Evidence-Based Physical Examination
BEST PRACTICES FOR HEALTH AND WELL-BEING ASSESSMENT

Kate Sustersic Gawlik
Bernadette Mazurek Melnyk
Alice M. Teall

The first book to teach physical assessment techniques based on evidence and clinical relevance.

Grounded in an empirical approach to history-taking and physical assessment techniques, this text for healthcare clinicians and students focuses on patient well-being and health promotion. It is based on an analysis of current evidence, up-to-date guidelines, and best-practice recommendations. It underscores the evidence, acceptability, and clinical relevance behind physical assessment techniques.

Evidence-Based Physical Examination offers the unique perspective of teaching both a holistic and a scientific approach to assessment. Chapters are consistently structured for ease of use and include anatomy and physiology, key history questions and considerations, physical examination, laboratory considerations, imaging considerations, evidence-based practice recommendations, and differential diagnoses related to normal and abnormal findings. Case studies, clinical pearls, and key takeaways aid retention, while abundant illustrations, photographic images, and videos demonstrate history-taking and assessment techniques. Instructor resources include PowerPoint slides, a test bank with multiple-choice questions and essay questions, and an image bank.

This is the physical assessment text of the future.

Key Features:
• Delivers the evidence, acceptability, and clinical relevance behind history-taking and assessment techniques
• Eschews “traditional” techniques that do not demonstrate evidence-based reliability
• Focuses on the most current clinical guidelines and recommendations from resources such as the U.S. Preventive Services Task Force
• Focuses on the use of modern technology for assessment
• Aids retention through case studies, clinical pearls, and key takeaways
• Demonstrates techniques with abundant illustrations, photographic images, and videos
• Includes robust instructor resources: PowerPoint slides, a test bank with multiple-choice questions and essay questions, and an image bank
• Purchase includes digital access for use on most mobile devices or computers
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Kate Sustersic Gawlik, DNP, APRN-CNP, FAANP, is an assistant professor of clinical nursing at The Ohio State University. She is certified by the American Nurses Credentialing Center as an adult and family nurse practitioner. She has extensive background in primary care, with experience in family practice, college health, urgent care, and reproductive care. Her clinical interests are evidence-based practice, population health, preventive medicine, clinician well-being, health professionals’ education, wellness, and cardiovascular disease prevention. She has served as the project manager for the Million Hearts® initiatives at Ohio State’s College of Nursing since 2013. She leads and serves on multiple state and national workgroups targeted at improving cardiovascular population health.

Dr. Gawlik started her nursing career in 2006 and completed her MSc in nursing with a specialization as an adult/geriatric nurse practitioner in 2009 from The Ohio State University. In 2015, she graduated with her DNP and a post-master's certificate as a family nurse practitioner from The Ohio State University. Dr. Gawlik was awarded the Outstanding Faculty Award in 2013 and the Outstanding Leadership Award in 2017 at The Ohio State University. She received an Abstract of Distinction at the Council for the Advancement of Nursing Science Conference in 2016 and the Editor’s Pick for 2017 Paper of the Year by the American Journal of Health Promotion for “An Epidemiological Study of Population Health Reveals Social Smoking as a Major Cardiovascular Risk Factor.” She was awarded the 2018 American Association of Nurse Practitioner State Award for Excellence for Ohio. She was inducted as a fellow into the American Association of Nurse Practitioners in June 2018.

Dr. Gawlik has been teaching nursing students since 2007. She has taught a variety of undergraduate, RN–BSN, and graduate nursing courses and serves as a clinical preceptor for advanced practice nursing students. Her passion lies in teaching in the online platform, both in synchronous and asynchronous classrooms. She has been teaching solely online since 2012. Dr. Gawlik developed an online educational module on cardiovascular population health that is used nationally and internationally. The educational module has led to the cardiovascular screening of over 75,000 people. Her educational interests include the development of new and innovative teaching modalities and pedagogies for online teaching with a focus on advanced assessment, evidence-based practice, and health promotion courses.

This is Dr. Gawlik’s first book. She is hopeful that by integrating her three passions—advanced assessment, evidence-based practice, and health promotion—into one book, students will have the opportunity to apply and assimilate these three foundational skills in their journey to become expert clinicians.

Bernadette Mazurek Melnyk, PhD, APRN-CNP, FAANP, FNAP, FAAN, is the vice president for health promotion, university chief wellness officer, and professor and dean of the College of Nursing at The Ohio State University. She is also a professor of pediatrics and psychiatry at Ohio State’s College of Medicine. In addition, she is the executive director of the Helene Fuld Health Trust National Institute for Evidence-Based Practice in Nursing and Healthcare. Dr. Melnyk earned her BSc in nursing from West Virginia University, her MSc with a specialization in nursing care of children and as a pediatric nurse practitioner from the University of Pittsburgh, and her PhD in clinical research from the University of Rochester where she also completed her post-master’s certificate as a psychiatric mental health nurse practitioner.

She is a nationally/internationally recognized expert in evidence-based practice, intervention research, child and adolescent mental health, and health and wellness and is a frequent keynote speaker at national and international conferences on these topics. Dr. Melnyk has consulted with hundreds of healthcare systems and colleges throughout the nation and globe on how to improve quality of care and patient outcomes through implementing and sustaining evidence-based practice. Her record includes over $33 million of sponsored funding from federal agencies and foundations as principal investigator and over 400 publications.

Dr. Melnyk is coeditor of six other books: Implementing the Evidence-Based Practice (EBP) Competencies in Healthcare: A Practical Guide for Improving Quality, Safety, and Outcomes; Evidence-Based Practice in Nursing & Healthcare: A Guide to Best Practice (4th Edition), an American Journal of Nursing Research Book of the Year Award winner; Implementing EBP: Real World Success Stories; A Practical Guide to Child and Adolescent Mental Health Screening, Early Intervention and Health Promotion (2nd Edition); Intervention Research and Evidence-Based Quality Improvement: Designing, Conducting, Analyzing and Funding (2nd Edition), also an American Journal of Nursing Research Book of the Year Award winner; and Evidence-Based Leadership, Innovation and Entrepreneurship in Nursing and Healthcare.

Dr. Melnyk is an elected fellow of the National Academy of Medicine, the American Academy of Nursing, the National Academies of Practice, and the American Association of Nurse Practitioners. She served a 4-year term on the 16-member U.S. Preventive Services Task Force and the National Institutes of Health’s National Advisory Council for Nursing Research and was a board member of the National Guideline Clearinghouse and the National Quality Measures Clearinghouse (NGC/NQMC). She currently serves as a member of the National Quality Forum’s
Alice M. Teall, DNP, APRN-CNP, FAANP, is director of graduate health and wellness programming, director of innovative telehealth services, and an assistant professor of clinical nursing at The Ohio State University College of Nursing. An expert in nursing education, Dr. Teall was honored with The Ohio State University Provost Award for Distinguished Teaching by a Lecturer and with the Wright State University Presidential Award for Faculty Excellence. While serving as director of the online Family Nurse Practitioner program, she was chosen as The Ohio State College of Nursing Graduate Educator of the Year for 4 consecutive years.

Alice M. Teall began her nursing career as a diploma graduate of Miami Valley Hospital School of Nursing in 1983. She earned her BSc in nursing from Capital University, her MSc with a specialization as a Family Nurse Practitioner from Wright State University, and her DNP from The Ohio State University. She has certifications as a Family and Pediatric Nurse Practitioner and as an Integrative Nurse Coach. Her clinical expertise and areas of interest include adolescent health, primary care of at-risk youth and families, college health, and recovery from substance use disorder. Dr. Teall has an extensive background in primary care, which includes addressing population health using telehealth technologies and improving access to care through statewide quality improvement initiatives. She has received leadership, alumni, and practice awards and is a Fellow of the American Academy of Nurse Practitioners.

An experienced educator, Alice M. Teall has taught assessment online and on campus for students across nursing programs, including LPN, traditional undergraduate, RN–BSN completion, accelerated graduate entry, traditional master’s, BS-to-DNP, post-master’s, and doctoral programs. Dr. Teall has published and presented nationally about the effective use of classrooms as engaged and collaborative communities of inquiry, where active learning, timely feedback, diversity of thought, and support for self-care and wellness are norms. Her contributions to advanced practice education include innovative use of synchronous web-conferencing, incorporation of health and wellness coaching techniques in clinical practice, and use of telehealth as an evaluation strategy for distance students. Her doctoral work included an evidence-based quality improvement initiative to improve clinician confidence in addressing health, wellness, and self-management of chronic disease using coaching strategies.

Dr. Teall has taught students nationally and internationally to provide evidence-based, patient-centered, collaborative care for individuals and families. This textbook includes best practice guidance gained from her experience in course and clinical teaching, program administration, and curriculum development. Her hope is that health science students will create authentic connection and partnerships with patients, peers, and faculty as they learn to implement the knowledge, skills, and attitudes required of evidence-based assessment.
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Editors
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This book is dedicated to my husband, Jason, who always believes in me and supports my dreams, no matter how wild and crazy they may be. There is no one else who I would want to be with on this journey. To my parents, Edward and Karen, who made me the person I am today and who never fail to amaze me with their selflessness, patience, and unconditional love. To Hadley, Tyler, Hunter, and Austin—may you continue to see the world the way you see it now. You are going to do great things.

—KATE SUSTERSIC GAWLIK

I dedicate this book to my loving husband, John, who has supported me throughout the past three decades to pursue my dreams; my three wonderful daughters, Kaylin, Angela, and Megan, who have provided understanding and support to me to fuel my passions; and my two awesome grandsons, Alexander and Bradley, who I will continue to encourage to dream, discover, and deliver throughout their life's journeys.

In addition, I would like to devote this book to all of my past and current students who have kept my “spirit of inquiry” thriving through their quest to become the best evidence-based providers to ultimately transform health and improve lives throughout the nation and world.

—BERNADETTE (BERN) MAZUREK MELNYK

The value of having someone who believes in you is impossible to measure. To my husband, Tom, this book is dedicated to you. Thank you for believing in me, keeping your sense of humor, and running our household while I spent the time and energy needed to do this work. To Amy, Mallory, Kevin, and Dominique, you are amazing adults, and I love sharing life with you. To my grandchildren, Noah, Aiden, Evan, Emma, Sebastian, and the little one still on the way, you are loved.

—ALICE M. TEALL
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Preface

“The only way to predict the future is to create it.”
—Peter Drucker

We begin this preface by emphasizing that the only way to ensure an accurate diagnosis for an individual’s health and well-being is through a thorough history and evidence-based health and well-being assessment. Learning to effectively assess the health and well-being of an individual involves integrating skills of history taking, physical examination, and diagnostic decision-making within the context of patient-centered, culturally sensitive, evidence-based clinical practice. The process of teaching and learning assessment is complex. As experienced faculty who have taught assessment and advanced assessment across educational programs, we recognize that health science students who learn evidence-based, valid, reliable assessment techniques and approaches are better prepared to deliver evidence-based, safe, quality clinical care. Student engagement in learning also requires that they understand and appreciate the importance of wellness for their own health and well-being.

Evidence-Based Physical Examination: Best Practices for Health and Well-Being Assessment was developed to reflect a practical, scientific, and holistic approach to the learning of advanced, as well as basic, assessment. The textbook includes a review of how to approach individuals across the life span, prioritizes a broad understanding of wellness, presents evidence-based recommendations for assessments, and systematically reviews the physical examination components required to inform clinical decision-making.

GOALS OF THIS TEXTBOOK

The overall goal of this textbook is to provide the strategies and best practices needed by clinicians to assess an individual’s health and well-being. The rationale for our evidence-based approach is that it creates the foundation for building a comprehensive differential diagnosis or problem list, provides the strategies for triaging the acuity of the patient, and creates the groundwork for the integration of wellness, health promotion, disease prevention, and support for self-efficacy into an individualized, patient-centered plan of care based on the best and latest evidence. Only with comprehensive, accurate, and evidence-based assessment can a clinician ensure patient safety and high-quality cost-effective care. Additional goals of this text include:

1. To promote evidence-based practice at the assessment and diagnostic levels to ensure that clinicians are using valid and reliable examination methods in which to base future decision-making
2. To incorporate an interprofessional, multidisciplinary approach that encompasses cultural competency, social determinants of health, and trauma-informed care while keeping mental health and a wellness perspective at the center of all patient interactions
3. To understand the utilization and integration of modern technology and its role in the assessment process
4. To provide information on specific assessment skills that are often overlooked or misunderstood
5. To summarize abnormal findings for common disease states across the life span
6. To ensure that clinicians are able to conduct a thorough self-assessment of their own personal health and take good self-care, because burnout and poor clinician well-being adversely affect healthcare quality and safety.

DISTINGUISHING FEATURES TO SUPPORT STUDENT LEARNING

Evidence-Based Physical Examination: Best Practices for Health and Well-Being Assessment strives to incorporate the latest and best clinical evidence for physical examination assessment skills that are valuable in everyday clinical practice. It includes assessment of the dimensions of wellness and health behaviors as a...
routine component of history taking and involves when and how to incorporate specific physical examination techniques. Evidence-based national guidelines are integrated into the recommendations for the history and physical examination for individuals across the life span.

The textbook incorporates several unique features. Each chapter begins with a motivational quote to inspire individuals as they learn evidence-based health and well-being assessments, followed by specific learning objectives. An extensive review of anatomy, physiology, and pathophysiology provides the foundation for the history and physical examination. Life-span considerations are included in every chapter, with an entire chapter dedicated to pediatric and adolescent differences and considerations. Due to their vital contributions to the assessment process, laboratory and imaging sections are included in chapters, when appropriate. These sections provide an overview of commonly ordered labs and imaging studies with an explanation of how they are useful to the assessment and diagnostic processes.

In addition, this textbook offers discrete chapters dedicated to specific populations or disease states that are often overlooked and/or misunderstood. There are entire chapters dedicated to current, priority topics, including the following unique chapters:

- Chapter 8: Approach to Evidence-Based Assessment of Body Habitus (Height, Weight, Body Mass Index, Nutrition)
- Chapter 18: Evidence-Based Assessment of Sexual Orientation, Gender Identity, and Health
- Chapter 23: Evidence-Based Assessment of Substance Use Disorder
- Chapter 24: Evidence-Based Assessment and Screening for Traumatic Experiences: Abuse, Neglect, and Intimate Partner Violence
- Chapter 28: Evidence-Based Assessment of Personal Health and Well-Being for Clinicians: Key Strategies to Achieve Optimal Wellness

**INTENDED AUDIENCE**

This textbook is intended for a broad audience of health science students and clinicians who strive to exemplify excellence in evidence-based assessment and practice. Educators who provide instruction to students enrolled in graduate, baccalaureate, and associate degree health science programs who aspire to provide an evidence-based advanced assessment approach to individuals across the life span will appreciate the scientific foundation, holistic perspective, and practical approach to history taking and physical examination. The courses/programs for which this text would be appropriate include:

- Graduate nursing assessment courses
- Undergraduate nursing assessment courses
- Medical student assessment courses
- Family/adult/pediatric/psychiatric nurse practitioner graduate programs
- Programs focused on acute care, primary care, or specialty care management
- Midwifery graduate programs
- School nursing specialty programs
- Child mental health graduate specialty programs
- Maternal–child health graduate programs
- Physician assistant graduate programs
- Pharmacy graduate programs
- Occupational therapy graduate programs
PART III: EVIDENCE-BASED PHYSICAL EXAMINATION AND ASSESSMENT OF SEXUAL AND REPRODUCTIVE HEALTH

Chapters 17 through 21 continue to use a systems approach, while more thoroughly presenting assessments related to sexual health. Assessment of gender identity and sexual orientation is included as a separate chapter to allow students an opportunity to learn and practice therapeutic communication when discussing sensitive topic areas. Breast assessment, male/female genitalia, and pregnancy assessment are also included as individual chapters.

PART IV: EVIDENCE-BASED PHYSICAL EXAMINATION AND ASSESSMENT OF MENTAL HEALTH

Chapters 22 through 25 focus on advanced assessment of mental health. While mental health assessments are incorporated throughout the text, these chapters provide a thorough review of pertinent anatomy, physiology, and pathophysiology and approaches to history and physical examination. Evidence-based screening tools are included, as are examples of how to apply these tools in clinical practice.

PART V: SPECIAL TOPICS IN EVIDENCE-BASED ASSESSMENT

Chapters 26 through 29 are unique additions to this textbook. Chapter 26 reviews special considerations for pre-participation physical examinations for adolescent athletes. Chapter 27 introduces the concept of how health technology can be incorporated into evidence-based assessments and clinical decision support. Chapter 28 invites the clinician to evaluate his or her own personal health and well-being, a priority in light of the prevalence of clinician burnout and its adverse consequences. The last chapter of the text provides a summary listing of the components of a comprehensive health history and physical examination.

We hope you enjoy using the book as much as we enjoyed creating it.

Kate Sustersic Gawlik, Bernadette Mazurek Melnyk, and Alice M. Teall
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Thank you to the authors from across disciplines and across the country who contributed to writing the chapters in this text. Your expertise in health and wellness assessments and insight into the evidence-based foundation of clinical practice will guide future health science students.

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Without the support from our team at Springer Publishing Company, this book would not exist. Thank you for this rewarding opportunity. Adrianne Brigido, your feedback has been invaluable. We are grateful for your work in bringing this text to publication. We are also grateful for the efforts of Robert Pancotti, Senior Content Development Specialist.

To all of the health science students whom we have had the opportunity to teach, thank you for demonstrating a willingness to learn and for your dedication to providing the best, evidence-based, patient-centered care for individuals, families, communities, and populations. You make us proud. We see you as clinicians who focus your clinical practice on partnering with individuals in a way that improves their health and wellness. You are changing the culture of the healthcare delivery system.
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Video 2.1  Well Exam: Adult With Diabetes—History and Physical Exam
Video 4.1  Well Exam: Well-Child History and Physical Exam
Video 4.2  Well Exam: Infant Exam
Video 4.3  Patient History and Counseling: Adolescent With Depression and Anxiety Symptoms
Video 5.1  Well Exam: Complete Physical Exam
Video 6.1  Follow-Up Exam: Adult With Hypertension
Video 6.2  Patient Case: Woman With Chest Pain
Video 7.1  Patient Case: Adult With Cough (Pneumonia)
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Video 13.1  Patient Case: Child With Ear Pain (Otitis Media)
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Video 15.1  Patient Case: Adult With Back Pain
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Video 19.1  Well Exam: Male Sexual History and Genitourinary Exam
Video 20.1  Well Exam: Women’s Health History and Gynecological Exam
Video 21.1  Well Exam: Prenatal Exam
Video 22.1  Patient History: Depression Symptoms
Video 23.1  Patient History: Smoking and Smoking Cessation
Video 26.1  Well Exam: Sports Physical
Video 27.1  Patient Case: Telehealth Visit for Woman With Dysuria

Instructor Resources

*Evidence-Based Physical Examination: Best Practices for Health and Well-Being Assessment* includes a robust ancillary package. Qualified instructors may obtain access to ancillary materials by emailing textbook@springerpub.com. Available resources:

- **Instructor’s Manual:**
  - Learning Objectives
  - Chapter Summaries
  - Case Studies with Questions and Answers/Rationales
  - Video Links

- **Test Bank:**
  - Multiple-Choice Questions with Answers/Rationales
  - Essay Questions with Answers/Rationales

- **Image Bank**

- **Chapter-Based PowerPoint Presentations**
FOUNDATIONS OF CLINICAL PRACTICE
Approach to Evidence-Based Assessment of Health and Well-Being

Kate Gawlik, Bernadette Mazurek Melnyk, and Alice M. Teall

“Health is a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity.”

—World Health Organization

LEARNING OBJECTIVES

• Describe the rationale for an evidence-based approach to the assessment of health and well-being.
• Apply the principles and steps of evidence-based practice that guide assessment of the dimensions of wellness.
• Identify evidence-based resources to guide health assessment strategies, approaches, and techniques.

SYSTEMATIC APPROACH TO ADVANCED HEALTH AND WELL-BEING ASSESSMENT

Assessment is the action of making an appraisal, judgment, or evaluation. Advanced skills of assessment include an interpretation of findings within the complexity of a situation. To effectively implement advanced assessment skills in clinical practice involves a complex series of steps; a foundation of knowledge; an ability to appreciate the information shared by an individual, patient, or family; and clinical interpretation of the assessments of health and well-being.

Advanced assessment is the cornerstone of clinical practice. Clinicians use advanced assessment skills as the foundation for delivering quality care. To deliver the highest quality of healthcare and ensure the best patient outcomes, there has been a dramatic shift in clinical practice to incorporating the latest research or best evidence and to questioning the processes and systems that have been in place for years to determine whether they are the most effective and efficient methods. Evidence-based practice (EBP) is a lifelong problem-solving approach to the delivery of care that incorporates the current best evidence with a clinician’s expertise and patient or family preferences and values (Melnyk & Fineout-Overholt, 2019). When implemented consistently, EBP results in the highest quality of care, improved population health outcomes, decreased costs, and clinician empowerment, otherwise known as the quadruple aim in healthcare (Bodenheimer & Sinsky, 2014; Melnyk & Fineout-Overholt, 2019). However, even with all of its positive benefits, EBP is not the standard of care in many healthcare systems owing to multiple barriers, including inadequate EBP skills in clinicians and cultures, which promote a philosophy of “that is the way we do it here.”

If assessments are not thorough or findings are not interpreted within the context of the best clinical evidence, errors are more likely. Findings from research indicate that approximately 400,000 people die every year from preventable medical errors, and this is now a public health epidemic and the third leading cause of death in the United States (Makary & Daniel, 2016). Although numerous factors influence the occurrence of errors, using the best evidence in clinical assessment and management has been identified as a priority in reducing the number of preventable medical errors and
improving population health outcomes. While there has been steady progress in the evidence-based management of clinical problems or diseases over the past 2 decades, incorporating the best evidence in health and well-being assessment has been much slower. Specifically, a number of commonly taught physical assessment techniques have demonstrated a low sensitivity, a low specificity, and negative predictive value (e.g., scoliosis screening), and yet these techniques continue to be incorporated when teaching clinicians assessment skills. Unfortunately, many well-meaning clinicians across the United States are steeped in a practice rooted in the way they were taught years before or are following outdated practices and policies not based on the best evidence. As a result, the quality, safety, and health outcomes of their patients are not as optimal as they could be if these clinicians were consistently steeped in EBP.

This book takes a new approach to the process of advanced health and well-being assessment through rigorous critical appraisal of the evidence underlying history and physical exam techniques, assessment strategies, the use of imaging tests or lab studies, and/or approaches to health and well-being. **Evidence-based assessment** lays the foundation for building comprehensive differential diagnoses or a problem list, provides the strategies for triaging the acuity of the patient, and creates the groundwork for integration of well-being, health promotion, and disease prevention into the plan of care based on the best and latest evidence. Thorough history-taking and assessment provide the clinician with key subjective information and tangible, objective information on which to base current and future decision-making. Only with comprehensive, accurate, and evidence-based assessment can a clinician ensure patient safety, quality, and cost-effective care.

**THE IMPORTANCE OF EVIDENCE-BASED ASSESSMENT**

**Kaylin’s Story**

Kaylin was 8 years old when she went to New Zealand and Australia with her parents for a dream trip. The trip’s first layover was at the Los Angeles airport, where Kaylin enjoyed dinner and an ice-cream sundae. She was the picture of health when leaving Los Angeles and was very excited to be going to the land of koala bears. However, approximately 3 hours from New Zealand, Kaylin awakened her mom, who is a pediatric nurse practitioner, from a deep sleep to let her know that she was feeling sick, specifically saying that her “belly hurt.” Her mom felt her forehead, which revealed she had a fever. Then, within an hour, Kaylin started vomiting, and her mom suspected early appendicitis. The pattern of fever and abdominal pain that preceded vomiting was the classic picture of appendicitis. Kaylin’s mom woke her dad to let him know that Kaylin was sick and that she suspected early appendicitis. Kaylin’s dad was convinced that this was the “gastrointestinal (GI) bug” that he had experienced 4 days earlier.

Kaylin continued to vomit intermittently for the rest of the flight to New Zealand. After landing, Kaylin’s parents took her immediately to a 24-hour medical facility, where they conveyed concerns about early appendicitis to the physician who evaluated her. After examining her and running a few lab tests, it was decided that she just had a GI virus and that she could be taken to her hotel. The physician kept emphasizing that Kaylin did not have abdominal rebound, which is a common physical assessment sign of appendicitis.

After 48 hours, Kaylin’s temperature dropped, and she stopped vomiting, so the family traveled to their next destination, Sydney, Australia, where they spent 4 days touring the most common attractions. Kaylin did not seem her normal self. She was even complainent about seeing and holding koala bears at the animal preserve, which was unusual since that was all that she talked about before the trip. In Sydney, Kaylin was without fever and did not complain any further about abdominal pain. However, she was pale, lacked an appetite, walked a little humped over, and was not her energetic self.

After 4 days in Sydney, the family flew to a place called Ayers Rock in the Australian outback. The second day there, they went to a dinner called the Sounds of Silence. Kaylin still lacked her appetite and literally fell asleep on the table at dinner. The family was to fly from Ayers Rock to Cairns, Australia, the next morning. During the night, Kaylin began to moan in her sleep with a fever of 104°F. Her mom was now convinced that Kaylin’s appendix had ruptured, leading to a serious medical situation with an abdominal abscess. The family took the next flight out of Ayers Rock and, as soon as they landed, took Kaylin to another medical facility. The physician there ordered blood work that showed a 33,000 white blood cell count, 92% neutrophils, and 36 bands/stabs. Immediately after these lab results were known, Kaylin’s mom and dad rushed her to the emergency department of the public hospital in Cairns, knowing Kaylin had a very serious medical situation.

In the emergency department, Kaylin was examined by multiple physicians and a surgeon, who had her jumping up and down on her right foot, assuring everyone that this was not an abdominal problem since she was able to do that task. More blood tests and cultures were performed, and, after hours, Kaylin’s parents were told that they could take her back to the hotel as it was just a virus, even though her mom was insistent that she had a ruptured appendix. She kept telling the physicians that the severe shift to the left in Kaylin’s lab work indicated a severe bacterial, not viral, infection. She begged the physicians for an MRI or ultrasound of her abdomen, but they would not perform the test. Finally,
after some time of pleading with the physicians to admit her to the hospital, Kaylin was admitted to the pediatric unit. The head nurse later told Kaylin's parents that she was labeled a “soft admission,” but that she was being admitted to the hospital because she was the daughter of a stressed-out nurse mom from the United States who was insistent on her admission.

Throughout the night and during the entire next day, Kaylin was evaluated by at least six physicians. Kaylin's parents told the same story to each physician, insisting that she had a ruptured appendix and was now experiencing an abdominal abscess. Kaylin was looking worse—her fever remained at 104°F, she had tachycardia out of proportion to her fever, and she was starting to look septic. After Kaylin's mom pleaded with multiple physicians, asking them for an ultrasound of her abdomen, the last physician finally agreed to the test. An ultrasound was performed, which revealed a huge abscess from a ruptured appendix in Kaylin's abdomen.

One of the public surgeons came in to communicate the results of the ultrasound to Kaylin's parents. He said that the best treatment was to place Kaylin on IV triple high-dose antibiotics for 6 weeks in hopes that her body would wall the abscess off, and, then, an elective surgery could be performed to remove it and what was left of the appendix. Kaylin's mom asked the surgeon for the evidence behind his recommended treatment, but he could not give her a solid answer. As Kaylin's mom was sobbing and wishing they were at home in the United States at a hospital with physicians with whom they were familiar and who would have believed and listened to them, Kaylin's nurse said that, as Americans, they could call for a consult from a private surgeon. They asked her to get them the best surgeon in town, where they could call for a consult from a private surgeon. They asked her to get them the best surgeon in town, which she did. Without that nurse, Kaylin may have never made it home.

A couple of hours later, the private surgeon walked into the room and evaluated Kaylin. He told Kaylin's parents that he needed to get Kaylin to the theater (operating room) immediately as she was full of infection and on the verge of sepsis. After more than a day of pleading with multiple physicians and asking for the evidence behind decisions that were being made, the family finally had a healthcare clinician who was engaged in evidence-based decision-making.

Kaylin was in surgery for several hours. By the time of surgery, she had full-blown peritonitis and pelvic sepsis, but never had she had classic guarding, which is typically seen with peritonitis. She was not the typical case of appendicitis as she had a retroverted appendix, so she did not have the classic “rebound” that is commonly seen in children with appendicitis. Because of her extensive infection, Kaylin's peritoneal cavity had to be flushed with saline for 2 solid hours. Her parents were never so relieved as to see the surgeon emerge from the operating room and tell them that he believed Kaylin would have an extensive recovery but that she would be all right.

Kaylin's recovery was very slow. She lost 10 pounds, developed an ileus after surgery, and had extensive infection that was challenging to resolve. After 2 weeks in the hospital, Kaylin finally recovered enough to be taken back to the family's hotel room. With her abdomen still distended, the family could not fly home for another week. During her hospital stay, the surgeon who examined Kaylin in the emergency department came to see them and apologized profusely for missing the diagnosis in the emergency department. Later that week, he conducted grand rounds and reviewed Kaylin's case with numerous physicians so that her atypical case of a ruptured appendix would not be missed again.

Parents know their children best but do not always have clinicians who listen well to the information they have to offer. Kaylin's case is a prime example of how various elements of EBP were not taken into consideration. If Kaylin's mom had not had the knowledge that she did in evidence-based assessment to be a strong advocate for her daughter during this experience, Kaylin might have died. Sadly, hundreds of thousands of people die every year from preventable medical errors, many from clinicians who do not take the family's history and input into thoughtful consideration and who do not consistently deliver evidence-based care.

One out of 10 patients admitted to the hospital will experience a medical error. We also know that EBP results in the highest quality, low-cost healthcare with the best patient outcomes. However, what is often not taught or emphasized enough in EBP is how to factor in a patient or family member's preferences or a clinician's expertise into the evidence-based decision-making process. It is our hope that Kaylin's story will help all clinicians to remember to listen to and heed the wisdom/preferences of patients and their family members and to always listen to their own clinical expertise when making the best evidence-based assessments and decisions about patient care. Through EBP and advocating for what we know is soundly based on the EBP process, medical errors and complications will be avoided and more patient lives will be saved.

Note: Kaylin is the daughter of Bernadette Mazurek Melnyk, coeditor of this book. The full story of Kaylin is included in a book with many other stories on how EBP makes a difference in the lives and health outcomes of patients and families by Melnyk and Fineout-Overholt (2011).

Jennifer’s Story

Jennifer was a healthy 38-year-old woman who was 8 weeks pregnant. She had no chronic illnesses and was not taking any medications. She visited a local urgent care center with upper respiratory symptoms. She reported a productive cough, low-grade fever of 99.0°F,
Fully integrating an assessment of wellness into practice involves understanding that being healthy involves more than physical health. Well-being assessment should include the nine dimensions of wellness, namely, physical, emotional, financial, intellectual, career, social, creative, environmental, and spiritual (Figure 1.1; Melnyk & Neale, 2018a, 2018b). Clinicians need to take each of these dimensions into consideration when assessing individuals and families. Each dimension can impact the other dimensions. Failing to take into account all nine dimensions results in an incomplete well-being assessment, which could lead to inaccurate conclusions and noneffective management.

For example, when a patient is struggling financially and has an unstable career (threatened financial and career wellness) to the extent of not being able to feed their family, the patient will forego buying blood pressure medication so as to be able to buy food. In making this decision, the patient is jeopardizing their short-term and long-term physical wellness. The patient’s stress level is high owing to constant worry about supporting the family, thereby threatening the patient’s emotional wellness. When the patient’s basic needs, such as not having a steady food source, are not being met, creative and environmental wellness are not a consideration or a priority. Failing to ask about a patient’s ability to pay for their medications and just labeling the patient as fatigue, and some nasal congestion. She reported no leg symptoms. During her visit, a d-dimer blood test was ordered to rule out a pulmonary embolism. The d-dimer test was mildly elevated. It was then recommended that she needed further evaluation owing to concern for a pulmonary embolism (PE). Based on her d-dimer level, Jennifer was advised to go to the local emergency department where she was told she needed to have a pulmonary computed tomography (CT) scan to rule out a PE. She was warned repeatedly of the risks to her fetus of having the CT scan but was still advised by multiple clinicians to complete the imaging study despite these risks. Despite feeling very conflicted about the scan, she completed it. The result of the CT scan was negative, and she was sent home with the diagnosis of an upper respiratory infection.

There were multiple opportunities where clinicians failed to utilize EBP during their assessment of Jennifer. The d-dimer test should never have been ordered. This is a nonspecific test that is often elevated in multiple conditions and always elevated in pregnancy (Goodacre, Nelson-Piercy, Hunt, & Chan, 2015). In fact, the American Thoracic Society/Society of Thoracic Radiology (ATS/STR) Clinical Practice Guideline for the Evaluation of Suspected Pulmonary Embolism in Pregnancy (Leung et al., 2012) recommends specifically against the use of d-dimer to exclude PE in pregnancy. Next, the pulmonary artery CT scan should never have been ordered. The ATS/STR guidelines recommend a chest x-ray as the first radiation-associated procedure. In addition, the Wells Criteria for Pulmonary Embolism is a risk stratification tool used to estimate the probability of an acute PE. If the clinicians in the hospital had utilized the Wells criteria, they would have discovered that Jennifer’s risk of having a PE was 3%. The evidence was clear that she did not need the CT scan and that the risks of the CT scan far outweighed the benefits, yet she was still advised by multiple clinicians to proceed with having it done. If the clinicians had utilized EBP during their assessment, Jennifer never would have had the CT scan and put herself and her fetus at risk.

MOVING TO A MODEL OF PREVENTION

Evidence-based assessment requires critical thinking beyond completion of the techniques of physical assessment and includes an understanding of the context of the health and well-being of populations. With the aging baby boomer population and the increasing rates of chronic diseases, patient care is getting more and more complex. Patients are presenting with multiple diagnoses, problems, and needs. Acuity is higher, and the healthcare system is becoming more difficult to navigate. Clinicians practicing today need to holistically approach patients and help them meet their optimal wellness goals by addressing the multiple aspects affecting their health and well-being.

![Figure 1.1 Nine dimensions of wellness: physical, emotional, financial, intellectual, career, social, creative, environmental, and spiritual.](image)
“noncompliant” can happen in this type of situation if a full well-being assessment is not conducted.

Approaching the steps of assessment in a manner that embodies patient-centered, evidence-based care and taking into account a patient’s individual needs and preferences will help to improve patient outcomes and overall population health. The patient’s individual well-being needs can be understood and addressed by asking the right questions and taking all dimensions of their wellness into consideration. Using this approach to assessment is imperative for promoting optimal health and preventing disease. Using advanced assessment strategies that are grounded in evidence and focusing on health promotion will help to move patients to a higher level of health and well-being. For all of these reasons, this text begins with a description of EBP and includes best evidence to guide assessment in each chapter.

**THE SEVEN STEPS OF EVIDENCE-BASED PRACTICE**

Without current best evidence, clinical practice becomes out-of-date, resulting in adverse outcomes to patients. Therefore, clinicians should be skilled in the seven steps of EBP, as described here, in order to provide the highest quality of care (Box 1.1; Melnyk & Fineout-Overholt, 2019).

**STEP #0: CULTIVATE A SPIRIT OF INQUIRY WITHIN AN EBP CULTURE AND ENVIRONMENT**

All clinicians need to develop a spirit of inquiry that prompts them to constantly ask questions regarding their practices (e.g., What is the best valid and reliable screening tool for depression in pregnant women? What is the most effective treatment for pneumonia in small children?). Working within an EBP culture and environment will help to support this spirit of inquiry instead of being part of a practice that is steeped in tradition or has the philosophy of “that is the way it is done here.”

**STEP #1: FORMULATE THE BURNING CLINICAL PICOT QUESTION**

In this step of EBP, it is important for clinicians to place their clinical questions in PICOT format (i.e., Patient population, Intervention or Issue of interest, Comparison intervention or group, Outcome, and Time frame) to yield the most relevant, efficient, and best evidence search of the literature. For example, a well-designed PICOT question would be: In overweight adults seen for a primary care well visit (the patient population), how does counseling on healthy lifestyle behaviors (the experimental intervention) compared with providing a pamphlet on healthy lifestyles (the comparison intervention) affect physical activity and healthy eating (the outcomes) 2 months after the well visit (the time frame it takes for the interventions to achieve the outcome)? When questions are asked in a PICOT format, searches are conducted in a more targeted and efficient way that saves time and yields an effective search to answer the PICOT question (Melnyk & Fineout-Overholt, 2019). For clinical questions that are not intervention focused, the meaning of the letter I can be “issue of interest” instead of “intervention.” An example of a nonintervention PICOT question would be: In teenagers (Patient population), how does screening for bullying (the Issue of interest) predict depression (the Outcome) 6 months later (Time)? In this question, there is no appropriate comparison group, so the PIOT is appropriate, yet it is still referred to as a PICOT question.

**STEP #2: SEARCH FOR THE BEST EVIDENCE**

The search for the best evidence should begin with each of the keywords from the PICOT question, which are entered one at a time, ending with the command to combine all keywords from the PICOT question. The strongest level of evidence (i.e., Level 1 evidence that is comprised of systematic reviews or meta-analyses) should be searched for first. See Figure 1.2 for an example of an evidence hierarchy that captures the levels of evidence. If there are no systematic reviews or meta-analyses available, then the search proceeds with the next strongest level of evidence to answer the
2. What are the results? (Reliability) In an intervention trial, this would include (a) whether the intervention worked, (b) how large a treatment effect was obtained, and (c) whether clinicians could expect similar results if they implemented the intervention in their own clinical practice setting (i.e., the preciseness of the intervention effect).

3. Will the results help the clinician in caring for their patients? (Applicability) This third rapid critical appraisal question includes asking whether: (a) the subjects in the study are similar to the patients for whom care is being delivered, (b) the benefits are greater than the risks of treatment (i.e., potential for harm), (c) the treatment is feasible to implement in the practice setting, and (d) the patient desires the treatment.

**Special Considerations for Health and Well-Being Assessment**

Evidence-based assessment involves an appreciation for the evidence that supports implementation of specific techniques and strategies.
Validity

Determining validity requires asking the question, is the clinician assessing the right thing in the right way to deliver accurate and useful assessment results? In the context of health assessment, this would refer to the extent to which a screening instrument or assessment technique is measuring what it is intended to measure (Sullivan, 2011). For example, if a clinician is screening a patient for depression and administers the Generalized Anxiety Disorder-7 (GAD-7) questionnaire, this would not be a valid way to determine whether the patient has depression. The clinician would be screening for anxiety, but not depression. In order to screen for depression, the clinician would need to administer a valid and reliable screening tool like the Patient Health Questionnaire-9 (PHQ-9). This screening tool has been validated and would accurately determine whether a patient is at risk for depression (Mitchell, Yadegarfar, Gill, & Stubbs, 2016; Moriarty, Gilbody, McMillan, & Manea, 2015).

Four major types of validity are discussed here: content validity, construct validity, criterion validity, and external validity. Each type estimates validity in a slightly different way.

Content Validity

Content validity is the degree to which the screening tool adequately covers the entire domain or all facets of the content it is seeking to evaluate (Sullivan, 2011). Depression can have a variety of symptoms, including sadness, anhedonia, anger, changes in appetite or sleep patterns, and guilt. Having high content validity would mean the PHQ-9 asks about all of these symptoms to ensure the tool is all encompassing of the range of symptoms that can present when a patient is depressed.

Construct Validity

Construct validity refers to the concept of testing the screening tool or assessment technique against similar measures to determine whether an association exists between measures (Sullivan, 2011). To measure the construct validity of the PHQ-9, for example, researchers have established that there is a strong association between PHQ-9 scores and functional status, disability days, and symptom-related difficulty, all of which assess for depression in different ways (Mitchell et al., 2016; Moriarty et al., 2015).

Criterion Validity

Criterion validity refers to the correlation between how well a screening tool or assessment technique predicts the outcome of another measure. In the case of the PHQ-9, criterion validity was established by having patients also interview with a mental health clinician. When the clinician’s interview and the PHQ-9 independently reach the same conclusion, namely, that the patient has a diagnosis of depression, criterion validity is high (Mitchell et al., 2016; Moriarty et al., 2015).

External Validity

External validity, also called generalizability, is the ability of the screening tool or assessment technique to be used with similar outcomes in a variety of settings and with a variety of populations. The PHQ-9 tool has been used in hospitals, outpatient clinics, specialty clinics, and with all genders and races, all with the same results. Because the PHQ-9 screening tool has been validated using large, randomized populations across clinical settings and across time, the tool has well-established generalizability, or high external validity (Mitchell et al., 2016; Moriarty et al., 2015).

Reliability

Reliability is focused on the concept of consistency and the degree to which the screening tool or assessment technique produces consistent results (Sullivan, 2011). An important consideration when discussing reliability is the difference between precision and accuracy. Precision is the ability to obtain the same results or outcomes every time the tool or assessment technique is used. Accuracy is the ability to obtain the correct result from a tool or technique. A tool or test can be precise but not accurate, or it can be accurate but not precise. For example, think about a scale used to measure weight. If multiple clinicians weigh a patient using the same scale and they all get the same weight, the scale would be a precise measurement. However, if the scale were improperly calibrated by 5 pounds, despite its being a precise form of measurement, it would not be an accurate measurement. Ideally, a reliable measure is both precise and accurate. There are three main ways to test reliability: test-retest reliability, internal consistency, and inter-rater reliability. Similar to validity, each type estimates reliability in a different way.

Test-Retest Reliability

Test-retest reliability is the ability of a test or technique to be consistent over time. In other words, if a patient completes the PHQ-9 and the same patient completes this test again in 24 hours, the results are considered reliable if the test results continue to be the same. This is measured by a test-retest reliability coefficient test. Results vary between 0 and 1, with 1 indicating perfect reliability and 0 indicating no reliability. Any score of 0.70 or higher is considered acceptable, with an ideal score being a 0.80 or higher (Sullivan, 2011).

Internal Consistency

Internal consistency is the degree of agreement between multiple items within a tool (Sullivan, 2011). In the PHQ-9 example, this screening tool is designed to
measure depression. Internal consistency means all nine questions measure depression, both separately and collectively. This is measured with a statistical test called Cronbach’s alpha. Cronbach’s alpha (\( \alpha \)) increases when correlations between test items increase and values range from 0 to 1, with a good reliability being at least 0.70 or higher (Melnyk & Morrison-Beedy, 2019).

**Inter-Rater Reliability**

**Inter-rater reliability**, also called interobserver reliability, is the ability of two or more independent raters or observers to draw the same conclusions or results. Using the example of depression, inter-rater reliability would be high if two clinicians make a diagnosis of major depressive disorder after each of them has clinically assessed the same patient. Inter-rater reliability is reported as a kappa statistic (k), which can range from 1 to −1. One indicates perfect agreement between raters, zero indicates a chance occurrence, and negative one indicates agreement is less than chance (Sullivan, 2011).

**Accuracy**

**Sensitivity and Specificity**

Appropriate interpretation of the results of screening tests involves understanding how likely the test is to be accurate. Measures of accuracy include sensitivity, or how likely the test will correctly identify individuals who have the condition for which the tool or test was designed (Ranganathan & Aggarwal, 2018a). A highly sensitive test is one in which there are few false negative results or few cases of a disease or condition being missed. The sensitivity of a screening test is related to the probability of detection, so this measure is also known as the true positive rate.

The specificity of a test refers to the likelihood that the test will correctly identify those without the condition for which the tool was designed. A highly specific test is one in which there are few false positive results (Ranganathan & Aggarwal, 2018a). Measures of specificity determine the true negative rate.

**Predictive Value**

One of the noteworthy measures of accuracy of a screening test is the test’s predictive value. Positive predictive value refers to the proportion of positive tests that are true positives and represents the presence of the disease in the population. Negative predictive value refers to the proportion of negative tests that are true negatives and represents the absence of the disease or condition in the population (Ranganathan & Aggarwal, 2018a). The measures of sensitivity, specificity, and negative and positive predictive values are depicted in **Figure 1.3**.

Using the diagram in **Figure 1.3**, sensitivity refers to the number of true positives (A) divided by the total number of those who actually have the condition (A + C). Specificity refers to the number of true negatives (D) divided by the number of those who actually do not have the condition (B + D). Positive predictive value refers to the number of true positives (A) divided by the number of positive results (A + B). Negative predictive value refers to the number of true negatives (D) divided by the number of negative results (C + D). Predictive values are influenced by the prevalence of disease in a population (i.e., when a disease or condition is highly prevalent, the positive predictive value of a screening test will be significantly higher).

### FIGURE 1.3 Sensitivity, specificity, positive predictive value, and negative predictive value. This figure depicts how they are determined and how they are interrelated.
and specific screening tools provide key assessments. The **likelihood ratio**, or LR, is the comparison of how likely the screening test is to detect the condition (true positive) compared with how likely the test is to be accurate when an individual does not have the condition (true negative; Ranganathan & Aggarwal, 2018b). In EBP, the LR is used for determining the value of using a screening or diagnostic test based on accuracy. The LR value depicts how much more likely the individual is to have a positive screening for an existing, undiagnosed condition compared with an individual without the condition (Ranganathan & Aggarwal, 2018b). Unlike predictive values, the LR does not depend on the prevalence of a condition in a population and is more a reflection of the characteristics of the screening test.

The PHQ-9 tool, which has been shown to have content validity and reliability, has also been critically appraised for sensitivity, specificity, and LR characteristics related to screening for mild, moderate, and severe depression. PHQ-9 scores of 10 or greater have an 81.3% sensitivity and an 85.3% specificity for major depression (Mitchell et al., 2016). The LRs confirm the association between increasing PHQ-9 scores and the likelihood of depression, as the LR is positive for PHQ-9 scores from 9 to 15 (Mitchell et al., 2016; Moriarty et al., 2015). Evaluating sensitivity, specificity, and LRs confirms that the test is able to identify individuals with and without depression.

When critically appraising study findings and conclusions, the clinician must note study limitations before widely implementing findings in clinical practice. Rigorous research findings provide the evidence needed for clinicians to implement valid, reliable, predictive, sensitive, specific, and generalizable screening tools that can provide important clinical assessments.

**STEP #4: INTEGRATE THE EVIDENCE WITH CLINICAL EXPERTISE AND PATIENT/FAMILY PREFERENCES TO MAKE THE BEST CLINICAL DECISION**

This step in EBP is integrating the best evidence found from the evidence search with the clinician’s expertise and patient/family preferences and values to implement a decision (i.e., putting the evidence found into action). To fully and effectively implement EBP within the context of assessing health and well-being, the clinician must have a broad understanding of health and wellness, screen for episodic and/or chronic problems related to all dimensions of wellness, ask clinical questions, critically appraise evidence, and interpret clinical evidence. Interpreting clinical evidence implies assimilating the steps of EBP within the context of the clinician’s expertise, and the patient’s history, presentation, and preferences. The interpretation of clinical evidence requires careful reasoning.

Expert clinicians often share the adage that “the patient’s diagnosis is found within their history.” Listening to the patient is key to diagnosing episodic, chronic, urgent, and/or emergent problems. The patient history is often the predominant determinant of a diagnosis; it typically comprises 80% of the diagnosis being made by a clinician. If a comprehensive thorough history is taken, the likelihood of making a correct diagnosis is extremely high. The physical assessment most often just confirms what a clinician is thinking as a result of a thorough history. The keys to correctly interpreting the clinical evidence that the patient provides are asking the appropriate history questions, deeply listening to the patient’s history, and considering appropriate differential diagnoses.

Differential diagnoses are those diagnoses that the clinician is considering based on their interpretation of clinical evidence during the patient encounter. Differential diagnoses are those conditions, problems, diseases, or alterations in health that present with similar signs and symptoms. Clinicians can use the process of establishing differential diagnoses to allow for a systematic and thorough interpretation of assessments obtained during the patient’s history and physical exam. Using an evidence-based approach to interpret patient history findings provides the clinician with an opportunity to recognize, interpret, and analyze clinical findings.

Components of the physical exam are determined by interpreting the findings from the patient’s history within the context of EBP. Clinicians employ various methods of physical exam (as described within this text) to verify the patient’s level of health and well-being across wellness dimensions, including diagnosis of an illness, risk factors for illness, or chronic conditions.

The interpretation of clinical evidence includes the patient’s perspective. The key to knowing the patient’s perspective is asking about the individual or family concerns, interpretation of findings, and expectations regarding what might be done to support the patient’s health and well-being. Remember that the patient is central to the interpretation of clinical evidence. The clinical significance of evidence is best understood within the context of the patient encounter; in other words, best practice for advanced assessment includes patient considerations and clinician expertise. Completing a thorough patient history leads to determination and analysis of clinically important assessments that allow the clinician to make diagnostic and management decisions in partnership with patients and/or families.

The complexity of diagnostic decision-making is on a continuum from straightforward and brief to complex, ongoing, and risk laden. One of the goals of this text is to provide the foundation for assessments across the continuum and to present the evidence to support
diagnostic decision-making. The interpretation of clinical findings through an evidence-based framework is intended to lead to clinical interactions that are patient centered, high quality, timely, and accurate.

STEP #5: EVALUATE THE OUTCOMES OF THE PRACTICE CHANGE BASED ON EVIDENCE

This step in EBP is evaluating the evidence-based practice change in terms of how the change affected patient outcomes or how effective the clinical decision was with a particular patient or practice setting. This type of evaluation is necessary to determine whether the change based on evidence resulted in the expected outcomes when implemented in the real-world clinical practice setting. Measurement of outcomes, especially “so-what” outcomes that are important to today’s healthcare system (e.g., length of stay, readmission rates, patient complications, turnover of staff, costs) is important to determine and document the impact of the EBP change on healthcare quality and/or patient outcomes (Melnyk & Morrison-Beedy, 2019). If a change in practice, based on evidence, did not produce the same findings as demonstrated in rigorous research, clinicians should ask themselves a variety of questions (e.g., Was the practice delivered in exactly the same way that it was implemented in the study? Were the patients in the clinical setting similar to those in the studies?).

STEP #6: DISSEMINATE THE OUTCOMES OF THE EVIDENCE-BASED PRACTICE CHANGE

The last step in the EBP seven-step process is disseminating the outcomes of the EBP change. Clinicians achieve many positive outcomes by making changes in their care based on evidence, but those outcomes are often not shared with others, even colleagues within their same practice. As a result, others do not learn about the outcomes or the process that led to the change, and clinicians as well as other patients do not benefit from that knowledge. It is important for clinicians to disseminate outcomes of their practice changes based on evidence through such venues as oral and poster presentations at local, regional, and national conferences; EBP rounds within their own practices or institutions; journal and newsletter publications; and lay publications.

EVIDENCE-BASED PRACTICE RESOURCES

There are a variety of excellent EBP resources that are available to assist clinicians in implementing best evidence in their practices. It is important to be familiar with these resources as they are high quality and save clinicians time in searching for best evidence to guide clinical care.

THE UNITED STATES PREVENTIVE SERVICES TASK FORCE EVIDENCE-BASED PREVENTION RECOMMENDATIONS

The United States Preventive Services Task Force (USPSTF) has been a major source of evidence-based prevention recommendations for both children and adults for the past three decades. These recommendations have been widely available to clinicians through the USPSTF website (www.uspreventiveservicestaskforce.org), which provides updated evidence-based recommendations for over 100 primary care screening and behavioral counseling topics.

The USPSTF is an independent panel of 16 national experts in disease prevention and EBP. The Task Force works to improve the health of all Americans by making evidence-based recommendations about clinical preventive services. Task Force members come from the fields of preventive medicine and primary care, including internal medicine, family medicine, pediatrics, behavioral health, obstetrics and gynecology, and nursing. Their recommendations are based on a rigorous review of existing peer-reviewed evidence and are intended to help primary care clinicians and patients decide together whether a preventive service is right for a patient’s needs. The Agency for Healthcare Research and Quality (AHRQ) has been authorized by the U.S. Congress to convene the Task Force and to provide ongoing scientific, administrative, and dissemination support to the Task Force. Each year, the Task Force makes a report to Congress that identifies critical evidence gaps in research related to clinical preventive services and recommends priority areas that deserve further examination.

Each topic that is addressed by the USPSTF (e.g., Cervical Cancer Screening; Colorectal Screening; Depression Screening in Children and Adolescents; Depression Screening in Adults; High Blood Pressure Screening in Adults; Obesity Screening in Children and Adolescents; Sexually Transmitted Infections: Behavioral Counseling) undergoes a rigorous systematic review of evidence that is conducted by EBP centers (EPCs) that are contracted by the AHRQ. After the literature review is completed and the evidence is appraised and summarized by the EPC, it is brought to the USPSTF for review and critical appraisal. Reviews are sent to outside experts for peer review, who are asked to provide critical feedback regarding the methods and conclusions of the evidence review. The USPSTF also assesses the “net benefit” of a preventive service by comparing the magnitude of benefits relative to harms associated with the service. Benefits are assessed by reviewing the magnitude of both the relative and the absolute improvements in health outcomes associated with the delivery of the service. The Task Force documents its methods in a procedure manual and other
resources to ensure that the recommendations and evidence reviews are of consistently high quality, methodologically sound, scientifically defensible, reproducible, and unbiased. See www.uspreventiveservicestaskforce.org/Page/Name/methods-and-processes for more information. Using both the magnitude of net benefit and the certainty of net benefit assessments, the USPSTF relies on a standard matrix to guide the assignment of a letter grade for its recommendations. After the Task Force releases its new or updated recommendations, they are disseminated on the USPSTF website for public feedback/comment.

The USPSTF assigns each of their recommendations a letter grade (an A, B, C, or D grade or an I statement) based on the strength of the evidence and the balance of benefits and harms of a preventive service. The Task Force does not consider the costs of a preventive service when determining a recommendation grade. The recommendations apply only to people who have no signs or symptoms of the specific disease or condition under evaluation, and the recommendations address only services offered in the primary care setting or services referred by a primary care clinician.

The USPSTF recommends services with “A” or “B” letter grades, which should be uniformly recommended for all patients who meet criteria for the service. “C”-rated services are appropriate for selected individuals and should be implemented after a discussion with patients and families about the relatively small net benefit and potential harms. “D”-rated services should not be offered because of the lack of benefit or net harm. The USPSTF recognizes that patients may have questions about or request grade D services. In this case, clinicians should make sure that patients and families are fully informed and make a collaborative decision based on the patients’ health status and preferences. Services with an “I” statement also should not be implemented on a routine basis without first introducing shared decision-making with patients and families about the insufficiency of evidence and uncertainty about the net benefit of the service (Table 1.1).

The Electronic Preventive Services Selector (ePSS) is an application designed to help primary care clinicians identify clinical preventive services that are appropriate for their patients. This tool can be downloaded to mobile devices and used in clinical practice to determine appropriate recommended services for patients, based on their sex and age.

### EVIDENCE-BASED CLINICAL PRACTICE GUIDELINES

Evidence-based clinical practice guidelines are specific practice recommendations grouped together that have been created from a methodologically rigorous review of the best evidence on a specific topic. Guidelines typically do not answer a single specific clinical question, but rather a group of questions about care. As a result, they have tremendous potential as tools for clinicians to improve the quality of care, the process of care, and patient outcomes as well as reduce variation in care and unnecessary healthcare expenditures (Institute of Medicine Committee on Standards for Developing Trustworthy Clinical Practice Guidelines, 2011).

It is important to note the latest publication date of clinical practice guidelines as many guidelines need updating so that the latest evidence is included in making practice recommendations. It is also important to note

<table>
<thead>
<tr>
<th>TABLE 1.1 USPSTF Recommendation Grades</th>
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<tr>
<td>Grade</td>
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<tr>
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</tr>
<tr>
<td>A</td>
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<tr>
<td>B</td>
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<tr>
<td>D</td>
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<tr>
<td>I</td>
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Letter grades are assigned to each recommendation statement. These grades are based on the strength of the evidence on the harms and benefits of a specific preventive service.

USPSTF, United States Preventive Services Task Force.

the process through which the guidelines were created, as there are many guidelines that have been created by professional organizations that have not followed rigorous processes for development (e.g., systematic reviews; Melnyk et al., 2012). Although clinical practice guidelines have tremendous potential to improve the quality of care and outcomes for patients as well as reduce healthcare variation and costs, their success depends on a highly rigorous guideline development process and the incorporation of the latest best evidence. In addition, guideline success depends on implementation by healthcare clinicians as their dissemination does not equate to implementation.

**ECRI Guidelines Trust™**

Since 1968, the ECRI Institute has been advancing the science of care throughout the world. Its mission is to protect patients from unsafe and ineffective medical technologies and practices. More than 5,000 healthcare institutions and systems worldwide, including four out of every five U.S. hospitals, rely on the ECRI Institute to guide their operational and strategic decisions. In addition, the Institute serves private payers; federal and state agencies; policy makers; ministries of health; associations; and accrediting agencies. The ECRI Guidelines Trust is a publicly available web-based repository of objective evidence-based clinical practice guideline content. Its purpose is to provide physicians, nurses, other clinical specialties, and members of the healthcare community with up-to-date clinical practices to advance safe and effective patient care. This centralized repository includes evidence-based guidance developed by nationally and internationally recognized medical organizations and medical specialty societies. The ECRI Guidelines Trust provides the following guideline-related content:

- **Guideline briefs**: Summarizes content providing the key elements of the clinical practice guideline.
- **TRUST (Transparency and Rigor Using Standards of Trustworthiness) scorecards**: Ratings of how well guidelines fulfill the IOM Standards for Trustworthiness (see https://guidelines.ecri.org).

**The Guidelines International Network**

The Guidelines International Network (G-I-N), founded in 2002, encompasses a comprehensive database of clinical practice guidelines. The mission of G-I-N is to “lead, strengthen and support collaboration in guideline development, adaptation and implementation . . . . G-I-N facilitates networking, promotes excellence and helps . . . members create high quality clinical practice guidelines that foster safe and effective patient care” and is comprised of 102 organizations representing 30 countries from all continents (G-I-N, n.d.). See www.g-i-n.net/home.

**The Registered Nurses’ Association of Ontario Clinical Practice Guidelines**

A tool kit to enhance the use of clinical practice guidelines is available from the Registered Nurses’ Association of Ontario. It can be downloaded from its website at http://ltctoolkit.rnao.ca.

**Research-Tested Intervention Programs and Quality Healthcare Innovations Exchange**

Other searchable databases that are helpful to clinicians in making decisions on what evidence-based interventions to implement in their practices are the Research-Tested Intervention Programs (RTIPs) by the National Cancer Institute and the AHRQ Health Care Innovations Exchange. RTIPs is a database of over 200 “evidence-based cancer control interventions and program materials . . . designed to provide . . . practitioners [with] easy and immediate access to research-tested materials” (National Cancer Institute, n.d., “Moving from Research” see https://rtips.cancer.gov/rtips/index.do). Programs listed have undergone rigorous reviews before their inclusion on this website. The Innovations Exchange was created to “speed the implementation of new and better ways of delivering health care” by sharing, learning about, and adopting evidence-based innovations and tools appropriate for a range of healthcare settings and populations (AHRQ, n.d., para. 1). See https://innovations.ahrq.gov.

**Choosing Wisely®**

In 2010, Howard Brody published “Medicine’s Ethical Responsibility for Health Care Reform—The Top Five List” in the New England Journal of Medicine. In this piece, Dr. Brody called on U.S. medical specialty societies to identify five tests and treatments that were overused in their specialty and did not provide meaningful benefit for patients (Brody, 2010). Shortly after, the National Physicians Alliance (NPA) piloted the “Five Things” concept through an American Board of Internal Medicine (ABIM) Foundation Putting the Charter Into Practice grant and created a set of three lists of specific steps physicians in internal medicine, family medicine, and pediatrics could take in their practices to promote the more effective use of healthcare resources. These lists were first published in Archives of Internal Medicine. Building on this work, the ABIM Foundation, along with Consumer Reports, formally launched the Choosing Wisely campaign in 2012 with the release of “Top Five” lists from nine specialty societies. The widespread media coverage from nearly every top-tier outlet, along with positive reactions from among the healthcare community, inspired 17 additional societies to join the campaign and release lists in February 2013. More than 70 societies, comprising over
Choosing Wisely

In 2013, the ABIM Foundation received a grant from the Robert Wood Johnson Foundation (RWJF) to advance the Choosing Wisely campaign by funding 21 state medical societies, specialty societies, and regional health collaboratives to help healthcare clinicians and patients engage in conversations aimed at reducing unnecessary tests and procedures. In 2015, the RWJF awarded a second grant to the ABIM Foundation to continue this important work.

The mission of Choosing Wisely is to promote conversations between clinicians and patients by helping patients choose care that is:

- Supported by evidence
- Not duplicative of other tests or procedures already received
- Free from harm
- Truly necessary

To help patients engage their clinician in these conversations and empower them to ask questions about what tests and procedures are right for them, patient-friendly materials were created on the basis of specialty societies’ lists of recommendations of tests and treatments that may be unnecessary. Choosing Wisely recommendations should not be used to establish coverage decisions or exclusions; they are meant to facilitate conversation about what is appropriate and necessary treatment. As each patient situation is unique, clinicians and patients should use the recommendations as guidelines to determine an appropriate treatment plan together (Choosing Wisely, n.d.). See www.choosingwisely.org/our-mission.

Key Takeaways

- EBP is a lifelong problem-solving approach to the delivery of care that incorporates the current best evidence with a clinician’s expertise and patient/family preferences and values.
- Clinicians should be skilled in the seven steps of EBP in order to provide the highest quality of care.
- Clinicians need to incorporate the EBP process into their health and well-being assessments through rigorous critical appraisal of the evidence underlying history and physical exam techniques, assessment strategies, the use of imaging tests or lab studies, and/or approaches to health and well-being.
- Clinicians should incorporate a well-being assessment into each exam, including the nine dimensions of wellness: physical, emotional, financial, intellectual, career, social, creative, environmental, and spiritual.
- Clinicians should understand and apply the concepts of validity, reliability, sensitivity, specificity, predictive values, and likelihood ratios during the assessment process to improve diagnostic accuracy and ensure high-quality patient care.
- Multiple, high-quality resources exist in which to guide clinicians in making evidence-based decisions.

REFERENCES


ANATOMY AND PHYSIOLOGY OF THE NERVOUS SYSTEM

The central nervous system (CNS) is composed of the brain and spinal cord and is responsible for control of the body. The cranial and spinal nerves and the ascending and descending pathways make up the peripheral nervous system (PNS), which is responsible for carrying information to and from the CNS. Coordination and regulation of the internal organs of the body (cardiac and smooth muscle) is the responsibility of the autonomic nervous system, which is divided into the sympathetic and parasympathetic divisions. The sympathetic division stimulates the body when physiologic or psychologic stress occurs and the parasympathetic division provides a protective function to conserve body resources and maintain digestion and elimination.

BRAIN

The major components of the brain are the cerebrum, cerebellum, and the brainstem (Figure 14.1). Brain tissue is gray or white. Gray matter is made up of neuronal cell bodies, which edge the surfaces of the cerebral hemispheres forming the cerebral cortex, the largest portion of the brain. White matter is made up of neuronal axons covered with myelin, which enables rapid movement of nerve impulses. The brain receives approximately 20% of
the total cardiac output from the internal carotid arteries and vertebral arteries. Butterfield (2019) describes the responsibilities of the brain as “enabling a person to reason, function intellectually, express personality and mood and perceive and interact with the environment” (p. 439).

**CEREBRUM**

The cerebrum is composed of the right and left cerebral hemispheres, which are divided into lobes (Figure 14.2). The gray outer layer of the cerebral cortex receives, stores, and transmits information and controls/integrates general movement, visceral functions, perception, and behavior. Each hemisphere controls/integrates general movement, visceral functions, perception, and behavior. Each hemisphere controls the opposite side of the body. Fibers interconnect areas within each hemisphere, providing communication between motor and sensory areas.

The motor cortex lies within the frontal lobe and is responsible for voluntary skeletal movement, fine repetitive movement, and eye movements. Areas in the primary motor area are associated with movement of specific body parts. Cortical spinal tracts extend from the primary motor area into the spinal cord.

The parietal lobe is responsible for processing sensory data as it is received. It also assists with interpretation of tactile information such as temperature, pressure, pain, size, shape, texture, and two-point discrimination, as well as visual, taste, smell, and hearing sensations. Association fibers connect cortical areas within each cerebral hemisphere, providing communication between motor and sensory areas.

Perception and interpretation of sounds, determining their source, and integrating taste, smell, and balance are the responsibilities of the temporal lobe.

Enclosed in the temporal lobe is the Wernicke area, a sensory speech area, responsible for receiving and interpreting speech. Hippocampi, located in the medial temporal lobes, are necessary for memory storage.

The occipital lobe contains the primary vision center (Brodmann area) responsible for visual data interpretation. Located deep within the brain are basal ganglia, which function as a pathway between the cerebral motor cortex and upper brainstem. The function of the basal ganglia is to refine motor movements.

**CEREBELLUM**

The cerebellum is located at the base of the brain (see Figure 14.2). The cerebellum works in conjunction with the motor cortex of the cerebrum to assimilate voluntary movement. The cerebellum also processes sensory movement from the eyes, ears, touch receptors, and the musculoskeletal system (Ball, Dains, Flynn, Solomon, & Stewart, 2019). The cerebellum and vestibular system use sensory data for reflex control of muscle tone and balance and posture to maintain the body in an upright position. Cerebellar hemispheres have same side control of the body.

**BRAINSTEM**

The brainstem is composed of the midbrain, medulla, and pons and serves as a pathway between the cerebral cortex and the spinal cord (see Figure 14.2). The midbrain is the reflex center for eye and head movement and contains the auditory relay pathway. The medulla houses the respiratory center and controls involuntary functions such as the circulatory system as well as swallowing, coughing, and sneezing reflexes. The pons regulates respiration and is the reflex center for pupillary action and eye movement (Ball et al., 2019).
SPINAL CORD
Originating at the foramen magnum and extending to just below the medulla, the CNS continues into the spinal cord, which is approximately 40 to 50 cm in length. The brain and spinal cord are bathed in cerebral spinal fluid. The spinal cord lies within the vertebral column, ending at the first or second lumbar vertebrae. The vertebral column is divided into 33 vertebrae: seven cervical, 12 thoracic, five lumbar, five fused sacral, and four fused coccygeal vertebrae (Butterfield, 2019; Figure 14.3). Spinal tracts, fibers which run through the spinal cord, carry sensory, motor, and autonomic impulses between high brain centers to the body. Spinal cord gray matter is butterfly-shaped with anterior and posterior horns, while the white matter of the spinal cord contains the ascending and descending spinal tracts.

CRANIAL NERVES
Twelve pairs of specialized peripheral cranial nerves arise from the cranial vault and travel from the skull foramina to structures in the head and neck. Cranial nerves are sequentially numbered with Roman numerals I through XII. Each nerve has motor or sensory functions, while others have specific functions for smell, vision, or hearing.

MOTOR PATHWAYS
Motor pathways, also known as motor tracts, are descending spinal tracts that transmit impulses from the brain (for cranial nerves) and in the spinal cord (for peripheral nerves; Figure 14.4). Motor pathways contain upper and lower motor neurons.
are pathways that send impulses from the brain to the spinal cord but affect movement only through lower motor neurons. Lower motor neurons, cranial and spinal neurons, originate in the anterior horn of the spinal cord, extending to the PNS, and control muscle tone, posture, and fine movements. There are three primary motor pathways that intersect within the anterior horn cells: the corticospinal tract, the basal ganglia system, and the cerebellar system, all of which innervate movement only through lower motor neuronal systems (Table 14.1). Any voluntary, autonomic, or reflex movement will travel through the anterior horn cells and be converted into movement.

**SENSORY PATHWAYS**

**Sensory pathways**, also known as spinal tracts, are a system of sensory receptors that transmit impulses from the skin, mucous membranes, muscles, tendons, and viscera into the posterior root ganglia, which direct the impulses into the spinal cord (Figure 14.5). The sensory impulse is then relayed to the sensory brain cortex by one of two sensory pathways: the spinothalamic tract and the posterior columns.

These pathways manage sensory signals that are necessary to perform complex discrimination. The spinothalamic tract consists of small, unmyelinated sensory neurons from free nerve endings in the skin and is responsible for light and crude touch, pressure, temperature, and pain. Impulses are relayed to the spinal cord, where they then enter the dorsal horn, which relays the impulse to the opposite side where they ascend to the thalamus. Posterior columns consist of larger, unmyelinated axons that are responsible for transmitting vibration, proprioception, pressure, and fine touch from the skin to the dorsal root ganglion. These nerve impulses travel to the medulla where they cross to the opposite side and travel to the thalamus. At this level, a general distinction of the sensation is perceived. The impulse is then sent to the sensory cortex of the brain where higher order discriminations are made.

**SPINAL NERVES**

There are 31 pairs of spinal nerves originating from the spinal cord and exiting at each intervertebral foramen. Eight cervical, 12 thoracic, five lumbar, and five sacral pairs of spinal nerves and one coccygeal nerve are named for the vertebral level where they exit (Figure 14.6). Spinal nerves have both sensory and motor function and supply and receive information in a specific skin distribution called a dermatome. Bickley and Szilagyi (2017) define dermatomes as “a band of skin innervated by the sensory root of a single spinal nerve” (p. 720; see Figure 14.7).

Each spinal nerve separates into anterior and posterior roots in the spinal cord. The motor fibers of the anterior root relay impulses from the spinal cord to muscles and glands. The sensory fibers of the posterior root relay impulses from sensory receptors to the spinal cord and brain. The sensory cortex of the brain

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**TABLE 14.1 Corticospinal, Basal Ganglia, and Cerebellar Motor Pathways**

<table>
<thead>
<tr>
<th>Pathway</th>
<th>Function</th>
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<tbody>
<tr>
<td>Corticospinal (pyramidal) tract</td>
<td>Mediation of voluntary movement; inhibition of muscle tone; coordination of complicated movements</td>
</tr>
<tr>
<td>Basal ganglia system</td>
<td>Controls muscle tone and body movements, including automatically performing a learned behavior</td>
</tr>
<tr>
<td>Cerebellar system</td>
<td>Coordinates muscle activity, sustains equilibrium, and maintains posture</td>
</tr>
</tbody>
</table>

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**FIGURE 14.5** Spinothalamic tract and posterior columns: sensory pathways.
determines higher order distinction. Spinal sensory neurons may produce a reflex response when tapped in a stretched muscle (motor and sensory function).

**SPINAL REFLEXES**

Deep tendon reflexes (DTRs), also known as muscle stretch reflexes, occur as the result of a sensory and motor response across a single synapse. Each reflex corresponds to specific spinal segments in sequence (Table 14.2). Superficial or cutaneous reflexes produced by stimulation of the skin, such as lightly stroking the skin of the abdomen, may cause a localized muscular twitch. Cutaneous reflexes also correspond to spinal segments (Table 14.3).

**FIGURE 14.6** Relationship of exiting spinal nerves to vertebrae from a lateral view.

**FIGURE 14.7** Dermatomal patterns from an anterior and posterior view. 

**LIFE-SPAN DIFFERENCES AND CONSIDERATIONS IN ANATOMY AND PHYSIOLOGY OF THE NERVOUS SYSTEM**

**Infancy**

Major brain growth occurs in the first year of life with myelinization of the brain and nervous system. Infection, biochemical imbalance, or trauma may disrupt development and growth, producing devastating results with eventual brain dysfunction. Neurologic impulses are provided by the brainstem and spinal cord at birth.
Older Adults

In addition to decreased brain size, cerebral neurons decrease with aging. Older adults experience decreased sensory functions of smell, taste, and vision. The rate of nerve impulse conduction decreases, causing the older adult to experience slower responses to stimuli, unsteady gait, sleep disturbances, decreased level of cognition, diminished appetite, and decreased range of motion.

KEY HISTORY QUESTIONS AND CONSIDERATIONS

HISTORY OF PRESENT ILLNESS

Common Presenting Symptoms

- Headache
- Dizziness or vertigo
- Weakness or paresthesia (generalized, proximal, or distal)
- Numbness, abnormal or absent sensation
- Fainting and blacking out (near syncope)
- Seizures
- Tremors or involuntary movements
- Gait coordination
- Pain

Example: Seizure

- Chief concern: Seizure
- Frequency: Age at first seizure; total length (reported time) of seizure activity
- Onset: Recent, chronic, or sudden
- Location: Where spasm began and moved through the body, change in character of motor activity during seizure
- Duration: Increasing, persistent
- Character: Aura, irritability, tension, confusion, blurred vision, mood changes, initial focal motor seizure activity, gastrointestinal (GI) distress, muscle tone flaccidity, stiffness, tension, twitching; postictal phase: weakness, transient paralysis, drowsiness, headaches, muscle aches, and sleeping following seizure; independent observers report: Falling to ground, shrill cry, change of color of face or lips, pupil changes or eye deviations, loss of consciousness, or loss of bowel or bladder control
- Aggravating factors: Time of day, meals, fatigue, emotional stress, excitement, menses, discontinuing medications or poor compliance with medications, complementary or alternative medication that may interfere with anti-epileptic medications, alcohol, or illicit drug use
- Relieving factors: Medications, anti-epileptics
- Red Flag symptoms indicating need for emergency evaluation: Seizures from alcohol or sedative withdrawal, trauma to head with loss of consciousness

<table>
<thead>
<tr>
<th>TABLE 14.2 Deep Tendon Reflex Dermatomal Innervation</th>
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<tbody>
<tr>
<td>Deep Tendon Reflex</td>
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<tr>
<td>---------------------</td>
</tr>
<tr>
<td>Achilles</td>
</tr>
<tr>
<td>Biceps</td>
</tr>
<tr>
<td>Brachioradial</td>
</tr>
<tr>
<td>Patellar</td>
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<tr>
<td>Triceps</td>
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Reflexes observed at this time are sucking, rooting, yawning, sneezing, hiccupping, blinking at bright lights, and withdrawing from painful stimulation, in addition to a few primitive reflexes such as the Moro, stepping, palmar, and plantar grasp reflexes. The Moro or startle reflex diminishes in strength by 3 to 4 months, disappearing by 6 months. The stepping reflex occurs at birth with disappearance at variable ages. Absence of this reflex may indicate paralysis. The palmar grasp should be strongest between 1 and 2 months, disappearing by 3 months. The plantar grasp reflex should be strong up to 8 months. These primitive reflexes diminish as the brain develops and advanced cortical functions and voluntary control become prominent.

<table>
<thead>
<tr>
<th>TABLE 14.3 Superficial Cutaneous Reflex Dermatomal Innervation</th>
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<tbody>
<tr>
<td>Superficial Reflex</td>
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<tr>
<td>--------------------</td>
</tr>
<tr>
<td>Cremasteric</td>
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<tr>
<td>Lower abdominal</td>
</tr>
<tr>
<td>Plantar</td>
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<tr>
<td>Upper abdominal</td>
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</table>
• Differential diagnoses: Focal seizures without impaired consciousness, generalized seizures, toxic or metabolic-induced seizure, drug toxicity

Example: Weakness
• Chief concern: Weakness
• Onset: Sudden, gradual or subacute, or chronic, over a long period of time
• Location: Body areas involved: proximal, distal, symmetrical or asymmetrical, generalized or focal, unilateral or bilateral, what movements are affected
• Duration: Abrupt onset, subacute onset, chronic, or gradual
• Character: Fatigue, apathy, drowsiness, or actual loss of strength; difficulty with movements such as combing hair, reaching up to a shelf, climbing stairs; worsening weakness when walking/improving after rest, decreased hand strength, tripping when walking
• Associated symptoms: Worsening weakness with effort, bilateral distal weakness with sensory loss, proximal weakness with sensation intact
• Aggravating factors: Activities of daily living, reaching, getting out of a chair, climbing stairs, opening jars
• Relieving factors: Rest, decreased activities
• Temporal factors: Recent onset of symptoms, recent/past illness/infection
• Red Flag symptoms including need for emergency evaluation: Abrupt onset of motor and sensory deficits, abrupt vision loss
• Differential diagnoses: Transient ischemic attack (TIA), stroke, Guillain-Barre syndrome, myopathy from alcohol, polyneuropathy from diabetes, and myasthenia gravis

PAST MEDICAL HISTORY
• Trauma: Concussion/brain injury, spinal cord injury or localized injury, CNS:
  - Insult, birth trauma, stroke
• Meningitis, encephalitis, lead poisoning, poliomyelitis
• Deformities, congenital anomalies, genetic syndromes
• Cardiovascular (CV) or circulatory problems: Hypertension, aneurysm, peripheral vascular disease
• Neurologic disorder, brain surgery, residual effects

FAMILY HISTORY
• Hereditary disorders: Neurofibromatosis, Huntington's chorea, muscular dystrophy, diabetes, pernicious anemia
• Alcoholism
• Intellectual disability
• Epilepsy or seizure disorder, headaches

• Alzheimer's disease or other dementia, Parkinson's disease (PD)
• Learning disorders
• Weakness or gait disorders, cerebral palsy (CP)
• Medical or metabolic disorder, thyroid disease, hypertension, diabetes

SOCIAL HISTORY
• Environmental or occupational hazards
• Hand, eye, and foot dominance; family patterns of dexterity and dominance
• Ability to care for self: Hygiene, activities of daily living, finances, communication, shopping, ability to fulfill work expectations
• Sleeping or eating pattern: Weight loss or gain
• Use of alcohol or recreational drugs, including mood-altering drugs
• Social support system
• Smoking history
• Use of cane or assistive device

REVIEW OF SYSTEMS
• General: Fever, chills, sleeplessness, fatigue, dizziness
• Head, eyes, ears, nose, throat (HEENT): Visual disturbances/visual difficulty, tearing or redness of eyes
• CV and respiratory: Respiratory irregularities, bruits, thrills
• Gastrointestinal (GI)/genitourinary (GU): Nausea, vomiting, urinary frequency, hesitancy, urgency, incontinence
• Neurologic: Weakness, numbness and tingling, change in sensation, loss of consciousness, headache, falls, dizziness
• Musculoskeletal: Headache, backache, nuchal rigidity, weakness
• Psychiatric: Depression, anxiety, changes in mentality, memory, or mood

PREVENTIVE CARE CONSIDERATIONS
• Healthy lifestyle behaviors/fall prevention
• Prevention of stroke and transient ischemic attack (TIA)
• Carotid artery screening
• Reducing risk of peripheral neuropathy, A1c within normal limits
• Herpes zoster vaccination
• Detecting delirium, dementia, and depression

Unique Population Considerations for History
Older adults may present with altered levels of cognition, not associated with or occurring as part of neurological disease. Polypharmacy occurs with many older
adults who may consume additional vitamins or herbal supplements, which may cause adverse reactions, leading to a decreased level of consciousness and gait disturbance. Alcohol, illicit drug use, or simultaneous use of opioids and benzodiazepines significantly increases risk of adverse drug reactions with resultant mentation changes or increased risk of falls. As a component of their assessment, ask individuals screening questions to assess fall risk, such as number of falls within the past year, if they feel unsteady when standing or walking, and if there are worries about falling. Depression screening is also important to determine if changes in cognition are related to depression or as part of a neurological disorder.

**MENTAL STATUS EXAMINATION**

The mental status examination should assess the patient's mood, cognition, and emotional responses. Cognition includes the patient's judgment, their ability to think and reason, and their ability to interact with their environment (Ball et al., 2019, p. 88). Mental status is typically obtained by observation of the patient and is composed of assessment of their appearance and behavior, speech and language, mood, thoughts, perceptions, and cognition.

**Appearance and Behavior**

- Level of consciousness
- Posture and motor behavior
- Dress, grooming, and personal hygiene
- Facial expression
- Manner/affect/relationship to people

**Speech and Language**

- Characteristics of patient's speech:
  - Talkative/quiet
  - Slow/rapid speech
  - Words clear
  - Nasal quality to speech
  - Articulation/fluency

**Mood**

- Anxiety/worry
- Contentment
- Detachment/indifference
- Euphoria
- Rage/anger
- Sad/melancholy

**Thoughts and Perceptions**

- Thought process:
  - Flight of ideas
  - Fabrication of facts
  - Incoherence
  - Repetition
- Thought content:
  - Anxiety
  - Delusions
  - Insight

**INSPECTION**

The clinician should begin the neurological examination as they would any examination. As the patient enters the room, observe gait, balance, and coordination. Listen to the patient’s response to questions, which provides information regarding the patient’s ability to follow directions. Conduct a general survey and document the patient’s vital signs. A height, weight, and body mass calculation should be completed and compared to previous visits if possible to identify signs of chronic disease or weight loss. Assess for depression. This is important to note for older adults as depression is more common in elders and those with chronic diseases, including neurological disorders such as dementia, multiple sclerosis (MS), and PD. The Patient Health Questionnaire-2 (PHQ-2) can accurately identify major depressive disorders by asking two questions: “Over the last 2 weeks, have you been feeling down, depressed, or hopeless (depressed mood)” and “Over the last 2 weeks, have you felt little interest or pleasure in doing things?” If the answer is yes to either or both of these questions, the entire Patient Health Questionnaire-9 (PHQ-9) should be administered. Also assess suicidality in depressed patients (Bickley & Szilagyi, 2017, p. 733).

Inspection of the face includes attention to symmetry, shape, features, and facial expression; symmetry of the eyebrows, eyes, ears, nose, and mouth; and position of facial features such as nasolabial fold and inspecting for facial muscle atrophy and tremors.

**EQUIPMENT**

- Penlight
- Tongue blade, paper clip, cotton-tipped applicator
- Tuning forks, 200 to 400 Hz and 500 to 1,000 Hz
- Familiar objects: Coins, keys, paper clip
- Cotton wisp
- 5.07 filament
- Reflex hammer
- Vials of aromatic substances: Coffee, orange, peppermint extract, oil of cloves for testing

**PHYSICAL EXAMINATION OF THE NERVOUS SYSTEM**

Neurological physical assessment is critical for diagnosis and management of the neurologic patient (Lederman, 2018). Secondary to the complexity of the examination, this section is divided into five sections: mental status, cranial nerves, proprioception/cerebellar function, reflexes, and sensory function.
vision loss, testing of both eyes can reveal a visual field deficit; testing with one eye will miss this finding.

Oculomotor, Trochlear, and Abducens (III, IV, and VI)
The oculomotor, trochlear, and abducens nerves are tested with movement of the eyes through the six cardinal points of gaze.

Trigeminal (V)
The three divisions of the trigeminal nerve are evaluated for sharp, dull, and light touch sensations. Motor function is evaluated by observing the face for muscle atrophy, deviation of the jaw to one side, and muscle twitching. To assess, the patient should clench their teeth tightly as the muscles over the jaw are palpated, evaluating tone (Figure 14.9). Facial tone should be symmetric, without tremor.

The three trigeminal nerve divisions are evaluated for sharp, dull, and light touch sensations. The patient's eyes are closed, and the clinician touches each side of the face at the scalp, cheek, and chin alternately using the sharp and smooth edges of a broken tongue blade or paper clip (Figure 14.10A). Ask the patient to report whether each sensation is sharp or dull. Then stroke the face in the same six areas with a cotton wisp asking the patient to report sensation (Figure 14.10B). Discrimination of all stimuli is expected over all facial areas.

Facial (VII)
The facial nerve is tested for facial symmetry by asking the patient to form specific facial expressions (Figure 14.11). The clinician requests the patient to raise the eyebrows, squeeze eyes shut, wrinkle the forehead, frown smile, show their teeth, purse their lips, and puff out their cheeks. Observe for tics, unusual

CRANIAL NERVES

Olfactory (I)
The olfactory nerve is tested when the patient is unable to discriminate odors. The least irritating aroma is used first so that patient perception of weaker odors is not injured. Tubes of orange or peppermint extract can be used. Before assessing, make sure the patient's nares are clear; have the patient occlude one naris at a time, and ask them to breathe in and out. Have the patient close their eyes. Holding an open vial under the nose, ask the patient to breathe deeply (Figure 14.8). Use a different aroma to test the other side. Repeat two to three times with two to three different odors. Patients are expected to perceive an odor on each side and to identify it.

Optic (II)
Testing for optic nerve function includes testing of distant and near vision, ophthalmoscopic examination of optic fundi, with special attention to the optic disc and testing visual fields by confrontation and extinction. When testing the visual fields, test each eye separately and both eyes together. In those patients with partial

FIGURE 14.8 Olfactory nerve testing. Patient occludes one nostril while the clinician places the aroma vial under the other nostril.

FIGURE 14.9 Motor function assessment of the trigeminal nerve.
FIGURE 14.10 Evaluation of trigeminal nerve divisions.

FIGURE 14.11 Facial nerve testing. Among other expressions, patient (A) raises eyebrows, (B) squeezes eyes shut, (C) frowns, (D) smiles, and (E) puffs out cheeks.
patient sip and swallow water. The patient should be able to swallow easily. Listen to the patient’s speech for hoarseness, nasal quality, or difficulty with guttural sounds.

**Spinal Accessory (XI)**

Evaluation of the spinal accessory nerve includes evaluation of the size, shape, and strength of the trapezius and sternocleidomastoid (SCM) muscles. To test the trapezius muscle, the clinician stands behind the patient and observes for atrophy or flickering movement of the skin (a symptom of disease of the nervous system). The clinician places a hand on each shoulder and asks the patient to shrug upward toward their hands and observes the strength and contraction of the muscle (Figure 14.13). To test the SCM muscle, the clinician asks the patient to turn the head to each side against their hand, observing the contraction of the opposite SCM muscle and the force of movement against the hand (Figure 14.14).

**Facial Movements, or Asymmetry.** Drooping of one side of the mouth, a flattened nasolabial fold, and/or sagging of the lower eyelid are signs of muscle weakness.

**Acoustic (VIII)**

Assess hearing with the whispered voice test. The clinician asks the patient to repeat numbers whispered into one ear while blocking or rubbing your fingers next to the opposite ear. An audiometry examination is completed. Vestibular function is tested with the Romberg test, which tests position sense. The clinician has the patient stand with the feet together and eyes open and asks the patient to close their eyes for 30 to 60 seconds without support (Figure 14.12). Observe the patient’s ability to maintain an upright posture. Minimal swaying is a normal finding.

**Glossopharyngeal (IX) and Vagus (X)**

An intact glossopharyngeal nerve gives the patient the ability to identify sour and bitter tastes on the posterior third of each side of the tongue, to gag, and to swallow. Inspect the palate and uvula, speech sounds, and gag reflex. Observe for difficulty swallowing, and assess for guttural speech sounds or hoarse voice sounds. Sensory function of taste may be completed during CN VII evaluation. Glossopharyngeal nerve function is simultaneously tested during the evaluation of the vagus nerve for nasopharyngeal sensation (gag reflex) and the motor function of swallowing. The gag reflex is initiated by touching the patient’s posterior pharyngeal wall with an applicator while observing for upward movement of the palate and contraction of the pharyngeal muscles. The uvula should remain in midline. Drooping or absence of an arch on either side of the palate is abnormal. Motor function is evaluated with inspection of the soft palate for symmetry. The clinician has the patient say “ah” and observes the movement of the soft palate. If there is damage to the vagus or glossopharyngeal nerve, the palate does not rise, and the uvula will deviate from midline. To complete testing, have the patient sip and swallow water. The patient should be able to swallow easily. Listen to the patient’s speech for hoarseness, nasal quality, or difficulty with guttural sounds.
Accuracy of Movements

The clinician tests the accuracy of movements with the use of the *finger-to-nose test*, which is performed with the patient’s eyes open. Ask the patient to use an index finger to touch their nose (Figure 14.18A), then touch the clinician’s index finger which should be positioned approximately 18 inches from the patient to allow full arm extension (Figure 14.18B). The clinician moves their finger position several times during the test, which is then repeated on the other hand. The *heel-to-shin test* is an alternative method to test accuracy of movement. This test can be performed with the patient sitting or supine. The clinician asks the patient to run the heel of one foot up and down the shin of the opposite leg and repeat the test with the other heel. The patient should be able to move the heel up and down the shin in a straight line without deviating to the side (Figure 14.19).

Balance

Balance is first evaluated with the Romberg test (see Figure 14.12). The clinician should be prepared if the patient starts to fall. Loss of balance is a positive sign, indicating cerebellar ataxia/dysfunction or sensory loss. If the patient staggers and loses balance, postpone other tests of cerebellar function, which require balance. Other methods of evaluating balance are as follows:

- Have patient stand with feet slightly apart and push the shoulders with enough effort to throw them off balance (be ready to catch the patient, if needed). The patient should be able to quickly recover balance.
- Request the patient to close their eyes, hold their arms at the sides of the body, and stand on one foot,

**Hypoglossal (XII)**

The clinician inspects the patient’s tongue while at rest on the floor of the mouth and while protruded from the mouth observing for size and shape. The patient is asked to move their tongue in and out of the mouth, side to side, and curled upward and downward. Muscle strength of the tongue is tested by asking the patient to push the tongue against the cheek as the clinician applies resistance with an index finger or hand (Figure 14.15). Assess lingual speech sounds (l, t, d, n) by listening to the patient’s speech (Box 14.1).

**MNEMONIC FOR CRANIAL NERVES**

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<tr>
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<td>Hypoglossal</td>
<td>H</td>
<td>Hops</td>
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**PROPRIOCEPTION AND CEREBELLAR FUNCTION**

**Coordination and Fine Motor Skills**

When assessing the motor system, focus on the patient’s body position during movement and at rest. Look for involuntary movements (tics or tremors), muscle bulk, muscle strength, muscle tone, and the patient’s coordination. Abnormal position may be due to monocular hemiparesis from stroke.

**Rapid Rhythmic Alternative Movements**

The clinician asks the seated patient to pat their knees with both hands, alternately turning the palms up and down and gradually increasing the speed of movements (Figure 14.16). Alternatively, the clinician may request the patient to touch the thumb to each finger on the same hand from the little finger and back (Figure 14.17). One hand is tested at a time, gradually increasing the speed. The clinician should model the movements for the patient before having the patient complete them. The patient should be able to accomplish these movements smoothly and rhythmically. Stiff, slow, or jerky clonic movements are abnormal.
repeating the test on the opposite foot. Slight swaying is normal, and the patient should be able to maintain balance on each foot for 5 seconds.

- With their eyes open, have the patient hop in place on one foot and then the other (tests proximal and distal muscle strength). The patient should be able to hop on one foot for 5 seconds without loss of balance. Observe for instability or need to continually touch the floor with the opposite foot or a tendency to fall.

**Gait**

The clinician asks the patient to:

- Walk across the room or down the hall and turn and come back, observing posture, balance, swinging of the arms, and intact movement. Walk heel-to-toe in a straight line (tandem walking; Figure 14.20).
- Walk on toes, then on their heels.
- Do a knee bend.

These tests assess for gait abnormalities, which increase fall risk (Table 14.4).

Tandem walking may reveal ataxia and distal leg weakness, and is a sensitive test for corticospinal tract damage. Difficulty hopping may be related to weakness, lack of position sense, or cerebellar dysfunction.

Testing for pronator drift should also be completed. The clinician asks the patient to stand for 20 to 30 seconds with eyes closed and both arms straight forward with palms up (Figure 14.21A). The patient is then instructed to keep their arms out and eyes shut. The clinician taps the arms briskly downward. The arms normally return smoothly to the horizontal position, which requires muscular strength, coordination, and good position sense. With loss of position strength, arms will drift sideward or upward, which is a positive test for pronator drift (Figure 14.21B). The patient may not notice the displacement.
TABLE 14.4 Abnormal Gait Pattern Characteristics

<table>
<thead>
<tr>
<th>Gait Pattern</th>
<th>Characteristics</th>
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<tbody>
<tr>
<td>Antalgic</td>
<td>Limited time of weight-bearing on the affected side; limping</td>
</tr>
<tr>
<td>Ataxic/cerebellar gait</td>
<td>Clumsy, staggering movements with wide-base gait; titubation present at rest</td>
</tr>
<tr>
<td>Choreiform/hyperkinetic gait</td>
<td>Nondirectional, jerky, involuntary movements in all extremities</td>
</tr>
<tr>
<td>Dystrophic/waddling gait</td>
<td>Legs wide apart/weight shifted side-to-side in waddling motion related to weak hip adductor muscles</td>
</tr>
<tr>
<td>Neuropathic/steppage/equine gait</td>
<td>Seen in patients with foot drop (weakness of foot dorsiflexion); patient attempts to lift leg high enough so the toe does not drag on the floor</td>
</tr>
<tr>
<td>Parkinsonian</td>
<td>Stooped posture with head and neck forward and flexion at the knees/rigid body/short shuffling steps/difficulty initiating steps and stopping/bradykinesia</td>
</tr>
</tbody>
</table>
Grip strength: The clinician asks the patient to squeeze two of their fingers as hard as possible and not let them go (Figure 14.23). Weak grip is seen in cervical radiculopathy, ulnar peripheral nerve disease, carpal tunnel syndrome, arthritis, and epicondylitis.

Finger abduction: Patient’s hand is positioned down with fingers spread. The clinician instructs the patient to prevent movement of fingers as the clinician tries to force them together (Figure 14.24). Weak finger abduction occurs in ulnar nerve disorders.

Thumb opposition: The clinician asks the patient to touch the top of the little finger with the thumb against resistance.

Muscle strength of the trunk: Flexion, extension, rotation, and lateral bending.

Flexion at the hip: The clinician places their hands on the patient’s mid-thigh and asks the patient to raise their leg against their hands.

Muscle Strength

Normal muscle strength varies, so the standard of normal should allow for age and sex. The patient’s dominant side is usually stronger than the nondominant side, although differences may be hard to detect. Muscle strength is tested by asking the patient to actively resist the clinician’s movement. The clinician should remember to give the patient the advantage as you try to overcome the patient’s resistance to judge the muscle’s strength. Some patients will give way during muscle strength testing secondary to pain, misunderstanding of the test, or malingering.

Muscle strength testing methods include:

- Biceps and brachioradialis at the elbow flexion and extension (Figure 14.22): The patient pulls and pushes against the clinician’s hand.
- Extension at the wrist: The patient makes a fist and resists as the clinician presses down.
- Grip strength: The clinician asks the patient to squeeze two of their fingers as hard as possible and not let them go (Figure 14.23). Weak grip is seen in cervical radiculopathy, ulnar peripheral nerve disease, carpal tunnel syndrome, arthritis, and epicondylitis.
- Finger abduction: Patient’s hand is positioned down with fingers spread. The clinician instructs the patient to prevent movement of fingers as the clinician tries to force them together (Figure 14.24). Weak finger abduction occurs in ulnar nerve disorders.
- Thumb opposition: The clinician asks the patient to touch the top of the little finger with the thumb against resistance.
- Muscle strength of the trunk: Flexion, extension, rotation, and lateral bending.
- Flexion at the hip: The clinician places their hands on the patient’s mid-thigh and asks the patient to raise their leg against their hands.

FIGURE 14.21 Testing for pronator drift. (A) Patient stands with eyes closed and arms straight forward with palms up. (B) Arms drifting sideward or upward after a brisk tap indicate a positive test.

FIGURE 14.22 Elbow extension (A) and flexion (B).
assesses foot dorsiflexion and plantar flexion, respectively.

**REFLEXES**

**Superficial Reflexes**

- Plantar reflex: Using the end of a reflex hammer, the clinician strokes the lateral side of the foot from heel to ball, then across the foot to the medial side with the result of plantar flexion of the toes (Figure 14.25). This is a normal sign.

- Abdominal reflex: With the patient supine, the clinician strokes the four abdominal quadrants of the abdomen with the end of a reflex hammer. Stroking downward and away from the umbilicus elicits the lower abdominal reflexes, which respond with a slight movement of the umbilicus toward the area of stimulation (Figure 14.26). The reflex response should be equal and bilateral.
**Deep Tendon Reflexes**

DTRs include the biceps, brachioradialis, triceps, patellar, and Achilles reflexes. These reflexes are tested with the patient in a seated position. Each reflex is scored as 0 to 4+. See Table 14.5 for DTR grading. The clinician tests each reflex and compares both sides. The reflex response should be symmetric, visible, and palpable. DTRs are obtained by positioning a limb with a slightly stretched tendon and quickly tapping the tendon to be tested with a percussion hammer. The expected response is a sudden contraction of the muscle. If the tendon response is absent, consider a neuropathy. Consider upper motor neuron disorder with hyperactive reflexes. If DTRs are symmetrically diminished or absent, use a technique of isometric contraction of other muscles, which might increase reflex activity.

- **Biceps reflex:** With the patient’s arm bent at a 45° angle at the elbow, the clinician palpates the biceps tendon and places their thumb over the tendon and their fingers under the elbow. The clinician then strikes the patient’s thumb with the reflex hammer to elicit contraction of the biceps muscle (Figure 14.27).

- **Brachioradialis reflex:** With the patient’s arm bent at a 45° angle at the elbow, the clinician rests the patient’s arm on theirs. The patient’s hand should be slightly pronated. The clinician directly strikes the brachioradial tendon 1 to 2 inches above the wrist with the reflex hammer (Figure 14.28). A normal response is forearm pronation and elbow flexion.

- **Triceps reflex:** With the patient’s arm flexed at a 90° angle, the clinician supports the patient’s arm just above the antecubital fossa and palpates the antecubital fossa and then directly strikes the triceps tendon with a reflex hammer just above the elbow. A normal response is extension of the elbow (Figure 14.29).

- **Patellar reflex:** With the patient’s knee flexed to a 90° angle, the clinician supports the patient’s upper leg with their hand to allow the patient’s lower leg to hang. The clinician strikes the patellar tendon just below the patella (Figure 14.30). A normal response is extension of the lower leg.

- **Achilles reflex:** With the patient sitting and the knee flexed to a 90° angle, keeping the ankle in a neutral position, the clinician holds the patient’s foot in their hand. The clinician strikes the Achilles tendon at

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**TABLE 14.5 Deep Tendon Reflex Grading**

<table>
<thead>
<tr>
<th>Grade</th>
<th>Description</th>
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<tbody>
<tr>
<td>Grade 0</td>
<td>No response</td>
</tr>
<tr>
<td>Grade 1+</td>
<td>Sluggish or diminished response</td>
</tr>
<tr>
<td>Grade 2+</td>
<td>Active or expected response (normal)</td>
</tr>
<tr>
<td>Grade 3+</td>
<td>Brisk/slightly hyperactive</td>
</tr>
<tr>
<td>Grade 4+</td>
<td>Brisk/hyperactive</td>
</tr>
</tbody>
</table>

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**FIGURE 14.27**  Biceps reflex test.

**FIGURE 14.28**  Brachioradialis test.

**FIGURE 14.29**  Triceps reflex test.
sensation by asking the patient to identify stimuli on the hands, distal arms, abdomen, feet, and legs. Each sensation procedure is tested with the patient’s eyes closed. Contralateral areas of the body are tested, and the patient is asked to compare sensations side to side. Normal findings include:

- Minimal side-to-side differences
- Correct description of sensations (hot, cold, sharp, or dull)
- Recognition of the side of the body tested
- Location of sensation and recognition if proximal or distal to the site previously tested

When testing, the clinician focuses on the areas that have numbness, pain, or motor or reflex abnormalities. Before testing, the clinician demonstrates what they are going to do and how the patient should respond. The clinician should compare symmetric areas on two sides of the body, including arms, legs, and trunk. With pain, temperature, and touch sensation, compare distal to proximal areas of the extremities. Test fingers and toes first for vibration and sensation. If these tests are normal, the clinician can assume the more proximal areas are normal. Evaluation of light touch and superficial pain can be evaluated together.

Monofilament testing is another important sensory testing tool commonly used in the evaluation of diabetic and peripheral neuropathy. Testing with a 5.07 monofilament should be done on several sites of the foot for all patients with diabetic and peripheral neuropathy.

- Monofilament testing: With the patient’s eyes closed, the clinician places the monofilament on several sites of the plantar surface of each foot and one side of the dorsal surface of the foot in a random pattern (Figure 14.31). The clinician applies pressure for 1.5 seconds to each site without repeating a test site. The correct amount of pressure is applied when the

**Figure 14.30** Patellar reflex test.

the level of the ankle malleoli. A normal response is plantar flexion of the foot.

**Primitive Reflex Testing in Infancy**

- Moro reflex: Supporting the infant’s head, body, and legs, the clinician suddenly lowers the body, causing the arms to abduct and extend, followed by relaxed flexion; the legs should flex.
- Stepping reflex: The clinician holds the infant under the arms, allowing one of the infant’s feet to touch the surface of the examination table. The clinician observes for flexion of the hip and knee. The foot should touch the table, while the other foot steps forward.
- Palmar reflex grasp: The clinician places a finger in the infant’s hand pressing against the palmar surface of the hand. The infant flexes all fingers to grasp the clinician’s finger. A positive grasp reflex, which lasts longer than 2 months, indicates CNS damage.
- Plantar reflex grasp: The clinician touches the sole of the infant’s foot at the base of the toes, causing the toes to curl.

**SENSORY FUNCTION**

Evaluation of the sensory system requires testing of several kinds of sensation such as pain and temperature (spinothalamic tracts), position and vibration (posterior columns), light touch (spinothalamic tracts and posterior columns), and discriminative sensations, which depend on pain, temperature, position, vibration, and light touch (the cortex). The clinician evaluates

**Figure 14.31** Monofilament test.
Primary Sensory Functions

- Light touch: Clinician lightly touches the skin with a cotton wisp and asks the patient to respond when and where the sensation is felt.
- Superficial pain: Clinician alternates the sharp and smooth edges of a broken tongue blade, Wartenberg wheel (Figure 14.32), or paper clip to touch the skin. The patient is asked to identify each sensation as sharp or dull and where the sensation is felt.
- Temperature: Testing skin temperature is omitted if pain sensation is normal. If there are sensory deficits, use test tubes filled with hot and cold water. The patient is asked to identify if the sensation is hot or cold and where the sensation is felt.
- Vibration: Clinician uses a low-pitched tuning fork (128 Hz, which has slower reduction of vibration). Placing the stem of a vibrating tuning fork against a bony prominence at the toe or finger joint (Figure 14.33), the patient is asked to identify when and where the buzzing sensation is felt.
- Proprioception joint position sense: Clinician assesses the great toe of each foot and a finger on each hand. Hold the joint to be tested by the lateral aspect, in the neutral position, and move the toe up and down (Figure 14.34). The patient is asked to identify the joint position. Expect the patient to identify the joint position.

SPECIAL TESTS

Cortical Sensory Function

Cortical sensory or discriminatory sensory function tests assess the patient’s ability to interpret sensation. Patients with lesions in the sensory cortex or posterior spinal cord would be unable to complete these tests. The patient’s eyes should be closed during testing.

- Stereognosis: Tests the patient’s ability to identify a familiar object by touch. The clinician places a key or coin in the patient’s hand. The patient’s ability to identify the object is a normal response.
• Brudzinski’s sign: The clinician should not use this test if there is injury or fracture of the cervical vertebrae or cervical cord. With the patient lying flat, the clinician puts their hands behind the patient’s head and flexes the neck forward, attempting to touch the patient’s chin to their chest (Figure 14.37A).

• Two-point discrimination: Using two ends of a cotton swab or paper clip, the clinician alternates touching the patient’s skin at various locations with one or two points (Figure 14.35).

The patient’s ability to identify one- or two-point touch is a normal response.

• Extinction phenomenon: The clinician simultaneously touches two areas on each side of the body (such as the cheek or hand) with the broken end of a tongue blade. The patient should be able to discriminate the number of touches and where they are felt bilaterally.

• Graphesthesia: With the blunt end of an applicator, the clinician draws a number or shape on the palm of the patient’s hand (Figure 14.36). The clinician then repeats the test using a different figure on the other hand. The patient should be able to identify the shape or number.

Other special tests are used when the clinician suspects meningeal irritation, which can occur with meningitis or subarachnoid hemorrhage.
CEREBRAL PALSY

CP is defined as a nonprogressive motor disorder secondary to damage of the fetal or infant brain. Risk factors include preterm birth, low birth weight, neonatal encephalopathy, neonatal sepsis, and meningitis (Watson & Pennington, 2015). Signs may not be evident at birth and the problems of CP continue into adulthood as those with disabilities related to the disease are living longer. Early signs may include abnormal muscle tone, abnormal motor development, and feeding difficulties. Age-related physiological changes, which occur in adults, include pain, osteoporosis, fatigue, and musculoskeletal and joint problems (Mudge et al., 2016).

Key History and Physical Findings
- Difficulty eating, drinking, and swallowing
- Poor nutrition
- Difficulty with speech, language, and communication
- Pain:
  - Musculoskeletal: Scoliosis, hip dislocation, non-specific back pain
  - Increased muscle tone: Dystonia and spasticity
  - Muscle fatigue
  - Headache
  - Nonspecific abdominal pain
  - Dental pain
  - Dysmenorrhea
- Sleep disruption
- Mental health problems:
  - Depression
  - Anxiety disorder

Normally, the patient can easily bend the head and neck forward. A positive test is when the patient bends the hips and knees in response neck flexion (Figure 14.37B).
- Kernig's sign: With the patient lying flat, the clinician flexes the patient's leg at the hip and knee, then slowly extends the leg, and straightens the knee (Figure 14.38). Normally, the patient should feel some discomfort behind the knee with extension. A positive test reveals pain with knee extension.

ABNORMAL FINDINGS OF THE NERVOUS SYSTEM

BELL'S PALSY

Bell's palsy is defined as inflammation of the facial nerve typically of unknown cause, although it has been related to herpes simplex type 1 infection and Lyme disease. The facial nerve is responsible for facial expression, taste, lacrimation, salivation, and ear sensation. Symptoms typically develop within hours, with maximum characteristics in 3 days. The patient usually recovers, but not always (Madhok et al., 2016).

Key History and Physical Findings
- Unilateral facial weakness and drooping (Figure 14.39)
- Eyelid weakness
- Facial pain
- Pain around the ear
- Abnormal taste
- Reduced tearing (Patel & Levin, 2015, p. 419)
with hemorrhagic stroke may have neurological deficits similar to ischemic stroke, but are more likely to have headache, altered mental status, seizures, nausea and vomiting, and/or pronounced hypertension. Women have a higher incidence of stroke and higher rates of hemorrhagic stroke than men, which may be due to longer life expectancy, history of preeclampsia, history of oral contraceptive use, and menopause. Risk of hemorrhagic stroke increases with advanced age, hypertension, previous stroke history, alcohol abuse, and cocaine use. Other causes include hypertension, coagulopathies, or anticoagulant therapy (Hemphil et al., 2015).

Key History and Physical Findings

- Trauma history
- General symptoms:
  - Nausea, vomiting, and headache
  - Altered level of consciousness
  - Seizures
- Focal symptoms:
  - Weakness or paralysis of an extremity, half of the body, or all extremities
  - Facial droop
  - Monocular or binocular blindness
  - Blurred vision
  - Dysarthria and trouble understanding speech
  - Vertigo or ataxia
  - Aphasia
- Subarachnoid symptoms may include:
  - Sudden onset of severe headache
  - Signs of meningitis (nuchal rigidity)
  - Photophobia and eye pain
  - Nausea and vomiting
  - Syncope

INTRACRANIAL TUMOR

Intracranial tumor is defined as “an abnormal growth in the cranial cavity that may be primary or secondary cancer” (Ball et al., 2019, p. 598). Brain tumors include glioblastomas, meningioma, and pituitary tumors. Brainstem gliomas are one of the most common tumors in children. Brainstem glioma refers to any tumor growth in the brainstem.

Key History and Physical Findings

- Persistent headaches that wake patient from sleep
- Seizures
- Visual changes: Reduced visual acuity, loss of vision
- Appetite loss, nausea, vomiting
- Changes in behavior and personality
- Children may exhibit irritability, lethargy, cranial nerve palsies, and weight loss
- Signs vary by tumor location
• Confusion
• Papilledema
• Aphasia
• Nystagmus
• Ataxia
• Brain computed tomography (CT) scan or magnetic resonance imaging (MRI) to confirm diagnoses

ISCHEMIC STROKE
Ischemic stroke is most commonly caused by an embolus from atrial fibrillation or atherosclerotic disease, which causes a sudden loss of blood circulation to the brain. Symptoms depend on the affected brain region. Ischemic stroke can occur in adults and children. Genetic factors such as age, sex, and ethnicity can put patients at risk. Factors such as smoking, excessive alcohol use, and limited exercise increase stroke risk. History of high cholesterol, hypertension, and diabetes also cause an increased risk for stroke. Ischemic stroke symptoms most often occur concurrently (Musuka, Wilton, Traboulsi, & Hill, 2015).

Key History and Physical Findings
• Sudden severe headache with no known cause
• Abrupt onset of hemiparesis or monoparesis
• Visual field deficits
• Facial droop
• Ataxia
• Nystagmus
• Aphasia: Expressive and receptive
• Sudden numbness or weakness of the face, arm, or leg
• Abrupt decrease in level of consciousness

MENINGITIS
Meningitis is defined as inflammation of the meninges of the brain or spinal cord. Bacterial, viral, or fungal organism colonization in the upper respiratory tract are the causative organisms. Following colonization, the organism enters the bloodstream, crosses the blood–brain barrier, and infects the cerebrospinal fluid and meninges. Symptoms can develop over several hours or over 1 to 2 days. The classic triad for bacterial meningitis is fever, headache, and neck stiffness; however, patients may present with only one or two of these symptoms (Hasbun, 2019).

Key History and Physical Findings
• Fever, chills
• Headache, neck stiffness
• Lethargy, sleepiness
• Nausea
• Vomiting
• Photophobia
• Confusion
• Irritability
• Delirium
• Seizures
• Coma
• Altered mental status
• Nuchal rigidity
• Fever
• Increased blood pressure with bradycardia
• Positive Brudzinski’s and Kernig’s signs
• Petechial and purpura rash with meningococcal meningitis
• Infants
• Bulging fontanelle
• Paradoxical irritability (quiet when lying flat and crying when held)
• High-pitch cry
• Hypotonia

MULTIPLE SCLEROSIS
MS is defined as an inflammatory demyelinating disease characterized by episodic neurological function in the brain, spinal cord, and optic nerves. MS is a progressive autoimmune disease. Onset is typically between 20 and 40 years of age, occurring more often in women. Patients will present with an acute neurologic episode, with multifocal symptoms lasting longer than 24 hours.

Key History and Physical Findings
• Paresthesia
• Muscle cramping due to spasticity
• Bowel, bladder, and sexual dysfunction
• Constipation
• Dysarthria, nystagmus, and intention tremor
• Lhermitte’s sign (an electric shock-like sensation that occurs with flexion of the neck and goes down the spine, often going into the limbs)
• Trigeminal neuralgia (TN)
• Irregular twitching of the facial nerves
• Fatigue
• Heat intolerance
• Decreased attention span, concentration, memory loss
• Depression
• Bipolar disorder, dementia
• Localized weakness
• Focal sensory disturbances (decreasing proprioception and vibration)
• Hyper-reactive reflexes
• Increased muscle tone or stiffness in the extremities
• Optic neuritis:
  • Unilateral loss of visual acuity
  • Pain
Muscle soreness
Difficulty swallowing
Drooling
Stooped posture
Short steps, shuffling gait, accelerating gait to maintain posture
Slow slurred speech, softened voice

PERIPHERAL NEUROPATHY

Peripheral neuropathy is the most common type of neuropathy and is caused by nerve lesions or tissue nerve damage, which produces hyperexcitability of primary sensory neurons and cells in the dorsal root ganglia (Huether & Rodway, 2019, p. 745). This hyperexcitability causes peripheral nerve endings to become responsive to weak, normally nonpainful stimuli (allodynia) and an exaggerated response to stronger stimuli (hyperalgesia; Cohen, 2018, p. 23). Causes of peripheral neuropathy include alcohol abuse, diabetes, nutritional disorders, and neurotoxic chemotherapy.

Key History and Physical Findings
- Gradual onset of symptoms:
  - Numbness, tingling, shooting, burning, electric shock sensations
  - All sensation is painful
  - Occurs in the feet or hands
  - Night pain in one or both feet
  - Reduced touch sensation
  - Reduced sensation in feet with monofilament examination
  - Diminished posterior tibial or dorsalis pedis pulses
  - Distal muscle weakness, cannot stand on toes or heels
  - Skin ulcerations that the patient is unable to feel

MYASTHENIA GRAVIS

Myasthenia gravis (MG) is a common autoimmune disease affecting neuromuscular junction transmission. The etiology is unknown. Physiologic changes occur when autoantibodies are directed against the acetylcholine receptor sites destroying and blocking transmission of nerve impulses that direct muscle contraction. MG causes weakness, which worsens with activity. Ocular symptoms are most common. Young adults 30 years of age are typically affected. Diagnosis is based on history and physical examination findings and confirmed by electrodiagnostic testing and positive serum antibodies directed at proteins in the neuromuscular junction (Statland & Ciafaloni, 2013, p. 126).

Key History and Physical Findings
- Drooping eyelids
- Double vision
- Difficulty swallowing or speaking
- Fatigue or weakness
- Difficulty walking
- Facial weakness when puffing out cheeks
- Hypophonia
- Respiratory compromise or failure
- Skeletal muscle weakness

PARKINSON’S DISEASE

PD is defined as a slowly progressive neurodegenerative disorder affecting movement, muscle control, and balance caused by destruction and loss of dopaminergic neurons. Early signs and symptoms may be subtle and difficult to detect or missed secondary to slow disease progression. Nonmotor symptoms can sometimes be seen prior to motor symptoms. Diagnosis is based on signs and symptoms, patient history, physical examination, and neurological assessment.

Key History and Physical Findings
- Nonmotor symptoms:
  - Constipation
  - Depression
  - Cognitive dysfunction
  - Dementia
  - Psychosis
- Motor symptoms considered cardinal signs of PD:
  - Rest tremors
  - Slowness of movement, freezing, or inability to continue movements
  - Rigidity
  - Postural instability
- Motor symptoms:
  - Pill-rolling movement of fingers bilaterally
  - Head tremors
  - Numbness, tingling

TRIGEMINAL NEURALGIA

TN is a common form of neuralgia in older adults, affecting women more often than men. TN presents as recurrent paroxysmal sharp pain radiating into one or more branches of the trigeminal nerve. The trigeminal nerve (fifth cranial nerve) has motor and sensory function and is divided into three branches: ophthalmic, maxillary, and mandibular. TN can be caused by small artery compression of the trigeminal nerve, causing demyelination of the trigeminal nerve root (Puskar & Droppa, 2015).

Key History and Physical Findings
- Unilateral burning, stabbing, electric shock, excruciating facial pain in the chin or cheek
- Pain episodes may occur several times a day to several times per month
CASE STUDY: Facial Weakness and Drooping

**History**
A previously healthy 48-year-old female is seen in the primary care clinician's office for evaluation of facial weakness and drooping. Onset of symptoms was 2 to 3 days ago with progressive weakness of the left side of her face and facial pain. She has not taken any medications for pain but has used ice packs with several minutes of pain relief. The patient describes severe pain rated 8/10, which interferes with work and sleep. She denies head injury, falls, injury to face or eye, cough, rash, nasal drainage, or increased tearing. The patient denies medication, food, seasonal, or environmental allergies. She is currently taking no medications. No significant family history. Positive smoking history 1 pack per day × 20 years. Denies abnormalities in taste or ear pain. Denies recent travel or sick contacts. She works in an insurance office and missed work today to be evaluated for the pain and facial drooping.

**Physical Examination**
She appears ill, fatigued, and anxious; she is alert, awake, and responding appropriately to questions. Vital signs: temperature, 99.6°F; pulse, 100 beats/minute; and respirations, 22 breaths/minute. Her weight is stable from previous visit. On examination: skin pink warm and dry, facial features reveal unilateral left-sided facial weakness, and drooping left eyelid and left corner of the mouth. Otoscopic examination is normal. Palpation of preauricular, postauricular, tonsillar, submandibular, and submental nodes are soft, mobile, and nontender bilateral. Negative masses noted with neck examination. Facial examination demonstrates absent forehead wrinkling on the left side when raising eyebrows, incomplete closure of the left eye when patient attempts to close eyes, upward movement of eyes with forced eye closure, and the patient is unable to completely close the left eye. Flattening of the nasolabial fold is noted on the left. Normal strength of buccinator muscle when patient puffs out cheeks. Asymmetry of the lips on left when patient puckers lips, asymmetric grimace on the left. Positive Bell phenomenon noted. **Note:** Bell phenomenon is upward and lateral deviation of the eyes with an attempt to close the eyes.

**Differential Diagnoses**
Bell's palsy, ischemic stroke, TN

**Laboratory and Imaging**
Serologic testing and imaging should not be routinely performed for patients with new onset Bell's palsy (Baugh et al., 2013; Grade C Recommendation).

**Final Diagnosis**
Bell's palsy

CASE STUDY: Jaw Pain

**History**
A previously healthy 64-year-old female is seen in her primary care clinician's office accompanied by her husband. She was recently seen by an oral surgeon who completed a tooth implant. Two weeks later she experienced pain in the jaw and submandibular area on the right lower jaw. She returned to the oral surgeon for reevaluation with the assessment that the implant was successful and there were no complications. Her husband states that at times (continued)
the jaw pain is so intense and sharp that she cries out and is inconsolable. She describes the pain as a burning, stabbing, electric shock pain, and rates the pain as 10/10 when it occurs. The patient states washing her face or brushing her teeth is painful and, at its worst, the pain is excruciating. Currently there is no pain, but pain is sporadic and lasts for several minutes. She states pain is progressively worsening and is now occurring several times per day. Medical history is positive for hypothyroidism, anxiety, and impaired hearing in the right ear. Surgical history is positive for tooth implant. Current medications include levothyroxine 75 mcg 1 tablet daily and fluoxetine 20 mg 1 tablet daily. Denies taking medications for pain. Denies medication, food, or seasonal or environmental allergies. The patient is up-to-date on immunizations and had a flu shot this year. Mammogram completed in 2018 was negative. She wears glasses and states her last eye examination was 6 months ago. She denies smoking, alcohol intake, or illicit drug use. She and her husband have been married for 40 years. She is a homemaker. The patient denies chills, fever, night sweats, cough, nasal congestion, eye or ear drainage, nausea, vomiting, numbness or weakness of the face, or headache. Denies any falls or falls with injury in the past year.

**Physical Examination**

She is alert, lucid, oriented, and appropriate. She is sitting on the examination table holding her hand to her right jaw. Skin pink, warm, and dry. Vital signs: temperature, 98.7°F; pulse, 72 beats/minute; and blood pressure, 118/70 mmHg. Assessment of cranial nerves I to XII completed and negative. Otoscopic and ophthalmoscopic examination were negative. Evaluation reveals tenderness to palpation over the right lower jaw, chin, and right posterior cheek in the mandibular branch of the trigeminal nerve root distribution. Palpation of preauricular, postauricular, tonsillar, submandibular, and submental nodes are soft, mobile, and nontender bilateral.

**Differential Diagnoses**

TN, post-herpetic neuralgia, MS

**Laboratory and Imaging**

Assessment confirmed unilateral neuropathic episodic pain with a normal neurological examination. No laboratory testing is needed. Imaging should include MRI to rule out structural causes of TN or tumor. Neurology referral would be appropriate.

**Final Diagnosis**

TN

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**CASE STUDY: Jaw Pain**

**Clinical Pearls**

- Develop a routine for the neurologic examination. Perform the examination the same way each time to ensure no portion of the examination is missed or forgotten.
- When assessing for protective sensation with use of the monofilament, do not test over callouses and do not repeat a test site.

**Key Takeaways**

- Neurological assessment can be difficult and time-consuming but yields significant information.
- Several neurological conditions do not present with neurologic deficits.

**REFERENCES**


