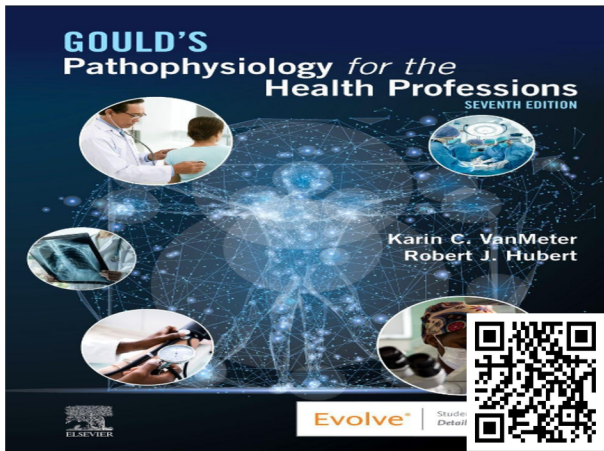


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GOULD'S Pathophysiology *for the* Health Professions

SEVENTH EDITION



Karin C. VanMeter
Robert J. Hubert



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Gould's Pathophysiology for the Health Professions

SEVENTH EDITION

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Preface

This textbook provides an introduction to pathophysiology for students in a variety of academic programs for the health professions at colleges and universities. Major disorders are described, as well as selected additional diseases, with the intention of providing information on a broad spectrum of diseases, with one or more distinguishing features for each. It is anticipated that additional information and resources pertinent to the individual's professional needs may be added to classroom presentations and assignments. We trust that students will enjoy studying these topics and proceed with enthusiasm to more detailed studies within their individual specialties.

Organization

The textbook is organized into five major sections, followed by the appendices.

Section I—Basic Concepts of Disease Processes

- An introduction to pathophysiology, including medical terminology and basic cellular changes, is provided.
- Topics such as fluid, electrolyte, and acid–base imbalances, basic pharmacology, and pain are covered.
- The core information for each topic is complemented by the inclusion of a specific disease/condition as an immediate clinical application at the end of each chapter.

Section II—Defense/Protective Mechanisms

- Topics such as inflammation and healing, infection, and immunity are covered.
- Specific areas included are a review of body defenses, healing involved in specific trauma such as burns, basic microbiology, review of the immune system components, and mechanisms.

Section III—Pathophysiology of Body Systems

- Selection of specific disorders is based on incidence and occurrence, as well as on the need to present a variety of pathophysiological processes and etiologies to the student.
- For major disorders, information is provided on pathophysiology, etiology, clinical manifestations, significant diagnostic tests, common treatment modalities, and potential complications.
- Other selected diseases are presented in less detail, but significant, unique features are highlighted.

Section IV—Factors Contributing to Pathophysiology

- Normal physiological changes related to cancer, adolescence, pregnancy, and aging, with their relevance and effect on disease processes and the treatment of the affected individual, are described.
- Specific disorders associated with cancer and the developmental stages are discussed.

Section V—Environmental Factors and Pathophysiology

- Factors such as immobility, stress, substance abuse, and environmental hazards are the major components in this section.
- Effects of the various environmental factors on the various body systems and potential complications beyond physical pathologies are discussed.
- New research and data are included, as these are areas of increasing concern with regard to pathophysiology and patient health.

Appendices—Additional Information

- Ready References include lists of anatomic terms, abbreviations and acronyms, a selection of diagnostic tests, an example of a medical history, a disease index, and a drug index.
- A glossary and a list of additional resources complete this resource.

Format and Features

The basic format as well as the straightforward, concise approach remain unchanged from the previous editions. Some material has been reorganized to improve the flow of information and facilitate comprehension. Many features related to the presentation of information in this textbook continue as before.

- Generic learning objectives are included in each chapter. Instructors may modify or add applicable objectives for a specific professional program.
- Cross-references are included, facilitating access to information.

- In the discussion of a particular disorder, the *pathophysiology* is presented *first*, because this “sets the stage,” describing the basic change(s) in the body. Once the student understands the essence of the problem, he or she can easily identify the role of predisposing factors or causes and relate the resulting signs and symptoms or complications. Diagnostic tests and treatment also follow directly from the pathophysiology.
- Changes at the *cellular* level are included when significant.
- Brief *reviews* of normal anatomy and physiology are presented at the beginning of each chapter to remind students of the structures and functions that are frequently affected by pathological processes. A review of basic microbiology is incorporated into the chapter on infections. Additional review material, such as the pH scale or the location of body cavities, may be found in the Appendices.
- Numerous *illustrations*, including flow charts, schematic diagrams, and photographs, clarify and reinforce textual information, as well as offering an alternative visual learning mode, particularly when complex processes are involved. Illustrations are fully labeled, including anatomical structures and pathologic changes. Different colors may be used in a figure to distinguish between the various stages or factors in a process.
- *Tables* summarize information or offer comparisons, which are helpful to the student in selecting the more significant information and for review purposes.
- Brief reference to *diagnostic tests* and *treatment measures* promotes understanding of the changes occurring during a disease.
- *Questions* are found in boxes throughout the text to stimulate application and review of new concepts. “Apply Your Knowledge” questions are based on review of normal physiology and its application, “Think About” questions follow each small section of information, and “Study” questions are located at the end of each chapter. Questions

may relate to simple, factual information, potential applications, or the integration of several concepts. These questions are helpful in alerting a student to points initially overlooked and are useful for student self-evaluation before proceeding to the next section. These features may also serve as a tool for review and test preparation. Brief answers are provided on the Evolve website.

- Brief, adaptable *case studies* with questions are incorporated at the end of many chapters and are intended to provide a basis for discussion in a tutorial, an assignment, or an alternative learning mode. It is expected that specific clinical applications may be added by instructors for each professional group.
- Chapter summaries precede the review questions in each chapter.

What's New?

- Information on specific diseases has been updated throughout.
- The specific disorders for each body system have been expanded to reflect current trends and research.
- A broader emphasis on all allied health professions has been incorporated.
- Sections and chapters have been reorganized to present the student with a building block approach: basic science and how it relates to human biology, the body's various mechanisms that respond to the disorders/diseases, the general overview of body systems and their specific disorders, other biological factors outside of the physiology of each system that contribute to instances of disorders/disease, and finally those environmental factors not directly attributed to a biological function or condition that may contribute to pathophysiology throughout a number of body systems.

- Figures have been updated with new photographs and illustrations to help in the recognition and identification of the various concepts and specific disorders.
- Tables have been updated with new information that has been made available since the previous edition.
- New boxes have been added:
 - **Technology**—presents information on newly developed tools/technologies being used to address the challenges in the specific chapter subject, with emphasis on artificial intelligence.
 - **The Bigger Picture**—in a body system chapter, a representative disorder/disease originating in that system is selected, and its effects in other body systems are listed, showing the interactions between different systems.
- Additional resources have been expanded and updated.
- Study questions and Think About questions have been reviewed and updated to cover new material in the chapter. The Apply Your Knowledge questions have replaced the Challenge questions in the previous editions.
- The Study Guide associated with this text has been updated to reflect the most recent information regarding various disorders.

Guidelines for Users

Certain guidelines were developed to facilitate the use of this textbook by students with diverse backgrounds studying in various health science programs. As well as ongoing general changes, some professional groups have developed unique practice models and language. In some disciplines, rapid changes in terminology have occurred, creating difficulty for some students. For example, current terms such as *chemical dependency* or *cognitive impairment* have many synonyms, and some of these are included to enable students to relate to a more familiar phrase. To avoid confusion, the common, traditional terminology has been retained in this text.

- The recipient of care or service is referred to as a *patient*.
- When a disease entity refers to a group of related disorders, discussion focuses on either a typical representative of the group or on the general characteristics of the group.
- *Key terms* are listed at the beginning of the chapter. They are presented in **bold** print and defined when initially used in the chapter. Key terms are not indicated as such in subsequent chapters but may be found in the glossary at the back of the book.
- *Italics* are used to emphasize significant words.
- It is assumed that students have studied anatomy and physiology prior to commencing a pathophysiology course.
- The concise, readable style includes sufficient scientific and medical terminology to help the student acquire a professional vocabulary and appropriate communication skills. An effort has been made to avoid overwhelming the student with a highly technical approach or impeding the learning process for a student with little scientific background.
- The presence of numeric values within textual information often confuses students and detracts from the basic concepts being presented; therefore, specific numbers are included only when they promote understanding of a principle.
- Suggested diagnostic tests and treatments are not individualized or necessarily complete, but are presented generally to assist the student's application of the pathophysiology. They are also intended to provide students with an awareness of the impact of certain diseases on a client and of possible modifications in the individualized care required. Diagnostic tests increase student cognizance of the extent of data collection and sifting that may be necessary before making a diagnosis, as well as the importance of monitoring the course of a disease or the response to treatment.

- A brief introduction to pharmacology is included in Section I, and specific drugs are referred to during the discussion of certain disorders. Drugs are identified by *generic name*, followed by a trade name. Examples provided in the appropriate chapter are not recommendations but are suggested only as frequently used representatives of a drug classification. A drug index with references to the applicable chapter is located in the appendices.
- Information regarding adverse effects of drugs or other treatment is included when there may be potential problems, such as high risk for infection or special precautions required of members of the health care team.
- Every effort has been made to present current information and concepts simply but accurately. This content provides the practitioner in a health profession with the prerequisite knowledge to recognize and understand a client's problems and the limitations and implications of certain treatment measures; to reduce exacerbating factors; to participate in preventive programs; and to be an effective member of a health care team. The student will develop a knowledge base from which to seek additional information. Individual instructors may emphasize certain aspects or topics, as is most appropriate for students in a specialty area.

Resources

In the textbook:

- Selected additional resources are listed in the appendices in Ready Reference 9.
- *Reference tables* are located inside the front book cover. These comprise common normal values for blood, cerebrospinal fluid, and urine; a pH scale for body fluids; a list of blood clotting factors; and diagnostic tests.
- The chapter introducing pharmacology and therapeutics is limited in content but, combined with the brief references

to treatments with individual disorders, is intended to complement the pathophysiology. This chapter also introduces a few traditional and nontraditional therapeutic modalities to facilitate the student's understanding of various therapies and of the impact of diverse treatments on the patient and on care by all members of the health care team. Also included are brief descriptions of a few selected forms of therapy, for example, physiotherapy, in hopes of clarifying the roles of different members of a health care team.

- The appendices at the back of the textbook are intended to promote effective use of study time. They include:
 - A brief review of anatomical terms describing *body cavities and planes*, with accompanying illustrations, as well as basic body movements.
 - Selected numerical conversions for temperature, weights, and volumes.
 - Lists of *anatomical terms* and combining forms, common *abbreviations*, and *acronyms*; because of the broad scope of pathophysiology, a medical dictionary is a useful adjunct for any student in the health-related professions.
 - A brief description with illustrations of common diagnostic tests such as ultrasound and magnetic resonance imaging.
 - An example of a medical history, which can be modified to fit the needs of a particular professional group.
 - A disease index, with a brief description and references to the relevant chapter.
 - A drug index identifying the principal action and references to the appropriate chapters.
 - A list of additional resources; websites consist primarily of health care groups or professional organizations that will provide accurate information and are likely to persist. Additional specific journals and websites are available for individual professions.

- A glossary, including significant terms used to describe diseases, as well as key words.
- Accompanying this textbook and developed for it, the ancillaries available include:
 - A study guide for students, which provides learning activities such as complex test questions, matching exercises, crossword puzzles, diagrams to label, and other assignments.
 - The interactive Evolve web site, which includes self-evaluation tools and can be found at <http://evolve.elsevier.com/Hubert/Goulds/>.

We appreciate the time and effort of reviewers and users of this text, of sales representatives, and of the editors, who have forwarded comments regarding the first four editions. We have attempted to respond to these suggestions while recognizing that comments come from a variety of perspectives, and there is a need to respect the primary focus of this textbook, space constraints, and student concerns.

We hope that teachers and students will enjoy using this textbook, and that it will stimulate interest in the acquisition of additional knowledge in this dynamic field.

**Robert Hubert
Karin VanMeter**

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I will dedicate this book to my mother Theresia “Susi” Sikora, a great mother who I took care of the last five years but passed away as we were finishing the last items for the book. Without her I would not have achieved what I did – “Danke Mutti”. To the same subject I would like to thank my children for their acceptance that they had a mom living between two continents and seeing me very little.

Karin C. VanMeter

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Robert J. Hubert

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After studying this chapter, the student is expected to:

1. Explain the role of pathophysiology in the diagnosis and treatment of disease.
2. Use the terminology appropriate for pathophysiology.
3. Explain the importance of a patient's medical history.
4. Describe common cellular adaptations and possible reasons for the occurrence of each.
5. Identify precancerous cellular changes.
6. List the common causes of cell damage.
7. Describe the common types of cell necrosis and possible outcomes.

What Is Pathophysiology and Why Study It?

Pathophysiology involves the study of *functional* or physiologic changes in the body that result from disease processes. This subject builds on knowledge of the normal structure and function of the human body. Disease development and the associated changes to normal anatomy or physiology may be obvious or may be hidden with its quiet beginning at the cellular level. As such, pathophysiology includes some aspects of *pathology*, the laboratory study of cell and tissue changes associated with disease.

Understanding Health and Disease

Disease may be defined as a deviation from the *normal* structure or function of any part, organ, or system (or combination of these), or from a state of wellness. Disease is a definite pathological process with characteristic sets of signs and symptoms. The World Health Organization (WHO) includes physical, mental, and social well-being in its definition of health.

A state of health is difficult to define because the genetic differences among individuals, as well as the many variations in life experiences and environmental influences, create a variable base. The context in which health is measured is also a consideration. A person who is blind can be in good general health. Injury or surgery may create a temporary impairment in a specific area, but the person's overall health status is not altered.

Homeostasis is the maintenance of a relatively stable internal environment regardless of external changes. Disease develops when significant changes occur in the body, leading to a state in which **homeostasis** cannot be maintained without intervention. Under normal conditions homeostasis is maintained within the body with regard to factors such as blood pressure, body temperature, and fluid balance. As frequent minor changes occur in

the body, the compensation mechanisms respond, and homeostasis is quickly restored. Usually the individual is not aware of these changes or the compensations taking place.

Steps to Health ([Box 1.1](#)) are recommended to prevent disease.

Box 1.1

Seven Steps to Health

1. Be a nonsmoker and avoid secondhand smoke.
2. Eat 5 to 10 servings of vegetables and fruit a day. Choose high-fiber, lower-fat foods. If you drink alcohol, limit your intake to one to two drinks a day.
3. Be physically active on a regular basis. This will also help you to maintain a healthy body weight.
4. Protect yourself and your family from the sun.
5. Follow cancer screening guidelines.
6. Visit your doctor or dentist if you notice any change in your normal state of health.
7. Follow health and safety instructions at home and at work when using, storing, and disposing of hazardous materials.

When one is defining “normal” limits for health indicators such as blood pressure, pulse, or laboratory data, the values used usually represent an average or a *range*. These values represent what is expected in a typical individual but are not absolutes. Among normal healthy individuals, the actual values may be adjusted for factors such as age, gender, genetics, environment, and activity level. Well-trained athletes often have a slower pulse or heart rate than the average person. Blood pressure usually increases slightly with age, even in healthy individuals. Also, small daily fluctuations in blood pressure occur as the body responds to minor changes in activity, body position, and even emotions. Therefore it is impossible to state a single normal value for blood pressure or

pulse rate. It is also important to remember that any one indicator or lab value must be considered within the total assessment for the individual client.

Likewise, a discussion of a specific disease in a text presents a general description of the typical characteristics of that disease, but some differences in the clinical picture can be expected to occur in a specific individual, based on similar variables.

Concept and Scope of Pathophysiology

Pathophysiology requires the use of knowledge of basic anatomy and physiology and is based on a loss of or a change in normal structure and function. Many disorders affecting a particular system or organ (e.g., the liver) display a set of common signs and symptoms directly related to that organ's normal structure and function. The interruption of the normal functioning of one organ (or tissue) will affect other organ systems as well. For example, when the liver is damaged, many clotting factors cannot be produced; therefore, excessive bleeding results. Jaundice, a yellow color in the skin, is another sign of liver disease, resulting from the liver's inability to excrete bilirubin. Also, basic pathophysiologic concepts related to the causative factors of a disease, such as the processes of inflammation or infection, are common to many diseases. Inflammation in the liver causes swelling of the tissue and stretching of the liver capsule, resulting in pain, as does inflammation of the kidneys. This cause-and-effect relationship, defined by signs and symptoms, facilitates the study of a specific disease.

To provide a comprehensive overview of disease processes, this text focuses on major diseases. Other disorders are included when appropriate to provide exposure to a broad range of diseases. The principles illustrated by these diseases can then be applied to other conditions encountered in practice. In addition, a general approach is used to describe diseases in which there may be several subtypes. For example, only one type of glomerulonephritis, a kidney disease, is described in the text—acute poststreptococcal

glomerulonephritis, which represents the many forms of glomerulonephritis.

Prevention of disease has become a primary focus in health care. The known causes of and factors predisposing to specific diseases are being used in the development of more effective preventive programs, and it is important to continue efforts to detect additional significant factors and gather data to further decrease the incidence of certain diseases. The Centers for Disease Control and Prevention (CDC) in the United States have a significant role in collection of data about all types of disease and provide evidence-based recommendations for prevention. Prevention includes activities such as maintaining routine vaccination programs and encouraging participation in screening programs such as blood pressure clinics and vision screening ([Box 1.2](#)). As more community health programs develop, and with the increase in information available on the Internet, health care workers are becoming more involved in responding to questions from many sources and have an opportunity to promote appropriate preventive measures in their communities. A sound knowledge of pathophysiology is the basis for preventive teaching in your profession.

Box 1.2

Primary, Secondary, and Tertiary Prevention

Primary Prevention

The goal is to protect healthy people from developing a disease or experiencing an injury in the first place. For example:

- Education about good nutrition, the importance of regular exercise, and the dangers of tobacco, alcohol, and other drugs
- Education and legislation about proper seat belt and helmet use
- Regular exams and screening tests to monitor risk factors for illness

- Immunization against infectious disease
- Controlling potential hazards at home and in the workplace

Secondary Prevention

These interventions happen after an illness or serious risk factors have already been diagnosed. The goal is to halt or slow the progress of disease (if possible) in its earliest stages; in the case of injury, goals include limiting long-term disability and preventing reinjury. For example:

- Telling people to take daily, low-dose aspirin to prevent a first or second heart attack or stroke
- Recommending regular exams and screening tests in people with known risk factors for illness
- Providing suitably modified work for injured workers

Tertiary Prevention

This phase focuses on helping people manage complicated, long-term health problems such as diabetes, heart disease, cancer, and chronic musculoskeletal pain. The goals include preventing further physical deterioration and maximizing quality of life. For example:

- Cardiac or stroke rehabilitation programs
- Chronic pain management programs
- Patient support groups

From <http://www.iwh.on.ca/wrmb/primary-secondary-and-tertiary-prevention>.

While studying pathophysiology, the student becomes aware of the complexity of many diseases, the difficulties encountered in diagnosis and treatment, and the possible implications arising from

a list of signs and symptoms or a prognosis. Sophisticated and expensive diagnostic tests are now available. The availability of these tests, however, also depends on the geographic location of individuals, including their access to large, well-equipped medical facilities. More limited resources may restrict the number of diagnostic tests available to an individual, or a long waiting period may be necessary before testing and treatment are available. When students understand the pathophysiology they can also better understand factors such as the disease manifestations, potential complications, and finally develop appropriate treatments. A solid knowledge base enables health care professionals to meet these increased demands with appropriate information.

Individuals working in health care have found that many new scientific developments have raised ethical, legal, and social issues. For example, the explosion in genetic information and related technologies has raised many ethical concerns (see [Chapter 21](#)). In relatively new areas of research such as genetics and artificial intelligence (including machine learning), discussion and resolution of the legal and ethical issues lag far behind the scientific advances. Health research is most often funded by commercial sources (up to 80%, according to some studies), and new breakthrough therapies are often announced before the start of any clinical trials. This causes increased hope and immediate demand for such treatments often as much as a decade before they become available. Understanding the research process and the time required for clinical trials of new therapies is crucial for answering questions about new therapies.

The research process in the health sciences is a lengthy three-stage process that aims to demonstrate both the safety and the effectiveness of a new therapy:

- The first stage in this process is often referred to as “basic science,” in which researchers work to identify a technology that will limit or prevent the disease process. This stage is carried out in the laboratory and often requires the use of animals or cell cultures.

- The second stage involves a small number of human subjects to determine if the therapy is safe for humans.
- The third stage only takes place if the results of the previous research are positive; the majority of therapies do not make it to this point. In the third stage of research, a large number of patients with the disease or at risk for the disease are enrolled in clinical trials. These are usually *double-blind studies* in which the research subject and the person administering the treatment do not know if the subject is receiving a standard, proven therapy or the therapy being tested. The subject is identified by number only, without the particular therapy administered. All results are recorded by the subject's identification number. The principal investigator is responsible for tracking data collected in trials with many patients, often in several different health centers. The data are then analyzed to determine if the new therapy is more effective than the traditional therapy. In studies of vaccines or other preventive measures, data are collected about the occurrence of disease in both the control group and the experimental group to determine if the new measure reduces the incidence of the specific disease.

Research findings that demonstrate merit after this three-stage process are often referred to as "evidence-based research findings." The research data collected up to this point are then passed on to regulatory bodies such as the U.S. Food and Drug Administration for review. If the therapy is deemed safe and better than the standard therapy used in the past, it will be approved for use for the specific disease identified in the research protocol.

Evidence-based research does not take into account cost, availability, or social and cultural factors that may influence use and acceptance of a therapy. These factors may be quite significant and affect the physician's or patient's acceptance of a therapy.

In rare cases, research trials in the third stage will be stopped if there is a significant difference in the mortality rate for the

experimental group versus the control group. Research on the first antiretroviral agent, azidothymidine (AZT), was stopped 6 months early when the research showed a striking difference in survival rates. Those in the experimental group receiving AZT were outliving the control group in significant numbers. When the results were analyzed, trials stopped, and all patients were given the option of receiving AZT.

Once a therapy is approved for use, it may show additional potential to treat a different disease. Such use is termed “off-label” use. For the manufacturer to advertise the drug or therapy for use in different diseases, it must go through the third stage of clinical trials in patients with the new disease. An example is research using the drug thalidomide to treat malignancies such as multiple myeloma. Another recent example for “off-label” use is the use of hydroxychloroquine in the fight against SARS-CoV2 (COVID-19). The drug is approved for the treatment and prevention of malaria, and for oral therapy for rheumatoid arthritis and systemic lupus erythematosus.

Think About 1.1

- a. Describe the stages of the research process in the health sciences.
- b. What is the purpose of a double-blind research trial?
- c. What is a placebo, and why is it used in some studies?

Other issues may affect professional practice. Current technology provides an opportunity to prolong life through the use of various machines, many advances in surgery, and the use of organ transplants. Legal and ethical issues about fetal tissue transplants, stem cell therapies, experimental drugs or treatments, and genetic engineering continue to be difficult topics to address. In these developing areas, the primary goal is to reduce the incidence of

disease and improve recovery rates. Concerns about new medical and health technologies include issues of access to therapy, costs, and relative risk versus benefits of new treatments. Questions have also been raised about the allocation of health care resources for new therapies such as heart transplants or *in vitro* fertilization (test-tube babies), which are very costly. A public health dilemma results, because a choice must be made between a high-cost treatment for one person and a low-cost treatment for many people, given the limited resources available. In many cases evidence-based research demonstrates little significant difference in outcomes for newer versus older technologies. Skill and professional training are essential in the use and interpretation of any technology. Clinical research funding is being directed to identifying treatments as well as preventive measures that are more effective on a cost-per-patient basis.

Many options other than traditional therapies are now available. Treatment by acupuncture or naturopathy may be preferred (see [Chapter 3](#)). These options may replace traditional therapies or may be used in conjunction with them. A patient may seek an alternative or complementary mode of treatment to supplement traditional care; thus, knowledge of these complementary therapies is often needed. It is also recognized that such therapies and practices should be part of a health history for any client seeking care.

Beginning the Process: A Medical History

Many individuals in the health professions will be contributing to, completing, or updating a patient's medical or health history (see Ready Reference 6 for an example). This information is essential to identify any impact health care activities might have on a patient's condition, or how a patient's illness might complicate care. The assessment includes questions on current and prior illnesses, allergies, hospitalizations, and treatment. Current health status is particularly important and should include specific difficulties and

any type of therapy or drugs, prescription, nonprescription, and herbal items, including food supplements.

A basic form is usually provided for the patient to fill out, and then it is completed by the health professional asking appropriate follow-up questions to clarify the patient's current condition and identify any potential problems. Knowledge of pathophysiology is essential to developing useful questions, understanding the implications of this information, and deciding on the necessary precautions or modifications required to prevent complications. For example, a patient with severe respiratory problems or congestive heart failure would have difficulty breathing in a supine position. Reducing stress may be important for a patient with high blood pressure. Prophylactic medication may be necessary for some patients to prevent infection or excessive bleeding. In some cases, additional problems or undesirable effects of medications may be detected.

New Developments and Trends

Both students and practitioners must constantly update their information and knowledge. Developments in all areas of health care are occurring at a rapid rate, primarily because of changes in technology. New causes of disease and more detail regarding the pathophysiology of a disorder are being uncovered, diagnostic tests are being improved, and more effective drugs are being formulated. Technology has greatly altered many aspects of health care.

Extensive research projects continue in efforts to prevent, control, or cure many disorders. For example, research indicated that most cases of cervical cancer resulted from infection by human papillomavirus. The next step involved development of a vaccine effective against the most common strains of the virus. In clinical trials, use of the vaccine showed a reduction in the number of women developing cervical cancer. This vaccine is now available to young women to prevent cervical cancer in later years. It does not provide 100% prevention, and other preventive health behaviors, such as routine screening, need to be maintained, but the number

of actual cases of cervical cancer and the cost of treatment are expected to decline dramatically in the coming decades.

It is essential for the student and practitioner to continually check for new information, employing reliable, accurate resources such as professional websites, journals, or seminars. Many changes in health care are anticipated in the near future as electronic devices are more frequently used. For example, sensors implanted under the skin may measure blood glucose levels in diabetic patients or release the amount of insulin appropriate to the patient's needs. The future of health care will also include technologies such as artificial intelligence, three-dimensional (3D) printing, robotics, and nanotechnology. The increased costs associated with technologic advances then are balanced against the costs of hospitalization or chronic care.

Reports from health professionals are gathered by the WHO, the United States Public Health Service, the CDC, and state and local authorities, as well as agencies in countries around the world. These data are organized and published, leading to new research efforts, tracking new or deadly diseases, or, in some cases, signaling a warning about predisposing conditions or current treatments. Awareness of deviations from the expected outcomes is a responsibility of those working in health care. Keeping up with new discoveries may sometimes feel like information overload, but it is a critical part of professional practice ([Box 1.3](#)).

Box 1.3

New Challenges: The Zika Virus

First discovered in 1947, Zika virus infections were for many years isolated to tropical Africa, Southeast Asia, and the Pacific Islands. In 2015, a case was confirmed in Brazil, which prompted the World Health Organization to declare the virus a public health emergency of international concern. Since identifying this new potential threat as an international concern, the U.S. Centers for Disease Control and Prevention elevated its response to the