Cardiac Nursing

SIXTH EDITION

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NORMAL REFERENCE RANGES FOR SELECTED LABORATORY BLOOD TESTS (SEE CHAPTER 11)*

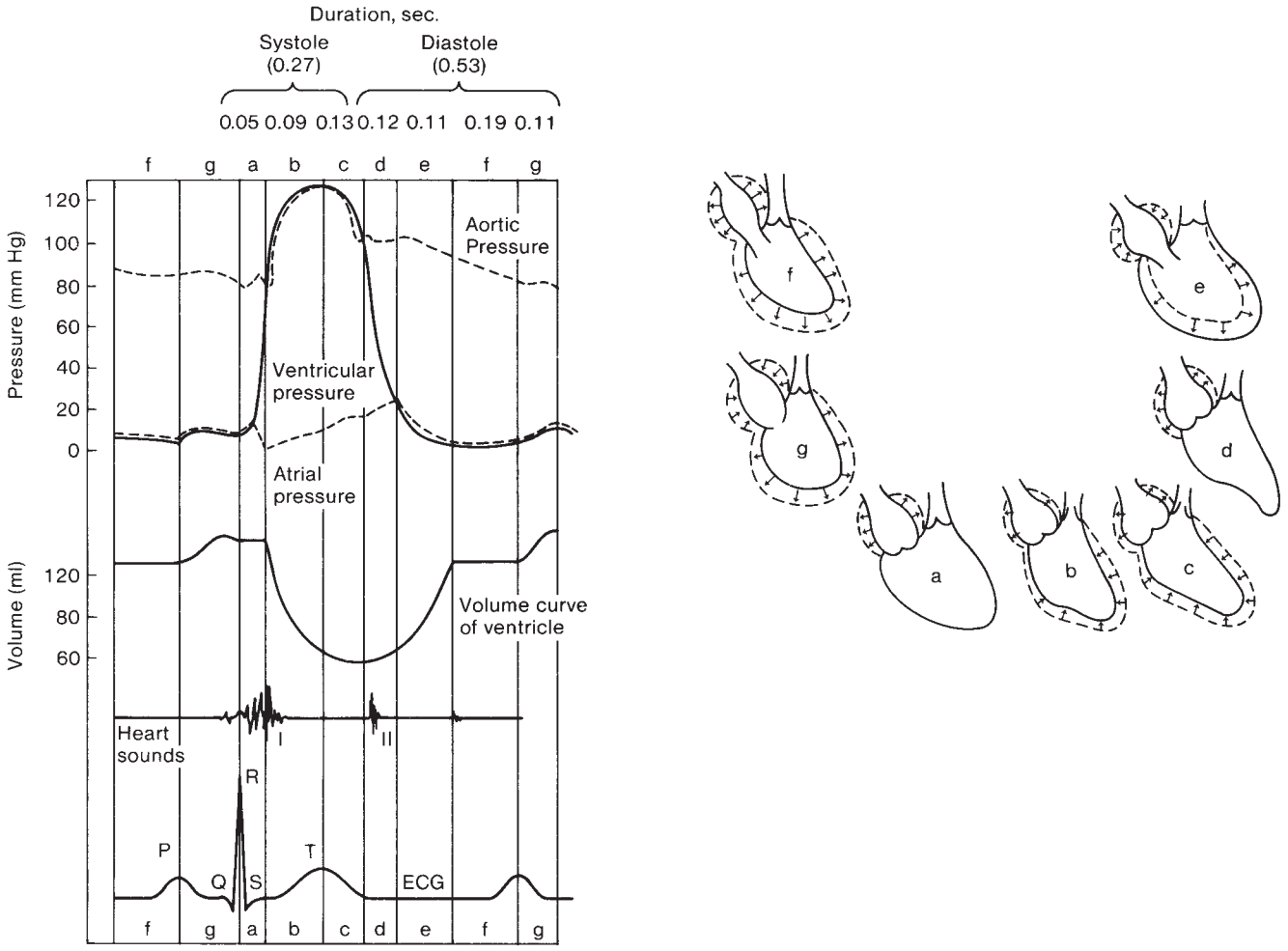
Blood Test	Reference Range
Total Blood Cholesterol†	
Desirable	<200 mg/dL
Borderline high	200–239 mg/dL
High	≥240 mg/dL
HDL-Cholesterol†	
Low, A major risk factor for CHD	<40 mg/dL
Better	40–59 mg/dL
High, Considered protective against heart disease	≥60 mg/dL
LDL-Cholesterol†	
Optimal	<100 mg/dL
Near or above optimal	100–129 mg/dL
Borderline high	130–159 mg/dL
High	160–189 mg/dL
Very high	>190 mg/dL
LDL Cholesterol Treatment Goals†	
No CHD or DM with 1 or no risk factors	<160 mg/dL
No CHD or DM with 2 or more risk factors	<130 mg/dL
CHD or DM patients	<100 mg/dL
Triglyceride†	
Normal	<150 mg/dL
Borderline high	150–199 mg/dL
High	200–499 g/dL
Very high	≥500 mg/dL
Apolipoprotein A-1‡	
Males	Normal 75–160 mg/dL
Females	Normal 80–175 mg/dL
Apolipoprotein B-100‡	
Males	Normal 50–125 mg/dL
Females	Normal 45–12 mg/dL
Coagulation Studies	
Platelet count	250,000–500,000/mm^3
Prothrombin time	12–15 sec
Partial thromboplastin time	60–70 sec
Activated partial thromboplastin time	35–45 sec
Activated coagulation time	75–105 sec
Fibrinogen level	160–300 mg/dL
Thrombin time	11.3–18.5 sec
Blood Chemistries	
Serum electrolytes	
Sodium	135–145 mEq/L
Potassium	3.3–4.9 mEq/L
Chloride	97–110 mEq/L
Carbon dioxide	22–31 mEq/L
Alkaline phosphatase	35–125 IU/L

Blood Test	Reference Range
Blood Chemistries (*cont.*)	
Alanine aminotransferase-ALT	0–40 IU/L
Aspartate aminotransferase-AST	5–40 IU/L
Bilirubin	
Total	0.2–1.3 mg/dL
Direct	0–0.4 mg/dL
Calcium	
Total	8.9–10.3 mg/dL
Free (ionized)	4.6–5.1 mg/dL
Creatinine	
Males	0.9–1.4 mg/dL
Females	0.8–1.3 mg/dL
Glucose (fasting)	65–110 mg/dL
Hb A1c (varies with laboratory method used)	
Nondiabetic adult	2.2%–4.8%
Good diabetic control	2.5%–5.9%
Fair diabetic control	6%–8%
Poor diabetic control	>8%
LDH	20–200 IU/L
Magnesium	1.3–2.2 mEq/L
Phosphorus	2.5–4.5 mg/dL
Protein (total)	6.5–8.5 g/dL
Urea nitrogen	8–26 mg/dL
Uric acid	
Males	4.0–8.5 mg/dL
Females	2.8–7.5 mg/dL
Serum Enzymes	
CK-MM	95%–100%
CK-MB	0%–5%
CK-BB	0%
Myocardial Proteins	
Troponin-I	0–0.2 ng/mL
Troponin-T	0–0.03 ng/mL
Myoglobin	
Males	20–90 ng/mL
Females	10–75 ng/mL
hs-CRP	
Low	<1.0 mg/L
Average	1.0–3.0 mg/L
High	>3.0 mg/L
Homocysteine	
Optimal	<12 μmol/L
Borderline	12–15 μmol/L
High risk for cardiovascular disease	>15 μmol/L
BNP (B-type natriuretic peptide)	
Most diagnostic of heart failure	>100 pg/mL

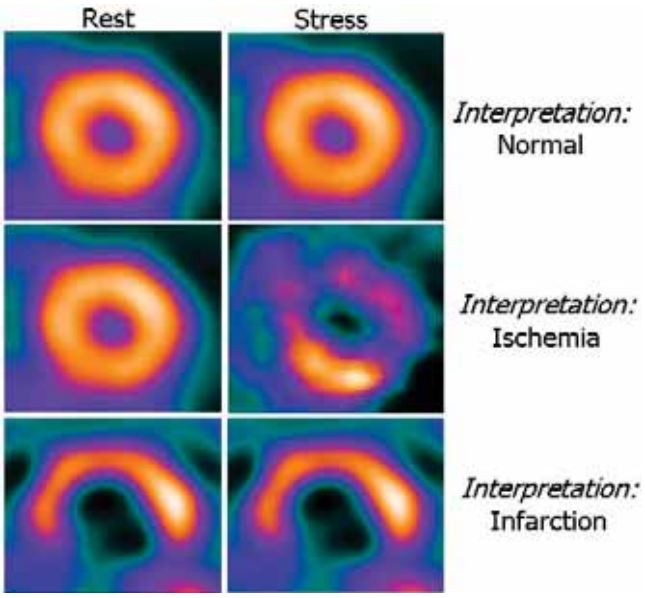
* Examples: regional laboratory techniques and methods may result in variations.

† From National Cholesterol Education Program (2001). Executive summary of The Third Report of The National Cholesterol Education Program (NCEP) Expert Panel on Detection, Evaluation, and Treatment of High Blood Cholesterol in Adults (Adult Treatment Panel III). *JAMA,* 285, 2486–2497.

‡ From Pagana, K. D. & Pagana, T. J. (2002). *Mosby's manual of diagnostic and laboratory tests* (pp. 106–107). St. Louis: Mosby.



The cardiac cycle, illustrating the changes in aortic, left ventricular, and left atrial pressures, and in left ventricular volume, in relation to the phonocardiogram and the electrocardiogram. The duration of each phase at a heart rate of approximately 75 beats/min is indicated at the top of the figure. a, isovolumetric ventricular contraction; b, rapid ventricular ejection; c, slow ventricular ejection; d, isovolumetric relaxation; e, rapid ventricular filling; f, diastasis; g, atrial contraction; I, first heart sound; II, second heart sound. Insets: Changes in the configuration of the left atrium, mitral valve, left ventricle, and aortic valve during various phases of the cycle. (Adapted from Wiggens. [1952]. *Circulatory dynamics.* New York: Grune & Stratton.)



CONVERSIONS TO SYSTÉME INTERNATIONAL (SI) UNITS

Component	System	Present Reference Intervals	Present Unit	Conversion Factor	SI Reference Intervals	SI Unit Symbol
Alanine aminotransferase (ALT)	Serum	5–40	U/L	1.00	5–40	U/L
Albumin	Serum	3.9–5.0	mg/dl	10	39–50	g/L
Alkaline phosphatase	Serum	35–110	U/L	1.00	35–110	U/L
Aspartate aminotransferase (AST)	Serum	5–40	U/L	1.00	5–40	U/L
Bilirubin	Serum					
Direct		0–0.2	mg/dl	17.10	0–4	μmol/L
Total		0.1–1.2	mg/dl	17.10	2–20	μmol/L
Calcium	Serum	8.6–10.3	mg/dl	0.2495	2.15–2.57	mmol/L
Carbon dioxide, total	Serum	22–30	mEq/L	1.00	22–30	mmol/L
Chloride	Serum	98–108	mEq/L	1.00	98–108	mmol/L
Cholesterol	Serum					
Age <29 yr		<200	mg/dl	0.02586	<5.15	mmol/L
30–39 yr		<225	mg/dl	0.02586	<5.80	mmol/L
40–49 yr		<245	mg/dl	0.02586	<6.35	mmol/L
>50 yr		<265	mg/dl	0.02586	<6.85	mmol/L
Complete blood count	Blood					
Hematocrit						
Men		42–52	%	0.01	0.42–0.52	1
Women		37–47	%	0.01	0.37–0.47	1
Red cell count						
Men		$4.6–6.2 \times 10^6$	$/mm^3$	10^6	$4.6–6.2 \times 10^{12}$/L	
Women		$4.2–5.4 \times 10^6$	$/mm^3$	10^6	$4.5–5.4 \times 10^{12}$/L	
White cell count		$4.5–11.0 \times 10^3$	$/mm^3$	10^6	$4.5–11.0 \times 10^9$/L	
Platelet count		$150–300 \times 10^3$	$/mm^3$	10^6	$150–300 \times 10^9$/L	
Cortisol	Serum					
8AM		5–25	μg/dl	27.59	140–690	nmol/L
8PM		3–13	μg/dl	27.59	80–360	nmol/L
Cortisol	Urine	20–90	μg/24 hr	2.759	55–250	nmol/24 hr
Creatine kinase	Serum					
High CK group (black men)		50–250	U/L	1.00	50–520	U/L
Intermediate CK group (nonblack men, black women)		35–345	U/L	1.00	35–345	U/L
Low CK group (nonblack women)		25–145	U/L	1.00	25–145	U/L
Creatinine kinase isoenzyme, MB fraction	Serum	>5	%	0.01	>0.05	1
Creatinine	Serum	0.4–1.3	mg/dl	88.40	35–115	μmol/L
Men		0.7–1.3	mg/dl	88.40		
Women		0.4–1.1	mg/dl	88.40		
Digoxin, therapeutic	Serum	0.5–2.0	ng/ml	1.281	0.6–2.6	nmol/L
Erythrocyte indices	Blood					
Mean corpuscular volume (MCV)		80–100	$microns^3$	1.00	80–100	fL
Mean corpuscular hemoglobin (MCH)		27–31	pg	1.00	27–31	pg
Mean corpuscular hemoglobin concentration (MCHC)		32–36	%	0.01	0.32–0.36	1

Ferritin	Serum					
Men		29–438	ng/ml	1.00	29–438	μg/L
Women		9–219	ng/ml	1.00	9–219	μg/L
Folate	Serum	2.5–20.0	ng/ml	2.266	6–46	nmol/L
Follicle-stimulating hormone (FSH)	Serum					
Children		12 or <	mIU/ml	1.00	12 or <	IU/L
Men		2.0–10.0	mIU/ml	1.00	2.0–10.0	IU/L
Women, follicular		3.2–9.0	mIU/ml	1.00	3.2–9.0	IU/L
Women, midcycle		3.2–9.0	mIU/ml	1.00	3.2–9.0	IU/L
Women, luteal		2.0–6.2	mIU/ml	1.00	2.0–6.2	IU/L
Gases, arterial	Blood					
Po_2		80–95	mm Hg	0.1333	10.7–12.7	kPa
Pco_2		37–43	mm Hg	0.1333	4.9–5.7	kPa
Glucose	Serum	62–110	mg/dl	0.05551	3.4–6.1	mmol/L
Iron	Serum	50–160	μg/dl	0.1791	9–29	μmol/L
Iron-binding capacity	Serum					
TIBC		230–410	μg/dl	0.1791	41–73	μmol/L
Saturation		15–55	%	0.01	0.15–0.55	1
Lactic dehydrogenase	Serum	120–300	U/L	1.00	120–300	U/L
Luteinizing hormone	Serum					
Men		4.9–15.0	mIU/ml	1.00	4.9–15.0	IU/L
Women, follicular		5.0–25	mIU/ml	1.00	5.0–25	IU/L
Women, luteal		3.1–13	mIU/ml	1.00	3.1–31	IU/L
Magnesium	Serum	1.2–1.9	mEq/L	0.4114	0.50–0.78	mmol/L
Osmolality	Serum	278–300	mOsm/kg	1.00	278–300	mmol/kg
Osmolality	Urine	None defined	mOsm/kg	1.00	None defined	mmol/kg
Phenobarbital, therapeutic	Serum	15–40	μg/ml	4.306	65–175	μmol/L
Phenytoin, therapeutic	Serum	10–20	μg/ml	3.964	40–80	μmol/L
Phosphate (phosphorus, inorganic)	Serum	2.3–4.1	mg/dl	0.3229	0.75–1.35	mmol/L
Potassium	Serum	3.7–5.1	mEq/L g/ml	1.00	3.7–5.1	mmol/L
Protein, total	Serum	6.5–8.3	g/dl	10.0	65–83	g/L
Sodium	Serum	134–142	mEq/L	1.00	134–142	mmol/L
Theophylline, therapeutic	Serum	5–20	μg/ml	5.550	28–110	μmol/L
Thyroid-stimulating hormone (TSH)	Serum	0–5	μIU/ml	1.00	0–5	mIU/L
Thyroxine	Serum	4.5–13.2	μg/dl	12.87	58–170	nmol/L
T_3-uptake ratio	Serum	0.88–1.19	1	1.00	0.88–1.19	1
Triiodothyronine (T_3)	Serum	70–235	ng/ml	0.01536	1.1–3.6	nmol/L
Triglycerides	Serum	50–200	mg/dl	0.01129	0.55–2.25	mmol/L
Urate (uric acid)	Serum					
Men		2.9–8.5	mg/dl	59.48	170–510	μmol/L
Women		2.2–6.5	mg/dl	59.48	130–390	μmol/L
Urea nitrogen	Serum	6–25	mg/dl	0.3570	2.1–8.9	mmol/L
Vitamin B_{12}	Serum	250–1000	pg/ml	0.7378	180–740	pmol/L

(Blair ER et al (eds): *Damon Clinical Laboratories Handbook*. Lexi-Comp, Inc., Stow OH,1989)

HEMODYNAMIC INDICES

Indices/Equations	Normal Values
Preload	
Right atrial pressure (RAP) or central venous pressure (CVP)	2–6 mm Hg
Pulmonary artery end-diastolic pressure (PAEDP)	8–12 mm Hg
Pulmonary artery wedge pressure (PAWP)	6–12 mm Hg
Afterload	
Systolic blood pressure (SBP)	120 mm Hg
Systemic vascular resistance (SVR)	800–1200 dynes/sec/cm^{-5}
$SVR = \frac{MAP - RAP}{CO} \times 80$	
Systemic vascular resistance index (SVRI)	1900–2400 dynes/sec/cm^{-5}/m^2
$SVRI = \frac{MAP - RAP}{CI} \times 80$	
Force of Contraction	
Stroke volume (SV)	60–180 mL/beat
$SV = \frac{CO \times 1000}{HR}$	
Stroke Volume Index	33–47 mL/beat/m^2
$SVI = \frac{CI \times 1000}{HR}$	
Right ventricular stroke work index (RVSWI) $RVSWI = SVI(MAP - CVP) \times 0.0136$	5–10 gm-m/m^2/beat
Left ventricular stroke work index (LVSWI) $LVSWI = SVI(MAP - PAWP) \times 0.0136$	45–65 gm-m/m^2/beat
Right Heart Function	
Right ventricular ejection fraction	40%–60%
Right ventricular end-systolic index	30–60 mL/m^2
Right ventricular end-diastolic volume index	60–100 mL/m^2
Functional Indices	**Predictive Value (Preload Dependence)**
RAP Variation (ΔRAP)	ΔRAP > 1
Systolic Pressure Variation (ΔPs)	>12–15 mm Hg associated with hypovolemia
$\Delta Ps\% = 100 \times (Ps_{max} - Ps_{min})/[(PS_{max} + Ps_{min})/2]$	Increase in ΔPs > 4 mm Hg indicative of blood loss > 10%
ΔDown	>2–5 mm Hg indicative of hypovolemia
Pulse Pressure Variation (ΔPp)	No absolute predictive value identified
$\Delta Pp\% = [(PP_{max} - PP_{min})/(PP_{max} + PP_{min})/2] \times 100$	>13%
Stroke Volume Variation (SVV)	>Neurosurgical patients 9.5% (Vt = 10 mL/kg)
$SVV = SVV_{max} - SVV_{min}/SVV_{mean}$	>13% (septic shock)
Aortic Blood Flow Velocity	>12% (septic shock)
$\Delta V_{peak}\ (\%) = 100 \times (Vpeak_{max} - Vpeak_{min})/[Vpeak_{max} + Vpeak_{min})/2]$	

EDITION 6

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Susan has been on the faculty at the University of Washington, School of Nursing since 1975, where she has taught both undergraduate and graduate courses. She is currently Professor of Biobehavioral Nursing and Health Systems and the Associate Dean for Academic Services in the School of Nursing. Her clinical and research focus has been in all aspects of cardiac nursing, particularly in measurement of cardiovascular variables and chronobiology. Susan was a founding board member of the Commission on Collegiate Nursing Education (CCNE) and was a member of the 2008–2009 CCNE Accreditation Standards Committee. She has been the recipient of the Distinguished Research Award from the American Association of Critical Care Nursing and the Katherine Lembright Award from the American Heart Association Council on Cardiovascular Nursing. Susan has also received the Alumni All-Around Award from Oregon Health Science University, where she obtained a PhD in Nursing. She is a fellow in the American Academy of Nursing and the American Heart Association. Susan has two children, Jaime Rose Navetta and Jennifer Mary Ferrer, and is married to Jim Woods. She enjoys traveling, gardening, swimming, and collecting shells.

Erika S. Sivarajan Froelicher, MA, MPH, PhD, RN, FAAN

Erika has advanced degrees in nursing, public health, and epidemiology. During more than 30 years of nursing and public health experience, she has been an emergency room nurse, a psychiatric nurse, a center director, a researcher, an epidemiologist, and a university professor. As a consultant, she has advised hospitals, businesses, and foundations in the areas of nursing and cardiac care. Currently, she serves on the editorial board of *Heart and Lung, Human Kinetics, Cardiovascular Nursing*, and *European Journal for Cardiovascular Nursing* and is both a Founding and Associate Editor for *Journal of Cardiovascular and Pulmonary Rehabilitation* as well as having acted as a reviewer for many other medical and nursing journals.

Erika has presented papers and given invited lectures on coronary disease prevention and rehabilitation to more than 100 national and international groups. Her articles and abstracts have appeared in such publications as *New England Journal of Medicine, Circulation, Heart and Lung*, *American Journal of Nursing*, *Advanced Journal for Nursing Scholarship, Patient Education and Counseling*, and *Circulation.* As coauthor, she has published books on critical care nursing and cardiac care.

She has dedicated herself to research and teaching in nursing and medicine internationally in Asia, Europe, South America, Canada, Australia the middle East (Jordan, Lebanon and Saudi Arabia), and Africa through consultation, collaborative research, and guest faculty as visiting professor in Hong Kong, University of Basel Switzerland, University of Natal South Africa, and the University of Vienna a Fulbright Scholar 2005–2006 at the University of Jordan and continues her teaching and research as a Visiting Professor, among others.

Sandra Adams (Underhill) Motzer, PhD, RN, FAHA, FAAN

Sandra is a diploma graduate from Washington Hospital Center School of Nursing, Washington, DC. She earned her BSN and MN at the University of Washington and her PhD at Oregon Health Sciences University, Portland. She completed a postdoctoral fellowship at the University of Washington. She was a founding coeditor of the journal *Progress in Cardiovascular Nursing*, is a charter Fellow of the American Heart Association's Council on Cardiovascular Nursing as well as the American Heart Association (FAHA), and a fellow of the American Academy of Nursing (FAAN). She is a past president of the Puget Sound Chapter of the American Association of Critical Care Nurses and is active in Sigma Theta Tau at the international and local levels. She has taught cardiovascular nursing for many years at all academic levels and in the community. Before retiring in 2008, she directed the master's-level medical—surgical nurse educator and clinical nurse specialist tracks at the University of Washington School of Nursing. She taught graduate-level courses in advanced pathophysiology, practice teaching, and, for the clinical nurse specialist and nurse educator students, clinical specialization and role development. Her funded research involved the effects of chronic health disturbances on immune function across the menstrual cycle and the effects of exercise on sleep in persons with heart failure. Sandy and her husband Tim enjoy hiking, beach walking, and traveling.

Elizabeth J. Bridges, PhD, RN, CCNS, FCCM, FAAN

Elizabeth has been a critical care nurse for the past 25 years, including 25 years active and reserve duty in the US Air Force. Her clinical research focuses on the integration of hemodynamic monitoring into the care of critically ill patients and the care of critically ill patients in military, unique, and austere environments. Specifically, she is studying functional hemodynamic monitoring, hemodynamic monitoring at altitude, aspects of thermal stress, and the maintenance of body temperature in critically ill patients under field conditions and long-distance aeromedical transport, factors that affect the efficacy of CPR under field conditions, and interventions to prevent decubitus ulcer formation during long-distance aeromedical transport. Elizabeth also served as the Director, Deployed Combat Casualty Care Research Team and was responsible for all Department of Defense human research in Afghanistan.

Preface to the 6th Edition

Cardiac Nursing continues to be *the* reference book for nurses caring for patients who have or are at risk for developing cardiac disease. *Cardiac Nursing*, Sixth Edition, provides the basic and advanced nurse with the most comprehensive evidence-based practice information. We believe that bedside nurses, clinical nurse specialists, nurse practitioners, nurse educators, and nurse researchers all will benefit from the content in this edition. We also support the Scope and Standards for Cardiovascular Nursing from the Task Force of Cardiovascular Nursing Organization Representatives, the summary of which appears on p. xi.

About This Edition

Global perspectives of cardiovascular disease have been enhanced in all chapters where appropriate and by the addition of a new chapter on global cardiovascular health (Chapter 43), which enhances the usefulness and generalizability of the content. A majority of the national clinical protocols were replaced with evidence-based protocols. Numerical citations were reintroduced to allow for more rapid identification of content related to specific areas. One new chapter on mechanical assist devices (Chapter 26) has been added. Other chapters, for example, Chapter 5 on pathophysiology of atherosclerosis and acute coronary syndrome and Chapter 24 on heart failure and cardiogenic shock, have been combined and reorganized to allow for more comprehensive coverage of the materials. There have been many changes in the care of cardiac patients since the fifth edition. Thus, all chapters have been updated to reflect the most current evidence-based practice guidelines.

Content and Organization

The emphasis on health promotion, health maintenance, and disease management has been maintained throughout the text. By adding, reorganizing, and revising chapters and content, the sixth edition will help all cardiac nurses provide care more confidently and effectively within the changing health care and economic environment across all practice settings. There are five parts in this edition:

PART ONE: ANATOMY AND PHYSIOLOGY. Includes chapters on anatomy and physiology, cardiopulmonary circulation, and the regulation of cardiac output and blood pressure.

PART TWO: PHYSIOLOGIC AND PATHOPHYSIOLOGIC RESPONSES. Includes chapters on genetics; atherosclerosis and acute coronary syndrome; hematopoiesis, coagulation, and bleeding; fluid and electrolyte and acid—base balances and imbalances; sleep; and aging.

PART THREE: ASSESSMENT OF HEART DISEASE. Includes chapters on history taking and physical examination; laboratory tests; radiologic examination of the chest; echocardiography; nuclear imaging, magnetic resonance imaging, and computed tomography imaging; electrocardiography; arrhythmias and conduction disturbances; heart rate variability; cardiac electrophysiologic procedures; exercise testing; cardiac catheterization; and hemodynamic monitoring.

PART FOUR: PATHOPHYSIOLOGY AND MANAGEMENT OF HEART DISEASE. Includes chapters on acute coronary syndrome; interventional cardiology techniques; heart failure and cardiogenic shock; cardiac surgery; mechanical assist devices; sudden cardiac death and cardiac arrest; pacemakers and implantable defibrillators; acquired valvular heart disease; pericardial, myocardial, and endocardial disease; and congenital heart disease.

PART FIVE: HEALTH PROMOTION AND DISEASE PREVENTION. Includes chapters on the assessment and management of coronary heart disease risk factors and disease prevention; psychosocial interventions; smoking cessation and relapse prevention; hypertension; hyperlipidemia; activity and exercise; obesity; diabetes and metabolic syndrome; adherence; complementary and alternative medicine; disease management models; and global cardiovascular health.

The Tradition of Excellence

The sixth edition continues our tradition of excellence in nursing care found in the previous five editions by having more than 90% of the chapters written by cardiac nursing experts. The "red book" maintains our nursing philosophy by organizing the content within the framework of the nursing process and includes numerous nursing care plans. Where possible, the rationale and evidence for treatments and interventions are included.

We sincerely appreciate all the comments we received about the previous editions. We hope you find that the sixth edition lives up to our standard of excellence of the past five editions and that it becomes your primary reference source for cardiac nursing.

Susan L. Woods, PhD, RN, FAHA, FAAN
Erika S. Sivarajan Froelicher, MA, MPH, PhD, RN, FAAN
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Standards of Cardiovascular Nursing Practice

Standards of Practice

STANDARD 1. ASSESSMENT
The cardiovascular registered nurse collects comprehensive data pertinent to the patient's health or the situation.

STANDARD 2. DIAGNOSIS
The cardiovascular registered nurse analyzes the assessment data to determine the nursing diagnoses or health-related issues.

STANDARD 3. OUTCOMES IDENTIFICATION
The cardiovascular registered nurse identifies expected outcomes for a plan individualized to the patient or the situation.

STANDARD 4. PLANNING
The cardiovascular registered nurse develops a plan that prescribes strategies and alternatives to attain expected outcomes.

STANDARD 5. IMPLEMENTATION
The cardiovascular registered nurse implements the identified plan.

STANDARD 5A: COORDINATION OF CARE
The cardiovascular registered nurse coordinates care delivery.

STANDARD 5B: HEALTH TEACHING AND HEALTH PROMOTION
The cardiovascular registered nurse employs strategies to promote health and a safe environment.

STANDARD 5C: CONSULTATION
The advanced practice registered nurse and the cardiovascular registered nurse provide consultation to influence the identified plan, enhance the abilities of others, and effect change.

STANDARD 5D: PRESCRIPTIVE AUTHORITY AND TREATMENT
The advanced practice registered nurse uses prescriptive authority, procedures, referrals, treatments, and therapies in accordance with state and federal laws and regulations.

STANDARD 6. EVALUATION
The cardiovascular registered nurse evaluates progress towards attainment of outcomes.

STANDARD 7. QUALITY OF PRACTICE
The cardiovascular registered nurse systematically enhances the quality and effectiveness of nursing practice.

STANDARD 8. EDUCATION
The cardiovascular registered nurse attains knowledge and competency that reflects current nursing practice.

STANDARD 9. PROFESSIONAL PRACTICE EVALUATION
The cardiovascular registered nurse evaluates one's own nursing practice in relation to professional practice standards and guidelines, relevant statutes, rules, and regulations.

STANDARD 10. COLLEGIALITY
The cardiovascular registered nurse interacts with and contributes to the professional development of peers and colleagues.

STANDARD 11. COLLABORATION
The cardiovascular registered nurse collaborates with patient, family, and others in the conduct of nursing practice.

STANDARD 12. ETHICS
The cardiovascular registered nurse integrates ethical provisions in all areas of practice.

STANDARD 13. RESEARCH
The cardiovascular registered nurse integrates research findings into practice.

STANDARD 14. RESOURCE UTILIZATION
The cardiovascular registered nurse considers factors related to safety, effectiveness, cost, and impact on practice in the planning and delivery of nursing services.

STANDARD 15. LEADERSHIP
The cardiovascular registered nurse provides leadership in the professional practice setting and the profession.

Contents

PART I

Anatomy and Physiology

CHAPTER 1

Cardiac Anatomy and Physiology

Eleanor F. Bond*

An understanding of cardiac anatomy is helpful for understanding cardiac physiology and the functional consequences of disease. This chapter describes normal human adult cardiac anatomy, cellular structure, and ultrastructure. The chapter also discusses electrical, mechanical, and metabolic activities that underlie cardiac pump performance. The coronary circulation is described and discussed in the context of its linkage to changing demands of cardiac tissue for nutrient delivery and waste removal. Finally, integrated cardiac performance is discussed.

GENERAL ANATOMIC DESCRIPTION

The heart is a hollow muscular organ encased and cushioned in its own serous membrane, the pericardium. It lies in the middle mediastinal compartment of the thorax between the two pleural cavities. Two thirds of the heart extends to the left of the body's midline (Fig. 1-1).

The heart consists of four muscular chambers, two atria and two ventricles, and associated structures. The right heart (right atrium and ventricle) receives blood from the body and pumps it into the low-pressure pulmonary arterial system. The left heart (left atrium and ventricle) receives oxygenated blood from the lungs and pumps it into the high-pressure systemic arterial system. Interatrial and interventricular septa separate the right from the left atrium and the right from the left ventricle.

The long axis of the heart is directed obliquely, leftward, downward, and forward. Any factor changing the shape of the thorax changes the position of the heart and modifies its directional axis. Respiratory alterations in the diaphragm and the rib cage constantly cause small changes in the cardiac axis. With a deep inspiration, the heart descends and becomes more vertical. Factors that may cause long-term axis variations in healthy people include age, weight, pregnancy, body shape, and thorax shape. A tall, thin person usually has a more vertical heart, whereas a short, obese person usually has a more horizontal heart. Pathologic conditions of the heart, lungs, abdominal organs, and other structures influence the cardiac axis.

The surfaces of the heart are used to reference its position in relation to other structures and to describe the location of damage, as in a myocardial infarction. The right ventricle and parts of the right atrium and the left ventricle form the anterior (or sternocostal) cardiac surface (Figs. 1-1 and 1-2). The right atrium and ventricle lie anteriorly and to the right of the left atrium and ventricle in the frontal plane. Thus, when viewed from the front of the body, the heart appears to be lying sideways, directed forward and leftward, with the right heart foremost.

The small portion of the lower left ventricle that extends anteriorly forms a blunt tip composed of the apical part of the interventricular septum and the left ventricular free wall. Because of the forward tilt of the heart, movement of this apex portion of the left ventricle during cardiac contraction usually forms the *point of maximal impulse*, which can be observed in healthy people in the fifth intercostal space at the left midclavicular line, 7 to 9 cm from midline. The sternum, costal cartilages of the third to sixth ribs, part of the lungs, and, in children, the thymus, overlie the anterior cardiac surface.

The left atrium and a small section of the right atrium and ventricle comprise the base of the heart, which is directed backward and forms the posterior surface of the heart (Fig. 1-3). The thoracic aorta, esophagus, and vertebrae are posterior to the heart. The inferior or diaphragmatic surface of the heart, composed chiefly of the left ventricle, lies almost horizontally on the upper surface of the diaphragm (Fig. 1-4). The right ventricle forms a portion of the inferior cardiac surface.

The right atrium forms the lateral right heart border; therefore, the right atrium and right lung lie close together. The entire right margin of the heart extends laterally from the superior vena cava along the right atrium and then toward the diaphragm to the cardiac apex. The lateral wall of the left ventricle and a small part of the left atrium form most of the left heart border. This portion of the left ventricle is next to the left lung and sometimes is referred to as the *pulmonary surface.*

The coronary [or atrioventricular (AV)] sulcus (groove) is the external landmark denoting the separation of the atria from the ventricles. The AV sulcus encircles the heart obliquely and contains coronary blood vessels, cardiac nerves, and epicardial fat. The aorta and pulmonary artery interrupt the AV sulcus anteriorly. The anterior and posterior interventricular sulci separate the right and left ventricles on the external heart surface. The *crux* of the heart is the point on the external posterior heart surface where

*The material in this chapter was originally co-authored with Carol Jean Halpenny.