2

Theories of Stress and Its Relationship to Health

Virginia Hill Rice

Conceptualizations of stress and the stress response have varied in form and context throughout the centuries. Florence Nightingale wrote in *Notes on Nursing* (1860/1969),

> In watching disease, both in private houses and in public hospitals, the thing which strikes the experienced observer most forcibly is this, that the symptoms or the sufferings generally considered to be inevitable and incidental to the disease are very often not symptoms of disease at all, but of something quite different—of the want of fresh air, or of light, or of warmth, or of quiet, or of cleanliness, or of punctuality and care in the administration of diet, of each or of all of these. (p. 8)

Nightingale believed that all patients were experiencing some *stress* (as it was later to be called) regardless of their illness. She wrote to nursing, "If you knew how unreasonably sick people suffer from reasonable causes of distress, you would take more pains about these things" (p. 104). Nursing's challenge is to facilitate the "reparative process" (p. 9). More than 70 years later, Hans Selye (1936), a young medical student at the University of Prague, wrote,

> Whether a man suffers from a loss of blood, an infectious disease, or advanced cancer, he loses his appetite, his muscle strength, and his ambition to accomplish anything; usually the patient also loses weight and even his facial expression betrays that he is ill. (p. 19)

He labeled this phenomenon the "syndrome of just being sick" and pursued the catalysts and processes of this syndrome in the laboratory and in his medical practice for more than 50 years. He described it as "stress-response theory" and systematically examined its relationship with health. Other researchers of the stress-response phenomenon include Mason (1971), McEwen (1998), and McEwen and Wingfield (2003). This chapter examines, in depth, the development of stress-response theory and the wealth of research, theory development, and clinical implications that have been derived from the work.

Stress-Response Theory

Selye (1976a) initially proposed a triadic model as the basis for the stress-response pattern. The elements included adrenal cortex hypertrophy, thymicolymphatic (e.g., the thymus, the lymph nodes, and the spleen) atrophy, and gastrointestinal ulcers. These three, he reasoned, were closely interdependent; they seemed to accompany most illnesses and were provoked no matter what the stimulus or illness. Selye could evoke the response in laboratory rats with agents such as formalin, enzymes, hormones, heat, and cold, and he

observed it in patients with such diverse health problems as infections, cancer, and heart disease. He noted that the syndrome probably represented an expression of a generalized "call to arms" of the body's defensive forces in reaction to excessive demands or provocative stimuli. Selye (1936) called this *nonspecific* response to damage of any kind *stress.* Later, he used the term *stressor* to designate the stimulus that provoked the stress response (Selye, 1976b). To derive a conceptualization of stress, Selye (1974) chose to delineate what it was not. He wrote that stress is not:

1. simply nervous tension; it can occur in organisms without nervous systems or in anesthetized or unconscious patients.
2. an emergency discharge of hormones from the adrenal medulla; although catecholamines are a part of the stress reaction, they are not the only hormones activated, and they play no role in generalized inflammatory diseases or local stress reactions.
3. everything that causes a secretion of the adrenal cortex (i.e., corticoids); adrenocorticotropic hormone (ACTH) can stimulate the release of corticoids without producing a stress response.
4. always the nonspecific result of damage; normal activities, such as tennis or a passionate kiss, can produce a stress response without conspicuous damage.
5. the same as a deviation from homeostasis (Cannon, 1932), the body's steady state: Reactions to loud noises, blinking of the eye, or contracting a muscle may cause deviations from the resting state without evidence of a generalized stress reaction.
6. anything that causes an alarm reaction: It is the stressor that is the stimulus and not the stress itself.
7. identical with the alarm reaction: These reactions are characterized by certain end-organ changes caused by stress and, hence, cannot be stress.
8. a nonspecific reaction: The pattern of the stress response is specific, although its cause and effects may vary.
9. necessarily bad: The stress of success, challenge, and creativity is positive, whereas that of failure, anxiety, and infection can be negative.
10. to be avoided: Stress cannot be avoided. It is ubiquitous; it is an essential ingredient of life.

Selye viewed stress as the common denominator of all adaptive reactions in the body and complete freedom from stress as death (Selye, 1974).

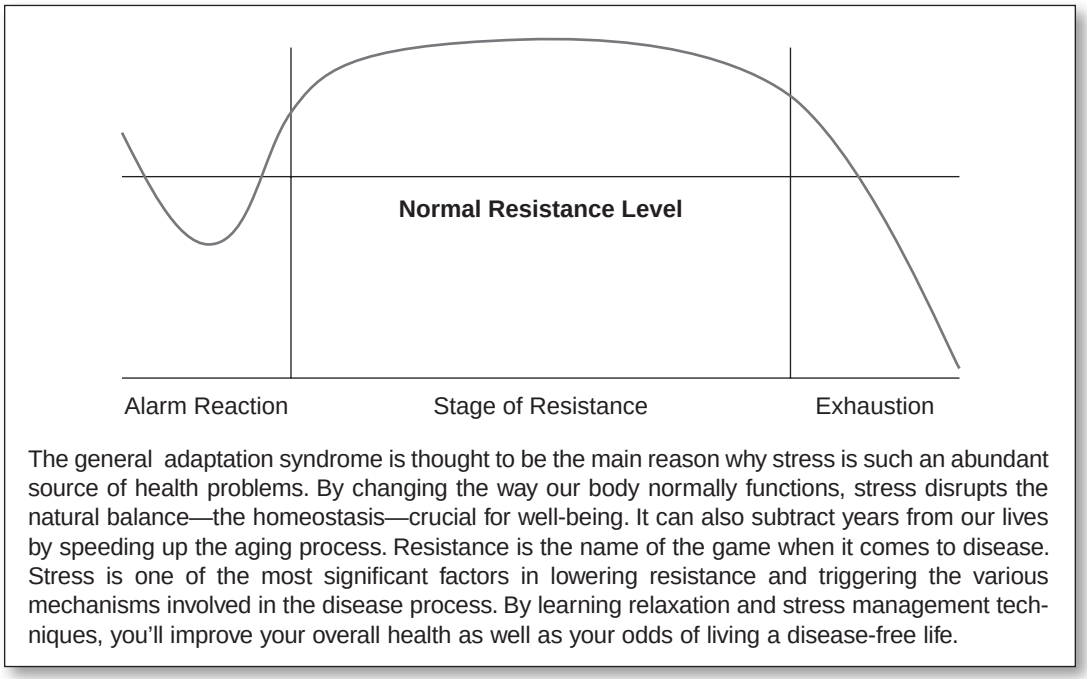
In his first publication on stress in *Nature* in 1936, Selye defined stress as *"the nonspecific response of the body to any demand made on it"* (p. 32). Following criticisms for being too vague, confusing, and ambiguous, he offered the following operational definition: *Stress is "a state manifested by a specific syndrome which consists of all the nonspecifically induced changes within the biological system*" (Selye, 1976b, p. 64). He proposed that such changes were measurable and occur at both the system and the local level. The entire stress process at the system level, including the threat and the individual's reaction to it, he called the general adaptation syndrome (GAS). (See Figure 2.1.) The regional response (e.g., localized inflammation where microbes have entered the body) he termed the local adaptation syndrome (LAS). The GAS and LAS are seen as closely coordinated, with the GAS acting as backup (Selye, 1976a). The GAS is described in detail in the following section.

General Adaptation Syndrome

Selye (1950, 1956) noted that throughout history aspects of stress and the stress phenomenon floated aimlessly like loose logs on the sea, periodically rising and falling in waves of popularity and disgrace. He attempted to bind together these loose logs of observable facts with solid cables (workable theories) and secure them with a resulting raft (GAS) by mooring it to generally accepted classical medicine in space and time. In space, the three fixed points were the triad of adrenal, thymicolymphatic, and intestinal changes. In time, three distinct phases were identified as the *alarm reaction, resistance stage,* and *exhaustion stage.* (See Figure 2.1.) Bringing together these points of space and time, he reasoned, permitted stress to be less ethereal and more amenable to scientific inquiry.

Selye (1976b) labeled this process general "because it was produced only by agents which have a general effect upon large portions of the body," adaptive "because it stimulated defense

Figure 2.1 Diagram of the General Adaptation Syndrome (GAS) Model



SOURCE: Health News Network, http://www.healthnewsnet.com/gap.html

and, thereby, helped in the acquisition and maintenance of a state of inurement," and syndrome "because its individual manifestations are coordinated and, even partly, dependent upon one another" (p. 38). This response to stimuli, he noted, included (a) the direct effect of the stress on the organism, (b) internal responses that stimulated tissue defense to destroy the damaging threat, and (c) internal responses that caused tissue surrender by inhibiting unnecessary or excessive defense. He noted, "Resistance and adaptation depend on a proper balance of these three factors that occur during the general adaptation syndrome" (p. 56).

In addition to the three theoretical stages of the GAS (i.e., alarm, resistance, and exhaustion), Selye (1976b) identified level of function and normal level of resistance as other constructs in his model. In routine day-to-day situations, he wrote, the organism functions within a level of normal resistance or homeostasis. Self-regulating and balancing devices, as well as problem solving, facilitate maintenance and adaptation to routine stressors and stress. Responses are automatic or habitual adaptations. When a stressor is encountered that exceeds current adaptive resources, an alarm is initiated. The alarm reaction involves activation of the hypothalamic-pituitary-adrenalcortical (HPA) axis.

Alarm Stage

Selye wrote that, even as a demand is being appraised and possible specific responses are being tested, certain cells in the hypothalamus are being alerted to a state of emergency. There is a generalized stimulation of the autonomic nervous system during this initial shock phase of the alarm reaction. A nonspecific breakdown of resistance occurs; sympathetic nervous system activity is suppressed, accompanied by a decrease in muscle tone, hypotension, and hypothermia. Other manifestations include hemoconcentration, hypocholoremia, hypoglycemia, and acidemia. Generalized protein catabolism occurs with altered capillary and cell membrane permeability. The initial shock stage can last from a few moments to as long as 24 hours depending on the intensity of the stressor and the vulnerability of the individual.

A counter-shock phase follows if the stressor persists or the individual is weak or both. This

phase is characteristic of the *fight-or-flight* reaction described by Cannon (1932). It involves stimulation of the sympathoadrenal medullary system with the release of catecholamines (epinephrine and norepinephrine). Epinephrine causes dilation of bronchi and pupils; increases in respirations, blood pressure, heart rate, blood volume, blood clotting, perspiration, alertness, blood supply to vital organs, and energy; and causes a decrease in peristalsis. Norepinephrine leads to peripheral vasoconstriction, renin secretion, and stimulation of aldosterone, which in turn causes sodium retention and potassium secretion. Simultaneously, the signal induces secretion of the corticortrophin-releasing factor (CRF) by median eminence cells in the hypothalamus. CRF is conveyed down the portal-venous system into the adenohypothysis, in which it triggers the release of the adrenocorticotropic hormone (ACTH) that is carried throughout the vascular system, acting directly on the adrenal cortex and regulating the secretions of a variety of hormones known collectively as the corticoids. Corticoids are carried to all parts of the body, inducing numerous effects, including gluconeogenesis, thymicolymphatic involution, eosinopenia, peptic ulcers, and decreased immune-inflammatory reactions.

Usually secreted in lesser amounts are proinflammatory cortocoids. They stimulate proliferative ability and the reactivity of connective tissue to build strong barricades to resist invasion, increase the platelet count, and cause protein catabolism. The corticoid hormones are known as *syntoxic* because they facilitate coexistence with the stressor pathogen either by reducing sensitivity to it or by encapsulating it within a barricade of inflammatory tissue. These are distinguishable from the *catatoxic* hormones that enhance the destruction of potential pathogens, mostly through the induction of poison-metabolizing enzymes in the liver. The effects of all these substances can be modulated or conditioned by other hormones (e.g., thyroxin), nervous reactions, diet, heredity, health state, and tissue memories of previous experiences with stress.

Symptomatically, the individual may complain of chest pain, palpitations, a racing heart, headache, dysphagia, or all these. Other manifestations include intestinal cramping, dysmobility, dysnea, feelings of lightheadedness, muscle tremors, joint pain, and bruxism. If survival of the organism is at all possible, a stage of resistance follows the alarm reaction. It is called the *stage of resistance* because opposition to a particular stressor has been established, but resistance to most other stressors tends to be less than normal. Manifestations of the second stage are the antithesis of the alarm reaction stage. In the former, for example, the adrenal cortex discharges its hormone-containing secretions into the bloodstream; consequently, the stores of the gland are depleted. In the stage of resistance, the cortex accumulates an abundant reserve of secretory granules.

Resistance Stage

The resistance stage is evidenced by a dramatic reduction in the alarm reaction as full resistance to the stressor is being established. Developmental (homotrophic) adaptation occurs in the tissues that must intensify their characteristic functional activity for the body to transcend the stressor. There is an attempt to maintain a higher level of functioning in the presence of the stressor as enlargement and multiplication of preexisting cell elements occur without qualitative change. Heterotrophic adaptation, involving tissue readjustment and transformation to perform diverse functions, also occurs at this time. The stage of resistance may be viewed as an attempt at survival through a carefully balanced use of the body's syntoxic and catatoxic defense mechanisms to facilitate coexistence of the organism and the stressor (Selye, 1976a).

Exhaustion Stage

If the organism is not able to return to a normal level of resistance (i.e., prealarm reaction homeostasis) or the initial insult is too overwhelming, a third stage, the stage of exhaustion, ensues. At this time, endocrine activity is heightened; high circulating levels of cortisol begin to have pronounced negative effects on the circulatory, digestive, immune, and other systems. The symptoms are strikingly similar to those of the initial alarm reaction, but such a high level of resistance cannot be maintained indefinitely. Human resources become depleted, and permanent damage to the system through *wear and tear* or death or both is likely to occur. In the usual course of events, the organism would experience all the GAS stages. Surprisingly little has been written about this final stage of adaptation, and few studies have been performed.

GAS Assumptions

The following assumptions are foundational to the general adaptation syndrome theory: (a) Any demand, positive or negative, can provoke the stress response; (b) the stress response is characterized by the same chain of events and pattern of physiological correlates regardless of the stressor or stimulus that provoked it; (c) what occurs systematically in the GAS is evident to a much lesser degree in the LAS; (d) the occurrence of the LAS or GAS or both defines the occurrence of stress; (e) the theory de-emphasizes differences among stimuli and organisms; and (f) the theory presumes adaptive resources are genetically determined and finite. According to Selye (1976a), every individual is endowed with a genetically predetermined quantity and quality of adaptative energy that may be spent with conservative discretion (producing a longer life) or with a reckless abandon (a shorter but more colorful existence).

Many criticisms of Selye's conceptualization of stress and the GAS have been raised by Mason (1971) and others. Mason identified the following: (a) Stress has too many ambiguous meanings (he thought that Selye should have coined a new word rather than selected one already in use); (b) stress is an abstraction—it has no real independent existence; (c) stress has been applied to both the agent and the consequence; (d) the stress response cannot be both specific and nonspecific; (e) there have been few attempts to arrive at a consensus definition and operationalization for the term stress; and (f) the stress definition and the GAS do not take into consideration cognition, perception, and interpretation of the stimulus.

Some of these concerns were addressed by Selye (1976c) in his article, "Forty Years of Stress Research: Principal Remaining Problems and Misconceptions." He argued that stress is the nonspecific response of the body to any demand, that the stressor is the agent that produces it, and that the GAS is the chronological development of the response to stressors when their action is prolonged. Selye wrote that the terms *nonspecificity* and *specificity* could be applied to both the eliciting agent and the response. By nonspecific is meant the *generalized effects or responses that are characteristic of many stimuli or agents—that is, the manifestations of the alarm reaction with secretion of ACTH, the catecholamines, thymicolymphatic involution, and so on.* These, he argued, are elicited by innumerable agents that make intense and systemic demands on the organism. Perception of a green light, however, is a highly specific response. It can occur only when given light wavelengths reach the retina. Selye noted that the stress response was affected by conditioning factors, such as age, genetic predisposition, sex, and exogenous treatments, and that these factors can cause the same stimulus to act differently in different individuals and to act differently in the same individual at different times.

Although *perception* and *cognition* were not identified in Selye's early work, he attempted to distinguish between agreeable (healthy) and disagreeable (pathogenic) stress as qualitatively different phenomenon. The first he called *eustress* and the latter, *distress.* He wrote that the body undergoes virtually the same nonspecific response during eustress and distress. In the former, however, there is much less damage. This notion of *appraisal* was addressed further by Selye's addition of perception, interpretation, and assessment to his 1985 model (Tache & Selye, 1985). According to Selye, perception and interpretation had not been developed because they were outside the realm of expertise of physiologists (such as himself) who had proposed the original theory (Tache & Selye, 1985).

Coping With Stress

Although not specified in his earlier works, Selye introduces the notion of coping in this later model (Tache & Selye, 1985). Coping he defined as *adapting* to stress situations. This is accomplished in our society, he wrote, "*by removing stressors from our lives, by not allowing certain neutral events to become stressors, by developing a proficiency in dealing with conditions we do not want to avoid, and by seeking relaxation or diversion from the demand*" (p. 20). Tache and Selye (1985) summarized the essential points of Selye's model of stress as follows:

1. All life events cause some stress.
2. Stress is not bad per se, but excessive or unnecessary stress should be avoided whenever possible.
3. The stressor is the stimulus eliciting a need for adaptation; stress is the response.
4. The nonspecific aspects of the body's reaction to an agent may not be as obvious as the specific effects. Sometimes, only disease or

dysfunction will make an individual realize that he or she is under stress.

5. Stress should be monitored through a battery of parameters.
6. Stress should not be equated with only ACTH, corticoid, or catecholamine secretions. These seem to manifest the main pathways of nonspecific adaptation; they are but a few of the elements of a very complex scheme, however.
7. Removal of the stressor eliminates stress.

They noted that stress is the price that organisms pay to survive as animals, and humans pay that same price to accomplish what they consider to be great things.

Stress, Disease, and Illness

According to Selye (Tache & Selye, 1985), the nervous and hormonal responses to stressors, as discussed previously, aid survival. He believed the demand-induced neuro-hormonal changes are carefully balanced to enhance the organism's capacity to meet challenges and, thus, are adaptive. If, however, there is an excess of defensive or submissive bodily reactions, then diseases of adaptation can occur. Conditions in which such maladaption is a factor include high blood pressure, diseases of the heart and blood vessels, diseases of the kidney, eclampsia, rheumatic and rheumatoid arthritis, inflammatory diseases of the skin and eyes, infections, allergies and hypersensitivity diseases, nervous and mental diseases, sexual dysfunctions, digestive diseases, metabolic diseases, cancer, and diseases of a compromised immune system. Simonton, Simonton, and Creighton (1978) and Goodkin, Antoni, and Blaney (1986) all proposed a strong relationship between stress and cancer. Matthews and Glass (1981) suggested a similar relationship between stress and heart disease.

Leidy (1989) presented the physiological processes of stress as a useful framework for nursing to understand the dynamics of chronic illness, its evolution, and trajectory. She suggested that the manifestations of chronic health problems such as chronic obstructive lung disease could be interpreted as expressions of chronic stress that evolve as a consequence of environmental stressors, such as cigarette smoking or prolonged exposure to air pollutants, and the individual pulmonary system vulnerability. She also noted the association between stress and nutritional imbalances, obesity, and diabetes mellitus.

Bryla (1996), a nurse researcher, reviewed the literature that addressed the relationship between stress and the development of breast cancer and the mediator effects of the immune system. She used published articles, book chapters, books, and workbooks from nursing and the medical literature as sources. The studies showed a positive relationship existed between stress and the development of breast cancer although the exact mechanism was not clear. Most of the researchers tended to characterize women who developed breast cancer or who experienced progression of the disease or both as having certain personality traits and being over-responsive to emotional stress. These traits include emotional suppression, depression, conflict avoidance, repressive coping style, uncertainty, extroversion, and sexual inhibitions. The inability to manage anger (so-called *anger in*), masochism, aggressiveness, and hostility (masked with a facade of pleasantness) all seem to contribute to breast cancer risk (Bahnson, 1981; Cooper, Cooper, & Faragher, 1989; Fox, 1983; Grassi & Cappellari, 1988). It has been suggested that the immune system might mediate the physiologic influence of stress on breast cancer (Hulka & Moorman, 2001; Peled, Carmil, Siboni-Samocha, & Shoham-Vardi, 2008). Bryla points out the problem of isolating an individual's perception of stress from the extraneous factors that often coexist with it (e.g., fear and depression).

Other studies have noted the connection between stress and breast cancer as a "stress-related" weakening of the immune system that, in turn, allows cancer cells to proliferate (Greer & Watson, 1985; Levy et al., 1990; Park & Kang, 2008; Watson, Pettingale, & Greer, 1984). This includes the effect of heuristic thinking (Facione, 2002). Measurable physiological effects include lymphocytopenia, thymus involution, and decreases in eosinophils, monocytes, macrophages, and T cells. Other changes are decreases in antibody production, inhibition of natural killer cells, and loss of tissue mass in the spleen and peripheral lymph nodes (Vitaliano, Scanlan, Ochs, Siegler, & Snyder, 1998). To date, most studies have been correlational and retrospective in nature, involving women who have already been diagnosed with cancer. Not considered was the potential potent influence of the cancer diagnosis, itself. Other methodological concerns included the diverse *operationalization* of the stress concept. For the most part,

stress has been measured as an emotion, such as anxiety, hostility, depression, or anger, or as physiological data. Linkages between manifest emotions and, for example, changes in heart rate and experienced stress have, at best, been inferred. Means to establish more direct linkages and measurements are necessary.

Bleiker and van der Ploeg (1999) reviewed 27 studies of the psychosocial factors in the etiology of breast cancer. Seven of the studies were retrospective, 12 were quasi-prospective, and 8 were prospective. The reviewers failed to find conclusive results and noted that there was a lack of specific knowledge on the relationship between breast cancer development and psychosocial factors, such as stressful life events, coping styles, depression, and the ability to express emotions. They concluded that at least three hypotheses have been described to explain a possible relationship between the psychosocial variables and cancer development. The first proposes a biological pathway in which stress through the central nervous system and the endocrine system compromises the immune system leading to cancer development. The second assumes that psychological variables are related to high-risk lifestyle behaviors—for example, personality characteristics lead to cigarette smoking, which in turn leads to increased risk for cancer. A third hypothesis suggests that an unknown factor (possibly hormonal or genetic) may be responsible for the increased risk for cancer and for the increased chance of having a given personality trait. The authors concluded that much prospective research is needed to explicitly determine the personality–cancer relationship. Butow et al. (2000) noted that the evidence for a relationship between psychosocial factors and breast cancer is weak at best. The strongest predictors seem to be emotional repression and severe life events. Future research would benefit from a stronger theoretical grounding and greater methodological rigor.

Carrieri-Kohlman, Lindsey, and West (2003), in *Pathophysiological Phenomena in Nursing: Human Response to Illness,* depict pathological consequences associated with the stress response and describes conditions antecedent to it. These physiological manifestations include lipolysis, proteolysis, gluconeogenesis, and urea-genesis. Antecedent conditions include multiple traumatic insult, ischemia, hypoxia, burns, surgery, sepsis, and loss of a loved one and other catastrophic socio-psychological losses. Fauci and others (2008), in *Harrison's Principles of Internal Medicine* (17th edition), describe clinical manifestations of many stress-related disorders, including depression, ulcers, and hypertension. The proposed relationship between stress and health and illness is explicated further in these texts.

Other Stress Response Theorists

Although Selye was the pioneer of stress response theory, other early contributors in the field included Mason (1971), McEwen (1998), and McEwen and Mendelson (1983). Mason believed that coping processes were constantly shaping the endocrine response to stressors and that this response varied with the particular properties of the stimuli. He disagreed with Selye that there was a nonspecific response to stimuli. Mason coined the term "psycho-endocrinology," thus attributing to mental processes some of the variance in the endocrine response to stressful stimuli.

Like Selye, McEwen and Mendelson (1983) and McEwen (1998, 2000) believed that a stressor was an event that challenged *homeostasis,* with disease the consequence of failure of the normal adaptive system. These scientists proposed that psychological stress (such as fear and anxiety) involved perceived threats to homeostasis and that these were likely to evoke psychosomatic reactions, such as gastric ulcers and immunosuppression. The focus of their work was on the neuroendocrine response of the brain to stressors and the development of depressive symptoms. They found glucocorticoids to be one of the body's natural antidepressants. These researchers believed the important first mediator of the GAS was psychological. This is discussed in more detail in subsequent chapters.

Allostasis and Allostatic Load Theories

The work of McEwen (1998, 2000), Sterling and Eyer (1988), and McEwen and Wingfield (2003) laid the foundation for the allostasis and allostatic load theories. They proposed that *homeostasis* is the regulation of the body to a balance, by single-point tuning such as blood oxygen level, blood glucose, or blood pH. On the other hand, allostasis proposes maintenance of stability outside of the normal homeostatic range where an organism must vary all the parameters of its physiological systems to match

them appropriately to chronic demands (i.e., reset the system parameters to a new set point). The main hormonal mediators of the stress response in this situation are cortisol and epinephrine (adrenaline). They have both protective and damaging effects on the body. (See Figure 2.2.)

Allostasis implies that many, if not all, physiological functions are mobilized or suppressed as reflected in a cascade of brain–organism interactions overriding local regulation. In the short run, they are essential for adaptation, maintenance of homeostasis, and survival *allostasis*. Yet, over longer time intervals, when called upon frequently, they exact a cost (i.e., an *allostatic load*) that can accelerate disease processes. Allostatic load can be measured in the physiological systems as chemical imbalances in the autonomic nervous system, central nervous system, and neuroendocrine and immune system activity as well as perturbations in the diurnal rhythms, and, in some cases, plasticity changes to the brain structures. McEwen (2000) identifies a number of physiological indicators for determining allostatic load. These include systolic and diastolic blood pressures, high-density lipoproteins (HDL) and total cholesterol, glycosylated hemoglobin (HbA1c) levels of glucose metabolism over time, serum dihydroepiandrosterone (DHEA-S), 17-Hydroxycorticosteroids or 24-hour urinary cortisol excretion, and overnight urinary noradrenaline and adrenalin excretions. Cortisol, noradrenalin, adrenalin, and DHEA are identified as the four primary mediators

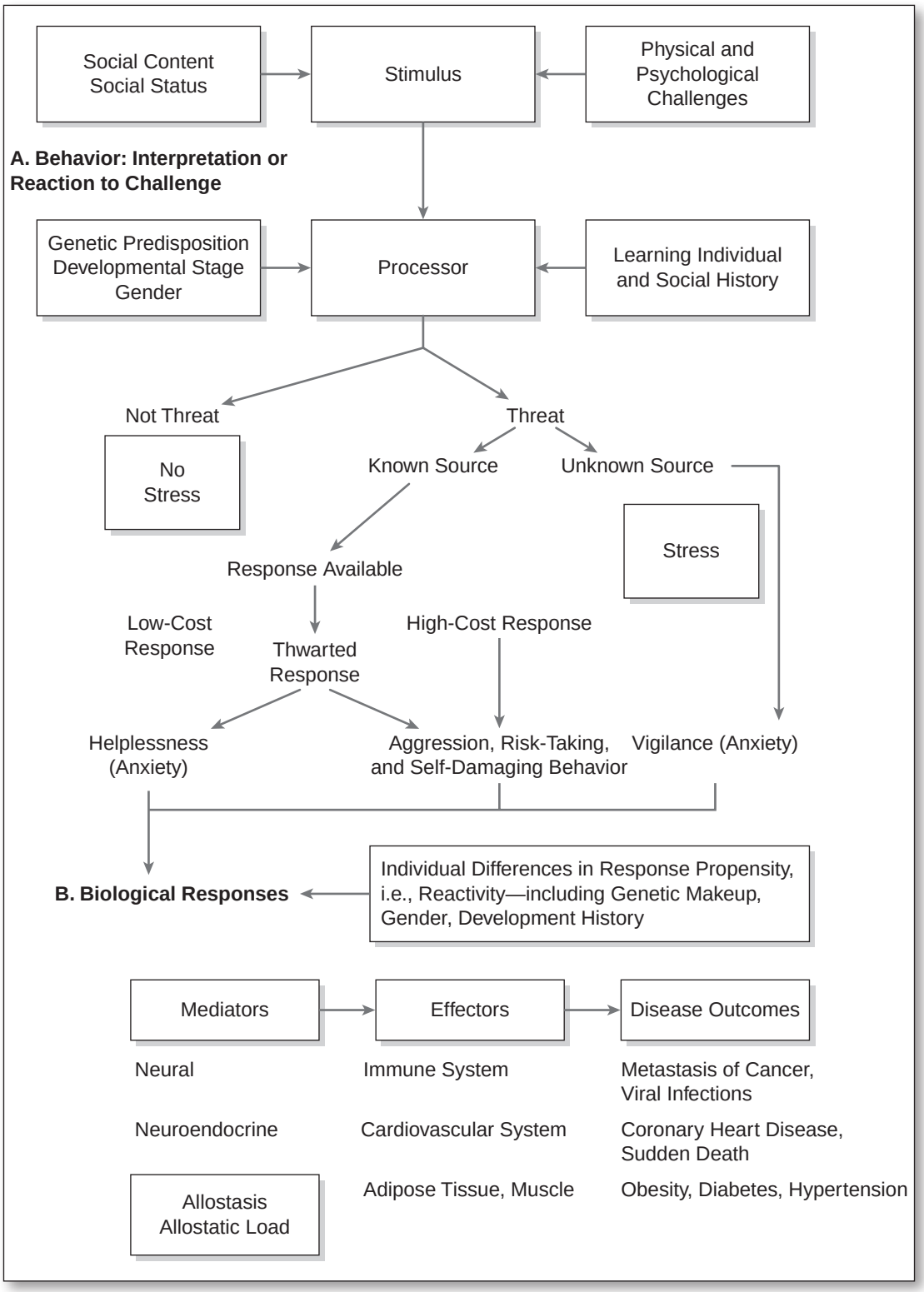
A search of the Cumulative Index of Nursing and Allied Health Literature (CINAHL) found six research studies in the recent decade (2000–2010) that used the allostasis theoretical framework. Shannon, King, and Kennedy (2007) used the framework to understand and evaluate perinatal health outcomes. Weiss and others (2007) looked at degree of obesity, glucose allostasis, and the major effectors of glucose tolerance in youth. Carlson and Chamberlain (2005) studied allostatic load and health. Chronic stress to explain posttraumatic brain injury depression (Bay, Kirsch, & Gillespie, 2004), chronic stress and depression in community-dwelling survivors (Bay, Hagerty, Williams, Kirsch, & Gillespie, 2005), and job stress related to allostatic load (Li et al., 2007) all used allostasis theory. There is a great deal of interest in conducting nursing research using the allostasis and allostatic load models.

Stress Response Measurement

The first physiological axis to become activated during the stress response is the autonomic nervous system (ANS). Primary ANS indicators of the stress response include heart rate, respiratory rate, blood pressure, heart rate variability, cardiac output, and electro-dermal activity. In addition, a rate pressure product has been used as a reliable noninvasive indicator of myocardial oxygen demand and impedance cardiography has been employed to determine noninvasive estimates of cardiac output and peripheral vascular resistance (Sherwood, 2010). An additional measure includes the finger arterial blood pressure. The finger arterial blood pressure monitoring method (i.e., Finapres, Datex Ohmeda) facilitates continuous finger arterial pressure waveforms (Imholz, Wieling, van Montfrans, & Wesseling, 1998). The equipment is easy to use and provides a method for continuous measurement of blood pressure changes. Although there are conflicting reports (e.g., Jagomägi, Raamat, & Talts, 2001; Jagomägi, Raamat, Talts, Länsimies, & Jurvelin, 2003) regarding its utility in the clinical setting in which treatment options are determined by blood pressure measurements, it provides a noninvasive method for tracking momentary blood pressure changes in stress studies (Imholz et al., 1998). Blood pressure measurements have been used as indicators of psychological and physiological stress in many, many recent research studies (i.e., Artinian, Washington, Flack, Hockman, & Jen, 2006; Han et al., 2010; Jefferson, 2010; Mikosch et al., 2010). Heart rate measures also have been used as indicators of psychological and physiological stress in many studies (e.g., Matsubara et al., 2011; McKay, Buen, Bohan, & Maye, 2010).

Nurse researchers have also used many of the biomarkers of the stress response including cotinine for tobacco users (Boran et al., 2010), urinary Na+/K+ ratios and 17-ketosteroids (Farr, Keene, Sampson, & Michael, 1984; Jia, Hong, Pan, Jefferson, & Orndoff, 2001), and plasma cortisol levels (Page & Ben-Eliyahu, 1997; Herrington, Olomu, & Geller, 2004). Farr et al. (1984) found altered circadian excretion of urinary catecholamines in postoperative surgical patients. Lanuza and Marotta (1987) reported cortisol elevations in cardiac pacemaker implant patients, and Lanuza (1995) found elevated cortisol levels in both coronary artery bypass graft patients and patients undergoing implantation

Figure 2.2 Allostatic Load



NOTE: Conceptual model of biology and behavior in which responses that are stressful result from the interpretation of, and behavioral and physiologic responses to, environmental challenges that may be stressful to some individuals and less or not stressful to others. (A) Physical and psychological challenges operate within social context that includes individual social status. The processing of this information by the nervous system is biased by factors such as genetic predisposition that are operated on by developmental history, learning, and socioeconomic status; developmental age and gender are also important factors. Interpretation of a stimulus as threatening results in behavioral responses that vary in degree and cost to the individual and that are therefore stressful to varying degrees. Nonthreatening situations and low-cost responses are not considered stressful because they do not elevate physiologic responses. Stress refers to responses that are costly in terms of arousal of physiologic systems and elicitation of behaviors that are harmful. Thwarted responses may lead to aggression or result in helplessness that is similar to a response being unavailable. High-cost responses, which may include aggression, are ones that consume energy and that further increase risk to additionally challenge. All these responses, including vigilance and helplessness, have biological counterparts, and they feed back to influence additional stimulation and processing of that stimulation. (B) Behavioral responses are accompanied by neural and neuroendocrine responses that act on effectors, such as the immune and cardiovascular systems and adipose tissue and muscle. Chronic or repeated stimulation of these effectors may be due to thwarted or high-cost responses or to anxiety associated with vigilance or helplessness and may lead to allostatic load that, over time, increases risk for pathology and disease. Acute stress more readily precipitates disease when chronic stress has laid a pathophysiologic foundation (McEwen & Stellar, 1993).

of an automatic cardioverter or defibrillator device. Strahler and others studied aging diurnal rhythms and chronic stress using salivary alpha-amylase and cortical levels (Strahler, Berndt, Kirschbaum, & Rohleder, 2010) and salivary alpha-amylase levels across different age groups (Strahler, Mueller, Rosenloecher, Kirschbaum, & Rohleder, 2010). Chapter 5 of this text presents other various stress response measures, including their source, research, reliability, validity, sensitivity, and specificity.

Stress Response Empirical Adequacy

During the past 60 to 70 years, thousands of studies have sought to explicate stress theory and the stress response. Selye (1979) wrote "30 books and about 15,000 technical articles on the subject" (p. xi) and produced *Selye's Guide to Stress Research* (1980) to present the then-current state of the knowledge of the stress concept. Included in Volume 1 are a preface and epilogue by Selye and the seminal works of Dohrenwend and Dohrenwend on life events theory, Lazarus's psychological stress and adaptation model, and Frankenhaeuser's psychoneuroendocrine approaches to the study of stressful person–environment transactions. Studies of stress as a response have been conducted in such diverse fields as business, law, pharmacy, psychology, anthropology, education, sociology, physiology, and philosophy. A major portion of the research has been conducted in the scientific fields of medicine and nursing because of the hypothesized relationships between stress and disease and stress and illness.

A MEDLINE search of the literature (since 1966), using the key word "stress," generated more than 95,000 citations; with "Selye" as the key word, 212 references resulted. When the focus-phrase "general adaptation syndrome" was added, 100 additional studies were indicated. Sampled literature indicates that stress as a response has been examined in adults experiencing surgery (Karlsson, Mattsson, Johansson, & Lidell, 2010; Lanuza, 1995; Slater, 2010), social isolation (Nicholson, 2009), living with a spinal cord injury (Chen & Boore, 2008), heart disease (Brown, 1976; Kasl, 1996; Robley, Ballard, Holtzman, & Cooper, 2010), panic (Lopez-Ibor, 1987; Desborough, 2000), fatigue (Aldwin, 2007; Eidelman, 1980), cancer (Vitaliano et al., 1998), biofeedback (Zolten, 1989), and antibody malproduction (Herbert & Cohen, 1993). It has been used to study music therapy (Bally, Campbell, Chesnick, & Tranmer, 2003; Nilsson, Rawal, & Unosson, 2003), children with cancer (Hinds et al., 2003), pain (Ramelet, Abu-Saad,

Rees, & McDonald, 2004), caregivers (Thompson et al., 2004), and chronic hypertension (Calhoun, 1992; Chummun, 2009; Doshi, Zuckerman, Picot, Wright, & Hill-Westmoreland, 2003). In addition, stress as a response has been used for the development of a culturally sensitive stress measure (Ruiz, Fullerton, Guerrero, Garcia-Atwater, & Dolbier, 2006) and for examining workplace demands of professional nurses (McVicar, 2003; Santamaria, 2001).

In the Cumulative Index for Nursing and Allied Health Literature (CINAHL) (dating from 1982), there were more than 11,000 references in nursing journals for the key word "stress as a response." There are 143 references for "Selye" and 94 for "general adaptation syndrome". In the last decade (2000–2010) there have been 283 "stress as a response" nursing studies. As examples, researchers have evaluated nursing interventions (Han et. al., 2010), stress in neonatal intensive care unit parents (Mackley, Locke, Spear, & Joseph, 2010), adolescent coping (Garcia, 2010), open heart surgery experiences for patients and their caregivers (Robley, Ballard, Holtzman, & Cooper, 2010), irritable bowel responses to acute stress (FitzGerald, Kehie, & Sinha, 2009), recovery from colorectal surgery (Slater, 2010), violence and women's health (Symes et al., 2010), and job stress in professional nursing (Chen, Chen, Tsai, & Lo, 2007; Ulrich et al., 2010; van den Tooren & de Jonge, 2008).

Stress Response Nursing Knowledge

Stress response nursing knowledge has been generated in theory development, nursing practice, and empirical research. Each of these content areas will be reviewed in this section.

Theory Development

Conceptualization of stress as a response has contributed to the development of many theories and models now being used in nursing science and practice. Among those detailed here is Roy's Adaptation Model (RAM).

Roy's Adaptation Model (RAM)

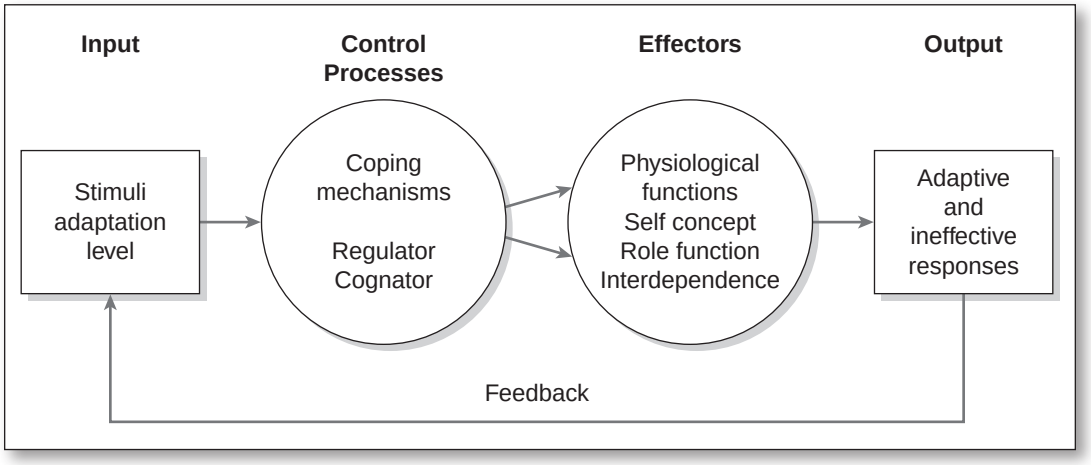
Sister Callista Roy developed one of the earliest nursing theories in 1964 while she was still a graduate student. The model has some of the characteristics of systems theory and some of the characteristics of stress and interaction theories. Roy borrowed and expanded on theories from others, including Selye (1936), Helson (1964), and Maslow (1970). She has continued to expand her model from its inception to the present (Galbreath, 2002). RAM focuses on the individual (person) as a bio-psychosocial adaptive system and describes nursing as a humanistic discipline that "*places emphasis on the person's own coping abilities to achieve health*" (Roy, 1984, p. 32).

This model relies heavily on stress theory, the notion of adaptation, and the ability of nursing to facilitate client adaptation or coping with stress. (See Figure 2.3.) From stress theory, Roy selected the concepts of stressor, stress, and adaptation for her model. She defines stress as "*a constantly changing point, made up of focal, contextual, and residual stimuli, which represent the person's own standard of the range of stimuli to which one can respond with ordinary adaptive responses*" (Roy, 1984, pp. 27–28). *Focal stimuli* are the internal and external demands immediately confronting the organism (e.g., a need for cancer surgery). *Contextual stimuli* are all other internal and external factors in the given situation (e.g., fear of dying). *Residual stimuli* are factors that may be affecting current emotions and behaviors but whose effects are not clearly validated (e.g., having a mother who died from cancer).

Stress, for Roy, represents the person's adaptive level. She wrote, "The human system has the capacity to adjust effectively to changes in the environment and, in turn, to affect the environment" (p. 22). She defined adaptation as "that which promotes the integrity of the person in terms of survival, growth, reproduction, and mastery" (p. 51). A person's adaptation level is determined by the combined effect of the three classes of stimuli (input). Health results when adaptation reaches the optimal level of the individual's potential to meet his or her physical, psychosocial, and self-actualization needs. The individual uses both innate and acquired biological, psychological, or social adaptive mechanisms or all three.

Roy's model postulates that there is an interchange between the adaptive system (individual) and various stimuli (input) from the environment and from the adaptive system. Responses to stimuli are processed through subsystems that

Figure 2.3 Roy's Adaptation Model (RAM)



SOURCE: Sister Callista Roy (1984), *Introduction to Nursing: An Adaptation Model* (2nd ed.). Retrieved from http://currentnursing.com/nursing_theory/application_Roy%27s_adaptation_model.html

include two control mechanisms as coping processes and four adaptive modes. One control mechanism is the *regulator subsystem*. It responds automatically via neural, chemical, and endocrine processes. Stimuli from the internal and external environment (through the senses) act as inputs to the nervous, circulatory, and endocrine systems of the body. Automatic, unconscious (coping) responses are produced. The second subsystem, a *cognator,* receives input from external and internal stimuli that involve psychological responses concerned with the process of perception (the link between the regulator and cognator), learning, judgment, and emotion.

The four modes are (a) physiological functioning (biological integrity derived from basic needs), (b) self-concept (interaction with others and the psychic integrity regarding perception of self), (c) role functioning (social integrity and the performance of duties based on positions within society), and (d) interdependence (seeking of help, affection, and attention along with relationships with significant others and support systems) (Roy & Andrews, 1991). Adaptation, Roy (1984) noted, may occur predominantly in one mode or simultaneously in several.

The output of the adaptive system is either adaptation or maladaptive (ineffective) responses. Ineffective responses (coping) result in illness. Adaptive coping results in health. The goal of nursing is to "maintain and enhance adaptive behavior and to change ineffective behavior to adaptive" (p. 59). According to Roy, each individual has finite adaptive potential that is affected by the conditions of the person or the individual's state of coping. This introduces the idea of control into stress, which goes beyond earlier theories of stress in which the individual was considered a passive recipient of stimuli. It also reflects a more optimistic view of the human capability and potential.

Roy's Adaptation Model Empirical Adequacy

Roy's Adaptation Model has served to guide the development of nursing curriculum, the sophistication of nursing practice, and nursing research (Frederickson, 2000). A search of CINAHL revealed 324 references to Roy's Adaptation Model. Since its inception, the model has been supported through research in practice and education (Bakan & Akyol, 2008; Bower & Baker, 1976; Chiou, 2000; DeSanto-Madeya, 2006; Jones, 1978; Mitchell & Pilkington, 1990; Rambo, 1983; Ryan, 1996; Zhan, 2000). Fawcett and Tulman (1990) built a program of research around RAM, and many midrange theories have been derived from the model (e.g., Calvert, 1989; Hamilton & Bowers, 2007; Ryan, 1996). The study by Sercekus and Mete (2010) provides yet

another example of using RAM to guide nursing interventions. Roy has authored 7 books (e.g., Andrews & Roy, 1986; Roy, 1984; Roy & Andrews, 1991), 21 articles, and numerous book chapters. Summary reviews of Roy's work can be found in Alligood and Marriner-Tomey (2006), Marriner-Tomey and Alligood (2006), and George (2002).

Critical Analysis of RAM Theory

Evaluation of RAM in terms of its level of theory development (using criteria proposed by Walker, 1994, and Walker & Avant, 1988) has shown it to be appropriately meaningful for nursing, logically adequate with well-defined concepts, and useful for guiding nursing practice, education, and research. It has been shown to be generalizable across age groups, health conditions, cultures, and time periods (Bakan & Akyol, 2008; Chiou, 2000; Jackson, 1990; Weiland, 2010; White, Richter, & Fry, 1992; Yeh (2001, 2003). RAM is fairly complex with numerous components and proposed relationships, thus reducing its parsimony. The model has generated many hypotheses that have been subjected to empirical testing through research (Aaronson & Seaman, 1989; Innes, 1992; Inouye, Albert, Mohs, Sun, & Berkman, 1993; Zhan, 2000).

Other theories for nursing that have incorporated stress response include Levine's (1973) four conservation principles, Neuman's (1982) systems model, and King's (1971, 1981) theory of goal attainment. These models are critically examined in the text *Nursing Theorists and Their Work* (Marriner-Tomey & Alligood, 2006), and their utility and application are described in *Nursing Theory: Utilization & Application* (Alligood & Marriner-Tomey, 2006). Nursing theories as a basis for professional nursing practice includes the most recent description of the RAM (George, 2002).

A Midrange Stress Model: An Example

The Psychophysiological Stress Model (PSM), an example of a midrange theory, was created by Toth (1984) as a result of her dissertation and used to direct her program of research. She designed it to explain the interplay of multiple stressors on affective and physiologic behavior that increased the likelihood of relapse in acute myocardial infarction (AMI) patients. This model was based on the work of Selye (1956, 1980) and the physiologic consequences of stress (Guyton, 1986). Stress was theoretically defined as *"a generalized stimulation of the autonomic nervous system that alerts a person to the presence of stressors arising from an actual or perceived threat"* (Toth, 1993, p. 36). The response of AMI patients to physiologic stressors translated into the specific consequences analogous to Selye's stage of alarm. Toth proposed that her model explained both the disease process that could result in an AMI and the negative consequences of multiple stressors in the recovering AMI patient.

Key concepts in her model include stressors (physiological, psychological, environmental, and sociocultural), psychophysiological stress, and conditioning effects. Toth noted that with stressors there are increases in heart rate, blood pressure, and myocardial oxygen consumption and that turn, in turn, leads to an increase in myocardial ischemia and the possibility of fatal dysrhythmias or reinfarction. Therefore, assessing stress level at hospital discharge for AMI patients was important to determine who may be at risk for a subsequent AMI. It was also essential for practitioners planning discharge patient care.

Psychophysiological Stress Model Measurement Development

Toth (1988) used the PSM to guide the development of Stress of Discharge Assessment Tool (SDAT). It is a 60-item, norm-referenced, self-report measure that is completed by acute myocardial infarction (AMI) patients at the time of their hospital discharge. The first 46 items assess stressors common to most AMI patients; 14 additional items measure the effects of stressors that may be specific to some AMI patients (e.g., those that relate to employment). Scoring is on a 5-point, Likert-type scale that assesses the degree of consensus with the items from "strongly agree" to "strongly disagree." Summative scores range from 60 to 300 points; the higher the score, the higher the experienced stress.

Scale items were determined through a literature search and reviewed by an eight-member panel of expert clinicians for content validity. Construct validity was examined with a sample of 104 AMI patients who completed the SDAT 48 hours prior to hospital discharge. Scores ranged from 86 to 168; 72% were within one standard

deviation of the mean. Internal consistency, using a Cronbach's alpha coefficient, was .85. Toth proposed that such assessment information is needed before initiation of interventions to reduce the stress response.

Six hypotheses were generated based on Toth's model. Each examined the value of factors measured by the SDAT to predict magnitude of stress following AMI prior to discharge in 104 adults. Variables included persistent symptoms, socioeconomic status (SES), age, previous AMI history, marital status, and severity of AMI. Only severity of AMI was significantly related to the stress response at hospital discharge. Toth (1987) found that older and younger AMI patients generally experienced similar stressors; younger patients, however, were less worried about having another AMI and had felt less sick during their hospitalization. Both age groups believed their partners worried about them too much and this was a source of stress. In a subsequent study, Toth (1993) found that women did not differ from men at hospital discharge in the magnitude of stress experienced as their most stressful concerns were the severity of AMI or their age. Women, however, had and reported more persistent cardiac symptoms than men. Findings from these studies serve to guide the nurse clinician in ensuring that AMI clients receive appropriate referrals for stress management or cardiac rehabilitation or both on discharge. Toth suggested that the SDAT be tested with other AMI samples and that SDAT scores be used as a dependent variable in assessing the effectiveness of different types of stress reduction and cardiac rehabilitation programs.

Critical Analysis of Psychophysiological Stress Model (PSM)

PSM, in terms of its level of theory development using criteria proposed by Walker and Avant (1988), has been shown to be appropriately meaningful in identifying persons in need of nursing care. It is useful to guide nursing practice in the planning of discharge care for AMI patients and their families. The model has logical adequacy in that all its key concepts are defined or specified by Toth. The theory has generated testable hypotheses and an instrument (SDAT) to operationalize concepts in the model. The PSM has shown generalizability across age groups and race (Toth, 1987) and gender (Toth, 1993). The PSM is fairly complex, with numerous components and proposed relationships when the physiological elements are explicated, thus reducing its parsimony. Empirical adequacy is limited. To date much of the research has been conducted by the designer of the model.

Stress Response and Clinical Practice Models

Many clinical practice models have evolved from the work of Selye and from response theory. Some of these are described briefly in the following sections.

An Adaptation Model for Nursing Practice

Jones (1978) designed an adaptation model for practice. She proposed that the interaction among unmet basic needs (as identified by Maslow, 1970), adaptability (as described by Selye, 1976b), and location on an illness–wellness scale (Dunn, 1959) constituted relative health. She conceptualized each of these factors on a continuum from below average to a high level. Envisioned as a linear model, a line can be plotted from any point on the basic needs continuum to its opposite apex and intersect with another line similarly plotted on the adaptability continuum. Thus, a person's position on the illness–wellness continuum is determined by finding where basic needs and adaptability lines intersect and drawing a vertical line from that point down to the illness–wellness continuum. As a person's position on either their basic needs or adaptability lines changes, so does their position on the illness–wellness continuum. For example, an older adult with hypertension who is low on adaptability but whose basic needs for normotension are being largely met may be placed at the point of average health. If the need to manage the hypertension increases, while adaptability remains the same, health will move in a direction below average.

Kidder (1989) offered a midrange framework that examined five factors (stress, coping, development, social support, and immunocompetence) from a bio-psychosocial perspective to gain a clearer understanding of why some children in intensive care recover faster than others. Her definition of physiological stress was derived

from the work of Selye. She concluded that a child's recovery from a critical illness is not merely a matter of providing the correct medical treatment at the appropriate time. Knowledge and analysis of the stressors in the child's environment, the child's ability to cope, developmental age, availability of social supports, and competence of the child's immune system are needed by nursing for understanding, planning, and implementing effective care.

Stress Response and Nursing Intervention Research

In this section, a sampling of the nursing research intervention studies guided by Selye's stress response theory and conducted in the past 10 years (2000–2010) are presented. A CINAHL review revealed 230 studies over that period of time; 33 were doctoral dissertations. Examples include reducing the stress response in adults with surgery (Mertin, Sawatzky, Diehl-Jones, & Lee, 2007), and in children with cancer (Hinds, 2000); gender differences in the stress response (Motzer & Hertig, 2004); the neuroendocrine and immunological correlates of chronic stress (Van den Berghe, 2001); the role of stress neuropeptides (Papathanassoglou, 2010); and psychological stress and anxiety in middle and late childhood (Washington, 2009).

Stress Response, Nursing Research Reviews, and Meta-Analyses

Three reviews of the stress response as a perspective for nursing research were examined. Lindsey (1983) reviewed nursing research studies of physiological phenomena between 1970 and 1980. She reported 141 studies divided into 3 categories: (a) phenomena investigated were primarily individual-related (n = 66), (b) phenomena studied were primarily related to the environment (n = 25), and (c) studies focused on some aspect of nursing therapeutics (n = 50). Following a detailed examination of all the studies, Lindsey concluded that a wide variety of physiological phenomena have been studied with relatively small sample sizes. Most of the studies were either preliminary in nature or pilot studies, most were single investigations without follow-up, few were replications or extensions, and most were imprecise or lacking in theoretical underpinnings.

Doswell (1988) focused her review on nursing research studies conducted between 1977 and 1987 that had examined physiological responses to stress. She found 19 studies, which she divided into four categories: life events, vocal stress, hospitalization and environmental stressors, and miscellaneous (covering single studies). The majority of the physiological response variables were studied in cardiovascular patients. All subjects were adults. The reviewer concluded that nursing studies of physiological responses to stress were only nominally linked to a conceptual framework. In addition, the number of published nursing studies was too small and too disjointed to provide any consistent support for stress-response relationships. She concluded that the research during that decade included a majority of single diverse studies measuring single cardiovascular variables using Selye's theory of stress. There was little attempt to build a systematic body of nursing knowledge in this area.

Werner (1993) conducted the third review. She examined the nursing research literature for studies on stressors and health outcomes between 1980 and 1990; she found seven studies that had a stress response theoretical orientation. Werner noted that a diminishing number of nursing researchers were using Selye's perspective of physiological stress as a response. She reasoned that this is the consequence of nursing taking a much broader view of the human condition in response to stress. It also may be related to the increasing interest in Lazarus's transactional model, with its heavy emphasis on cognition and appraisal (Lazarus & Folkman, 1984). Lyon and Werner (1987) noted that response models of stress are incompatible with nursing's view of the holistic human experience. Focusing on physiological phenomena without consideration of the person's perspective, psyche, and emotions was seen as only treating one half of the person.

In an effort to arrive at a solid evidence-based nursing practice (Melnyk & Fineout-Overholt, 2010), meta-analyses are being conducted to combine and solidify the results of intervention studies that address the same research hypotheses. Six meta-analytic studies conducted in the

past decade have addressed the stress-response issue. They include (1) psychological interventions for needle-related procedural pain and distress in children and adolescents (Uman, Chambers, McGrath, & Kisely, 2006); (2) psychosocial interventions for reducing fatigue in cancer patients (Goedendorp, Gielissen, Verhagen, & Bleijenberg, 2009); (3) psychosocial and psychological interventions for preventing postpartum depression (Dennis & Creedy, 2004); (4) preventing occupational stress in health care workers (Ruotsalainen & Verbeek, 2006); (5) noninvasive interventions for improving well-being and quality of life in patients with lung cancer (Solà, Thompson, Casacuberta, & Lopez, 2004); and (6) support for mothers, fathers, and families after a perinatal death (Flenady & Wilson, 2008).

Conclusion

There is a very long history of stress-response theory and its evolution in psychology, medicine, and nursing. It has led to numerous theoretical models, thousands of research studies and publications, and the development of health care provider curricula and interventions. Selye (1936) might be considered the founding father of stress-response theory. It was one of the most significant contributions to the field of stress and coping. He designed it to describe, predict, and explain living organisms' physiological reactions to ubiquitous life stressors. He gave it prominence and detail with his general adaptation syndrome (GAS). The GAS is able to describe and explain, in part, physiological responses to stressors. Noticeably absent, however, is the connection between the body and the mind. It is this missing piece that has given the theory limited usefulness for nursing.

Some of the early research in nursing also examined the stress response physiologically; in addition, nursing has sought to assess, predict, and explain both the physiological and the psychosocial components of stress. With the need to understand the patient as a whole, nursing moved rather quickly toward using models and theories that took into consideration both components. This is reflected in the broad adoption of biopsychosocial models, measurements, and intervention arenas of research. These developments in stress, coping, and health are further explicated in this book.

References

Aaronson, L., & Seaman, L. (1989). Managing hypernatremia in fluid deficient elderly. *Journal of Gerontological Nursing, 15,* 29–36.

Aldwin, C. (2007). *Stress, coping, and development* (2nd ed.). New York, NY: Guilford.

Alligood, M. R., & Marriner-Tomey, A. (2006). *Nursing theory: Utilization & application* (3rd ed.). St. Louis, MO: Mosby.

Andrews, H., & Roy, C. (1986). *Essentials of the Roy Adaptation Model.* Norwalk, CT: Appleton-Century-Crofts.

Artinian, N. T., Washington, O. G. M., Flack, J. M., Hockman, E. M., & Jen, K. C. (2006). Depression, stress, and blood pressure in urban African-American women. *Progress in Cardiovascular Nursing, 21*(2), 68–75.

Bahnson, C. (1981). Stress and cancer: The state of the art. *Psychosomatics, 22,* 207–220.

Bakan, G., & Akyol, A. D. (2008). Theory-guided interventions for adaptation to heart failure in Turkey. *Journal of Advanced Nursing, 61*(6), 596–608.

Bally, K., Campbell, D., Chesnick, K., & Tranmer, J. E. (2003). Effects of patient-controlled music therapy during coronary angiography on procedural pain and anxiety distress syndrome. *Critical Care Nurse, 23*(2), 50–51, 53–58.

Bay, E., Hagerty, B. K., Williams, R. A., Kirsch, N., & Gillespie, B. (2005). Chronic stress, salivary cortisol response, interpersonal relatedness, and depression among community dwelling survivors of traumatic brain injury. *Journal of Neuroscience Nursing, 37,* 4–14.

Bay, E., Kirsch, N., & Gillespie, B. (2004). Chronic stress conditions do explain posttraumatic brain injury depression. *Research, Theory and Nursing Practice, 18*(2–3), 213–228.

Bleiker, E., & van der Ploeg, H. M. (1999). Psychosocial factors in the etiology of breast cancer: Review of a popular link. *Patient Education and Counseling, 37,* 201–214.

Boran, A., Shotar, A., Khatib, A., Hamza, M., Hadidi, M. S., & Rice, V. H. (2010). Patterns of cotinine excretion among diabetic, cardiac patients and healthy smokers in Jordan. *Research Journal of Biological Science, 5,* 476–483.

Bower, H., & Baker, B. (1976). The Roy Adaptation Model: Using the adaptation model in a practitioner curriculum. *Nursing Outlook, 24,* 686–689.

Brown, A. (1976). Effect of family visits on the blood pressure and heart rate of patients in CCU. *Heart & Lung, 5,* 291–296.

Bryla, C. (1996). The relationship between stress and the development of breast cancer: A literature review. *Oncology Nursing Forum, 23,* 441–448.

Butow, P. N., Hiller, J. E., Price, M. A., Thackway, S. V., Kricket, A., & Tennant, C. C. (2000). Epidemiological evidence for a relationship between life events, coping style, and personality factors in the development of breast cancer. *Journal of Psychosomatic Research, 49*(3), 169–181.

Calhoun, D. (1992). Hypertension in blacks: Socioeconomic stressors and sympathetic nervous system activity. *American Journal of Medical Sociology, 304,* 306–311.

Calvert, M. (1989). Human-pet interaction and loneliness: A test of concepts from Roy's Adaptation Model. *Nursing Science Quarterly, 2*(4), 194–202.

Cannon, W. B. (1932). *The wisdom of the body.* New York, NY: Norton.

Carrieri-Kohlman, V., Lindsey, A., & West, C. (2003). *Pathophysiological phenomena in nursing: Human responses to illness* (3rd ed.). Philadelphia, PA: W. B. Saunders.

Carlson, E., & Chamberlain, R. (2005). Allostatic load and health disparities: A theoretical orientation. *Research in Nursing & Health, 28*(4), 306–315.

Chen, H.-Y., & Boore, J. (2008). Living with a spinal cord injury: A grounded theory approach. *Journal of Nursing and Healthcare of Chronic Illness* in association with *Journal of Clinical Nursing 17,* 5a, 116–124.

Chen, Y., Chen, S., Tsai, C., & Lo, L. (2007). Role stress and job satisfaction for nurse specialists. *Journal of Advanced Nursing, 59*(5), 497–509.

Chiou, C. (2000). A meta-analysis of the interrelationships between the modes in Roy's Adaptation Model. *Nursing Science Quarterly, 13*(3), 252–258.

Chummun, H. (2009). Hypertension—a contemporary approach to nursing care. *British Journal of Nursing, 18*(13), 784–789.

Cooper, C., Cooper, R., & Faragher, E. (1989). Incidence and perception of psychosocial stress: The relationship with breast cancer. *Psychological Medicine, 19,* 415–422.

Dennis, C. L., & Creedy, D. K. (2004). Psychosocial and psychological interventions for preventing postpartum depression. *Cochrane Database of Systematic Reviews,* Issue 4.

DeSanto-Madeya, S. (2006). The meaning of living with spinal cord injury 5 to 10 years after the injury. *Western Journal of Nursing Research, 28,* 265–289.

Desborough, W. (2000). The stress response to trauma and surgery. *British Journal of Anesthesia, 85*(1), 109–117.

Doshi, J. A., Zuckerman, I. H., Picot, S. J., Wright, J. T., Jr., & Hill-Westmoreland, E. E. (2003). Antihypertensive use and adherence and blood pressure stress response among black caregivers and non-caregivers. *Applied Nursing Research, 16*(4), 266–277.

Doswell, W. (1988). Physiological responses to stress. *Annual Review of Nursing Research, 7,* 51–69.

Dunn, H. (1959). *High level wellness.* Arlington, VA: R. W. Beatty.

Eidelman, D. (1980). Fatigue toward an analysis and unified definition. *Medical Hypotheses, 6,* 517–526.

Facione, N. C. (2002). Perceived risk of breast cancer: Influence of heuristic thinking. *Cancer Practice, 10*(5), 256–262.

Farr, L., Keene, A., Sampson, D., & Michael, A. (1984). Alterations in circadian excretion of urinary variables and physiological indicators of stress following surgery. *Nursing Research, 33,* 140–146.

Fauci, A. S., Braunwald, E., Kasper, D. L., Hauser, S. L., Longo, D. L., Jameson, J. L., & Loscalzo, J. (Eds.). (2008). *Harrison's principles of internal medicine* (17th ed.). New York, NY: McGraw-Hill.

Fawcett, J., & Tulman, L. (1990). Building a programme of research from the Roy Adaptation Model of nursing. *Journal of Advanced Nursing, 15,* 720–725.

FitzGerald, L. Z., Kehoe, P., & Sinha, K. (2009). Hypothalamic-pituitary-adrenal axis dysregulation in women with irritable bowel syndrome in response to acute physical stress. *Western Journal of Nursing Research, 31*(7), 818–836.

Flenady, V., & Wilson, T. (2008). Support for mothers, fathers and families after perinatal death. *Cochrane Database of Systematic Reviews,* Issue 1.

Fox, B. (1983). Current theory of psychogenic effects on cancer incidence and prognosis. *Journal of Psychosocial Oncology, 1,* 17–31.

Frederickson, K. (2000). Nursing knowledge development through research: Using the Roy Adaptation Model. *Nursing Science Quarterly, 13*(1), 13–17.

Galbreath, J. (2002). Roy Adaptation Model: Sister Callista Roy. In J. B. George (Ed.), *Nursing theories: The base for professional nursing practice* (pp. 295–338). Upper Saddle River, NJ: Prentice Hall.

Garcia, C. (2010). Conceptualization and measurement of coping during adolescence: A review of the literature. *Journal of Nursing Scholarship, 42*(2), 166–185.

George, J. B. (2002). *Nursing theories: The base for professional nursing practice* (5th ed.). Upper Saddle River, NJ: Prentice Hall.

Goedendorp, M. M., Gielissen, M. F. M., Verhagen, C. A. H. H. V. M., & Bleijenberg, G. (2009). Psychosocial interventions for reducing fatigue during cancer treatment in adults. *Cochrane Database of Systematic Reviews,* Issue 1.

Goodkin, K., Antoni, M., & Blaney, P. (1986). Stress and hopelessness in the promotion of cervical intraepithelial neoplasia to invasive squamous cell carcinoma of the cervix. *Journal of Psychosomatic Research, 30,* 67–76.

Grassi, L., & Cappellari, L. (1988). State and trait psychological characteristics of breast cancer patients. *New Trends in Experimental and Clinical Psychiatry, 4,* 99–109.

Greer, S., & Watson, M. (1985). Towards a psychobiological model of cancer. Psychological considerations. *Social Science and Medicine, 20,* 773–777.

Guyton, A. (1986). *Textbook of medical physiology* (7th ed.). Philadelphia, PA: W. B. Saunders.

Hamilton, R. J., & Bowers, B. J. (2007). The theory of genetic vulnerability: A Roy Model exemplar. *Nursing Science Quarterly, 20*(3), 254–264.

Han, L., Li, J. P., Sit, J. W. H., Chung, L., Jiao, Z. Y., & Ma, W. G. (2010). Effects of music intervention on physiological stress response and anxiety level of mechanically ventilated patients in China: A randomised controlled trial. *Journal of Clinical Nursing, 19*(7–8), 978–987.

Helson, H. (1964). *Adaptation level theory.* New York, NY: Harper & Row.

Herbert, T., & Cohen, S. (1993). Stress and immunity in humans: A meta-analytic review. *Psychosomatic Medicine, 55,* 364–379.

Herrington, C., Olomu, I., & Geller, S. (2004). Salivary cortisol as indicators of pain in preterm infants: A pilot study. *Clinical Nursing Research, 13*(1), 53–68.

Hinds, P. S. (2000). Fostering coping by adolescents with newly diagnosed cancer. *Seminars in Oncology Nursing, 16*(4), 317–336.

Hinds, P. S., Srivastava, D. K., Randall, E. A., Green, A., Stanford, D., Pinlac, R., . . . Taylor, K. (2003). Testing the revised stress-response sequence model in pediatric oncology nurses. *Journal of Pediatric Oncology Nursing, 20*(5), 213–232.

Hulka, B. S., & Moorman, P. G. (2001). Breast cancer: Hormones and other risk factors. *Maturitas, 38,* 103–113.

Imholz, B. P., Wieling, W., van Montfrans, G. A., & Wesseling, K. H. (1998). Fifteen years experience with finger arterial pressure monitoring: Assessment of the technology. *Cardiovascular Research, 38*(3), 605–616.

Innes, M. (1992). Managing upper airway obstruction. *British Journal of Nursing, 9*(14), 732–735.

Inouye, S., Albert, M., Mohs, R., Sun, K., & Berkman, L. (1993). Cognitive performance in a high-functioning community-dwelling elderly population. *Journal of Gerontology, 48,* 146–151.

Jackson, B. (1990). Social support and life satisfaction of black climacteric women. *Western Journal of Nursing Research, 12,* 25–27.

Jagomägi, K., Raamat, R., & Talts, J. (2001). Effect of altering vasoactivity on the measurement of finger blood pressure. *Blood Pressure Monitoring, 6,* 33–40.

Jagomägi, K., Raamat, R., Talts, J., Länsimies, E., & Jurvelin, J. (2003). Effect of deep breathing test on finger blood pressure. *Blood Pressure Monitoring, 8*(5), 211–214.

Jia, Q. L., Hong, M. F., Pan, Z. X., Jefferson, & Orndoff, S. (2001). Quantification of urine 17-ketosteroid sulfates and glucuronides by high-performance liquid chromatography–ion trap mass spectroscopy. *Journal of Chromatography B: Biomedical Sciences and Applications, 750*(1), 81–91.

Jefferson, L. L. (2010). Exploring effects of therapeutic massage and patient teaching in the practice of diaphragmatic breathing on blood pressure, stress, and anxiety in hypertensive African-American women: An intervention study. *Journal of National Black Nurses Association, 21*(1), 17–24.

Jones, P. (1978). An adaptation model for nursing practice. *American Journal of Nursing, 78,* 1900–1906.

Karlsson, A., Mattsson, B., Johansson, M., & Lidell, E. (2010). Well-being in patients and relatives after open-heart surgery from the perspective of health care professionals. *Journal of Clinical Nursing, 19*(5–6), 840–846.

Kasl, S. V. (1996). The influence of the work environment on cardiovascular health: A historical, conceptual, and methodological perspective. *Journal of Occupational and Health Psychology, 1,* 42–56.

Kidder, C. (1989). Reestablishing health: Factors influencing the child's recovery in pediatric intensive care. *Journal of Pediatric Nursing, 4,* 96–103.

King, I. (1971). *Toward a theory for nursing: General concepts of human behavior.* New York, NY: John Wiley.

King, I. (1981). *A theory for nursing: Systems, concepts, process.* New York, NY: John Wiley.

Lanuza, D. (1995). Postoperative circadian rhythms and cortisol stress response to two types of cardiac surgery. *American Journal of Critical Care, 4,* 212–220.

Lanuza, D., & Marotta, S. (1987). Endocrine and psychologic responses of patients to cardiac

pacemaker implantation. *Heart & Lung, 16,* 496–505.
Lazarus, R. S., & Folkman, S. (1984). *Stress, appraisal, and coping.* New York, NY: Springer.
Leidy, N. (1989). A physiological analysis of stress and chronic illness. *Journal of Advanced Nursing, 14,* 868–876.
Levine, M. (1973). *Introduction to clinical nursing* (2nd ed.). Philadelphia, PA: F. A. Davis.
Levy, S., Herberman, R., Lee, J., Whiteside, T., Kirkwood, J., & McFeeley, S. (1990). Estrogen receptor concentration and social factors as predictors of natural killer cell activity in early-stage breast cancer patients. *Natural Immune Cell Growth Regulation, 9,* 313–324.
Li, W., Zhang, J. Q., Sun, J., Ke, J. H., Dong, Z. Y., & Wang, S. (2007). Job stress related to glyco-lipid allostatic load, adiponectin and visfatin. *Stress and Health, 23,* 257–266.
Lindsey, A. (1983). Stress response. In V. Carrieri-Kohlman, A. Lindsey, & C. West (Eds.), *Pathophysiological phenomena in nursing: Human responses to illness* (2nd ed.). Philadelphia, PA: W. B. Saunders.
Lopez-Ibor, J. (1987). The meaning of stress, anxiety, and collective panic in clinical settings. *Psychotherapy and Psychosomatics, 47,* 168–174.
Lyon, B., & Werner, J. (1987). Stress. In J. Fitzpatrick & R. Taunton (Eds.), *Annual review of nursing research.* New York, NY: Springer.
Mackley, A. B., Locke, R. G., Spear, M. L., & Joseph, R. (2010). Forgotten parent: NICU paternal emotional response. *Advanced Neonatal Care, 10*(4), 200–203.
Marriner-Tomey, A., & Alligood, M. R. (2006). *Nursing theorists and their work* (6th ed.). St. Louis, MO: Mosby.
Maslow, A. H. (1970). *Motivation and personality* (2nd ed.). New York, NY: Harper & Row.
Mason, J. W. (1971). A re-evaluation of the concept of "non-specificity" in stress theory. *Journal of Psychiatric Research, 8,* 323–333.
Matsubara, T., Arai, Y. C., Shimo, K., Nishihara, M., Sato, J., & Ushida, T. (2011). Comparative effects of acupressure at local and distal acupuncture points on pain conditions and autonomic function in females with chronic neck pain. *Evidence-Based Complementary and Alternative Medicine, 2011,* 1–6.
Matthews, K., & Glass, D. (1981). Type A behavior, stressful life events, and coronary heart disease. In B. Dohrenwend & B. Dohrenwend (Eds.), *Stressful life events and their context.* New York, NY: Prodist.
McEwen, B. S. (1998). Protective and damaging effects of stress mediators. *New England Journal of Medicine, 338,* 171–179.
McEwen, B. S. (2000). Allostasis and allostatic load: Implications for neuropsychopharmacology. *Neuropsychopharmacology, 22*(2), 108–124.
McEwen, B. S., & Mendelson, S. (1983). Effects of stress on the neurochemistry and morphology of the brain: Counterregulation versus damage. In L. Goldberger & S. Breznitz (Eds.), *Handbook of stress: Theoretical and clinical aspects* (3rd ed.). New York, NY: Free Press.
McEwen, B. S., & Wingfield, J. C. (2003). The concept of allostasis in biology and biomedicine. *Hormone Behavior, 43*(1), 2–15.
McKay, K. A., Buen, J. E., Bohan, K. J., & Maye, J. P. (2010). Determining the relationship of acute stress, anxiety, and salivary alpha-amylase level with performance of student nurse anesthetists during human-based anesthesia simulator training. *Journal of the American Association of Nurse Anesthetists, 78*(4), 301–309.
McVicar, A. (2003). Workplace stress in nursing: a literature review. *Journal of Advanced Nursing, 44*(6), 633–642.
Melnyk, B. M., & Fineout-Overholt, E. (2010). *Evidence-based practice in nursing & healthcare: A guide to best practice* (2nd edition). Philadelphia: Wolters Kluwer/Lippincott, Williams & Wilkins.
Mertin, S., Sawatzky, J. V., Diehl-Jones, W. L., & Lee, T. (2007). Roadblock to recovery: The surgical stress response. *Dynamics, 18*(1), 14–22.
Mikosch, P., Hadrawa, T., Laubreiter, K., Brandl, J., Jurgen, P., Stettner, H., & Grimm, G. (2010). Effectiveness of respiratory-sinus-arrhythmia biofeedback on state-anxiety in patients undergoing coronary angiography. *Journal of Advanced Nursing, 66*(5), 1101–1110.
Mitchell, G., & Pilkington, B. (1990). Theoretical approaches to nursing practice: A comparison of Roy and Parse. *Nursing Science Quarterly, 3,* 81–87.
Motzer, S. A., & Hertig, V. (2004). Stress, stress response, and health. *Nursing Clinics of North America, 39*(1), 1–17.
Neuman, B. (1982). *The Neuman Systems Model.* Norwalk, CT: Appleton-Century-Crofts.
Nicholson, N. R. (2009). Social isolation in older adults: An evolutionary concept analysis. *Journal of Advanced Nursing, 65*(6), 1342–1352.
Nightingale, F. (1969). *Notes on nursing: What it is and what it is not.* New York, NY: Dover. (Original work published 1860)
Nilsson, U., Rawal, N., & Unosson, M. (2003). A comparison of intra-operative or postoperative exposure to music—a controlled trial of the effect on postoperative pain. *Anaesthesia, 58,* 699– 673.
Page, G. G., & Ben-Eliyahu, S. (1997). The immune-suppressive nature of pain. *Seminars in Oncology Nursing, 13,* 10–15.

Papathanassoglou, E. D. (2010). Psychological support and outcomes for ICU patients. *Nursing Critical Care, 15,* 118–128.

Park, N., & Kang, D. (2008). Breast cancer risk, distress, and natural killer cell activity (NKCA) in healthy women. *Southern Online Journal of Nursing Research, 8*(2).

Peled, R., Carmil, D., Siboni-Samocha, O., & Shoham-Vardi, I. (2008). Breast cancer, psychological distress and life events among young women. *BMC Cancer, 8,* 245.

Rambo, B. (1983). *Adaptation nursing: Assessment and intervention.* Philadelphia: W. B. Saunders.

Ramelet, A., Abu-Saad, H. H., Rees, N., & McDonald, S. (2004). The challenges of pain measurement in critically ill young children: A comprehensive review. *Australian Critical Care, 17*(1), 33–34.

Robley, L., Ballard, N., Holtzman, D., & Cooper, W. (2010). The experience of stress for open heart surgery patients and their caregivers. *Western Journal of Nursing Research, 32*(6), 794–813.

Roy, C. (1984). *Introduction to nursing: An adaptation model* (2nd ed.). Englewood Cliffs, NJ: Prentice Hall.

Roy, C., & Andrews, H. (1991). *The Roy Adaptation Model: The definitive statement.* Norwalk, CT: Appleton & Lange.

Ruiz, R. J., Fullerton, J., Guerrero, L. C., Garcia-Atwater, M., & Dolbier, C. L. (2006). Development of a culturally sensitive stress instrument for pregnant Hispanic women. *Hispanic Health Care International, 4*(1), 27–35.

Ruotsalainen, J. H., & Verbeek, J. H. (2006). Preventing occupational stress in healthcare workers. *Cochrane Database of Systematic Reviews,* Issue 4, Art. No.: CD002892. doi:10.1002/14651858.CD002892.pub2

Ryan, M. (1996). Loneliness, social support, and depression as interactive variables with cognitive status: Testing Roy's model. *Nursing Science Quarterly, 9,* 107–114.

Santamaria, N. (2001). The relationship between nurses' personality and stress levels reported when caring for interpersonally difficult patients. *Australian Journal of Advanced Nursing, 18*(2), 20–26.

Selye, H. (1936). A syndrome produced by diverse nocuous agents. *Nature, 138,* 32.

Selye, H. (1950). Forty years of stress research: Principal remaining problems and misconceptions. *CMA Journal, 115,* 53–55.

Selye, H. (1956). *The stress of life.* New York, NY: McGraw-Hill.

Selye, H. (1974). *Stress without distress.* Philadelphia, PA: J. B. Lippincott.

Selye, H. (1976a). *Stress in health and disease.* Reading, MA: Butterworth's.

Selye, H. (1976b). *The stress of life* (Rev. ed.). New York, NY: McGraw-Hill.

Selye, H. (1976c). Forty years of stress research: Principal remaining problems and misconceptions. *CMA Journal, 115,* 53–55.

Selye, H. (1979). *The stress of my life: A scientist's memoirs.* New York, NY: Van Nostrand.

Selye, H. (1980). *Selye's guide to stress research.* New York, NY: Van Nostrand Reinhold.

Sercekus, P., & Mete, S. (2010). Effects of antenatal education on maternal prenatal and postpartum adaptation. *Journal of Advanced Nursing, 66*(5), 999–1010.

Shannon, M. T., King, T. L., & Kennedy, H. P. (2007). Allostasis: A theoretical framework for understanding and evaluating perinatal health outcomes. *Journal of Obstetric, Gynecologic, and Neonatal Nursing, 36*(2), 125–134.

Sherwood, L. (2010). *Human physiology: From cell to system* (7th ed.). London, England: Cengage Learning.

Simonton, C., Simonton, S., & Creighton, J. (1978). *Getting well again.* Los Angeles, CA: Tarcher.

Slater, R. (2010). Impact of an enhanced recovery programme in colorectal surgery. *British Journal of Nursing, 23,* 19–21.

Solà, I., Thompson, E. M., Casacuberta, M., Lopez, C., & Pascual, A. (2004). Non-invasive interventions for improving well-being and quality of life in patients with lung cancer. *Cochrane Database of Systematic Reviews,* Issue 4.

Sterling, P., & Eyer, J. (1988). Allostasis: A new paradigm to explain arousal pathology. In S. Fisher & J. Reason (Eds.), *Handbook of life stress, cognition and health* (pp. 629–649). New York, NY: J. Wiley & Sons.

Strahler, J., Berndt, C., Kirschbaum, C., & Rohleder, N. (2010). Aging diurnal rhythms and chronic stress: Distinct alteration of diurnal rhythmicity of salivary alpha-amylase and cortisol. *Biological Psychology, 84,* 248–256.

Strahler, J., Mueller, A., Rosenloecher, F., Kirschbaum, C., & Rohleder, N. (2010). Salivary alpha-amylase stress reactivity across different age groups. *Psychophysiology, 47,* 587–595.

Symes, L., McFarlane, J., Frazier, L., Henderson-Everhardus, M., McGlory, G., Watson, K. B., . . . Hoogeveen, R. C. (2010). Exploring violence against women and adverse health outcomes in middle age to promote women's health. *Critical Care Nursing Quarterly, 33*(3), 233–243.

Tache, J., & Selye, H. (1985). On stress and coping mechanisms. *Issues in Mental Health Nursing, 7,* 3–24.

Thompson, R. L., Lewis, S. L., Murphy, M. R., Hale, J. M., Blackwell, P. H., Acton, G. J., . . . Bonner, P. N. (2004). Are there sex differences in emotional and biological responses in

spousal caregivers of patients with Alzheimer's disease? *Biological Research for Nursing, 5*(4), 319–330.

Toth, J. (1984). *Variables associated with the stressful experience of hospital discharge during acute myocardial infarction* (Doctoral dissertation). The Catholic University of America, Washington, DC. Retrieved from Dissertation Abstracts International. (A82857)

Toth, J. (1987). Stressors affecting older versus younger AMI patients. *Dimensions of Critical Care Nursing, 6,* 147–157.

Toth, J. (1988). Measuring the stressful experience of hospital discharge following acute myocardial infarction. In C. Waltz & O. Strickland (Eds.), *Measurement of nursing outcomes* (pp. 3–23). New York, NY: Springer.

Toth, J. (1993). Is stress at hospital discharge after acute myocardial infarction greater in women than in men? *American Journal of Critical Care, 2,* 35–40.

Ulrich, C. M., Taylor, C., Soeken, K., O'Donnell, P., Farrar, A., Danis, M., & Grady, C. (2010). Everyday ethics: Ethical issues and stress in nursing practice. *Journal of Advanced Nursing, 66*(11), 2510–2519.

Uman, L. S., Chambers, C. T., McGrath, P. J., & Kisely, S. R. (2006). Psychological interventions for needle-related procedural pain and distress in children and adolescents. *Cochrane Database of Systematic Reviews,* Issue 4.

Van den Berghe, G. (2001). The neuroendocrine response to stress is a dynamic process. *Clinical Endrocrinology & Metabolism, 15*(4), 405–419.

van den Tooren, M., & de Jonge, J. (2008). Managing job stress in nursing: What kind of resources do we need? *Journal of Advanced Nursing, 63*(1), 75–84.

Vitaliano, P., Scanlan, J., Ochs, H., Siegler, I., & Snyder, E. (1998). Psychosocial stress moderates the relationship of cancer history with natural killer cell activity. *Annals of Behavioral Medicine, 20,* 199–208.

Walker, L. O. (1994). *Strategies for theory construction in nursing* (3rd ed.). Norwalk, CT: Appleton & Lange.

Walker, L. O., & Avant, K. C. (1988). *Strategies for theory construction in nursing.* Norwalk, CT: Appleton & Lange.

Washington, T. D. (2009). Psychological stress and anxiety in middle to late childhood and early adolescence: Manifestations and management. *Journal of Pediatric Nursing, 24*(4), 302–313.

Watson, M., Pettingale, K., & Greer, S. (1984). Emotional control and autonomic arousal in breast cancer patients. *Journal of Psychosomatic Research, 28,* 467–474.

Weiland, S. (2010). Integrating spirituality into critical care: An APN perspective using Roy's Adaptation Model. *Critical Care Nursing Quarterly, 33*(3), 282–291.

Weiss, R., Cali, A. M., Dziura, J., Burgert, T. S., Tamborlane, W. V., & Caprio, S. (2007). Degree of obesity and glucose allostasis are major effectors of glucose tolerance dynamics in obese youth. *Diabetes Care, 30*(7), 1845–1850.

Werner, J. S. (1993). Stressors and health outcomes: Synthesis of nursing research, 1980–1990. In J. Barnfather & B. Lyon (Eds.), *Stress and coping: State of the science and implications for nursing theory, research, and practice* (pp. 11–38). Indianapolis, IN: Sigma Theta Tau International.

White, N. E., Richter, J. M., & Fry, C. (1992). Coping, social support, and adaptation to chronic illness. *Western Journal of Nursing Research, 14*(2), 211–224.

Yeh, C. H. (2001). Adaptation in children with cancer: Research with Roy's model. *Nursing Science Quarterly, 14*(2), 141–148.

Yeh, C. H. (2003). Psychological distress: Testing hypotheses based on Roy's Adaptation Model. *Nursing Science Quarterly, 16*(3), 255–263.

Zhan, L. (2000). Cognitive adaptation and self-consistency in hearing-impaired older persons: Testing Roy's Adaptation Model. *Nursing Science Quarterly, 13*(2), 158–165.

Zolten, A. (1989). Constructive integration of learning theory and phenomenological approaches to biofeedback training. *Biofeedback Self Regulation, 14,* 89–99.