The Role of Neuro-Endocrine System in Stress Mediation and Health Maintenance

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Human beings do have several stresses, and the scientific study of stress has been taken care of by several disciplines in the past decades. But, especially when the whole body and mind is looked upon, then ‘Neuro-Psycho-Endocrinology’ appears to be a promising area of research. Squire et al. (2003) observed that stress is an internal cue that disrupts the homeostatic status of the animal. The neuroendocrine system involved in mediating the stress response is the brain-pituitary adrenal axis. The findings of Euler (1946, 1956); Selye’s (1950) pioneering work on the pituitary-adrenal cortical system and the General Adaptation Syndrome form the basis of today’s psychoendocrine stress research. The hypothalamic hormone controlling this axis is corticotrophin-releasing hormone (CRH), produced in highest levels in the medial parvicellular part of the paraventricular nucleus (mp PVN). Hamburg & Kessler (1976) highlighted the importance of the neuroendocrine functions in the regulation and the stress mediation. They observed mainly on CNS regulation of endocrine function, especially the effects of psychological stress on adrenocortical functions.

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“The brain and endocrine system may be viewed together as a functional unit in adaptation”, opined Hamburg and Kessler (1967). They added, “The superordinate integration of these two systems has become a major object of research”. Much experimental evidence has recently indicated that the endocrine system functions largely under CNS control. At the same time there is a growing body of evidence that circulating hormones exert feedback controls on the brain. Thus, information from both internal and external environment is integrated in the brain (particularly in the brain stem), and the function of the various endocrine glands adjusted accordingly (Scharrer & Scharrer, 1963; Nalbandov, 1963).

In order to emphasize the importance of the developmental phases in creating stress Hamburg and Kessler (1967) pointed out that “in the present context, it is especially interesting to note that several groups of endocrinologists have reported the precipitation of hirsutism in adolescent and adult women by intense, prolonged psychological stress- e.g. precipitated by the suicide of a parent or other loss of a loved person. Presumably this is mediated by the sustained, high ACTH levels, produced via C.N.S stimulation. Bush and Mahesh (1959), and later Lloyd (1963), have studied identical twins, ones of whom developed hirsutism rapidly after a severe emotional stress. The reasons are sought after by Lloyd (1964) as he comments:

The correlation between emotional hyperreactivity and the hirsutism is too frequent to be a coincidence… Many patients have a personality pattern that contains basic anxieties and tensions that were present before those that result from the hirsutism itself.

**Stress & Endocrine System in PTSD**

The limbic Hypothalamic Pituitary Adrenal (HPA) axis and the sympathetic adrenal medullary arms of the stress system have been investigated in subjects with PTSD. In a review of studies,
Vythilingam & Charney (2003) reported that although increased levels of corticotrophin releasing hormone (CRH) are reported in patients with combat-related PTSD, plasma cortisol levels can be paradoxically low, particularly in the late evening and early morning. Cortisol levels in 24-h collections of urine are decreased, increased or not significantly any thing different compared to control subjects.

Patients with PTSD respond to low doses of dexamethasone with a greater reduction of plasma cortisol compared to control subjects, suggesting that PTSD is associated with an increased number and sensitivity of glucocorticoid receptors. Persistent abnormalities in the sympathetic nervous system in patients are indicated by significant and consistent increases in CSF and plasma norepinephrine in response to exposure to traumatic reminders and even during the administration of drugs that stimulate the sympathetic nervous system, such as antagonist, Yohimbine.

Several studies in humans with related PTSD found a smaller hippocampal volume; however, a twin study in Vietnam veterans with PTSD suggests that a smaller hippocampal volume could be a risk factor for developing PTSD, rather than consequence.

**Endocrine Variation Associated with Unemployment**

Employment has been taken as a serious variable playing a role in the stress creation and the physiological changes. Brick & Pollard (1999) opine that most of the studies have addressed the possible impact of distress generated by these situations on cortisol levels. Generally the research trends show that the acute experience of anticipation of job loss may well be associated with an elevation in cortisol levels, but there is some evidence that those who have been unemployed for some time show normal levels.

In general, endocrine glands, and their hormones fully participate in psychologic stress and hence, they act as links in
the production of total psychosomatic disturbance. Psychologic stress first reduces disturbance in cerebral cortex leading to disturbed regulation, integration and correlation of various external and internal stimuli received by it. This is soon followed by disturbance in the cortico-subcortical interactions. The ultimate result is that there occurs a serious disturbance in the functioning of hypothalamus leading to derangement of autonomic activity, homeostasis, and metabolic function. Various clinical and experimental studies have shown that endocrine involvement of psychogenic stress is most commonly multiglandular.

The role of individual differences in the mediation of stress has been pointed out in several instances as it is observed “individual differences in 17-hydroxycorticosteroid excretion—consistent over several months and through several stressful experiences (Bunney, Mason & Hamburg, 1965; Sachar et al., 1965). So Hamburg and Kessler opine that “in principle, there are good reasons for anticipating that a variety of genetic and environmental factors might contribute to the formation of consistent individual differences in stress response and hence to differential susceptibility”. (1967, pp. 252).

The Endocrine & Immune System during Stress

Considering the great role that this intriguing system plays in stress mediation, Straub (2002) observed that endocrine system is the body’s relatively slow acting communication system consisting of a network of glands that secrete hormones directly into the bloodstream. Under stress, the hypothalamus orders the pituitary gland to secrete Adreno Cortico Trophic Hormone (ACTH); which is taken up by receptors in the adrenal glands, a pair of small endocrine glands lying just above the kidneys.

Research on behavior-endocrine-genetic relations in stress has taken two major avenues of approach, opined Hamburg and Kessler (1976). In one route of study, the stress responsivity of
the mature organism has been emphasized; in the other, developmental aspects have been considered. A considerable body of evidence has accumulated over the past few years which indicate that environmental conditions which are perceived by an individual as threatening to him precipitate detectable states of emotional distress accompanied by elevation in levels of plasma and urinary 17-OHCS (Hamburg, 1962), elevation of catecholamine levels (Euler & Lundberg, 1954; Elmadjian, Hope & Lamson, 1958; Levi, 1966), and changes in thyroid hormone levels (Hamburg & Lunde, 1966). In humans, studies have centred on correlations of hormone levels and distress estimates in naturally occurring psychologic stresses (Hamburg, 1962).

**Physiological Functions: At a Glance**

The release of stress hormones exhibits a circadian rhythmicity (Gore, 1998). For the stress axis, the primary level at which the circadian pattern of glucocorticoid release is generated is the hypothalamus (Squire et al., 2003). ACTH is the primary effector of the stress axis, and its release into the general circulation from the pituitary corticotrope has effects on the target organ, the adrenal cortex, to affect the production of glucocorticoids. The hippocampus also appears to play a role in mediating the stress response, and there are multiple redundant pathways between the hippocampus & PVN (Squire et al., 2003).

Four endocrine glands are primarily involved in the stress response: pituitary, thyroid, adrenal cortex and pancreas. These glands secrete hormones into the circulatory system that affect target organs sensitive to those chemicals. From all the 5 trophic hormones secreted from pituitary gland, only 2 hormones: Adrenocorticotropic hormone (ACTH) and thyroid stimulating hormone (TSH) affect the stress response. Another hormone antidiuretic hormone (ADH) secreted from posterior pituitary is also involved in stress response.
Pituitary Gland

The effect of stress on the endocrine control mechanisms is no doubt significant. It is very well known now that environmental stresses trigger hypothalamic-adrenohypo-adrenocortical axis through complex neural pathways converging on the hypothalamus which, in turn, accelerate the secretion of ACTH, GH, TSH, FSH, prolactin, LH. The endocrine response to stress modifies biogenic amine activity in the CNS. Both Indole and Catecholamines are concentrated in brain areas and are concerned with behaviour. ‘Stressful conditions’, observes Pestonzee (1992), “deplete amines from the brain or endocrine secretions which antagonize their effect at appropriate sites, ultimately disrupt behaviour, resulting in neurological and behaviour disorders” (p.40).

Under stress there is an increased release of growth hormone by the pituitary. GH enhances the cellular utilization of energy and affects an increase in blood sugar (Asterita, 1985). The resulting increase in available energy and efficient utilization of that energy prepare the person to take vigorous physical action response to the stressor (Snyder, 1989). Under stress, the pituitary also releases ADH, which acts on the kidney to increase fluid reabsorption to raise fluid levels in the body (Asterita, 1985), which also projects against potential blood loss and shock due to injury (Snyder, 1989). It also results in increased blood pressure because of an increase in blood volume.

Pineal Gland

Melatonin is one of the pineal hormones which have been studied by some researchers. Among them, Devi, Subramanian and Srinivasan (1977) argued that it is quite likely that melatonin acting at different levels may affect hypothalamic-pituitary-adrenal response to stress. Another possibility according to them is that stress situations may activate the pineal itself.
The stimulatory effect of different stresses on the pineal gland has been mainly interpreted in a 3-fold manner by Pestonzee:

(a) Pineal activation is the cause of triggering the hypothalamic-pituitary-adrenal axis to the stressor response thus participating in neuroendocrine response to stress.

(b) Pineal stimulation is the consequence of the activation of the pituitary-adrenal system.

(c) Stress simultaneously triggers activity in the pineal gland and the hypothalamo-hypophyseal system.

Among these, the latter 2 possibilities according to Pestonzee are of adaptive significance, as they may either through feedback or directly, may keep in check the hyperactivity of the neuroendocrine system.

**Adrenal Gland**

Adrenal glands consist of two independent glands: one centrally located called adrenal medulla and other outer covering called adrenal cortex. When the hypothalamus sends an order via the pituitary land, the adrenal medulla secretes epinephrine and norepinephrine into the blood. These hormones are known to trigger the familiar fight-or-flight responses that are noticeable almost immediately: the heart pounds, the mouth becomes dry, and sweat pours from the palms of the hands and armpits. So the interaction that goes on between SNS and adrenal medulla is called Sympathoadreno-medullary (SAM) System.

Adrenal hormones are of primary importance in the biochemical changes that occur during stress, as are a number of neurotransmitters or messenger peptides. The adrenals produce both corticosteroids (adrenal cortex), which serve to regulate such bodily functions as metabolism, and catecholamines (adrenal medullae), which affect sympathetic arousal (Lester et al., 1994).
In stressful situations it is found that exogenous administration of ACTH activates the adrenal gland and its degree of activation varies with the increase in stressfulness. Unfortunately, all the Indian studies reviewed by Pestonzee (1992) are conducted on animals, losing their verifiability for human subjects. Only one study conducted by Chansouria, Sharma and Udupa (1977) shows a data on human cases. In this study on thyrotoxicosis (120), anxiety neurosis (50), Ischemic heart disease (86), diabetes Mellitus (46), peptic Ulcers (23) and hypertension (40) a careful comparison is done between stress reaction patterns and physiological changes. A comparison of the blood samples of these cases with 120 normal controls revealed that circulating catecholamines, DBH, MAO, Cortisol and urinary VIA limits of these clinical cases were elevated. These studies suggest enhanced adrenal function in stress disorders.

(a) Adrenal Medulla

Waltor Cannon was the first person to propose that emotional stress causes excess of adrenaline secretion from adrenal medulla leading to tachycardia, high blood pressure, etc. Later, it was found that all these manifestations occur not only from adrenaline secretion but also from over activity of the neither sympathetic nervous system that liberates nor adrenaline at its nerve endings.

(b) Adrenal Cortex

When an excess of cortisone is secreted, it does include further changes not only in the body, but also in the activities of the nervous system itself, leading to further changes in vicious circle in the various parts of the body. It is clear that cerebral cortex, which is on receipt of stressful stimuli, activates the hormonal mechanisms of the adaptation process and the hypophysico-adrenal system is an intermediary link for the complex reaction in various target organs and tissues.
Thyroid Glands

In a study on albino rats, Gupta, Prasad and Udupa (1977) examined the effect of stress on biogenic amines and endocrine glands, particularly thyroid and adrenal glands. This study revealed a significant increase in the acetylcholine content followed by catecholamine in the blood. Further, a fall in the acetylcholine content in the brain and an increased level of catecholamines in the brain as well as adrenal gland were also observed. This hyperactivity of the thyroid gland was found to be correlated with histological and histochemical observations.

Thyroxine regulates cellular respiration including that of central nervous system, internal organs, and muscles. The thyroid releases Thyroxine in adequate quantity to regulate tissue respiration effectively. Whenever there occurs psychogenic stress, thyroid gland becomes overactive. Thus, in about 85% cases of thyrotoxicosis, a positive history of psychogenic stress is recorded a few days or months before the onset of the disease.

In experimental animals, in response to stress, the weight of the thyroid glands increases while the diameter of individual follicle decreases. The disturbance of higher nervous activity with forced immobilization produces typical features of hyperthyroidism with rapid pulse rate, exophthalmus, etc.

The Role of Glucocorticoids in Stress Mediation

(i) The stress axis is subject to developmental and age-related regulation due to changes in afferent connections to Hypothalamus, glucocorticoid, and mineralocorticoid receptor-binding changes and alterations in the negative feedback of Glucocorticoids on CRH neurons.

(ii) Glucocorticoids exert more effects on the cardiovascular system, causing elevations in heart rate and blood flow. They act in close coordination with the ANS to exert their effects.
In general, their role is to mobilize energy stores and to improve cardiovascular tone.

(iii) Glucocorticoids can interact with hormones produced by other neuroendocrine axes such as those involved in thyroid function, reproductive function & growth (Squire et al., 2003). Chronic stress can suppress the growth axis and reproductive function and cause hyperthyroidism (O’Connor et al., 2000).

Except these, as an adaptive measure, under stress, there is an increase in ACTH release and consequently in the secretion of glucocorticoids from the adrenal cortex. The glucocorticoids mobilize proteins and fats from body tissues and cause the liver to convert these proteins and fats to glucose. This results in an increase in sugar and fat levels in the blood, providing the person with the readily available supply of energy needed for a physical response to a stressor (Snyder, 1989).

The glucocorticoids also affect the body’s response to injury and infection. They suppress inflammation in response to injury and infection by inhibiting the passage of plasma out of the blood stream and the ability of white blood cells to reach the site of injury or infection. The glucocorticoids also inhibit the immune response by shrinking the thymus, spleen, and lymph nodes and by suppressing the development of lymphocytes and antibodies (Asterita, 1985).

The increased release of glucocorticoids under stress thus not only keeps the “furnace stroked with fuel” but suppresses the body’s built-in defenses against injury and infection (Snyder, 1989). Reduced inflammation keeps blood plasma in the blood stream, where it transports energy and promotes the physical mobility needed for “fight or flight”. Under stress, a hormone named thyroxine, which basically enhances glucose and utilization is over secreted. The mobilization of available energy and the enhanced utilization of that energy prepare the person to take action in response to stress (Asterita, 1985).
Under stress, the heavy utilization of blood sugars as a result of physical activity stimulates the release of glucagons to replenish blood sugar levels, keeping the person ready for physical action. The lowered blood sugar levels resulting from vigorous activity under stress inhibits insulin release in blood sugar levels resulting from the increased release of E, NE, Thyroxine, and glucocorticoids under stress would normally stimulate insulin release. E from the adrenal medulla counteracts the release of insulin. The net result is an increased level of blood sugar, which supplies the person with ready energy to fuel “fight or flight” (Asterita, 1985).

The endocrine changes associated with consequently alter immune functioning. The thymus and other tissues serving the immune response may also be altered by the autonomic nervous system. The effect of stress on immune functioning opines Snyder is very complex. Both enhanced and decreased immune functioning has been associated with stress, depending on the conditions under which the stress occurs and on which facet of immune functioning is observed.

**Hypothalamic Control of Stress**

Hypothalamus is known to modulate stress reactions through its various nuclei, especially the supraoptic Nucleus that is the starting point for two pathways leading to pituitary gland. The supraoptic hypophyseal tract connects the above nucleus with the posterior lobe. This lobe is responsible for the secretion of ADH, vasopressin and oxytocin. The other is the humoral pathway of hypothalamo-hypophyseal system that connects hypothalamus with anterior pituitary through portal blood vessels. The nuclei in hypothalamus secrete various neurosecretions to regulate the function of anterior pituitary. Thus, the supra-optic hypothalamus stimulates the hypothalamo-hypophyseal system and produces corticotrophin releasing and gonadotropin activating factors and...
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simultaneously produces prolactin-inhibiting factors. However, hypothalamus plays an important role in producing various changes leading to efficient adaptation to stress, although hypothalamus is not an independent centre in the brain and its functions are closely regulated by the cerebral cortex.

In another more unique way endocrine system helps in fighting with stress. Hypothalamic-Pituitary-Adrenocortical (HPAC) system is a system of delayed response, which helps in restoring the body to its baseline state, a process known as homeostasis. The HPAC system is activated by messages relayed from the central nervous system to the hypothalamus, which in turn secretes CRH (corticotrophin releasing hormone). CRH stimulates the production of adrenocorticotrophic hormone (ACTH) by the pituitary gland, which then activates the adrenal cortex to secrete corticosteroids, steroid hormones that combat inflammation, promote healing and help mobilize the body’s energy resources.

Mechanisms of Action: A Close Examination

The HPA axis consists of three major molecules: corticotrophin-releasing hormone (CRH), proopiomelanocortin (POMC), and cortisol. CRH is a 41- amino acid peptide that has a dual role as both the major regulator of pituitary corticotroph activity and a neurotransmitter with profound behavioural effects. CRH causes the pituitary to release adrenocorticotrophic hormone (ACTH) (Berkenbosch et al., 1987; Sapolsky et al., 1987). This in turn results in release of corticosteroids, which have a key role in immunity (Cupps et al., 1982; Munck et al., 1984). It has been marked that the mechanism by which peripheral immune mediators affect brain function has been the subject of intense investigation.

Opp & Krueger (1994, 1993) show that inhibition of IL-1 activity by neutralizing antibodies or by IL-1ra affects normal sleep, rebound sleep after sleep deprivation, and sleep induced by inflammatory mediators. Additionally, endogenous IL-1 in the
brain may contribute to the regulation of neuronal cell death and survival. Indeed, *in vitro* studies have shown that IL-1 can be neurotoxic or neuroprotective, depending upon the neuronal stage or maturation stage (Brenneman *et al.*, 1993). In adulthood it seems that IL-1 can be profoundly neurotoxic. Relton & Rothwell (1992) have shown that inhibition of IL-1 activity can reduce neuronal death by 50% in an animal model of ischemia caused by middle cerebral artery occlusion, and can also reduce neuronal cell death by 70% in a model of acute neurodegeneration caused by excitotoxic damage resulting from administration of an NMDA receptor agonist in the striatum.

Independent of the role they have in normal physiology, cytokine-mediated activation of the HPA axis is relevant to the susceptibility to disease. When inflammatory mediators fail for any reason to activate the HPA axis there is increased susceptibility to and severity of inflammatory disease (Sternberg *et al.*, 1992). Lewis (LEW/N) rats are highly susceptible to inflammatory disease, and their susceptibility to inflammation has been related to their inability to produce HPA axis activation in response to peripheral inflammatory mediators or other stimuli.

In conclusion interruptions of immune-neuroendocrine communication pathways, whether based on genetic factors of LEW/N rats, or as a result of a surgical or pharmacological manipulations in otherwise resistant strains, increase susceptibility to inflammatory disease. Conversely it has been observed that reconstitution of the immune-neuroendocrine axis reverses the inflammatory susceptibility in these strains (Sternberg *et al.*, 1989), or experimental allergic encephalomyelitis (EAE) (Mac Phee *et al.* 1989), in a dose related way.

Most cytokines stimulate functions required for an adequate response to infection or to inflammatory stress: those functions include fever, increased sympathetic output, and hypothalamic-pituitary-adrenal (HPA) axis activation, which ultimately provides
the necessary negative feedback to inhibit inflammation. On the other hand, most cytokines inhibit functions that are not essential during inflammatory stress; those vegetative functions inhibited by cytokines include food intake and reproduction (Licinio & Sternberg, 1996). The studies that are reported, among them the most important findings say that disruptions of IL-1/HPA interactions lead to disease susceptibility. (Sternberg et al., 1992; Wick et al., 1993).

The associations between differential behavioural responses to stress and differential inflammatory disease susceptibility may be clinically relevant and might explain the long-recognized association in humans between affective disorders, such as depression, and inflammatory diseases, such as rheumatoid arthritis (RA) (Sternberg et al., 1992; Cash et al., 1992). Melancholic depression is characterized by HPA axis hyperactivity and atypical depression seems to be associated by HPA hyporesponsiveness (Gold et al., 1988(a), 1988(b).

Susceptible people when getting screwed up by the major life stressor along with a inflammatory stimulus might develop depression and RA. Decreased HPA axis responsiveness may also explain some of the clinical features of fatigue states, such as fibromyalgia and chronic fatigue syndrome, associated with varying degrees of immune activation and depressive symptoms (Demitrack et al., 1991; Sternberg et al., 1993; Crofford et al., 1994).

Other immuno-neuroendocrine systems including the reproductive hormones, such as estrogen, progesterone, and prolactin are immunostimulatory rather than immunosuppressive. Additionally, sympathetic nervous system activation of immune organs such as thymus and spleen has an important role in inflammation (Felten et al., 1991; Madden et al., 1994; Tollefson et al., 1990), and may be affected during the response to stress. During chronic inflammation it has been observed that there is a
shift in the regulation of HPA regulation, which becomes mostly AVP (arginine vasopressin) driven (Harbuz et al., 1992; Whitnall et al., 1992).

**The Role of Cortisol**

Frankenhaeuser’s model (1989) base on laboratory research, suggests that epinephrine levels tend to rise in response to increased demand but that cortisol increases when mental distress is experienced. Many studies have shown that feelings of lack of control lead to distress (Spector, 1986), and it is for this reason that Frankenhaeuser suggested that perceptions of lack of control at work are likely to lead to elevated cortisol levels.

The endocrine system also has preventive functions in its possession. It has a mechanism that can halt the body’s stress response before it damages the body. It involves cortisol; a hormone secreted by adrenal the adrenal glands. Cortisol has a potent effect on all the body’s tissues, increasing the level of glucose in the blood, stimulates the breakdown of proteins into amino acids, and inhibiting the uptake of glucose by the body tissues but not by the brain. “In a finely tuned feedback mechanisms, the released cortisol acts back on the hypothalamus and the course, that CRH has already been released from the hypothalamus and ACTH from the pituitary” (Straub, 2002).

Studies have shown however, that cortisol levels are higher when people are at work (Cullen, et al., 1979; Frankenhaeuser et al., 1989; Van Eck & Nicolson, 1994), nor has the expectation of Frankenhaeuser’s model that lack of control at work should result in elevated cortisol levels been fulfilled (Pollard et al., 1986).

The connection between corticosteroid changes and stress was first systematically drawn by Selye (1936, 1976), who believed that increased adrenal cortical activity attributable to stress caused such nonspecific physiological responses as enlarged
adrenal cortices, shrinkage of thymic and lymphoid tissue, and ulcers of the gastrointestinal tract (Selye, 1936, 1976). Various environmental and psychosocial stressors are associated with increased adrenal cortical activity, and psychological stress-mediating variables, such as coping, have been shown to modify corticosteroid levels (Baum et al., 1982; Wolff, Friedman, Hofer & Mason, 1964).

The Role of PAC Axis: A Review of Selye’s Model

The hormonal responses of the PAC axis were emphasized in Selye’s (e.g., 1956, 1976) influential description of a nonspecific (general) physiological reaction that occurs in response to aversive stimulation. Selye argued that pathogens, physical stressors (e.g., shock or noise), and psychosocial stressors all elicit the same pattern of physiological response. This process is said to proceed in a characteristic three stage pattern famously called GAS (General Adaptation Syndrome).

General Adaptation Syndrome

In the process described by Selye some of the important phases are of importance to pin point:

• Marked enlargement of the adrenal cortex
• Involution of lymphatic system including thymus and spleen including, and
• Gastrointestinal ulcerations and hemorrhages.

All these changes occur in three stages:

(a) In the first stage, which is known as ‘alarm reaction’, the above responses are relatively in mild form and other constitutional reactions appear all of a sudden in an acute form. During this stage, the organism’s physiological changes reflect the initial reactions necessary to meet the demands made by the stressor agent. The anterior pituitary gland secretes ACTH, which then activates the adrenal cortex to secrete
additional hormones (cortical steroids). The hormone output from the adrenal cortex increases rapidly during this stage.

(b) This is followed by a ‘stage of resistance’ in which most of the above changes are seen in a chronic form due to which the bodily defense forces are built up to adapt the body fully to face the environmental stress successfully. This stage, involves a full adaptation to the stressors with consequent improvement or disappearance of symptoms. The output of cortical steroids remains high but stable during the resistance stage.

(c) This is sooner or later followed by the ‘stage of exhaustion’, if the stressful state continues for a long time and it may even lead to a fatal outcome if the attempt to adapt is not successful. In fact, the main purpose of the above reaction is to make an attempt by the body to restore the state of equilibrium and to maintain homeostasis. This stage occurs if the stressor is sufficiently severe and prolonged to deplete somatic defenses (Cohen et al., 1986). The anterior pituitary and the adrenal cortex lose their capacity to secrete hormones, and the organism can no longer adapt to the stressor.

Adaptive Role of Neuro-Endocrine System in Stress

It is very well established that endocrine glands play an important role in the etiology of stress related diseases. Let’s see how it also helps in the stress mediation and health maintenance.

“Whenever there occurs a psychological or physiological stress, the entire psychosomatic apparatus of our body tries to adapt itself in order to face the external environmental challenges more effectively and successfully”. Perhaps Udupa was very right when he had said this in a high tone.

After stress all the changes of the body occur to adapt the bodily system efficiently with the capricious effects created. Another major guiding force of the Udupa’s writings is influenced by the fact that stress reaction is not mediated directly through
pituitary and adrenal cortex, but indirectly through the hypothalamus.

Psychogenic stress may also involve posterior pituitary gland via the supracortical nuclei of the hypothalamus. In stressful situations the cerebral cortex through its subcortical connection stimulates the posterior pituitary to put out more of antidiuretic hormone (ADH) that regulates the water and salt metabolism through its action on the renal tubules. Therefore, a prolonged psychogenic stress leads to the development of neurosis and, there occurs a disturbance in the kidney function resulting in the disorders of water and salt metabolism and saturnine in the urinary excretion.

Endocrine glands are very sensitive to environmental stress in the sense that they respond to various stimuli by recognizing and altering their glandular activities. Such adaptive responses to environmental conditions are governed by excessive excretion or decrease of endocrine juices, which ultimately affect the bodily system, resulting in various types of stress related diseases.

**Evidences**

(1) The susceptibility of the sympathetic-adrenal medullary system to psychosocial factors was first demonstrated by Walter B. Cannon and his associates at Harvard. Results from a series of experiments on cats led Cannon (1914, 1932) to formulate the “emergency function” theory of adrenal-medullary activity, stating that many of the physiological effects of adrenaline serve the goals of preparing the organism to meet threatening situations involving fear or rage or pain.

(2) Catecholamine output and Behavioural Efficiency:

(a) Frankenhaeuser & Andersson (1974) show that performance in a learning task was consistently superior in high-adrenaline subjects (*i.e.*, subjects above and below the median adrenaline-excretion value).

(b) The positive relationship between adrenaline secretion and psychological efficiency at low to moderate stimulus levels is
not confined to acute situations but applies to cognitive functions in general (Frankenhaeuser, 1980). For example, studies of children show that school achievement and measures of intelligence correlate positively with catecholamine secretion (Johansson, Frankenhaeuser, and Magnusson, 1973).

(c) Moreover, according to teacher’s ratings and self-ratings, high adrenaline children are happier, livelier, and better adjusted to the school environment than their low adrenaline peers (Frankenhaeuser, 1980).

3) Stress Mediation:

Licinio & Sternberg (1994) find that a neuroendocrine stress negatively response in modulating effect which suppresses inflammation. If such responses are blunted or absent, inflammation will persist unchecked. They also say that other neuronal and hormonal factors called into play during stress and inflammant on may have similar immunosuppressive or opposing immunostimulatory effects. So also they end their discussion with saying that “the final effect of stressors on inflammatory severity will depend on the balance of neuronal and neuroendocrine factors called into play during the organism’s response to stress.

This article in itself tries to review several studies and present a view point of how stress mediation has been prudently and efficaciously taken care of by the whole endocrinological system. In this an attempt is made to understand the underlying physiological processes of stress mediation which occurs as a result of the endocrinological functions for the adaptive purpose of an organism. Several studies though point out the stress and endocrinological system as playing a negative role mainly, still the adaptive features have been highlighted and several major studies in the field have been corroborated. So as an implication this follows that we can go on having state of the art researches in the area of Neuro-psycho-endocrinology, so that we will be better able to control and regulate the processes of neuroendocrine functioning for the better up keeping of human beings.
REFERENCES


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