

The nephSAP editorial team and the KSAP editorial board extend their sincere appreciation to the following reviewers. Their efforts and insights help improve the quality of these postgraduate education offerings.

nephSAP Review Panel

Mustafa Ahmad, MD, FASN
King Fahad Medical City
SAUDI ARABIA

Jafar Al-Said, MD, FASN
Bahrain Specialist Hospital
UNITED STATES

Carmichael Angeles, MD, FASN
Pharmaceutical Product Development, LLC
UNITED STATES

Kisra Anis, MD
Jacobi Medical Center, Albert Einstein College of Medicine
UNITED STATES

Naheed Ansari, MD, FASN
Jacobi Medical Center, Albert Einstein College of Medicine
UNITED STATES

Nabeel Aslam, MD, FASN
Mayo Clinic Florida
UNITED STATES

Nisha Bansal, MD, FASN
Kidney Research Institute
UNITED STATES

Krishna M. Baradhi, MD, FASN
University of Oklahoma Health Sciences Center
UNITED STATES

Gopal Basu, MD, MBBS, FASN
The Alfred Hospital
AUSTRALIA

Emmy Klip Bell, MD, MPH
University of Alabama at Birmingham
UNITED STATES

Mona B. Brake, MD, FASN
VA Medical Center
UNITED STATES

Ruth C. Campbell, MD, FASN
Medical University of South Carolina
UNITED STATES

Chia-Ter Chao, MD, PhD, FASN
National Taiwan University Hospital
TAIWAN

Joline L.T. Chen, MD, MS, FASN
University of California, Irvine
UNITED STATES

Karen I. Ching, MD, FASN
Hawaii Permanente Medical Group
UNITED STATES

Armando Coca, MD, MPH
Hospital Clínico Universitario
SPAIN

Scott D. Cohen, MD, MPH, FASN
George Washington University
UNITED STATES

Beatrice P. Concepcion, MD, FASN
Vanderbilt University Medical Center
UNITED STATES

Gabriel Contreras, MD, MPH
University of Miami Health System
UNITED STATES

Patrick Cunningham, MD, FASN
University of Chicago Medical Center
UNITED STATES

Kevin A. Curran, MD
Kevin A. Curran, MD, PA
UNITED STATES

Rajiv K. Dhamija, MD
Rancho Los Amigos National Rehabilitation Center
UNITED STATES

Alejandro Diez, MD, FASN
Ohio State University
UNITED STATES

John J. Doran, MD, FASN
Emory University School of Medicine
UNITED STATES

Lynda A. Frassetto, MD, FASN
University of California San Francisco
UNITED STATES

Tibor Fulop, MD, PhD, FASN
Medical University of South Carolina
UNITED STATES

Duvuru Geetha, MD, FASN
John Hopkins Bayview Medical Center
UNITED STATES

Ilya Glezerman, MD
Memorial Sloan Kettering Cancer Center
UNITED STATES

Carl S. Goldstein, MD, FASN
Medical Diagnostic Associates, PA
UNITED STATES

Steven M. Gorbalkin, MD, PhD, FASN
Emory University School of Medicine
UNITED STATES

Aditi Gupta, MD, FASN
University of Kansas Medical Center
UNITED STATES

Susie L. Hu, MD, FASN
Warren Alpert Medical School of Brown University
UNITED STATES

Ekambaram Ilamathi, MD, FASN
Northwell Health - Southside Hospital
UNITED STATES

Talha Hassan Imam, MD
Kaiser Permanente
UNITED STATES

Joshua Kaplan, MD, FASN
Rutgers New Jersey Medical School
UNITED STATES

Amir Kazory, MD, FASN
University of Florida
UNITED STATES

Quresh T. Khairullah, MD, FASN
St. Clair Nephrology
UNITED STATES

Yong-Lim Kim, MD, PhD
Kyungpook National University Hospital
SOUTH KOREA

Nitin V. Kolhe, MD, FASN
Royal Derby Hospital
UNITED KINGDOM

Farrukh M. Koraishy, MD, PhD, FASN
Stony Brook University New York
UNITED STATES

Eugene C. Kovalik, MD, FASN
Duke University Medical Center
UNITED STATES

Steven W. Kraft, MD
Western Nephrology
UNITED STATES

Vineeta Kumar, MD
University of Alabama at Birmingham
UNITED STATES

Norbert H. Lameire, MD, PhD
University Hospital
BELGIUM

Sheron Latcha, MD, FASN
Memorial Sloan Kettering Cancer Center
UNITED STATES

Vincent W.S. Lee, MBBS, PhD
Westmead Hospital
AUSTRALIA

Paolo Lentini, MD, PhD, FASN
Ospedale San Bassiano, Bassano del Grappa (VI)
ITALY

Tingting Li, MD, MS, FASN
Washington University in St. Louis
UNITED STATES

Orfeas Liangos, MD, DrMed, FASN
Kuratorium für Dialyse und Nierentransplantation
GERMANY

Ajit Mahapatra, MD
The Permanente Medical Group
UNITED STATES

A. Bilal Malik, MD
University of Washington Medical Center
UNITED STATES

Ernest I. Mandel, MD, MS, FASN
Brigham and Women's Hospital
UNITED STATES

Naveed N. Masani, MD, FASN
Winthrop University Hospital
UNITED STATES

Ellen T. McCarthy, MD
University of Kansas Medical Center
UNITED STATES

Kirtida Mistry, MBChB, FASN
US Food and Drug Administration
UNITED STATES

Lawrence S. Moffatt, MD
Charlotte Medical Clinic South Park
UNITED STATES

Thangamani Muthukumar, MD, FASN
*New York Presbyterian Hospital Weill Cornell
Medical Center*
UNITED STATES

Mohanram Narayanan, MD, FASN
Baylor Scott & White Healthcare
UNITED STATES

Macauley A. Onuigbo, MD, MS, MBA, FASN
University of Vermont Medical Center
UNITED STATES

Rosemary Ouseph, MD
St. Louis University
UNITED STATES

Todd E. Pesavento, MD, FASN
Ohio State University Wexner Medical Center
UNITED STATES

Phuong-Thu T. Pham, MD, FASN
UCLA Medical Center
UNITED STATES

Pairach Pintavorn, MD, FASN
East Georgia Kidney Group
UNITED STATES

Roberto Pisoni, MD
Medical University of South Carolina
UNITED STATES

Paul H. Pronovost, MD, FASN
Waterbury Hospital
UNITED STATES

Mohammad A. Quasem, MD
United Health Services Hospitals-Binghamton
UNITED STATES

Wajah Y. Qunibi, MD
University of Texas Health Science Center
UNITED STATES

Pawan K. Rao, MD, FASN
Nephrology Hypertension Associates
UNITED STATES

Hernan Rincon-Choles, MD, MS, FASN
Cleveland Clinic
UNITED STATES

Dario Roccatello, MD
Ospedale San Giovanni Bosco
ITALY

Ehab R. Saad, MA, MD, FASN
Medical College of Wisconsin
UNITED STATES

Mark C. Saddler, MBChB
Durango Nephrology Associates
UNITED STATES

Mohammad N. Saqib, MD
Valley Kidney Specialists, PC
UNITED STATES

Hitesh H. Shah, MD, FASN
Zucker School of Medicine at Hofstra/Northwell
UNITED STATES

Michiko Shimada, MD, PhD, FASN
Hirosaki University
JAPAN

Shayan Shirazian, MD
Winthrop University Hospital
UNITED STATES

Arif Showkat, MD, MBBS, MPH, FASN
University of Tennessee
UNITED STATES

Stephen M. Sozio, MD, FASN
Johns Hopkins University School of Medicine
UNITED STATES

Ignatius Yun-Sang Tang, MD, PharmD, FASN
*University of Illinois Hospital and Health Sciences
System*
UNITED STATES

Ahmad R. Tarakji, MD, FASN
King Saud University
SAUDI ARABIA

Hung-Bin Tsai, MD, MS, PhD
National Taiwan University Hospital
TAIWAN

Kausik Umanath, MD, MS, FASN
Henry Ford Health System
UNITED STATES

Puchimada M. Uthappa, MD, MBBS, FASN
Columbia Asia Hospital, Mysore
INDIA

Anthony M. Valeri, MD
Columbia University Medical Center
UNITED STATES

Allen W. Vander, MD, FASN
Kidney Center of South Louisiana
UNITED STATES

Jon R. Von Visger, MD, PhD
Jacobs School of Medicine & Biomedical Sciences
UNITED STATES

Nand K. Wadhwa, MD, FASN
New York Health Center for Nephrology
UNITED STATES

Connie J. Wang, MD
Hennepin County Medical Center
UNITED STATES

Maura A. Watson, DO, FASN, MPH
Walter Reed National Military Center
UNITED STATES

Dawn F. Wolfgram, MD, FASN
Medical College of Wisconsin
UNITED STATES

Brian Y. Young, MD
UC Davis Medical Center
UNITED STATES

Mario Javier Zarama, MD, FASN
Kidney Specialists of Minnesota
UNITED STATES

Learning Objectives

1. To examine recent scientific advances in our understanding of the pathophysiology of disorders of fluid, electrolytes, and acid-base balance.
2. To review how the understanding of pathophysiology can be applied to the care of patients.
3. To analyze how recent studies related to fluid, electrolyte, and acid-base disorders can be applied to clinical decision making.

Target Audience:

Physicians, scientists, advanced practitioners, nurses, pharmacists, and other health professionals working and training in the field of nephrology.

Accreditation and AMA Credit Designation Statements



JOINTLY ACCREDITED PROVIDER®
INTERPROFESSIONAL CONTINUING EDUCATION

In support of improving patient care, the American Society of Nephrology is jointly accredited by the Accreditation Council for Continuing Medical Education (ACCME), the Accreditation Council for Pharmacy Education (ACPE), and the American Nurses Credentialing Center (ANCC), to provide continuing education for the healthcare team.

The American Society of Nephrology designates this internet activity (enduring material) for a maximum of 10.00 *AMA PRA Category 1 Credits*™. Physicians should claim only the credit commensurate with the extent of their participation in the activity.

ABIM MOC Statement

Successful completion of this CME activity, which includes participation in the evaluation component, enables the participant to earn up to 10.00 MOC points in the American Board of Internal Medicine's (ABIM) Maintenance of Certification (MOC) program. Participants will earn MOC points equivalent to the amount of CME credits claimed for the activity. It is the CME activity provider's responsibility to submit participant completion information to Joint Accreditation for the purpose of granting ABIM MOC credit.

MOC points will be applied to only those ABIM candidates who have enrolled in the MOC program. It is your responsibility to complete the ABIM MOC enrollment process.

Original Release Date

January 2022

CME/MOC Termination Date

December 31, 2023

Examination Available Online

On or before January 30, 2022

Estimated Time for Completion

10 hours

Self-Assessment Examination

- ▶ Answers with explanations are provided with a passing score after the first and/or second attempt.
- ▶ This issue will be archived in January 1, 2024, and answers with explanations will be posted on the ASN website.

Method of Participation

- ▶ Read the entire issue that is supplemented by original articles in the reference lists.
- ▶ Complete the online self-assessment examination.
- ▶ Each participant is allowed **two attempts** to pass the examination (75% correct) for CME and MOC.
- ▶ Upon completion, review your score and incorrect answers and print your certificate.

Activity Evaluation, CME, and MOC

1. Go to the **ASN eLEARNING CENTER** (education.asn-online.org)
2. Select **MY ACTIVITIES** from the left-hand navigation.
3. Select the corresponding issue.
4. Read all information on the Overview screen.
5. Follow the onscreen instructions to:
 - a. Complete the Exam (i.e., post test),
 - b. Complete the Evaluation,
 - c. Claim credit/MOC, and
 - d. Print a Certificate

Your complete ASN Transcript is available on the **ASN eLEARNING CENTER**:

- ▶ Select **TRANSCRIPT** on the left-hand navigation.
- ▶ View course status, credits claimed, or print a certificate for completed learning activities.

System Requirements

Compatible Browser and Software

The nephSAP website (nephsap.org) is formatted for cross-browser functionality and should display correctly in all currently supported web browsers. Individual nephSAP articles are available as dynamic HTML or in Portable Document Format (PDF), which requires Adobe Reader or comparable PDF viewing software.

Monitor Settings

The nephSAP website was designed to be viewed in a 1024 × 768 or higher resolution.

Medium or Combination of Media Used

The media used include content provided online as dynamic HTML or downloadable PDF, in addition to an online evaluation and self-assessment examination.

Technical Support

If you have difficulty viewing any of the pages, please refer to the nephSAP technical support page for possible solutions. If you continue having problems, contact ASN at nephsap@asn-online.org.

ASN Disclosure Policy

It is the policy of American Society of Nephrology (ASN) that all individuals in a position to control the content of ASN's educational activities are expected to disclose all their and their life spouse/partner's financial relationships with "ineligible companies" within the prior 24 months as well as other non-financial interests. ("Ineligible companies" are those whose primary business is producing, marketing, selling, re-selling, or distributing health care products used by or on patients.) Participants should note that the use of products outside U.S. Food and Drug Administration (FDA) approved labeling should be considered experimental and are advised to consult current prescribing information for approval indications.

The intent of this policy is not to prevent expert faculty with relevant relationship(s) with commercial interest(s) from involvement in educational activities, but rather to ensure that these activities promote quality and safety, are effective in improving medical practice, are based on valid content, and are independent of control from commercial interests and free of commercial bias. In addition, all faculty were instructed to provide balanced, scientifically rigorous, and evidence-based presentations.

ASN requires all individuals in a position to control content for this activity to complete disclosure forms on the ASN website. Responses are listed below.

Disclosures have been reviewed and assessed by ASN. All relationships with ineligible companies have been identified and all relevant financial relationships have been mitigated.

EDITORS:

Alice M. Sheridan, MD—*Employer(s)*: Brigham and Women's Hospital; No additional relevant financial relationship(s) with ineligible companies to disclose.

Martina M. McGrath, MBChB, FASN—*Employer(s)*: Brigham and Women's Hospital; VA Boston Medical Center; No additional relevant financial relationship(s) with ineligible companies to disclose.

EDITORIAL AUTHOR:

Julian L. Seifter, MD—No additional relevant financial relationship(s) with ineligible companies to disclose.

AUTHORS:

Robert Jay Alpern, MD—*Employer(s)*: Yale University School of Medicine; *Ownership Interest*: Abbott, AbbVie, Tricida, Apple, Berkshire Hathaway, IBM, Icahn Enterprises, Ford, Intel, Johnson and Johnson, Kraft Heinz, Merck, Pfizer, Verizon, Coca-Cola, UPS, Microsoft, Newell Brands, Organon, Peoples United Financial, Texas Pacific Land Corp, First Trust Nasdaq Bank, T. Rowe Price Real Estate Investor; *Advisory/Leadership Role*: Director of Abbott, AbbVie and Tricida. All are publicly traded for-profit; *Other Interests/Relationships*: Director of NewHYTES, a non-profit that uses tennis and education to help underprivileged children in New Haven.

Tushar Chopra, MD, FASN—*Employer(s)*: University of Virginia Health System; *Patents/Royalties*: UpToDate

Thomas D. DuBose, Jr., MD, FASN—*Employer(s)*: Wake Forest School of Medicine; No additional relevant financial relationship(s) with ineligible companies to disclose.

David H. Ellison, MD, FASN—*Employer(s)*: Oregon Health & Science University, Portland VA Medical Center; *Patents/Royalties*: UpToDate

Namrata Krishnan, MD—*Employer(s)*: Veterans Affairs Medical Center, West Haven, CT; Yale School of Medicine, New Haven, CT; *Advisory/Leadership Role*: Leadership roles within my institution, no outside paid roles; *Other Interests/Relationships*: NKF education committee, KSAP question writing committee.

Ruediger W. Lehrich, MD—*Employer(s)*: Duke University Medical Center; No additional relevant financial relationship(s) with ineligible companies to disclose.

Martina M. McGrath, MBChB, FASN—*Employer(s)*: Brigham and Women's Hospital, VA Boston Medical Center; *Other Interests/Relationships*: Deputy Editor, nephSAP; No additional relevant financial relationship(s) with ineligible companies to disclose.

Solomiia Savedchuk, MD—*Employer(s)*: Duke University; No additional relevant financial relationship(s) with ineligible companies to disclose.

Zhabiz Solhjoui, MD—*Employer(s)*: Brigham and Women's Hospital; *Patents/Royalties*: Microneedle-Based Platform for Simultaneous Local Delivery of Drugs and Interstitial Skin Fluid Sampling for Management of Immune Mediated Skin Diseases; *Other Interests/Relationships*: ASN member

Andrew S. Terker, MD, PhD—*Employer(s)*: Vanderbilt University Medical Center; *Consultancy*: Andrew Terker consultancy fees by Ampio Pharmaceuticals; *Ownership Interest*: Ampio Pharmaceuticals

Naoto Tominaga, MD, PhD—*Employer(s)*: Kawasaki Municipal Tama Hospital; *Research Funding*: Bayer Yakuhin, Ltd.; Chugai Pharmaceutical Co., Ltd.; Kyowa Kirin Co., Ltd.; Mitsubishi Tanabe Pharma Corp.; Otsuka Pharmaceutical Co., Ltd.; Takeda Pharmaceutical Co., Ltd.; Teijin Pharma Co., Ltd.; *Honoraria*: Astellas Pharmaceutical Inc.; Bayer Yakuhin, Ltd.; Baxter Ltd.; Chugai Pharmaceutical Co., Ltd.; Daiichi Sankyo Co., Ltd.; Edwards Lifesciences Corp.; Fuso Pharmaceutical Industries, Ltd.; Kissei Pharmaceutical Co., Ltd.; Kyowa Kirin Co., Ltd.; Mitsubishi Tanabe Pharma Corp.; Mochida Pharmaceutical Co., Ltd.; Otsuka Pharmaceutical Co., Ltd.; Sanwa Kagaku Kenkyusho Co., Ltd.

Joseph G. Verbalis, MD—*Employer(s)*: Georgetown University; *Consultancy*: Corcept, EUSA, Otsuka; *Honoraria*: Corcept, EUSA, Otsuka

ASN STAFF: Suzanne P. Armstrong, MA—*Employer(s)*: American Society of Nephrology; No additional relevant financial relationship(s) with ineligible companies to disclose.

Commercial Support

There is no commercial support for this issue.