Disease Control and Prevention
CHD	Coronary heart disease/disorder
CHF	Congestive heart failure
CHO	Carbohydrates
CI	Confidence interval
CIN	Calcineurin inhibitor nephrotoxicity
CKD	Chronic kidney disease
CMV	Cytomegalovirus
CNF	Congenital nephritic syndrome of Finnish type
CNS	Congenital nephrotic syndrome
CoA	Coenzyme A
COPD	Chronic obstructive pulmonary disease
CPGs	Clinical practice guidelines
CPK	Creatine phosphokinase
Cr	Chromium
CRAI	Chronic renal allograft injury
CRF	Chronic renal failure
CRIB	Critical Risk Index for Babies
CRISP	Consortium for Radiologic Imaging Studies of Polycystic Kidney Disease
CRP	C-reactive protein
CRRT	Continuous renal replacement therapy
CsA	Cyclosporine
CSF	Cerebrospinal fluid

Cu	Copper
CVD	Cardiovascular disease/disorder
CVVH	Continuous veno-venous haemofiltration
CVVHDF	Continuous veno-venous haemodiafiltration
D/PCr	Dialysate-to-plasma creatinine ratio
DASH	Dietary Approach to Stop Hypertension
DC	Discontinue
DCCT	Diabetes Control and Complications Trial
DCI	Daily calorie intake
DCT	Distal convoluted tubule
DEI	Dietary energy intake
DEXA	Dual-energy X-ray absorptiometry
DGP	Diabetic gastroparesis
DHA	Docosahexaenoic acid
DKA	Diabetic ketoacidosis
DKD	Diabetic kidney disease
DM	Diabetes mellitus
DMP	Dentin matrix protein
DMS	Diffused mesangial sclerosis
DNA	Deoxyribonucleic acid
DOCA	Deoxycorticosterone acetate
DOPPS	Dialysis Outcomes and Practice Patterns Study
DPI	Daily protein intake
DPI	Dietary protein intake
DPN	Diabetic peripheral neuropathy
DRI	Dietary reference intake
DSME	Diabetes self-management education
EAA	Essential L-amino acids
EAR	Estimated average requirement
EBM	Expressed breastmilk
ECF	Extracellular fluid
ECM	Extracellular matrix
ECV	Extracellular volume
EER	Estimated energy requirement
eGFR	Estimated glomerular filtration rate
EN	Enteral
EPA	Eicosapentaenoic acid
EPO	Erythropoietin
ER	Endoplasmic reticulum
ESA	Erythropoietin-stimulating agents
ESPEN	European Society for Clinical Nutrition and Metabolism
ESR	Erythrocyte sedimentation rate
ESRD	End-stage renal disease
FA	Fatty acid
FFA	Free fatty acid
FFM	Fat-free mass
FGF-23	Fibroblast growth factor 23
FGFR	Fibroblast growth factor receptor
FH	Frankfort horizontal
FSGS	Idiopathic focal segmental glomerulosclerosis

FTRP	Free tryptophan
GAA	General amino acids
GBM	Glomerular basement membrane
GD	Glycaemic load
GDR	Glucose disposal rate
GFR	Glomerular filtration rate
GI	Gastrointestinal
GI	Glycaemic index
GIP	Glucose-dependent insulinotropic polypeptide
GIT	Gastrointestinal tract
GL-3	Globotriacylceramide
GLP	Glucagon-like peptide
GMB	Glomerular basement membrane
GMP	Guanosine monophosphate
GN	Glomerulonephritis
GP	General population
GRA	Glucocorticoid-remediable aldosteronism
GS	Glomerulosclerosis
GSH	Glutathione
H&E	Hematoxylin and eosin
HBV	Hepatitis B virus
HBV	High biological value
HCl	Hydrochloric acid
HD	Haemodialysis
HDL	High-density lipoprotein
HDL-C	High-density lipoprotein cholesterol
HELLP	Haemolysis, elevated liver enzyme levels, and low platelet levels
HEMO	Haemodialysis (HEMO) Study Group
HMG CoA	3-hydroxy-3-methylglutaryl coenzyme A
HPRT	Hypoxanthine-guanine phosphoribosyl A transferase
HSP	Henoch-Schonlein purpura
HTN	Hypertension
i.v.	Intravenous
IAH	Intra-abdominal hypertension
IAP	Intra-abdominal pressure
IBW	Ideal body weight
ICU	Intensive care units
IDF	International Diabetes Federation
IDH	Intradialytic hypotension
IDL	Intermediate-density lipoprotein
IDNT	Irbesartan Diabetic Nephropathy Trial
IDPN	Intradialytic parenteral nutrition
IFN	Interferon
IGA	Immunoglobulin A
IgAN	IgA nephropathy
IGF	Insulin-like growth factor
IGF-1	Insulin-like growth factor 1
IGT	Impaired glucose tolerance
IL-6	Interleukin 6

IMN	Idiopathic membranous nephropathy
IPAA	Intraperitoneal amino acid
IPN	Intraperitoneal nutrition
iPTH	Intact parathyroid hormone
IR	Insulin resistance
IRR	Intrarenal reflux
IRS-1	Insulin receptor substrate
ISRNM	International Society of Renal Nutrition and Metabolism
IVH	Intraventricular haemorrhage
JNC	Joint National Committee
JNK	C-Jun N-terminal kinase
K	Potassium
KCl	Potassium chloride
KCNJ1	Potassium voltage-gated channel subfamily J member 1
KDOQI	Kidney Disease Outcomes Quality Initiative
KTR	Kidney transplant recipient
KTU	Kidney transplant unit
LAC diet	Low-antigen-content diet
LBM	Lean body mass
LCAT	Lecithin-cholesterol acyltransferase
LCT	Long-chain triglycerides
LDL	Low-density lipoprotein
LFT	Liver function test
LN	Lupus nephritis
LNAA	Large neutral amino acid
LOH	Loop of Henle
LPD	Low-protein diet
LVF	Left ventricular failure
L VH	Left ventricular hypertrophy
MA	Metabolic acidosis
MAC	Mid-arm circumference
MAP	Mean arterial pressure
MBD	Mineral or bone disorder
MCC	Major comorbid condition
MCD	Minimal-change disease
MCKD	Medullary cystic kidney disease
MCT	Medium-chain triglyceride
MD	Maintenance dialysis
MD	Mean difference
MDRD	Modification of Diet in Renal Disease
MHD	Maintenance haemodialysis
MIA	Malnutrition, inflammation, and atherosclerosis syndrome
MICS	Malnutrition-inflammation complex syndrome
MIS	Malnutrition inflammation score
MM	Metanephric mesenchyme
MMF	Mycophenolate mofetil
Mn	Manganese
MPA AUC	Mycophenolic acid area under curve

mRNA	Messenger ribonucleic acid
MS	Metabolic syndrome
mTorc1	Mammalian target of rapamycin complex 1
MUAC	Mid-upper-arm circumference
MUFA	Monounsaturated fatty acid
MW	Molecular weight
Na	Sodium
NCCT	Non-contrast computerised tomography
NCEP	National Cholesterol Education Programme
NCV	Nerve conduction velocity
ND	Not determined
NEAA	Non-essential amino acids
NECOSAD	Netherlands Cooperative Study on the Adequacy of Dialysis
NF- κ B	Nuclear transcription factor-kappa B
NG	Nasogastric
NHANES	National Health and Nutrition Examination Survey
NICU	Neonatal intensive care unit
NKF	National Kidney Foundation
NKF/KDOQI	National Kidney Foundation/Kidney Disease Outcomes Quality Initiative
NO	Nitric oxide
NODAT	New-onset diabetes after transplantation
NOS	Nitric oxide synthase
nPCR	Normalised protein catabolic rate
NPH	Normal pressure hydrocephalus
nPNA	Normalised protein nitrogen appearance
NPY	Neuropeptide Y
NS	Nephrotic syndrome
NS	Normal saline
NSAIDs	Non-steroidal anti-inflammatory drugs
NTS	Nucleus of the solitary tract
OGTT	Oral glucose tolerance test
OHA	Oral hypoglycaemic agent
OMA	Ocular motor apraxia
ONS	Oral nutritional supplements
P	Phosphorus
PAI-1	Plasminogen activator inhibitor 1
PAL	Physical activity level
PAS	Periodic acid-Schiff
PCR	Protein catabolic rate
PCR	Protein-creatinine ratio
PCT	Proximal convoluted tubule
PD	Peritoneal dialysis
PDCAS	Protein digestibility corrected amino acid score
PDGF	Platelet-derived growth factor
PEM	Protein-energy malnutrition
PEW	Protein-energy wasting
P _{GC}	Glomerular hydrostatic pressure
P _{GC}	Intraglomerular capillary pressure
PGE2	Prostaglandin E2

PH	Primary hyperoxaluria
PH1	Primary hyperoxaluria type 1
Pi	Phytates
PKD	Polycystic kidney disease
PN	Peripheral neuropathy
PNA	Nitrogen appearance
POMC	Pro-opiomelanocortin
PPAR	Peroxisome proliferator-activated receptor
PRPS	Phosphoribosylpyrophosphate synthetase
PTDM	Post-transplant diabetes mellitus
PTH	Parathyroid hormone
PTRA	Percutaneous transluminal renal angioplasty
PUFA	Polyunsaturated fatty acid
PYY	Peptide tyrosine tyrosine
RAAS	Renin-angiotensin-aldosterone system
RAS	Renal artery stenosis
RAS	Renin-angiotensin system
RCT	Randomised controlled trial
RDA	recommended dietary allowance
REE	Resting energy expenditure
REGARDS	Reasons for Geographic and Racial Differences in Stroke
RENAAL	Reduction in End Points in NIDDM with the Angiotensin II Antagonist Losartan
rhGH	Recombinant human growth hormone
RLS	Restless leg syndrome
RN	Reflux nephropathy
RNA	Ribonucleic acid
RNI	Reference nutrient intake
ROS	Reactive oxygen species
RP	Retinitis pigmentosa
RPM6	Transient receptor potential cation channel subfamily M member 6
RR	Relative risk
RRF	Residual renal function
RRT	Renal replacement therapy
RTA	Renal tubular acidosis
S	Stromal cells
S	Sulphur
Sat	Saturated fat
sd	Syndrome
SDS	Standard deviation score
Se	Selenium
SEEK	Screening and Early Evaluation of Kidney Disease
SFA	Saturated fatty acid
SFA/BMI	Subcutaneous fat area/body mass index
SG	Specific gravity
SGA	Subjective Global Assessment
sHPT	Secondary hyperparathyroidism
SHT	Sitting height table
SLC12A1	Solute carrier family 12 member 1