The effects of physiological stressors on nurse anesthetists at the induction of general anesthesia

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Fourteen active practicing certified registered nurse anesthetists participated in this study. Each was assigned to administer anesthesia to a patient undergoing a cardiac or neurological surgical procedure. Each CRNA's blood pressure, heart rate, skin temperature and serum cortisol levels were observed and recorded prior to and 15 minutes after the induction of general anesthesia.

As stated by Hans Selye's Theory on General Adaptation, "Stressors stimulate the adrenal glands, mainly the adrenal cortex and medulla. In chronic stress situations, both systems release hormones, but one system may be more predominant than the other depending on the type of stress."

The results in this study indicated that 12 out of 14 participants experienced some form of a stress response, but only one system predominated. The particular stress response was dependent on the subject’s years of anesthesia experience.

Literature review

The word "stress" is derived from the Latin word stringere (strictus), which means to draw tightly or bind. By 1843, the term "stress" was defined as a "strain upon a bodily organ or a mental power."

In the International Encyclopedia of Social Sciences, Lazarus notes that "stress suggests excessive demands on man and animals, demands that produce disturbances of physiological, social and psychological systems." One must beware of...
assuming that all stressful events will necessarily produce disturbances or pathological consequences for the individual, or that events which are stressful for some individuals will be stressful for all individuals. In fact, stress can have positive, beneficial consequences for a person in certain circumstances.

There have been many conceptual models of stress, including a psychosomatic model, a psychological response model, a cognitive-appraisal model and a biochemical model.

The psychosomatic model of stress is based upon the fundamental thesis that where strain is experienced in one bodily system, it may produce pathological conditions in other parts of the body. An individual's physiological processes may be seriously affected by conflicts to which the human organism is capable of responding adequately.

The psychological model of stress has three fundamental aspects: (1) a disaster or traumatic event, (2) the individual's psychological responses to the stressful event, and (3) the situational determinants of the responses. All of these reduce the individual's intellectual and mental efficiency.

The third model, the cognitive-appraisal model, proposes that stress responses are the product of the organism's appraisal of situations and events. It is the way in which the individual perceives and interprets things that dictates whether or not they will be stressful.

The fourth model of stress is Selye's biochemical model, which regards stress as "a state manifested by a specific syndrome which consists of all the nonspecifically induced changes within a biological system." Selye describes these nonspecifically induced changes in terms of the three stages of the general adaptation syndrome. The first stage is the alarm reaction, followed by resistance in the second stage and, if the organism is still affected by the stressors, the final stage of exhaustion is reached.

Stressors stimulate the adrenal glands, which are found above the kidneys and are divided into two functionally independent parts. The adrenal medulla contains groups of nerve cells surrounded by blood vessels, and its activity is controlled by the splanchnic nerve. This nerve releases acetylcholine, a neurotransmitter substance, which in turn causes the release of the two major catecholamines—adrenalin and noradrenalin. Adrenalin produces an increase in blood pressure and mobilizes the glycogen found in body tissues. The importance of adrenalin tends to obscure the functions of noradrenalin, which are vital to the main-tenance of sympathetic and cardiovascular tone. The greatest vascular need in a stress situation is for an adequate amount of blood to reach the brain, lungs and muscles so that they can deal with the situation.

The outer capsule of the adrenal gland is called the cortex. The adrenal cortex contains three zones and is vital for life. The inner-most zone is responsible for the production of glucocorticoid and sex hormones. The glucocorticoid hormones consist chiefly of cortisol and corticosterone which are released in times of stress. During "stress" situations, cortisol is secreted into the blood stream.

In chronic situations, both systems release hormones, but one system may be more predominant than the other depending on the type of stress and the organism's appraisal of that stressful event.

Methodology

Subjects. Fourteen CRNAs participated in this study. Four key physiological parameters of stress are blood pressure, heart rate, skin temperature and serum cortisol levels. The determination of the time factor for measuring the four parameters was obtained from Levy's study. The selection determination as to the "most stressful" part of anesthesia administration and selection of surgical case was based on a previous study done by Tobias. (Table I.)

Procedure. Data on the relative response factor affecting nurse anesthetists was collected by the use of a Dinamap blood pressure and heart rate monitor placed on the participant's upper left arm. An elevation in systolic blood pressure by 10 torr in comparison to baseline parameters was considered significant. Also, an increase in ten heart

<table>
<thead>
<tr>
<th>Table I</th>
<th>Analysis of subjects' years of anesthesia experience and types of surgical procedures performed during the experiment</th>
<th>Surgical procedures</th>
<th>CABG</th>
<th>AVR</th>
<th>Neurological</th>
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<tr>
<td>Years in anesthesia</td>
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<tr>
<td>Totals</td>
<td>8</td>
<td>2</td>
<td>4</td>
<td>14</td>
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beats per minute from baseline parameters was considered significant.

A Y.S.I. Skin Telethermometer™ was positioned on the upper chest area. An increase or decrease in skin temperature by .5 degrees centigrade in comparison to baseline readings was considered significant.

Discussion and conclusion

Of the 14 nurse anesthetists who participated in this study, 12 experienced a detectable (measurable) response. These responses varied from an increase in systolic blood pressure and heart rate, which are elicited from the adrenal medulla to adrenal cortisol responses.

Nurse anesthetists with 0 to 5 years of anesthesia experience exhibited the greatest increase in heart rate and elevated systolic blood pressure (Table II). This is related to adrenal medulla stimulation, which increases the secretion of adrenalin and noradrenalin. These two catecholamines cause a rise in blood pressure and heart rate, and are associated with feelings of well being, mental alertness and the ability to cope with stressful situations. The next group of anesthetists, consisting of those with 6 to 10 years of anesthesia practice, rated second highest in adrenal medulla stimulation responses.

Anesthetists with 16 to 20 years did not exhibit an increase in either blood pressure, pulse or cortisol levels. Individuals with 21 to 30 years of experience did not exhibit any significant adrenal medullary responses, but did show increased serum cortisol levels. This hormone released from the adrenal cortex is associated with feelings of panic and helplessness in individuals who are under stress. Chronic elevated levels can lead to permanent damage to body organs.

Nurse anesthetists function every day in the operating room suite under stressful conditions. The response to this stress may be of a psychological and physiological nature. The stressors may be related to the type of surgical case for which the nurse anesthetist is administering anesthesia. The results of this study imply that during stressful situations in the operating room, the adrenal cortical and medullary system may release hormones; however, one hormonal system seems to predominate. After repeated exposures to stress in the operating room, the patterns of physiological responses to stress may shift from the medullary to the cortical system.

In this research project, there were several assumptions in the methodology.

The first is that although physiological responses may not be independent from the psychological responses which are evoked from work demands, it is possible to investigate certain physiological stress responses that are elicited during the administration of general anesthesia. There are persons and situations in which the degree of response to stress will vary from day to day, but it is assumed that in most cases the range of response will be narrow.

One obvious limitation of this research is that only four physiological responses are investigated. Although these factors have been considered to be of key importance, other factors may also be important in evaluating physiological stress factors. This research study included only 14 nurse anesthetists in the immediate geographical area; therefore, the results may not be generally applied to the total population of nurse anesthetists. Also in an institution where cardiac and neurosurgical procedures are performed on a routine basis, the stress responses would vary. Even for this geographic

<table>
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<th>Years in anesthesia</th>
<th>Number of anesthetists</th>
<th>Systolic blood pressure (torr)</th>
<th>Heart rate (beats/min)</th>
<th>Serum cortisol levels (μg/dL)</th>
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area, the results of this pilot study indicate a general trend and are not applicable to all staff nurse anesthetists.

Future research should include a more comprehensive study of the physiological parameters to include determination of adrenal and cortisol levels in the blood and urine. Also, personality tests should be administered to determine the individuals' personality types and relate these psychological and physiological components to the study. Perhaps the results of the study might be obtained and broken down according to male and female anesthetists. Most importantly, a larger group of anesthetists from a wider demographic area should be studied to improve the validity of the results.

REFERENCES

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Terrence G. Evon, CRNA, MS, is a graduate of Allegheny County Community College, School of Nursing, Pittsburgh, Pennsylvania and Mercy Hospital of Pittsburgh School of Nurse Anesthesia. He received his BSEd from California University of Pennsylvania and his MS in Leadership, Education and Administrative Development from the University of Pittsburgh, School of Health Related Professions, Pittsburgh, Pennsylvania. Mr. Evon is chief nurse anesthetist at Divine Providence Hospital of Pittsburgh. He is now pursuing a PhD in Public Health, with emphasis on hospital administration, at the University of Pittsburgh School of Public Health. This article is the result of a research project done to fulfill requirements for a Master's degree.

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