The effect of day and night shifts on oxidative stress and anxiety symptoms of the nurses

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Abstract. – Background: Oxidative stress is believed to have a role in the development of chronic diseases. It is also known that long-term night and shift work in nurses might be associated with many health-related problems like fatigue, sleep problems, anxiety and difficulties in maintaining regular lifestyles.

Aim: In this study, we aimed to evaluate the changes of oxidative stress parameters and anxiety indexes of the nurses on day and night shifts.

Materials and Methods: One hundred and twenty nurses in ordinary service and intensive care unit (ICU) were enrolled to the study. Subjects were divided into 2 groups; group 1 (n=60) consisted of nurses working in a day shift and group 2 (n=60) as working in the night shift. Further, both groups were divided in to 2 groups again; group 1a and 2a (both n=30) who working in the ICU, group 1b and 2b (both n=30) in the ordinary service. Just before and the end of the shifts, blood samples were obtained to measure total antioxidant status (TAS) and total oxidant status (TOS). Oxidative stress index (OSI) was calculated. Anxiety index were determined at the end of the shift using State-Trait Anxiety Inventory index.

Results: Oxidative stress parameters were increased in all nurses at the end of the day and night shifts (p < 0.05). However, both in service and ICU nurses TAS, TOS, and OSI levels were not significantly different at the beginning and the end of the shifts (p > 0.05). Anxiety indexes of each ordinary service and ICU nurses were found to be similar (p > 0.05).

Conclusions: Ordinary service and ICU nurses’ oxidative stress parameters and anxiety indexes were not different and all nurses suffer the similar effects of the shifts both in day and night.

Introduction

Number of the shift workers has rapidly increased worldwide over the last decades. Nurses work long hours under conditions of intense stress, is often suffer from excessive workloads and minimal social support. Long-term night and shift work in nurses becoming more cynical and less empathetic as their training progresses, and might be associated with many health-related problems like fatigue, sleep problems, anxiety and difficulties in maintaining regular lifestyles1-4. Reduced rest and recovery time leads to physiologic depletion or exhaustion that continues into the next workday. Consequently, shift workers have a higher prevalence of being unhealthy5,6. Numerous studies have shown high amounts of psychological distress in doctors, nurses, and other healthcare professionals working in various situations7,9. However, whether prolonged physical and extreme workload and mental stress induce relevant metabolic changes remains poorly understood10-12.

Oxidative stress is believed to have a role in the development of chronic diseases. Once the balance between reactive oxygen species (ROS) production and antioxidative defense activity is disrupted, oxidative stress can occur, which may

Key Words:
Nurses, Workload, Oxidative stress, Anxiety.
result in cell injury or death, subsequent tissue
damage, and, finally, chronic disease. Increased oxidative stress associated with different
jobs has been demonstrated by isolated studies. Also exhaustive and prolonged exercise has been
shown to induce oxidative stress.

Although based on these knowledge mentioned above, no clinical research have been
performed until now to evaluate the oxidative stress parameters with comparing the anxiety
symptoms of the nurses. In this study we aimed, therefore, to evaluate anxiety symptoms using
State Trait Anxiety Inventory (STAI) index and evaluate the changes of oxidative stress parame-
ters of the nurses on day and night shifts. Moreover, we aimed to compare these levels between
the ordinary service and intensive care unit (ICU) nurses.

Materials and Methods

Study Design

This prospective study was conducted at the Harran University School of Medicine, Sanli-
urfa, Turkey. Prior to subject recruitment, the study protocol was reviewed and approved by
the local Ethics Committee, in accordance with the ethical principles for human investigations
(ethical approval number; 28.01.2010: B.10.IEGO.0.11.00.01/021), as outlined by the
Second Declaration of Helsinki and written informed consents were obtained from all the nurs-
es. From January-2011 to September-2011 consecutively 120 nurses were recruited to the study.

All study subjects were divided into 2 groups; group 1 (n=60) consisted of nurses working in a
normal day shift (08 am to 16 pm, 8 hours) and group 2 (n=60) as working in the night shift (16
pm to 08 am, 16 hours). Further, both groups were divided into 2 groups again; group 1a and
2a (both n=30) who working in the ICU, group 1b and 2b (both n=30) in the ordinary service.
The exclusion criteria were as follows: recent acute infectious illness; any inflammatory, or in-
filtrative disorder; any evidence of liver, kidney, or respiratory disease; diabetes mellitus; malign-
nancy; regular alcohol use; smokers; pregnancy; depression; psychiatric or neurological disorders.
None of the patients had problems with adapta-
tion to answer the questions of the STAI index. Just before the shift, blood samples were obtained
to measure total antioxidant status (TAS) and total oxidant status (TOS). After the shift,

Baseline Definitions and Measurements

Weight and height were measured according to standardized protocols. Body mass index was
calculated as the weight in kilograms divided by the height in meters squared (kg/m²). Blood
pressure was measured by using a sphygmo-

Biochemical Analysis

All blood samples were drawn from a large antecubital vein without interruption of venous
flow, using a 19-gauge butterfly needle connect-
ed to a plastic syringe. Twenty milliliters of
blood was drawn, with the first few milliliters
discarded. The residual content of the syringe
was transferred immediately to polypropylene
tubes, which were then centrifuged at 3000 rpm
for 10 minutes at 10 to 18°C. Supernatant serum
samples were stored in plastic tubes at -80 °C un-
til assayed. For the serum markers of oxidant
stress, TOS was measured and the oxidative
stress index (OSI) calculated. TAS was measured
as an indicator of antioxidant status.

Measurement of Total Oxidant Status

Serum TOS was measured using a novel au-
tomated method developed by Erel. Oxidants pre-
sent in the sample oxidize the ferrous ion-o-
dianisidine complex to ferric ion. The oxidation
reaction is enhanced by glycerol molecules,
which are abundant in the reaction medium. The
ferric ion generates a colored complex with
Xylenol Orange in an acidic medium. Color in-
tensity, which can be measured spectrophotomet-
rically (V-530; Jasco®, Tokyo, Japan), is related
to the quantity of oxidant molecules present in
the sample. The assay is calibrated with hydro-
gen peroxide and the results expressed in terms
of micro-molar hydrogen peroxide equivalents
per liter (mol H₂O₂ equiv./l).

Measurement of Total Antioxidant Status

Serum TAS was measured using a novel au-
tomated method developed by Erel. In this
method, hydroxyl radical, the most potent bio-
logical radical, is produced. In the assay, fer-
rous ion solution in reagent 1 is mixed with hy-
drogen peroxide present in reagent 2. Sequen-
tially-produced radicals, such as the brown-col-
Oxidative Stress Index

The OSI was defined as the ratio of the TOS to TAS levels. For the calculation, TAC units were changed to mmol/l and the OSI value calculated according to the following formula: OSI (arbitrary unit) = TOS (μmol H₂O₂ equiv./l) / TAS (mmol Trolox equiv./l).

Oxidative Stress Index (OSI) was defined as the ratio of the TOS to TAS levels. For the calculation, TAC units were changed to mmol/l and the OSI value calculated according to the following formula: OSI (arbitrary unit) = TOS (μmol H₂O₂ equiv./l) / TAS (mmol Trolox equiv./l).

Determination of the State Trait Anxiety Inventory (STAI) Index

The STAI was used to measure anxiety symptoms. The nurses were asked to complete a questionnaire concerning socio-demographic characteristics, the Turkish version of the Spielberger State-Trait Anxiety Inventory (STAI)23. The STAI is a self-report questionnaire consisting of two subscales, the state anxiety subscale and the trait anxiety subscale, each containing 20 items. Only the state anxiety subscale (STAI-S), which measures anxiety at the moment of scoring, was used in the analyses. Respondents use a four-point scale ranging from 1 to 4, the scores in this subscale range from 20 to 80 and higher scores indicate higher state anxiety. A sample response is ‘I feel secure’.

Statistical Analysis

All statistical analyses were performed using SPSS for Windows version 17.0 (SPSS Inc., Chicago, IL, USA). After the shift and baseline differences of STAI-S indexes, TAS and TOS levels were calculated. Kolmogorov-Smirnov tests were used to test the normality of data distribution. The data were expressed as arithmetic means and standard deviations. Independent sample T-test was respectively used in normally and non-normally distributed continuous variables between groups. Paired t-test was used to analyze changes within each group. Pearson’s correlation analysis was used to examine the association of oxidative stress parameters and STAI-S indexes in all groups. Two-sided p value < 0.05 was considered statistically significant.

Results

Group 1 Results

Clinical, biochemical and demographic characteristics of study subjects are presented on Table I. There were no statistical differences in biochemical and demographic characteristics...
The effect of day and night shifts on oxidative stress and anxiety symptoms of the nurses

**Table II.** Comparison of baseline and at the end of the day shift oxidative stress parameters.

<table>
<thead>
<tr>
<th></th>
<th>Group 1a (n = 30)</th>
<th>Group 1b (n = 30)</th>
<th>p^\text{a}</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>At 8 am</td>
<td>At 16 pm</td>
<td></td>
</tr>
<tr>
<td>TAS, μmol H₂O₂ equiv./l</td>
<td>1.00 ± 0.10</td>
<td>0.94 ± 0.11</td>
<td>&lt; 0.05</td>
</tr>
<tr>
<td></td>
<td>0.99 ± 0.12</td>
<td>0.95 ± 0.14</td>
<td>&lt; 0.05</td>
</tr>
<tr>
<td>TOS, mmol Trolox equiv./l</td>
<td>10.25 ± 2.13</td>
<td>11.35 ± 3.27</td>
<td>&lt; 0.05</td>
</tr>
<tr>
<td></td>
<td>9.62 ± 1.79</td>
<td>11.69 ± 3.96</td>
<td>&lt; 0.05</td>
</tr>
<tr>
<td>OSI, arbitrary unit</td>
<td>1.02 ± 0.21</td>
<td>1.19 ± 0.36</td>
<td>&lt; 0.05</td>
</tr>
<tr>
<td></td>
<td>0.98 ± 0.23</td>
<td>1.23 ± 0.41</td>
<td>&lt; 0.05</td>
</tr>
<tr>
<td>STAI index score</td>
<td>39.66 ± 5.67</td>
<td>38.93 ± 6.07</td>
<td>&gt; 0.05</td>
</tr>
<tr>
<td></td>
<td>39.33 ± 5.18</td>
<td>37.46 ± 4.63</td>
<td>&gt; 0.05</td>
</tr>
</tbody>
</table>

All measurable values were given with mean ± standard deviation. TOS: total oxidant status; TAS: total antioxidant status; OSI: oxidative stress index; STAI: State Trait Anxiety Inventory. Paired sample T^\text{b} test was used.

among subgroups (p > 0.05 for all). Compared to group 1b, group 1a was not significantly different regarding to TAS, TOS, OSI levels at baseline and the end of the shift (p > 0.05 for all). In similar, STAI-S indexes, difference of TAS and TOS levels were not significantly different both in two subgroups (p > 0.05 for all). Besides, compared to baseline, at the end of the shift TAS levels were significantly decreased, TOS and OSI levels were significantly increased both in two subgroups (p < 0.05 for all) (Table I, II).

**Group 2 Results**

Clinical, biochemical and demographic characteristics of study subjects are presented on Table III. All of the findings in group 2 were found similar with respect to group 1 results (Table III, IV).

<table>
<thead>
<tr>
<th></th>
<th>Group 2a (n = 30)</th>
<th>Group 2b (n = 30)</th>
<th>p^\text{a}</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gender, female</td>
<td>30</td>
<td>30</td>
<td>NS</td>
</tr>
<tr>
<td>Age, years</td>
<td>28.54 ± 4.23</td>
<td>27.03 ± 3.81</td>
<td>NS</td>
</tr>
<tr>
<td>BMI, kg/m^2</td>
<td>23.92 ± 3.31</td>
<td>22.67 ± 3.52</td>
<td>NS</td>
</tr>
<tr>
<td>Systolic BP, mmHg</td>
<td>113.65 ± 11.98</td>
<td>117.25 ± 8.86</td>
<td>NS</td>
</tr>
<tr>
<td>Diastolic BP, mmHg</td>
<td>72.53 ± 8.63</td>
<td>74.05 ± 7.42</td>
<td>NS</td>
</tr>
<tr>
<td>TAS at 16 pm, μmol H₂O₂ equiv./l</td>
<td>1.03 ± 0.12</td>
<td>1.07 ± 0.22</td>
<td>NS</td>
</tr>
<tr>
<td>TOS at 16 pm, mmol Trolox equiv./l</td>
<td>10.99 ± 3.49</td>
<td>10.87 ± 2.57</td>
<td>NS</td>
</tr>
<tr>
<td>OSI at 16 pm, arbitrary unit</td>
<td>1.08 ± 0.37</td>
<td>1.05 ± 0.34</td>
<td>NS</td>
</tr>
<tr>
<td>TAS at 8 am, μmol H₂O₂ equiv./l</td>
<td>0.92 ± 0.14</td>
<td>0.90 ± 0.09</td>
<td>NS</td>
</tr>
<tr>
<td>TOS at 8 am, mmol Trolox equiv./l</td>
<td>12.67 ± 3.37</td>
<td>12.52 ± 4.64</td>
<td>NS</td>
</tr>
<tr>
<td>OSI at 8 am, arbitrary unit</td>
<td>1.34 ± 0.49</td>
<td>1.38 ± 0.46</td>
<td>NS</td>
</tr>
<tr>
<td>Difference of TAS</td>
<td>0.11 ± 0.15</td>
<td>0.16 ± 0.24</td>
<td>NS</td>
</tr>
<tr>
<td>Difference of TOS</td>
<td>-0.92 ± 4.13</td>
<td>-1.64 ± 5.49</td>
<td>NS</td>
</tr>
<tr>
<td>STAI index score at 16 pm</td>
<td>38.80 ± 5.30</td>
<td>40.63 ± 4.95</td>
<td>NS</td>
</tr>
<tr>
<td>STAI index score at 8 am</td>
<td>37.60 ± 5.59</td>
<td>37.03 ± 4.48</td>
<td>NS</td>
</tr>
<tr>
<td>Difference of STAI index score</td>
<td>1.20 ± 5.10</td>
<td>3.60 ± 4.61</td>
<td>NS</td>
</tr>
</tbody>
</table>

All measurable values were given with mean ± standard deviation. NS: non significant; BP: blood pressure; BMI: body mass index; TOS: total oxidant status; TAS: total antioxidant status; OSI: oxidative stress index; STAI: State Trait Anxiety Inventory. Independent sample T^\text{c} test was used.

In bivariate analysis no correlations were found between oxidative stress parameters and STAI-S indexes in all groups (p > 0.05 for all).

**Discussion**

The main findings of this study were that: (1) oxidative stress parameters were increased in all service and ICU nurses at the end of the shifts; (2) however both in service and ICU nurses TAS, TOS, and OSI levels were not significantly different at the beginning and the end of the shifts; (3) besides, STAI-S indexes of each ordinary service and ICU nurses were found to be similar.

Measuring different oxidant and antioxidant molecules is impractical, and their oxidant and antioxidant effects are additive. Since there are nu-
merous oxidants and antioxidants in the body, measuring total oxidant-antioxidant status is more valid and reliable\textsuperscript{21,22}. When only a few parameters are measured, their levels may be unchanged or decreased, even when the actual oxidant status is increased, or vice versa. For these reasons, we used TOS and TAS levels in our study.

Several studies report stressful working conditions and/or poor work-related health outcomes among healthcare workers, generally nursing personnel. A large amount of authors agree that there are multiple and important stressors at the clinics and hospitals where nursing personnel generally work\textsuperscript{24-28}. Some studies have concluded that inadequate work planning and a poorly organized work schedule may impact health. In particular, this may result in a reduced quantity and quality of sleep, a decline in cognitive and physical performance and an associated increased risk for errors, and interference with family and social engagements\textsuperscript{29-33}. Additionally, previous research studies on night shift working also pointed out the risk or associated factors in pathophysiology, lifestyle behaviour and job-related conditions and impaired circadian rhythms\textsuperscript{34-36}.

In literature, only one research study has been performed to evaluate oxidative stress parameters of the shift nurses, no research study has been performed to investigate the anxiety indexes of the nurses on their shifts. The only one study which Buyukhatipoglu et al\textsuperscript{1} performed showed an increased oxidative stress in nurses working on their shifts. In our study, comparing to baseline, we found an increased oxidative stress at the end of the shift in all nurses. Presumably because of prolonged higher level physical activity, although other factors such as high period of shift time may have played a role for this. Beyond the previous published study, we compared ordinary service and ICU nurses’ oxidative stress parameters and anxiety symptoms by using STAI-S index on their shifts, and found no difference among them. Namely, all ordinary service and ICU nurses suffer the similar effects of the shifts both in day and night shifts. As a result, we consider that the main reason for increased oxidative stress that we observed in nurses was prolonged, incessant, and low-grade to moderate-grade physical activity. Also, we hypothesized that increased workload without sufficient time to rest might disrupt oxidative and antioxidative balance, thereby causing oxidative stress in on-duty nurses. However, the mechanisms of these effects are poorly understood and contentious.

The results of this study raise concerns about the long-term influences of oxidative stress on the health of nurses, because oxidative stress has been implicated in the pathophysiology of a large number of diseases. Certain limitations of the present study should be considered. First of all, evaluation of continued 24 hour parameters which have been analyzed in the present study might represent the chronobiological characteristics of the nurses. The second was; sample size was relatively small. Therefore, these results should be verified with large-scale, multicenter prospective cohort studies.

### References


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