SHOCK

Comprehensive nursing management

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Introduction

The definition of shock has changed over the years concomitant with an improved understanding of its pathophysiology. Beland* described shock as a disproportion between the volume of blood and the capacity of the vascular chamber. The nature of shock is seen on the basis of this earlier conceptualization as a circulatory imbalance in which the ability to maintain blood flow is impaired by either a deficiency in blood volume or an expanded capacity of the vascular system. Conceptualizing shock as a circulatory imbalance gave clinicians a whole-organ perspective. This allowed for the recognition that multiple body systems become involved as a result of inadequate organ perfusion resulting from decreased venous return and cardiac output. However, the whole-organ concept did not direct therapy toward the real culprit. The pathophysiology of shock can now be dissected to a cellular level, giving physicians and nurses the information needed to initiate early preventive therapy.

Currently shock is defined as a deficiency of tissue perfusion associated with the inadequate delivery of oxygen and nutrients to the cells.† A cellular conceptualization of the alterations created by shock provides improved insight into the origin of clinical manifestations, the etiology of complications, and the rationale for comprehensive therapy. This insight has implications for the nurse.

Management of the patient in shock is of course no simple task. A comprehensive understanding of the pathological interrelationships that exist is a basic requirement for the clinician. The nurse must not be guided only by the physician's eyes. This is to say that he or she should not become complacent in relying on the focus of medical therapy as the only direction for assessment or intervention. It is the nurse who will spend the most time caring directly for the acutely ill shock patient. It is imperative that the nurse be prepared with a sound theoretical background to make the independent decisions necessary for management of critically ill individuals.

The purpose of this text is to provide the nurse with the most current information from medical and nursing research to explain the entity of shock. An emphasis on physiology as well as pathophysiology equips the nurse with the essential background of knowledge to make quick and insightful observations, decisions, and interventions. Likewise, the emphasis on pathophysiology aids in clarifying the rationale for various treat-

*Beland, I.: Clinical Nursing: pathophysiological and psychosocial approaches, New York, 1965, Macmillan Publishing Co., Inc.

†O'Donnell, T.F., Jr., and Belkin, S.C.: The pathophysiology, monitoring, and treatment of shock, Orthopedic Clinics of North America 9:589, 1978; Groer, M.E., and Shekelton, M.: Basic pathophysiology: a conceptual approach, St. Louis, 1979, The C.V. Mosby Co.; Guyton, A.C.: Textbook of medical physiology, ed. 5, Philadelphia, 1976, W.B. Saunders Co.

ment modalities. Throughout the text the relationship of the function of one body system to that of another is stressed. Content representing the biological, physiological, and social sciences is integrated. A holistic approach is utilized to stress the need for the nurse to remain aware of how the patient is affected psychologically as well as physically by serious illness.

In planning the textbook's contextual format, it was decided an attempt would be made to provide readers with a simple referential approach to shock. Being able to conceptualize the nature of major pathological alterations on the basis of a knowledge of normal physiological mechanisms would enable the clinician to gain a fuller understanding of shock syndromes. For this reason the chapters on physiological mechanisms have been thoroughly developed.

The initial portion of the text introduces the reader to a physiologically centered conceptual framework. Four physiological concepts are developed: the heart, the blood vessels, the blood volume, and the lung. Syndromes of shock create pathological alterations that influence the homeostasis of each of these physiological entities. With an inadequacy in tissue perfusion there exist alterations in blood volume distribution. Changes occur in the regulatory status of the vessels themselves that alter vessel integrity and fluid balance. The heart, if able, must compensate as a result of the disturbance in venous return. Of the many organ systems involved, the lung is a crucial one, for there must be an adequate provision of oxygen to reverse the progression of shock. When the pathological nature of a specific shock syndrome directly affects the heart, vessels, blood volume, or lung, the ability of the whole organism to adapt to the insult is seriously impaired.

Chapters on the heart, cardiovascular control mechanisms, and microcirculation provide an in-depth understanding of normal circulatory regulation. The reader is able to recognize the adaptive responses that occur when circulatory equilibrium is threatened. The chapter on microcirculation explores the physiology of fluid balance and exchange. It provides a reference for understanding the mechanisms of cellular pathology described later in the chapter on the classification of shock. The oxygenation chapter explores in depth the requirements for adequate delivery of oxygen at the cellular level.

Each chapter on physiology provides readers with an exploration of anatomical structures as well as a detailed look at physiological function. Terminology familiar to the critical care nurse is carefully explained and applied to relevant physiological processes. The reader gains a comprehensive knowledge of the compensatory and interdependent mechanisms existing within the heart, blood vessels, and lung to maintain perfusion and oxygen delivery to cells. Understanding regulatory responses that maintain circulation and oxygenation will aid the nurse in the early recognition of signs of shock. In completing the physiological review, the reader will be prepared to understand all of the ramifications of the pathogenic process known as shock.

The reader is introduced to the varieties and nature of shock in the next section. The introduction to the classification system for shock reveals to the reader that shock is not a single disease entity but rather a complex syndrome. The clinical status of a given patient can change dramatically during the course of shock. The different causes of shock as well as the different levels of severity create a challenge for the practitioner seeking the most appropriate means of therapy. The current classification systems are presented in a concise manner to provide the reader a means of learning terminology and concepts.

A chapter on hemodynamic monitoring follows the review of the classification systems of shock. Sophisticated machinery is now utilized to record subtle changes in a patient's hemodynamic status. The use of hemodynamic monitoring is consistent with the management of all shock types. The nurse must be responsible for the efficient functioning of this monitoring equipment as well as the analyzing and reporting of significant data findings. The chapter on hemodynamic monitoring explores the use of the Swan-Ganz catheter in carefully recording the ongoing condition of the shock patient. A thorough look at the function and purpose of Swan-Ganz monitoring is presented.

The text next presents an in-depth look at four different types of shock. The clinical pictures of hypovolemic, cardiogenic, septic, and anaphylactic shock are described in detail. Each clinical picture begins with a look at its specific pathological nature. The most recent medical research directed toward understanding the nature of the various shock entities is utilized. A summary of clinical signs and symptoms accompanied by a physiological rationale for each is also given. This informs the nurse of the types of assessment measurements required as well as the significance of the findings gathered. Current diagnostic methods and criteria for their use are also explored.

Within the management section of each clinical picture, both medical and nursing therapies are carefully presented. A goal-oriented approach is utilized to organize the content of the management section. The authors have taken care to explain the most current forms of therapy and the proposed therapeutic rationale for each. In cases in which the form of therapy is controversial, each treatment modality is explored for its benefits and disadvantages. In situations in which similar types of nursing therapy are utilized for all types of shock, one chapter is used to explore that therapy in depth. Within all of the clinical pictures the nursing implications that evolve from therapeutic measures are highlighted. The reader is prepared with a complete picture of the nurse's responsibilities concerning each type of shock. Current pharmacological therapy is integrated throughout all of the chapters.

To assist the reader in assimilating theory with practice, patient vignettes are presented at the end of each clinical picture. A hypothetical patient-care situation is presented, and the reader is asked to reflect on the previously discussed theory. A series of four to six questions requires the reader to make decisions similar to those confronted in the clinical setting. A final explanation of the answers affords a useful summarization of theoretical viewpoints.

The final section of the text deals with common complications resulting from shock. Adult respiratory distress syndrome, disseminated intravascular coagulation, and renal failure, although common complications of shock, are disease entities in their own right. The amount of recent literature dealing with each is voluminous. However, there have been few attempts to thoroughly explore these complications as they relate to shock from a nursing focus. Each complication is given the same comprehensive presentation as the clinical pictures of shock. Prevention as well as management of the complications is considered.

A question a reader might ask is, Will this textbook serve to improve nursing care? The theme of the text is to do just that. As the nurse faces the challenge of caring for a shock patient many questions arise:

What conditions favor the development of shock?
Can these conditions be prevented by nursing measures?
What clinical signs and symptoms can the nurse expect to see?
What is the significance of these signs and symptoms?
What assessment measurements are critical for the nurse to make?
What subtle findings help to discriminate the nature of different forms of shock?
What interventions become a priority during the acute onset of shock?
What is the specific scientific rationale for these interventions?
What measures are utilized to monitor the patient's progress?
How can the nurse specifically maintain and support existing functions to prevent complications?
What is the therapeutic rationale for controversial treatment modalities?
How can the nurse maintain the patient's identity and sense of worth during a time of critical illness?

This text attempts to provide answers to all of these questions. With the rapid expansion of knowledge and technology, it is imperative that the nurses be prepared to continually expand their learning. The field of critical care has grown by leaps and bounds during the last decade.

The authors have attempted to prepare a concise, cohesive, and comprehensive look at shock. Texts often provide a cookbook approach to a particular nursing care problem without giving thought to the ''cook's'' background or knowledge. This text has been developed with the goal of providing the nurse the most complete and accurate information available. Each chapter has been prepared with the whole text in mind.

Patricia Ann Potter

Contents

PART TWO MANAGEMENT OF THE PATIENT IN SHOCK

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Anne Griffin Perry
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Judith L. Myers

PART ONE

PHYSIOLOGICAL CONTROLS

1 Cardiovascular control systems

LINDA NIEDRINGHAUS

The function of the cardiovascular system is to supply oxygen and nutrients to all tissues of the body according to their metabolic requirements. Normally, each tissue and organ receives the exact blood flow required for adequate nutrition. To meet these variations in circulatory requirements, the cardiovascular system responds through a multitude of regulatory mechanisms. These mechanisms respond to stress by increasing the blood supply to active tissues. When the challenge is severe, blood flow to the vital organs such as the heart and brain is maintained at the expense of the circulation to the rest of the body. An understanding of the manner in which this system responds to stress is of importance to the nurse since signs and symptoms of shock are caused by an impairment of these responses.

COMPONENTS OF THE CARDIOVASCULAR SYSTEM

The cardiovascular system is a closed transport system composed of a heart serving as a pump, blood serving as the carrier, and vessels serving as conduits for the blood. All three of these components must be functioning to provide all of the body tissues with adequate oxygen and nutrients.

The heart

The heart is a pulsatile four-chambered pump composed of two atria and two ventricles. The atria function as entryways to the two ventricles and also serve to pump blood into the ventricles during the latter part of diastole. The ventricles generate the main force that propels blood through the lungs and peripheral circulatory system. The functional activities of the heart are related to three of the physiological properties of heart muscle: rhythmicity, conductivity, and contractility. Each of these properties is developed to different degrees in various areas of the heart. *Rhythmicity* is well developed in the pacemaker region of the heart, which is responsible for initiating impulses conducted to the rest of the heart. The property of *conductivity* is especially developed in the region of the Purkinje network, which is responsible for the rapid conduction of impulses from the pacemaker cells to the ventricles. *Contractility* is developed in the walls of the atria and to a greater extent in the muscular walls of the ventricles. The cardiac muscle, valves, conduction system, blood supply, and neural mechanisms must be intact for the heart to function normally. All of these components work together to ensure that the rate, force, and volume of blood pumped into the circulation will be adequate to supply all body tissues when the person is at rest or when metabolic demands are increased by illness, exercise, or stress. (See Chapter 2 for a complete discussion of the heart as a pump.)

The blood

Blood serves as the carrier of the cardiovascular transport system. The normal circulating blood volume of a man weighing 70 kg is approximately 8% of the body weight, or 5600 ml. About 55% of this volume is plasma. Whole blood contains plasma proteins, red blood cells, white blood cells, and platelets, which are suspended in the plasma. Although small amounts of oxygen and carbon dioxide are dissolved in the plasma, most of it is bound to hemoglobin in the red blood cells. Nutrients are dissolved in the plasma, and hormones are bound to plasma proteins for transport from their endocrine glands to sites of action (target tissues). Nitrogenous and other wastes are also transported by the blood to the kidney for excretion. Blood volume must be adequate to ensure that the cardiovascular transport system functions normally.

The vessels

The system of vascular conduits, the third component of the cardiovascular transport system, is composed of arteries, arterioles, capillaries, venules, and veins. Each of these structures has a particular function, which correlates directly with its individual vessel size and wall structure (Table 1-1).

The aorta and large arteries serve as temporary storage facilities, storing some pressure in their elastic walls during systole and releasing or returning pressure to the cardiovascular system during diastole. These elastic properties prevent large fluctuations in pressure and provide for even distribution of blood flow to the peripheral tissues. The aorta is the largest vessel in the body with a lumen diameter of 2.5 cm and a wall thickness of 2 mm. The arteries have a lumen diameter of about 0.4 cm and a wall thickness of 1 mm. A large diameter and wall thickness are necessary for these vessels to tolerate the full force of the pumping action of the left ventricle.

The arterioles serve as resistance vessels. The lumen diameter of the arterioles is about 30 μm with a wall thickness of 20 μm. These relatively thick, muscular vessels

Table 1-1. Characteristics of various types of blood vessels

	Lumen diameter	Wall thickness	Function
Aorta	2.5 cm	2 mm	Pressure storage
Artery	0.4 cm	1 mm	Pressure storage
Arteriole	30 μm	20 μm	Resistance
Capillary	6 μm	1 μm	Exchange
Venule	20 μm	2 μm	Volume storage
Vein	0.5 cm	0.5 mm	Volume storage

are richly innervated by sympathetic and parasympathetic nerves that allow them to constrict or dilate, thereby controlling systemic blood pressure and allowing for capillary runoff, which lowers arterial pressure. Thus arterioles are the major site of resistance to blood flow. Small changes in their caliber cause large changes in the total peripheral resistance and blood pressure.

The arterioles divide into smaller, muscle-walled vessels called metarterioles. These divide further into capillaries that are the exchange vessels. Porelike openings in the walls of the capillaries allow for the exchange of oxygen and nutrients from capillaries to body cells and the exchange of carbon dioxide and wastes from cells to capillaries. The rate of blood flow from an arteriole into a capillary bed is influenced by metarterioles and precapillary sphincters. These alter capillary circulation in response to the increased oxygen needs of the body cells served by a particular capillary bed.

The walls of the venules are only slightly thicker than those of the capillaries. These vessels are the capacitance vessels that function as reservoirs for volume storage. Veins, which are slightly larger, also serve the same function. The walls of venules and veins are thin and easily distended allowing them to store large volumes of blood with minimal changes in pressure. More than one half of the body's blood supply is normally contained in these capacitance vessels. These vessels are innervated by sympathetic nerves, which can respond to stimulation by constriction, thus providing a way of mobilizing this blood reserve when the system is stressed.

FUNCTIONS OF THE CARDIOVASCULAR SYSTEM

Transport of oxygen, nutrients, hormones, and waste products

The primary function of the cardiovascular system is to serve the capillary bed or microcirculation as a transport system to meet individual tissue needs. Blood delivers oxygen, glucose, amino acids, fatty acids, hormones, and electrolytes to cells while removing carbon dioxide, urea, lactic acid, and other waste products.

Transport and distribution of heat

The cardiovascular system helps to regulate body temperature by transporting warmed blood from active tissues, such as exercising muscle, to the skin where some of the heat is radiated to the environment. Blood flow to active tissues is regulated by the cardiovascular center in the medulla in response to the temperature-regulating center in the hypothalamus. The cardiovascular center receives nervous impulses from the hypothalamus and, in turn, regulates blood flow in the peripheral tissues by causing alternate vasodilation and constriction of blood vessels in the skin to dissipate the heat.

Maintenance of fluid and electrolyte balance

The cardiovascular system serves as a storage and transport system for body water and electrolytes. These two substances are delivered to body cells by the interstitial fluid that is formed by continuous filtration, diffusion, and reabsorption from the blood. In addition to providing the cells with adequate water and electrolytes, the cardiovascular system pumps 1700 L of blood to the kidneys each day. Here the quantity of water and electrolytes in the body can be adjusted and maintained. The blood itself serves as an important buffering mechanism to maintain an optimum pH of 7.35 to 7.45. Hemoglobin and plasma proteins play key roles in this buffering mechanism.

REGULATORY MECHANISMS

The human body has multiple cardiovascular regulatory mechanisms that increase the blood supply to active tissues by increasing the cardiac output. Cardiac output is regulated by variations in heart rate, stroke volume, and venous return. The remainder of this chapter will focus on control mechanisms that influence heart rate, stroke volume, and venous return.

Mechanisms controlling heart rate

Under normal resting conditions the heart beats about 70 times each minute. This rate of contraction is controlled by the heart's own intrinsic control mechanism regulated by the sinoatrial node (SA node), atrioventricular node (AV node), and Purkinje system (Chapter 2).

During periods of emotional excitement or muscular exercise, the heart can contract up to 200 times each minute. Normally the heart rate is regulated by the insertion of the sympathetic and parasympathetic branches of the autonomic nervous system; sympathetic stimulation increases the heart rate, whereas parasympathetic stimulation has an inhibiting effect on the heart rate via the vagus nerve.

Cardiovascular reflexes. There are four major reflexes mediated by the autonomic nervous system. These four reflexes, the baroreceptor reflex, the chemoreceptor reflex, the Bainbridge reflex, and the respiratory reflex, regulate the heart rate.

The *baroreceptor reflex* is perhaps the most important reflex controlling heart rate and blood pressure. The baroreceptors are stretch or pressure receptors located in the carotid sinus and aortic arch. These receptors are stimulated by the distention or stretching of the walls of the aorta or carotid artery. When these receptors are stretched by an increase in blood pressure or blood volume, they increase their firing rate of nervous impulses over their afferent fibers to the inhibitor portion of the cardiovascular center in the medulla. From the cardiovascular center in the medulla, efferent impulses are transmitted over autonomic nerves to the heart and to the peripheral blood vessels, thereby causing a decrease in heart rate and peripheral vascular resistance (Fig. 1-1).

The range of the baroreceptor response can be illustrated by two examples, hypertensive crisis and hypovolemic shock. In hypertensive crisis, the baroreceptor response to an increase in carotid sinus and aortic pressure is to decrease the sympathetic nervous discharge to the heart and peripheral blood vessels. At the same time, parasympathetic nervous discharges over the vagal nerves to the SA node are increased. This combination of reactions slows the heart rate and causes vasodilation; thus blood pressure falls.

During hypovolemic shock, the low mean arterial blood pressure causes fewer

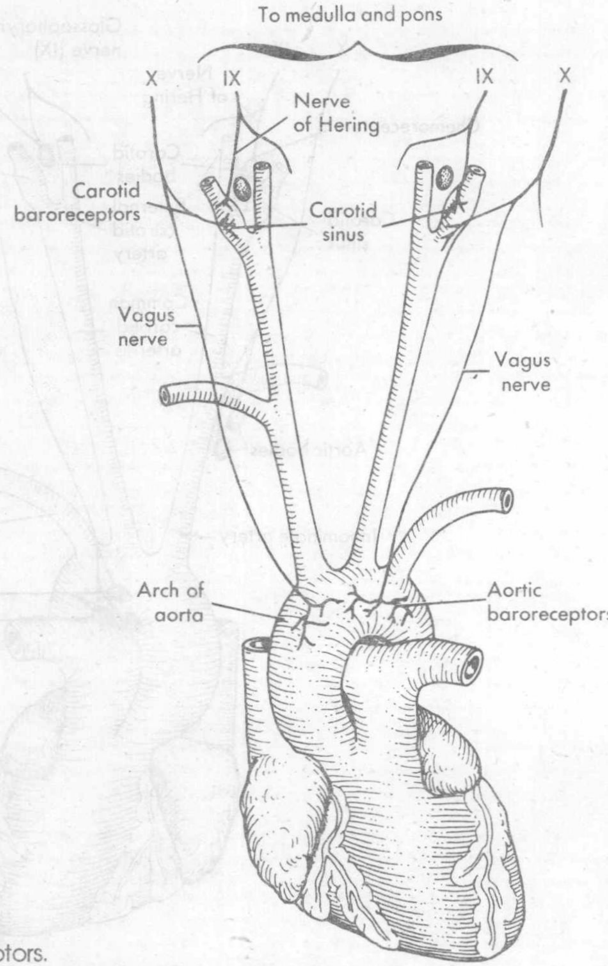

Fig. 1-1. Location of baroreceptors.

afferent impulses to be conducted to the cardiovascular center in the medulla. Following the drop in the rate of transmission of impulses from the baroreceptors, sympathetic stimulation to the SA node and the peripheral vessels increases. Heart rate, as well as peripheral vascular resistance, is increased. Both of these reactions serve to increase the blood pressure and cardiac output for the patient suffering from hypovolemic shock. Initially these compensatory mechanisms can save a patient's life until medical and nursing care are available.

The *chemoreceptor reflex* produces changes in heart and respiratory rates in response to changes in partial pressure of oxygen (Pa_{O_2}), partial pressure of carbon dioxide (Pa_{CO_2}), and changes in serum hydrogen ion concentration (pH).

Cardiac response to chemoreceptor stimulation can be divided into primary and secondary reflex mechanisms. At first, the primary reflex causes bradycardia in re-