AVERY'S NEONATOLOGY BOARD REVIEW

CERTIFICATION AND CLINICAL REFRESHER

PATRICIA R. CHESS

ELSEVIER

Expert CONSULT Built with inkling | E books

Any screen. Any time. Anywhere.

Activate the eBook version
of this title at no additional charge.

Expert Consult eBooks give you the power to browse and find content, view enhanced images, share notes and highlights—both online and offline.

Unlock your eBook today.

1. Visit **expertconsult.inkling.com/redeem**
2. Scratch off your code
3. Type code into "Enter Code" box
4. Click "Redeem"
5. Log in or Sign up
6. Go to "My Library"

It's that easy!

Scan this QR code to redeem your eBook through your mobile device:

Place Peel Off Sticker Here

For technical assistance:
email expertconsult.help@elsevier.com
call 1-800-401-9962 (inside the US)
call +1-314-447-8200 (outside the US)

ELSEVIER

2015v1.0

Avery's Neonatology Board Review

Certification and Clinical Refresher

This page intentionally left blank

Avery's Neonatology Board Review

Certification and Clinical Refresher

FIRST EDITION

Patricia R. Chess, MD

Professor of Pediatrics (Neonatology) and Biomedical Engineering
Director, Neonatal-Perinatal Medicine Fellowship Program
Vice Chair for Education
Golisano Children's Hospital
University of Rochester School of Medicine and Dentistry
Rochester, New York
United States

ELSEVIER

ELSEVIER

1600 John F. Kennedy Blvd.
Ste 1800
Philadelphia, PA 19103-2899

AVERY'S NEONATOLOGY BOARD REVIEW: CERTIFICATION AND CLINICAL REFRESHER, FIRST EDITION ISBN: 978-0-323-54932-5

Library of Congress Control Number: 2019934902

Content Strategist: Sarah Barth
Content Development Specialist: Caroline Dorey-Stein
Publishing Services Manager: Deepthi Unni
Senior Project Manager: Manchu Mohan
Design Direction: Brian Salisbury

Printed in China

Last digit is the print number: 9 8 7 6 5 4 3 2 1

Preface

When preparing for the Neonatal-Perinatal Board exam, it is helpful to utilize a variety of tools. This first edition of *Avery's Neonatology Board Review: Certification and Clinical Refresher*, partner to *Avery's Diseases of the Newborn*, has been created as an aide to neonatologists preparing for their subspecialty boards as well as for neonatologists interested in brushing up on their neonatal knowledge. Additional educational tools are available through the American Academy of Pediatrics, including *Neoreviews*, *Neoreviews-Plus*, and *NeoPREP*. The outline and content are based on the 2016 American Board of Pediatrics Content Outline for Neonatal-Perinatal Medicine. I would like to thank all of the authors and section editors for their contributions to this book.

Acknowledgments

I would like to thank my mentors, my patients and their families, and neonatology fellows past, present, and future, who were the inspiration for creating this book, as well as the authors and section editors, in particular Dr Dylag for providing critical review of the entire book. I would also like to thank my family, especially my husband Mitch, my rock and my wings, and our children, Rachel, Laura, Daniel, and Stephen, and grandchildren Jaimie and Evan, our greatest joy.

Notice

Contributors

Rebecca Abell, DO
Assistant Professor of Pediatrics
Division of Pediatric Gastroenterology
University of Rochester School of Medicine and Dentistry, Rochester
New York
United States

Jeffrey R. Andolina, MD, MS
Associate Professor of Pediatrics
Division of Pediatric Hematology and Oncology
University of Rochester School of Medicine and Dentistry, Rochester
New York
United States

Georgianne Lee Arnold, MD, MS
Professor of Pediatrics and Medicine
Division of Medical Genetics
University of Pittsburgh Medical Center, Pittsburgh
Pennsylvania
United States

Sonia Lomeli Bonifacio, MD
Clinical Associate Professor of Pediatrics
Division of Neonatal & Developmental Medicine
Stanford University School of Medicine, Palo Alto
California
United States

Jennifer Burnsed, MD, MS
Assistant Professor of Pediatrics
Division of Neonatology
University of Virginia, Charlottesville
Virginia
United States

Melissa Carmen, MD
Assistant Professor of Pediatrics
Division of Neonatology
University of Rochester School of Medicine and Dentistry, Rochester
New York
United States

Mitchell Chess, MD
Associate Professor of Imaging Sciences
Division of Pediatric Diagnostic Imaging
University of Rochester School of Medicine and Dentistry, Rochester
New York
United States

Patricia R. Chess, MD
Professor of Pediatrics and Biomedical Engineering
Division of Neonatology
University of Rochester School of Medicine and Dentistry, Rochester
New York
United States

Bernard A. Cohen, MD
Professor of Pediatrics and Dermatology
Division of Pediatric Dermatology
Johns Hopkins Children's Center, Baltimore
Maryland
United States

Carl T. D'Angio, MD
Professor of Pediatrics and Medical Humanities and Bioethics
Division of Neonatology
University of Rochester School of Medicine and Dentistry, Rochester
New York
United States

Rita Dadiz, DO
Associate Professor of Pediatrics
Division of Neonatology
University of Rochester School of Medicine and Dentistry, Rochester
New York
United States

Andrew Dylag, MD
Assistant Professor of Pediatrics
Division of Neonatology
University of Rochester School of Medicine and Dentistry Rochester
New York
United States

Alison Falck, MD
Clinical Assistant Professor of Pediatrics
Division of Neonatology
University of Maryland, Baltimore
Maryland
United States

Emer Finan, MB, DCH, MEd
Assistant Professor of Pediatrics
Division of Neonatology
Mount Sinai Hospital, Toronto
Ontario
Canada

Megan E. Gabel, MD
Assistant Professor of Pediatrics
Division of Pediatric Gastroenterology
University of Rochester School of Medicine and Dentistry, Rochester
New York
United States

Matthew Gearinger, MD
Associate Professor of Ophthalmology and Pediatrics
Division of Pediatric Ophthalmology
Flaum Eye Institute, University of Rochester School of Medicine and Dentistry, Rochester
New York
United States

Kelly Gibson, MD
Assistant Professor of OB/GYN
Division of Maternal Fetal Medicine
Case Western Reserve University School of Medicine
Cleveland
Ohio
United States

J. Christopher Glantz, MD, MPH
Professor of OBGYN and Public Health Sciences
Division of Maternal Fetal Medicine
University of Rochester School of Medicine and Dentistry, Rochester
New York
United States

Lisa M. Gray, MD
Assistant Professor of Obstetrics and Gynecology
Division of Maternal Fetal Medicine
University of Rochester School of Medicine and Dentistry, Rochester
New York
United States

Ronnie Guillet, MD, PhD
Professor of Pediatrics
Division of Neonatology
University of Rochester School of Medicine and Dentistry, Rochester
New York
United States

Benjamin Hammond, MD
Assistant Professor of Ophthalmology
Division of Ophthalmology
Flaum Eye Institute - University of Rochester School of Medicine and Dentistry, Rochester
New York
United States

Catherine K. Hart, MD, MS
Associate Professor of Otolaryngology
Division of Pediatric Otolaryngology Head and Neck Surgery
Cincinnati Children's Hospital Medical Center, University of Cincinnati College of Medicine, Cincinnati
Ohio
United States

Marlyse Haward, MD
Assistant Professor of Pediatrics
Division of Neonatology
Albert Einstein College of Medicine; Children's Hospital at Montefiore, Bronx
New York
United States

William W. Hay Jr., MD
Professor of Pediatrics
Division of Neonatology
University of Colorado School of Medicine, Aurora
Colorado
United States

Kendra Hendrickson, MS
Dietitian
Neonatal Intensive Care
University of Colorado Hospital, Aurora
Colorado
United States

Narayan Prabhu Iyer, MBBS, MD
Assistant Professor of Clinical Pediatrics, Fetal and Neonatal Institute
Division of Neonatology, Children's Hospital Los Angeles
Keck School of Medicine, University of Southern California, Los Angeles
California
United States

Annie Janvier, MD, PhD
Associate Professor of Pediatrics
Division of Neonatology, Clinical Ethics, Palliative Care
University of Montreal, CHU Sainte-Justine, Montreal
Quebec
Canada

Deepak Kumar, MD
Professor of Pediatrics
Division of Neonatology
Case Western Reserve University, MetroHealth Medical Center, Cleveland
Ohio
United States

Echezona Maduekwe, MD, DCH (RCPI)
Assistant Professor of Pediatrics
Division of Neonatology
Stony Brook Children's Hospital, Stony Brook
New York
United States

William Maniscalco, MD
Professor of Pediatrics
Division of Neonatology
University of Rochester School of Medicine and Dentistry, Rochester
New York
United States

Tracey L. McCollum, Pharm.D.
Pediatric Clinical Pharmacist
Department of Pharmacy
University of Rochester Medical Center/Golisano Children's Hospital, Rochester
New York
United States

Thornton Mu, MD
Associate Professor of Pediatrics
Division of Neonatology
Uniformed Services University of the Health Sciences
Brooke Army Medical Center
Joint Base San Antonio, Fort Sam Houston, Texas
United States

Niranjana Natarajan, MD
Assistant Professor Department of Neurology
Division of Child Neurology
University of Washington, Seattle
Washington
United States

Tola Oyesanya, MD
Department of Dermatology
Kaiser Permanente Mid-Atlantic Permanente Medical Group, Rockville
Maryland
United States

Allison H. Payne, MD, MS
Assistant Professor of Pediatrics
Division of Neonatology
Rainbow Babies and Children's Hospitals/Case Western Reserve University, Cleveland
Ohio
United States

Laura Price, MD
Assistant Professor of Pediatrics
Division of Neonatology
University of Rochester School of Medicine and Dentistry, Rochester
New York
United States

Erin Rademacher, MD, MS
Assistant Professor of Pediatrics
Division of Pediatric Nephrology
University of Rochester School of Medicine and Dentistry, Rochester
New York
United States

Aarti Raghavan, MD
Associate Professor of Clinical Pediatrics
Division of Neonatology
University of Illinois at Chicago, Chicago
Illinois
United States

Vicki Roth, MS
Assistant Dean and Executive Director
Center for Excellence in Teaching & Learning
University of Rochester, Rochester
New York
United States

Kristin Scheible, MD
Assistant Professor of Pediatrics
Division of Neonatology
University of Rochester School of Medicine and Dentistry, Rochester
New York
United States

Jacqueline Selph, MD
Resident Physician
Department of Dermatology
Johns Hopkins University, Baltimore
Maryland
United States

Jotishna Sharma, MD, MEd
Associate Professor of Pediatrics
Division of Neonatology
University of Missouri- Kansas City School of Medicine, Children's Mercy Hospital, Kansas City
Missouri
United States

Christina Sollinger, MD
Assistant Professor of Pediatrics
Division of Neonatology
University of Rochester School of Medicine and Dentistry Rochester
New York
United States

Laurie Steiner, MD
Associate Professor of Pediatrics
Division of Neonatology
University of Rochester School of Medicine and Dentistry, Rochester
New York
United States

Kimberly Vera, MD, MSCI
Assistant Professor of Pediatrics
Division of Pediatric Cardiology
Vanderbilt University, Nashville
Tennessee
United States

David R. Weber, MD, MSCE
Assistant Professor of Pediatrics
Division of Pediatric Endocrinology
University of Rochester School of Medicine and Dentistry, Rochester
New York
United States

Geoffrey A. Weinberg, MD
Professor of Pediatrics
Division of Pediatric Infectious Diseases
University of Rochester School of Medicine & Dentistry, Rochester
New York
United States

Lyndy Wilcox, MD
Assistant Professor
Division of Pediatric Otolaryngology
Monroe Carell Jr Children's Hospital
Vanderbilt University, Nashville
Tennessee
United States

The authors, publishers and editor would like to thank the following section editors for carefully reviewing their associated section chapters, listed as follows, and for Dr Dylag for reviewing the entire book:

Section	Section Editors
Respiratory, Dermatology	Andrew Dylag
Cardiovascular, Ethics	Christina Sollinger
Neurology, Neurodevelopment	Ronnie Guillet
Eye, Ear, Nose and Throat, Nutrition	Jotishna Sharma
Pharmacology, Hematology and Oncology, Bilirubin	Deepak Kumar
Asphyxia, Genetics, Infectious diseases, Immunology	Thornton Mu
Renal, Endocrinology, Scholarly activity, Gastroenterology	Alison Falck
Maternal Fetal Medicine	Kelly Gibson

Contents

Avery's Neonatology Board Review

Certification and Clinical Refresher

This page intentionally left blank

1 Maximizing Test Performance

VICKI ROTH

Before Beginning Your Review

- Completing a self-assessment
  - Prior to the date you intend to begin your studies, take stock of your initial preparedness. Using the content outline for this exam, create a quick chart rating your fund of knowledge and experience with each topic.
  - As you know, the topics on this exam tap into a range of learning approaches (e.g., visual and quantitative learning, simultaneous vs. sequential reasoning, memorization vs. conceptual thinking, etc.). So, in addition to rating your readiness by topic, a good self-assessment also includes a brief evaluation of your preferences, strengths, and weaknesses as a learner. (More on this issue later.)

TIP: If you will not be attending an in-person review course that includes a self-assessment, use a portion of the items in your question bank to create your own pretest.

- Building a study map
  - A study map ensures that all topics are addressed well and that appropriate review strategies are employed for each one. A study map also makes life easier, as the decisions about what to study in a given week are front loaded.
  - A well-constructed study map begins with time finding. Short bursts of study time can appear spontaneously during the day; when they do, be prepared to use them (see "Deciding where to study" below But more extensive periods of review time are needed, too, and finding them usually requires some detective work.
  - In addition to the start date for your study and your anticipated exam date, an effective map also includes the following elements:
    - Specific dates for the review of each topic
    - Dates for catch-up study sessions
      - Catch-up hours are earmarked for study but have no assigned topic until close to the study-session dates.
        - Catch-up hours make room for study when other work or life commitments have interfered with your map. They also provide opportunities for additional study of topics that prove to be more challenging than expected.
        - Candidates often significantly underestimate the number of catch-up study hours needed, so it is advisable to include many such sessions in the study map right from the beginning.
    - Dates for loop-back sessions
      - Loop-backs are brief and lightweight study periods designed to reconnect with material that you examined in more detail 1–2 weeks earlier. The goal of these study periods is to improve the student's ability to retrieve information across time and to reduce anxiety about retaining information that has already been studied.
  - Creating a map with the features described here requires about 1.5–2 hours.

TIP: Given the density and volume of material to review, it is easy to build ambitious study maps that are impossible to maintain. A good plan is one that takes into account the practical requirements of your other responsibilities (i.e., make a map that is livable).

TIP: If you have a disability that qualifies for testing accommodations under the Americans with Disabilities Amendments Act and you intend to seek an accommodation, your map should include the time needed to complete the request process.

- Assembling your study kit
  - Just as we are more likely to go to the fitness center for a workout if we pack a gym bag the night before, we make better use of our study time if we collect and organize a set of review material in advance.
  - To prevent a scattered approach to study, it often works best to think of your study materials in three layers:
    - The first is your set of central resources, like this text, that can provide the overall foundation for your review.
    - The second layer might include several resources, perhaps ones you already own, that you turn to for short, detailed study of specific subtopics that need more attention. These first two layers should provide most of the resources needed for your study.
    - The third layer of materials is only for limited occasions when you encounter a persistently difficult subtopic that needs to be looked at from another angle. It is likely you already possess much of what is needed for this third layer as well.
  - For your study kit, also collect other materials including a notebook or portfolio, paper flashcards and/or a flashcard application, markers, etc. In addition, if you will not have easy access to a white board during your study sessions, consider purchasing a large sketchpad.
- Deciding where to study
  - When you find yourself with a few moments prior to a meeting or while waiting in a queue, make use of this time by having quick-review materials close at hand (e.g., review notes on your phone or a deck of flashcards

in your pocket). In these cases, deciding where to study is not a priority; rather, the goal is to benefit from these slivers of time when and wherever they appear. A fair bit of learning is additive, meaning that we take on about a flashcard's worth of information at a time. So, use these short study interludes during your day, even if your location is not ideal.
- However, planning for longer sessions should include decisions about study locations. It may be simpler to study in a single accessible location, but this can be a suboptimal approach for board review. As we study, elements of our environment, such as the type of lighting or the color of the walls, can become embedded with the target information. Later on, when those environmental cues are no longer present, retrieval can then be more difficult than anticipated. Changing study locations from time-to-time helps build the geographic independence that allows you to remember concepts and details, regardless of where you are.

TIP: Sometimes the only plausible place to work on your board review is in your own home. When this is the case, set up a place to study that is dedicated solely for this purpose.
TIP: As you will not have control over the environmental conditions of your actual test location, consider working at times in a location that includes a slightly uncomfortable feature. For example, study for a few sessions in a chilly room, if air conditioning annoys you; in a room with fluorescent bulbs, if that type of lighting is irksome; and so on. This practice will help you plan ahead (e.g., by dressing in layers) or at least will build your capacity to cope with any irritating conditions in the testing room.

The Review Itself

- For each group of concepts and facts, make sure that your study approaches include all three stages of the learning cycle: input, quizzing, and testing steps.
  - The *input step* employs reading, listening, and watching study materials, such as texts and review guides, podcasts, lectures, and videos.
    - While you are engaged with these input activities, you are likely to be jotting something down. It may feel as if writing and drawing should cement your learning, but the making of study tools such as flashcards, charts, diagrams, and concept maps—while all good options—largely still fits within this first step of the learning cycle. It is true that creating a study tool requires selectivity about what you write down and the use of your own words or images, but just creating study tools is typically not enough. It is likely that your retention of the materials written in these study tools will be less than expected.
  - So, within each session, stop periodically to examine your retention of the material you have taken in during the input step. The essential feature of this *quizzing step* is asking yourself questions and then immediately checking the accuracy of your responses. Easy ways to complete this step include reviewing any flashcards you have just created and generating questions from the rows and columns of the charts you have made.
    - During this stage of the learning cycle, special attention should be paid to the power of drawing. A great deal of the material you need to review is visual and sequential in nature, so quickly made illustrations, flowcharts, and concept maps are effective ways to rehearse this material.
    - Do not spend time making artistically sophisticated illustrations and charts, however. The goal is to sketch out your ideas quickly from memory and then check your work.
  - During the *testing step*, set up conditions that simulate some elements of the actual exam. While completing practice questions, add time limits and refrain from stopping in-between questions to check your answers. More information about this step can be found in the "Practice question review" section, later.

TIP: Given the amount of material you have to review, it can seem more productive to complete extensive swaths of input activities before turning to the quizzing or testing steps of the learning cycle. Resist the impulse to just remain in the input stage by remembering how productivity is calculated. Getting the optimal amount of output for the amount of input you invest is your goal; this typically requires frequent toggling between the three stages of the learning cycle.
TIP: At intervals, add a self-check about the learning cycle to your study map. As time goes on, it is easy for the balance among these steps to become skewed. A common issue, for instance, is to lapse into an approach dominated by one of the stages of the learning cycle (e.g., just reading or just doing practice questions). While it is not necessary to allocate an exact one-third of study time to each of the stages, it works best if some attention is paid to all three for each set of concepts and facts.

- Pacing yourself
  - As mentioned, brief units of study time can be valuable, but some longer study sessions are also essential for adequate preparation. However, at times it can be difficult to maintain full engagement with your review materials during these more extensive sessions. Appropriate pacing helps to offset exhaustion and distraction.
  - A recommended rhythm for longer sessions includes studying in about 50-minute periods followed by 10-minute breaks. To help you stay on track, use a timer on your phone for both the learning and the break portions of your study.
  - The nature of the mini-breaks has more influence than you might initially think. "Negative" breaks can lead to reduced concentration in the next cycle, while "positive" ones work in your favor.
  - Negative breaks are those that introduce other agendas, even those that are entertaining. So, avoid using the 10-minute breaks to check messages, make calls, watch videos, surf the Internet, watch television, and the like. Nobody concludes such breaks feeling energized and ready to take on the next learning challenge. (It may be that your work and family obligations require you to take messages, but the time devoted to these duties should not be counted as mini-breaks.)
  - Positive mini-breaks are those that allow you to recenter for a few minutes. A light snack, a few minutes of

stretching, a quick walk around the block, listening to a favorite song—all of these can help you get ready for the next 50 minutes of study, and they neatly fit within the recommended 10-minute time frame.

TIP: Because you are so pressed for time in general, you may have developed an approach to work that propels you through long sessions without stopping. If so, keep in mind that this work habit leads to diminishing returns during board review sessions. Let yourself take those short breaks so your learning can become consolidated.

TIP: The 50:10-minute study cycle dovetails well with the steps of the learning cycle described earlier. For instance, you might designate the first 50 minutes for input practice by reading a text, taking a short break next, and then going on to a 50-minute period of quizzing yourself about the material you just read. Another helpful pattern is to devote your first session of the day to timed questions about the material studied earlier that week. Subsequent 50-minute sessions can include the input, quizzing, and testing pattern with new material.

Reviewing Practice Questions

This section details how to make the best use of the testing stage of the learning cycle. To efficiently process a group of timed questions that you have already completed, try labeling each of your answers as follows:

A. *A correct answer that was easy for you to get right.* Some review of the explanatory material provided for the wrong answers can be helpful, but keep this part of your review light so you can devote sufficient time to the following answer categories.

B. *A correct answer that required more effort for to achieve.* To clarify, this category is for questions that made you hesitate because you had difficulty recalling the required information. You may have been able to narrow down the answers to two choices, and, in this case, you selected the correct one.

The most efficient way to make use of such items for further review is to answer this question:

What would I have known if I had been able to answer this question easily?

This question helps you zero in on the precise information or steps in reasoning that you need to practice.

C. A correct answer that you selected for the wrong reason or through a lucky guess. Treat these like wrong answers as per D, E, and F below.

D. *An item you got wrong because you never knew the needed information.* For these questions, sometimes the explanations provided in the answer key are enough to master the subject at hand. However, some of the time, you need to read additional material. In these cases, it is smart to assign a value to the concept to be reviewed, and then set a timer accordingly. For instance, you may have missed a question that reveals a gap in your knowledge base that would take about 10 minutes to remediate, while another topic might require 20 minutes of work. Timing these extra reviews helps you return to your original task promptly. (If you uncover the need for extensive review of a topic, it is often a good idea to move this larger unit of study to one of the upcoming catch-up periods that you have scheduled on your study map.)

E. *An item that you got wrong because you partially knew the needed information.* This category is the flipside of (B), that is, you may have been able to make some headway toward the answer, but you were unable to pinpoint the correct choice. Again, the strategy here is to look for those small elements of information that would allow you to answer a question on this topic correctly in the future.

F. *An item that you got wrong because of a misconception about the topic.* This category differs from (D) and (E) above in that the learner believes something to be true, when in fact it is not. For instance, many young students believe that plants increase in mass by taking it up from the soil; while others think that seasonal changes in temperature result from an increase or decrease in Earth's proximity to the sun. While you undoubtedly understand carbon fixation and the tilt of Earth's axis, we all have errors in our overall base of knowledge. However diligent we may be, our own misconceptions can be difficult to spot. A clue that a misconception might be in play can be found when we answer items incorrectly, but the correct answers do not make sense, even after careful review. An efficient way to remedy misconceptions is to work collaboratively with a study partner. More on this next.

More Advice

- Studying with a colleague.
  - While finding time to review board material with a colleague can be an issue, the payoff can be significant. In addition to rooting out misconceptions, these sessions can provide the chance for needed repetition and a motivational boost.
  - It is optimal during these sessions for the person who knows the least about a given subtopic to explain what he or she can, and then to allow the other to make additions and corrections.
  - Use Skype or other videoconferencing applications when in-person sessions are not practical.
- Visiting the testing center
  - If this will be your first time taking an exam at the testing center where you are registered, plan a visit to this location. This will allow you to gauge more accurately the time needed to get there, to check out parking options, and to appraise the location where the test will be taking place.
- Attending to diet, sleep, and exercise
  - Also essential is finding time for a reasonable level of self-care. Because reviewing for this exam adds to your workday, it is easy to let nutrition, rest, and exercise fall by the wayside. However, both the review process and the exam itself require stamina, so looking after your well-being is part of good preparation.
  - Self-care does not need to be perfect to be good. If you are not able to fit in an entire workout routine, for example, then a brisk walk can still be beneficial. Similarly, while long sessions of home cooking might not fit into your day, making better choices at the hospital cafeteria is probably doable.

- The goal of the day before the test date is to set up conditions that optimize knowledge retrieval during the exam. So, do not use this day trying to force in one last set of facts or asking yourself to answer another set of practice questions. Instead, to the extent your work and family duties allow, make this a day for light activity and rest.

- Thinking positively
  - As sports psychologists know, the way we visualize our future performance has an impact on how we ultimately do. So as the exam gets closer, try these positive images:
    - recalling a prior time when you did well on a challenging exam;
    - imagining a question on your upcoming board exam that you do not answer with full confidence, shaking it off, and continuing onto the next item;
    - picturing success with a complicated question;
    - visualizing yourself dispelling nervousness by using short relaxation strategies;
    - imagining yourself answering the last question on the exam knowing that you had acquitted yourself well overall;
    - picturing yourself walking out of the testing center knowing that this was a successful day.

SECTION 1

Maternal-Fetal Medicine

J. CHRISTOPHER GLANTZ and LISA M. GRAY

2 Pregnancy

J. CHRISTOPHER GLANTZ and LISA M. GRAY

Maternal Adaptation to Pregnancy

- Hemodynamic
  - Plasma volume increases 50% while red blood cell (RBC) mass expands 20%; physiologic anemia of pregnancy
  - Heart size increases 10% (hypertrophy and increased diastolic filling)
  - Stroke volume and heart rate increase; 50% increase in cardiac output
  - When supine and ≥20 weeks, uterine compression of the vena cava lowers venous return and cardiac output, causing hypotension
  - Uterine blood flow increases 10-fold to ≈1 L/min
  - Systemic vascular resistance declines (progesterone, prostaglandin, angiotensin resistance, and shunting through low-resistance placenta)
  - Diastolic blood pressure (BP) declines 10 mm Hg by 20 weeks, then gradually increases back to baseline
- Renal
  - Renal blood flow and glomerular filtration rate increase by 50%
  - Serum urea nitrogen and creatinine levels decrease by 40%
  - Glucose load exceeds loop reabsorption, causing glycosuria
  - Dilation of renal calyces and ureters; "physiologic" hydronephrosis is common (right > left due to uterine dextrorotation)
  - Glycosuria plus urine stasis increase the risk of pyelonephritis
- Respiratory
  - Minimal change in respiratory rate but increase in tidal volume causes increased minute ventilation (no change in FEV_1 (Forced Expiratory Volume (in one second) or forced vital capacity)
  - Hyperventilation raises Po_2 (Partial pressure of oxygen) and lowers Pco_2 (partial pressure of carbon dioxide); improves maternal-fetal gradients
  - Compensatory increased renal bicarbonate excretion maintains pH and avoids respiratory alkalosis
  - Decreased functional reserve capacity increases susceptibility to hypoxia
- Hematologic
  - Increased thrombogenesis + decreased thrombolysis = hypercoagulable
  - Venous thromboembolism (VTE) risk increased five-fold
  - White blood cell (WBC) count increases; mild thrombocytopenia common
- Endocrine
  - Placental hormones alter maternal metabolism; increased fatty acid metabolism + insulin resistance = more glucose available to fetus
  - Steroid hormone synthesis increases
  - Estrogen induces production of thyroid-binding globulin; increased total thyroid hormone levels, but free levels are unchanged
- Gastrointestinal
  - Gastrointestinal motility is slowed; increases nutrient-water absorption
  - Nausea, vomiting, and constipation are common
- Changes in laboratory values
  - Increased: steroid hormones, prolactin, total T_4, WBC, alkaline phosphatase (from placental production), lipids, coagulation factors, PO_2
  - Decreased: hematocrit (Hct), platelets, creatinine, blood urea nitrogen (BUN), glucose, sodium, calcium (total but not ionized), bicarbonate, Pco_2
  - No change: free thyroxine (T_4), transaminases, bilirubin, prothrombin time (PT), partial thromboplastin time (PTT), bleeding time

THE PLACENTA

- Morphology and development
  - Trophoblast derived from extraembryonic cells in blastocyst
    - Cytotrophoblast: cells extend into decidua to anchor villi and invade maternal spiral arteries, dilating them to improve flow
    - Syncytiotrophoblast: a "shell" of fused cytotrophoblasts
  - Progressive placental growth increases cross-sectional vascular area and lowers placental vascular resistance
  - Hemochorial architecture
    - Maternal blood in direct contact with fetal chorion (not fetal blood)
    - Villi containing fetal blood vessels project into intervillous spaces
- Respiratory gas exchange
  - Efficient transfer of respiratory gases by simple diffusion along gradients
  - Fetal hemoglobin has higher affinity for O_2 than maternal hemoglobin; preferentially offloads O_2 to the fetus
  - Transfer is flow-dependent; gas exchange is limited by maternal uterine vascular disease, hypotension, hypovolemia, infection, placental infarction, abruption, or hypoplasia.

- Placental transport: substances cross via different mechanisms based on size, lipid solubility, protein binding, and presence of transporters
  - Simple diffusion: respiratory gases, small nonpolar molecules
  - Facilitated diffusion: glucose, some glucocorticoids
  - Channels: water and some ions
  - Active transport: sodium, potassium, amino acids, proteins
  - Receptor-mediated endocytosis: low-density lipoproteins (LDLs) and iron
- Metabolism and endocrine function
  - Fetus has limited gluconeogenesis; most glucose is maternally derived
  - Human placental lactogen and placental growth hormone stimulate maternal lipolysis and gluconeogenesis, increasing glucose levels for fetal use
- Abnormal placentation
  - Poor trophoblast invasion is associated with fetal loss and preeclampsia
  - Excessive or abnormal trophoblast invasion causes placenta accreta/percreta

MULTIFETAL GESTATIONS

- Zygosity (number of ova fertilized):
  - Monozygous = one ovum; multizygous = more than one ovum (most common)
- Chorionicity (number of placentas) and amnionicity (number of sacs) are determined by zygosity and/or time of conceptus split.
  - Multizygous: each fetus has its own placenta and sac
  - Monozygous with splitting in:
    - 1–3 days: each fetus has its own placenta and amniotic sac
    - 3–8 days: shared placenta (monochorionic) but two amniotic sacs
    - 8–13 days: shared placenta and sac (monoamniotic)
    - >13 days: conjoined twins
- Multifetal gestations are associated with adverse infant outcomes.
  - Anomalies, aneuploidy, stillbirth, preterm delivery (PTD), fetal (intrauterine) growth restriction (IUGR), preterm premature rupture of membranes (PPROM), perinatal death, intraventricular hemorrhage (IVH), and periventricular leukomalacia

ASSISTED REPRODUCTIVE TECHNOLOGY (ASSISTANCE WHEN INFERTILE)

- Ovulation induction
  - Medications used to improve ovulation when egg quality is normal
  - Use of clomiphene citrate or letrozole has 8%–10% twinning risk
  - Use of injectable gonadotropins has increased risk of high-order multiples
- Intrauterine insemination (partner or donor)
  - Bypasses cervix in cases of abnormal sperm count
  - Not independently associated with increased risk of multifetal gestation
  - Unrelated donor used if male factor infertility or to avoid inherited disease
- In vitro fertilization (IVF)
  - Process
    - Injectable gonadotropins stimulate multiple ovarian follicles
    - Eggs are harvested via ultrasound-guided transvaginal aspiration
    - Eggs and sperm are mixed in vitro
    - Conceptus is incubated and then transferred into the uterus
  - May use unrelated egg donor to address premature ovarian failure or poor egg quality, or to avoid inherited disease
  - IVF is an independent risk factor for
    - Multifetal gestation risk related to number of embryos transferred
    - Aneuploidy, fetal anomalies, hypertensive disorders of pregnancy, IUGR, PTD, abnormal placentation, cesarean delivery

Prenatal Care

PRECONCEPTION CARE

- Maternal health optimization before pregnancy improves perinatal outcomes
  - Control chronic medical conditions: discontinue teratogenic medications
  - Screen for relative contraindications to pregnancy (e.g., severe renal insufficiency, certain cardiac conditions)
- Reproductive planning
  - Avoid short interpregnancy interval (delivery to next conception <18 months)
  - Contraception until health is optimized
- Testing and immunization
  - Sexually transmitted infection (STI) screening and treatment
  - Update needed immunizations
  - Expanded genetic carrier screening for high-risk groups (e.g., Ashkenazi Jews, French Canadian, Mediterranean, Southeast Asian)
- Substance use and teratogens
  - Counsel on smoking cessation
  - Avoid teratogens and illicit substance use (refer for treatment)
- Nutrition and dietary supplementation
  - Reduce excess body weight: healthy diet (refer for nutrition consultation), regular exercise, bariatric surgery (if appropriate)
  - 400 μg folic acid started 1-month preconception decreases rate of open neural tube defects (ONTDs); 4 mg daily for women with prior defect
  - Assess diet and consider supplementation to achieve recommended daily doses of calcium, vitamin D, iron, and other vitamins and minerals as needed

INITIAL PRENATAL VISIT

- Establish prenatal care in first trimester
- Complete history and risk assessment
  - Medical, obstetrics and gynecology (OB/GYN), family, genetic, and social history
  - Medication use, substance use and abuse, domestic violence
- Determination of gestational age (GA), estimated due date (EDD)
  - Menstrual history, uterine size, and ultrasound (if discrepant findings)
  - Accurate GA vital, especially if possible PTD, IUGR, or postdates
- Physical examination; routine prenatal laboratory tests
  - Complete blood count (CBC)
  - Blood typing and antibody screening
  - STI screening: serology for rubella, syphilis, hepatitis B surface antigen, human immunodeficiency virus (HIV); chlamydia and gonorrhea testing
  - Urinalysis and culture
- Possible additional laboratory tests
  - Cystic fibrosis carrier testing, hemoglobin electrophoresis (if at risk for hemoglobinopathy), hepatitis C, urine drug screening

SUBSEQUENT PRENATAL VISITS

- Monthly until 28 weeks, then every other week to 36 weeks, then weekly
  - Weight, BP, urine protein and glucose levels, fundal height, fetal heart rate (FHR)
  - Assess for signs and symptoms of labor, hypertensive disorders, or abnormal fetal growth.

OTHER ROUTINE ASSESSMENTS AND INTERVENTIONS

- Aneuploidy screening
  - Low-risk patients: first-trimester screen at 11–13 weeks or second-trimester (quad screen) at 14–22 weeks
  - High-risk patients (maternal age ≥35 years, prior aneuploidy, abnormal serum screening, ultrasound): cell-free DNA analysis at ≥10 weeks
  - Diagnostic testing: chorionic villus sampling (CVS) at 10–13 weeks, amniocentesis at ≥15 weeks
- Maternal serum alpha fetoprotein (AFP) screening at 14–22 weeks
- Fetal anatomy ultrasound at 18–20 weeks
- Gestational diabetes (GDM) screening at 24–28 weeks
- Repeat antibody screen at 28 weeks if Rh-negative; Rh immune globulin administration
- Immunizations
  - Hepatitis B: all susceptible women
  - Hepatitis A: if hepatitis B or C positive (+)
  - Influenza: all women in every pregnancy
  - Tdap: all women after 27 weeks in every pregnancy
  - Pneumococcal or meningococcal: HIV+, sickle cell disease, or asplenia
- Group B streptococcus (GBS) culture at 35–37 weeks

Pregnancy Complications

MATERNAL HEALTH CONDITIONS

- Obesity: prevalence in women of reproductive age is ≈30%; ≈60% when overweight and obese categories are combined
  - Confers increased maternal risk proportional to body mass index
  - Maternal effects: hypertension, GDM, cesarean delivery (intraoperative and postoperative complications), venous thromboembolism (VTE)
  - Fetal effects: miscarriage, stillbirth, birth defects (particularly neural tube and cardiac), macrosomia
  - Management
    - Weight loss (or bariatric surgery) prior to conception
    - Early screening for gestational diabetes (GDM)
    - Fetal surveillance to monitor growth (fundal heights are unreliable)
- Diabetes mellitus (DM)
  - Complicates ≈6%–10% of pregnancies (90% GDM)
  - Pregestational DM
    - May have comorbid renal, cardiovascular, and neurologic disease that worsen perinatal outcome
    - Risk of complications proportional to degree of glycemic control and comorbid conditions
  - Gestational DM
    - Lower risk of complications than pregestational DM
    - Early screening diagnoses likely represent previously undiagnosed type 2 DM (although still characterized as gestational)
  - Maternal effects of DM
    - Hypertension, delivery lacerations, hemorrhage, cesarean delivery
  - Fetal effects of DM
    - Pregestational DM only: miscarriage, stillbirth, and birth defects (especially heart and ONTD)
    - Any DM: fetal growth disorders (usually macrosomia), cardiomyopathy, birth injury, neonatal metabolic abnormalities, respiratory distress syndrome (RDS)
  - Management
    - Nutritional counseling to attempt dietary control
    - Achieve glycemic control: blood glucose (BG) checks—qid
      - Fasting BG < 95 mg/dL
      - 1-hour postprandial BG < 140 mg/dL
      - Metformin, glyburide, or insulin if diet fails
    - Fetal evaluation
      - Targeted anatomic ultrasound; echocardiography for pregestational diabetics
      - Fetal surveillance (ultrasound to monitor growth and antepartum testing to monitor fetal oxygenation; note that this will be referred to as "fetal surveillance" from now on)
      - Delivery timing determined by degree of glycemic control
        - Gestational with good control: 40 weeks
        - Pregestational with good control: 39 weeks
        - Poor control: typically 37–38 weeks
      - Cesarean if estimated fetal weight (EFW) >4500 g; twice the risk of shoulder dystocia compared with the same EFW without DM

- Hypertensive disease
  - Complicates ≈10% of pregnancies
  - Chronic hypertension (CHTN)
    - Hypertension preceding conception or noted before 20 weeks
    - At risk for superimposed preeclampsia
    - Comorbid renal disease or diabetes worsens outcomes
    - Management
      - Baseline laboratory evaluation of renal and liver function
      - BP monitoring; antihypertensive management (if required)
      - Fetal surveillance; delivery at term (38–39 weeks)
  - Gestational hypertension
    - Asymptomatic high BP first noted after 20 weeks of pregnancy
    - May progress to preeclampsia, so close follow up is required
    - Management: same as CHTN, but deliver slightly earlier (37-38 weeks)
  - Preeclampsia syndromes
    - Preeclampsia: hypertension associated with proteinuria (>300 mg/day), laboratory abnormalities, or symptoms at >20 weeks of pregnancy
    - Eclampsia: new-onset seizures in a woman with preeclampsia
    - HELLP syndrome: severe subtype of preeclampsia with abnormal laboratory profile
      - Hemolysis: elevated lactate dehydrogenase (LDH) level, low Hct, abnormal smear
      - Elevated liver enzyme levels: transaminases ≥ 2× normal
      - Low platelets: thrombocytopenia (<100K)
    - Signs and symptoms usually resolve rapidly in postpartum period but some diagnoses are not made until after delivery.
    - Gestational age and severity of disease dictate management; severity often inversely proportional to gestational age at onset.
    - Severe features defined by the presence of any of the following:
      - Persistent systolic BP ≥160 or diastolic BP ≥110 mm Hg
      - Persistent symptoms: headache, visual disturbances, upper abdominal pain, dyspnea (pulmonary edema)
      - Laboratory abnormalities: those seen with HELLP, or serum creatinine ≥1.1 mg/dL (or doubling from baseline)
    - Management
      - Maternal hospitalization; close outpatient observation can be considered for mild disease
      - Steroids for fetal maturity (if appropriate)
      - Serial BP, laboratory testing, and fetal monitoring
      - Antihypertensive management (if required)
      - Intrapartum magnesium sulfate for maternal seizure prophylaxis and/or for fetal neuroprotection (<32 weeks)
    - Delivery timing
      - Immediate if: eclampsia, pulmonary edema, refractory hypertension, abruption, fetal demise, non reassuring fetal status, or if any severe features at ≥ 34 weeks.
      - Expectant management is appropriate when < 37 weeks and no severe features, or in some cases < 34 weeks if severe features are present but stable and hypertension is controlled,
      - In those cases, give steroids for lung maturation and attempt to delay delivery ≥ 48 hrs if otherwise stable.
  - Antihypertensive therapy
    - For severe-range hypertension to prevent maternal stroke
      - First line: IV labetalol or hydralazine; PO nifedipine
      - Other beta or calcium channel blockers may be used, but their safety is less clear.
      - Methyldopa: historically used due to fetal safety profile but less effective than first-line agents
      - Diuretics: counteract normal expansion of blood volume; not usually started during pregnancy
      - Angiotensin-converting enzyme inhibitors (ACEIs), angiotensin receptor blockers (ARBs): contraindicated in pregnancy due to decreased fetal renal perfusion and skull ossification
    - Antihypertensives are of unproven benefit for milder hypertension, and thus are not typically recommended.
  - Maternal effects: stroke, seizures, renal dysfunction, hemorrhage, death
  - Fetal effects: IUGR, PTD, placental abruption, hypoxia, perinatal death
- Cardiac disease
  - Complicates 1%–4% of pregnancies
  - Congenital heart disease (CHD) is more common than acquired disease
  - A leading cause of maternal mortality: preconception consultation to
    - Optimize prepregnancy maternal medical or surgical therapy
    - Provide contraception until maternal health is optimized
    - Discuss pregnancy contraindications (high maternal mortality)
      - New York Heart Association (NYHA) Class III or IV symptoms, severe mitral or aortic stenosis, aortic root dilation > 4.5 cm, severe pulmonary hypertension, ejection fraction ≤ 30%, prior peripartum cardiomyopathy with persistent dysfunction, or symptomatic coronary artery disease
  - Most conditions are managed similarly to those in the nonpregnant state, but
    - Higher risk of decompensation (increased cardiovascular demands)
    - Some medical therapy contraindicated (e.g., ACEIs, ARBs)
    - Surgical interventions may carry unacceptable fetal risks
      - Fetal loss risk with maternal cardiopulmonary bypass
    - Maternal effects: cardiac arrhythmias, functional decompensation (may be permanent), heart failure, VTE, death
    - Fetal effects: IUGR, PTD, death, CHD (up to 15% if maternal CHD)
  - Management
    - Serial assessment of maternal cardiac function (with echocardiography [echo])