Original Article

Physiology Section

Differences in Heart Rate and Galvanic Skin Response among Nurses Working in Critical and Non-critical Care Units

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ABSTRACT

Introduction: Health care environment usually remains stressful for health care professionals which may have impact on their psycho-physiological health.

Aim: This study was conducted to find the differences in Heart Rate (HR) and Galvanic Skin Response (GSR) among critical and non-critical care unit nurses.

Materials and Methods: A comparative study was conducted to find the differences in HR and GSR value of nurses posted in critical and non-critical units. Critical and non-critical care units were classified using patient's acuity category classification.

A total of 100 nurses, 50 from critical and 50 from non-critical care units were selected by simple random sampling technique.

HR and GSR were recorded on a digital polygraph (Medicaid systems). Descriptive and inferential statistics were used to analyse the data.

Results: The mean heart rate (beats per minute) and GSR (Amp ~ K) score of nurses working in critical care units (88.32±9.63 and 916.9±473.4) was higher than the nurses working in non-critical units (83.56±5.82 and 687.8±270.0). The difference in the scores of critical care unit nurses were significantly higher than the non-critical unit nurses (p<0.001).

Conclusion: Present study revealed that work environment has great role in the physiological health of nurses.

INTRODUCTION

In the era of competition, every institution wants a quality outcome and better productivity, which solely depends upon physical and mental health of employees [1]. In the last few years, globalisation, rapid advancement in the technology, high expectations of patients, and shortage of staffing has changed work environment, the employment pattern of nurses significantly, which has contributed to work related stress and related health issues [2,3].

Studies have reported that stress can produce effect on various human physiological system such as endocrine, immune and haemopoietic [4]. Stress is a psychological response which increases the activity of hypothalamic-pituitary-adrenocortical axis that increase the circulation of glucocorticoids in blood. Also, changes in the heart rate, BP, respiration, skin temperature and galvanic skin responses [5,6].

Autonomic response to the physical and psychological or emotional strain remains an area of interest for research from more than a century. In the year 1915, Walter Cannon studied about the physiology of emotions [7].

It is well known phenomenon that human physiological and psychological components are prone to wear and tear related to daily activities. These are seen in the form of stress in the everyday life [8]. In the health care setting, critical care units are always highly stressful environment due to high rates of mortality, morbidity and confrontation with ethical issues while caring for critically ill patients, short staffing, great workload, communication interruption, death and sometimes pressures arising from errors in drug administration [9,10].

Nursing profession is both stressful and challenging and most of the time nurses have to perform unplanned duties, and unavoidable lengthy working hours, tons of paper work. Many times they are exposed to physical, verbal abuse from patients or their relatives.

Nurses working in critical areas are exposed to very specific stresses such are artificial light, radiation, continuous sounds of monitors and other biomedical equipment, and heat or cold. In addition to work environmental stress, they too have various family responsibilities and personal problems such as parents and their health, children's education, spouse, other family members, friends and social responsibility [11-13]. All these factors develop physical and emotional strain among nurses working in critical units [14-16]. These stress and strain can develop various health problem among nurses such as depression, emotional distress, anger, anxiety, back pain, cardiovascular disorders, decreased immunity and respiratory disorders [17,18].

It has been accepted by the neuroscience and psychology that emotional reaction and strain activates sympathetic component of Autonomic Nervous System (ANS) that can be measured in the form of physiological components. There are various methods to measure psycho-physiological strain by personal experience, behavioural and physiological responses. Measurement of stress and emotions with physiological methods are more reliable as these responses are based on changes in the ANS. During stress and strain situations, sympathetic nervous system releases adrenaline hormone which causes vasoconstriction of superficial blood vessels thus causing increased heart rate. Also, adrenaline hormone activates sweat glands secretion, which increases the conductance of the skin and measured as increased galvanic skin response [19].

Though, there are several literatures available which has assessed psychological parameters to identify effects of working environment among health care personals. But, none has been found, which reveals how work related sympathetic overactivity in nurses can change physiological parameters. This may be the first clinical Indian study where researchers are trying to find, whether working in critical and non-critical areas may result in changes in physiological parameters.

MATERIALS AND METHODS

A comparative study was conducted from Dec. 2014 to June 2015 in a teaching hospital, which serves as tertiary level health care in Uttarakhand state, India. All the inpatient units of the hospital were categorised into critical care and non-critical care with the Patient's Acuity Category (PAC) classification [20,21].

The PAC classification has five acuity categories (complicated procedures, education, psychosocial/therapeutic interventions, number of oral medications, and complicated I.V. drugs and other medications). Each category had rating options from 1 to 4, where 1 denotes low and 4 denotes high acuity. In present study, patients were evaluated from each unit with PAC and those who scored category 1 and 2 were classified as non-critical unit and 3 and 4 as critical units.

To estimate sample size, there was no previous published literature available on these variables (GSR and Heart rate) in nursing population.

To enroll study participants, a list of 376 nurses' data was obtained from the HR Department. Nurses with one year of work experience in same unit, posted in three shift duties, and willing to participate in the study were included. Whereas, nurses with the history of any kind of chronic illness, current history of pregnancy (including pre and postnatal period), loss of a family member in last 6 months were excluded.

Finally 108 nurses, 54 from critical care and 54 from non-critical care units were included in the study with the simple random technique. Out of 108 nurses, 8 nurses did not respond or refused to participate in the study. Therefore, the data were analysed from 100 nurses.

All the selected nurses were contacted and scheduled different dates based on their morning duty. Nurses were requested to come at 10 am for the computerised stress profile and instructed not to drink any kind of beverages (e.g., coffee, tea, cold drink, etc.,), smoke, chew tobacco and not to eat anything after 8.30 am, so the physiological parameters should not alter due to effects of drinks, food and any other substance. After arrival to the Lab, nurses were given 15 minutes of rest in a sitting position.

The Lab was situated in an isolated area with a comfortable chair, foot rest and controlled room temperature at 23±1°C to control external stimuli such as temperature variation and sound which could alter the readings of study variables. It's a well-known fact that circadian rhythm regulates the blood flow, one of the physiological markers that is significantly decreased in the extremities causing a lowering of temperature. Here, we need to consider the link of fight-flight response with an increase in peripheral temperature. "Fight-flight response" takes place when a person suddenly perceives danger or stress. Hence the theory is if a person is under stress his/her peripheral temperature will increase. Now to discriminate if an increase in peripheral temperature is due to stress or due to the ambient temperature we need to have a control of room temperature.

Participants were explained about the procedure to make them at ease and to obtain cooperation. Nurses were given socio-demographic proforma to fill, along with a written consent form. The heart rate and GSR data were recorded on a digital polygraph (Medicaid systems).

Digital polygraph is a computerised test to measure components of autonomic nervous system, namely the heart rate, GSR, electromyography (EMG), respiration, systolic and diastolic blood pressure and skin temperature.

Galvanic skin response was measured by attaching sensors to the 1st and 3rd finger of right hand and a plethysmographic sensor was attached to thumb of right hand to measure heart rate in beats per minute. Participants were exposed to different task phases (Math, Verbal, Ruler, Unpleasant, and Gazing) for one minute and after each task one minute of quite phase was given to normalise the physiological response of task phase. Data of HR and GSR parameters were recorded during task phases on machine and used for the analysis.

DATA ANALYSIS

All the recorded data were extracted and recorded in Microsoft excel spreadsheet. Descriptive (mean and standard deviation) and inferential (t-test) statistical test were used to analyse the data with the help of Epi-Info and Microsoft excel (2013). Data were subjected to statistical computation using mean, standard error and t-test, p-value <0.05 was accepted as significant.

Ethical Considerations

The study plan and protocol was approved by the ethical and University Research Committee (HIHTU/Reg/Int.2013-123). Study participants were explained about the study and requested to sign a written consent.

RESULTS

The mean age (in years) of nurses; working in critical care and non-critical care units were almost equal 31.35±4.47 and 31.89±4.66 respectively. Gender wise distribution of nurses was similar in both groups, but the proportion of female was more 58 (58%) than male 42 (42%).

Among both the groups, the proportion of married nurse was more 74 (74%) than unmarried 26 (26%) in critical care and non-critical care units respectively. Only 8% nurses had a habit of smoking or alcohol use in both the groups.

Majority 71 (71%) nurses were with more than 5 years of professional experience. About number of patient assignment, 25 (50%) nurses from critical care unit reported that they were getting 1-2 patient and 40 (80%) nurses from non-critical care units reported that they were getting 6-10 patient in their daily assignment.

Results [Table/Fig-1] show that the demographic factors, except the number of daily patient assignment, in both the groups; were found similar.

Demographic factors	Critical care nurses (n=50)	Non critical care nurses (n=50)	Total	p-value
Age (years) Mean±SD	31.35±4.47	31.89±4.66	31.72±4.76	0.55[a]
Gender				
Female	29 (58%)	29 (58%)	58	1.0[b]
Male	21 (42%)	21 (42%)	42	
Marital Status				
Married	36 (72%)	38 (76%)	74	0.65[b]
Unmarried	14 (28%)	12 (24%)	26	
Habit of Smoking/Alcoholism/Tobacco use				
Yes	4 (8%)	4 (8%)	8	1.0[b]
No	46 (92%)	46 (92%)	92	
Professional experience (in years)				
Mean±SD	7.31±3.6	7.58±3.75	9.82±3.0	0.71[a]
>1-5	14 (28%)	15 (30%)	29	0.17[b]
>5 years	36 (72%)	35 (70%)	71	
Average daily patient assignment				
1-2 patients	25 (50%)	0 (0%)	25	<0.05[b]
3-5 patients	25 (50%)	10 (20%)	35	
6-10 patients	0 (0%)	40 (80%)	40	

[Table/Fig-1]: Demographic profile of nurses.
a=t-test; b=chi-square test

The mean heart rate and GSR scores of nurses working in critical care units were significantly higher than the non-critical care nurses (p<0.001) [Table/Fig-2].

Stress profile parameter	Nurses posted in	Mean±SD	Mean Diff (95% CI)	Independent t-test value	p-value
Heart rate (beat/minute)	Critical care units	88.32±9.63	4.7 (1.6, 7.9)	2.99	<0.001
	Non-critical care units	83.56±5.82			
GSR (Amp ~ K)	Critical care units	916.9±473.4	229.1 (76.0, 382.1)	2.97	<0.001
	Non-critical care units	687.8±270.0			

[Table/Fig-2]: Heart rates, and GSR scores of nurses (n=100).
df=98

DISCUSSION

In present study, results indicate that nurses working in the critical care units are more stressed, as the mean scores of heart rate of nurses were found higher in this group than the non-critical care unit nurses. As a nature of the job, staff nurses have to always rush for delivering nursing care for critically ill patients, lifting of heavy weight unconscious patients and many more strenuous activities; they were involved in making decision in disconnecting life supporting devices from patients in ICU [22].

Critical care units have lots of noise which comes from alarming bio-medical equipment (e.g., cardiac monitor, infusion pump, and ventilator); ringtone sounds from telephone and Cellphone; vigorous movement of health care workers and patients [23]. This typical, continuous, monotonous sound creates stress among staff working in that area. In a study, Nurses working in Paediatric intensive care unit have shown a positive relationship between noise and self-reported stress, also they found that there was an increase in HR as the level of sound increased [24,25].

Study by Rennie KL et al., [26] noted that HR was found to be higher (and cardiac rhythm lower) in subjects having physical activity from moderate to vigorous and during increased mental activity [27]. In a study [28], results have shown there were significant differences in heart rate during hectic working days and non-working days.

In response to psychological arousal or physical strain, sweat glands are activated by sympathetic nervous system which results in increased secretions from sweat glands and thus increases conductivity of skin [29]. Similarly, in present study, the GSR values were significantly higher among nurses working in critical units than non-critical unit nurses which indicated that nurses working in critical units were more strained.

In another study, physiological variables (GSR, Blood Volume Pulse, Pupil Diameter and Skin Temperature) were measured to assess the stress level. Subjects were exposed to computer game to elicit mental stress; results show significant changes in physiological variables [30]. Similarly, Feng TS et al., assessed mental stress by using GSR, HR as a main parameter of their study and found that both were good indicator to detect existence of stress [31].

Previous study [32], reported that different work environment produces an impact on health, it may be on psychological as well as on physical health. Most of the job related strain originates from the work environment and working conditions. Nurses and physicians working in critical units witness death and suffering of patients creating psychological and physiological strain which reduces immunity and increases risk of autonomic disorders [33-35]. Nurses working in ICUs usually experience different kind of psychological events while working on critically ill patients, many times they need to take decisions regarding life of patient and have to face many questions and querries from patients and their family members. At the same time nurses have to follow multiple institutional policies

[36,37], these all together makes ICU nurses stressed and could cause increase in heart rate and galvanic skin responses.

RECOMMENDATION

Hospital administration has a big role in keeping the nurses free from stress at certain levels. Nurses have multiple tasks to perform while providing patient care, among which one of the important task is communication with patient and their family members. Many times due to heavy work pressure, nurses may not able to follow and practice basic communication skill which may result into frustration and stress at work place. Hence, it is needed to conduct communication skills training programmes periodically for nurses. Also, it is necessary to organise relaxation activities such as fun game, yoga, meditation etc., to break the chain of stress which piles up in the body and mind of nurses, doctors and other health care workers from the critical areas.

LIMITATION

The data was from single observation and the study participants were from only one large private institution which cannot be generalised in large population. Level of clinical competencies of nurses would inversely influence the level of stress which was not completely addressed in the present study.

CONCLUSION

Present study revealed that the work environment of an organisation has great impact on the physiological health of nursing personnel. Critical care environment is always demanding, where nurses has to provide care to the patients who are critically ill; where nurses has to act promptly, make decisions deliberately and coordinate with other health care professional involved in critical care. These circumstances make nurses stressed, which are measured in terms of variations in physiological parameters such as increased heart rate and GSR. So, it may be assumed to have poor nursing care and more chances of making errors by the nursing personnel who are under stress.

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