Heart Rate as a Marker of Stress in Ambulance Personnel: A Pilot Study of the Body's Response to the Ambulance Alarm

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PTSD = post-traumatic stress disorder

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Abstract

Introduction: Studies have demonstrated the presence of stress and post-traumatic stress among ambulance personnel, but no previous research has focused on the body's reaction in the form of the change in heart rate of ambulance staff in association with specific occupational stress.

Hypothesis: The purpose of this study is to investigate whether work as an ambulance professional generates prolonged physiological arousal that can be measured by heart rate in different situations.

Methods: Twenty participants carried a pulse-meter in the form of a wristwatch, which continuously measured and stored their heart rate 24 hours per day for a period of seven days. All ambulance alarms that occurred during the test period were recorded in journals, and the participants completed diaries and a questionnaire describing their experiences. The alarms were divided into different phases. Correlations between heart rate in the different phases were computed.

Results: Analysis of study data indicated a significant rise of heart rate unrelated to physical effort during an emergency alarm and response. This increased heart rate was noticed throughout the mission and it was not related to the length of experience the staff had in the ambulance profession. In addition, a non-significant trend suggested that alarms involving acutely ill children lead to an even higher increase in heart rate. In addition, this research showed that constant tension existed during sleep, while available for an emergency, indicated by a noticeable increase in heart rate during sleep at work compared to sleeping at home.

Conclusions: A rise in heart rate was experienced during all acute emergency missions, regardless of a subject's experience, education, and gender. Missions by themselves generated a rate increase that did not seem to correlate with physical effort required during an emergency response. This study shows that working on an ambulance that responds to medical emergencies is associated with a prolonged physiological arousal.

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Introduction

People working in high- or medium-risk professions such as police officers, ambulance personnel, or firefighters are exposed to stress when serving persons in emergency situations. Ambulance personnel have been shown to be vulnerable to the development of symptoms of post-traumatic stress disorder (PTSD).[1] Modern ambulance service is a diverse and advanced profession that places great demands on the personnel with potential stress encountered during emergency responses and some situations that often are more stressful, e.g., when children are involved or when the ambulance workers have poor information about the mission.[2–6]

During an emergency call, the time before arrival to the patient is especially stressful. This also is true if ambulance staff receive unclear address information for the call. In addition, each healthcare environment is unique.[7,8] When reaching the hospital, staff may experience stress as complex patient situations are being reported to the emergency department in environments that may be chaotic.[9] High expectations and requirements may lead to anxiety for ambulance personnel, which, in turn, can lead to a decreased ability to be empathatic and compassionate for the patient.[10] In addition, studies show that stress and burnout related to the ambulance profession may lead to reduced empathy from the staff.[11] One way to deal with

stress and anxiety for ambulance staff during a mission is to try to work systematically, in a structured way, according to guidelines.[8] Influencing factors include exposure to situations involving patients who are dying or suffering, medical errors, fatigue, or situations that can be related to the staff's private life.[11] Nordby and Nöhr have shown that parents of children affected by cot death (Sudden Infant Death Syndrome) were not satisfied with how the ambulance staff showed empathy and their capacity for either verbal or non-verbal communication.[12] A professional approach is characterized by the ability to feel and show empathy, by listening and understanding, and empathy with a patient or relatives in an emergency situation.[11] In order to show empathy the ability to focus both on the patient and the relatives while performing a task is required. The demands of the ambulance profession generates an experience of anxiety.[13] Studies have shown that 20% of the men and 25% of the women in the ambulance profession were experiencing at least two reactions to stress that can be related to their profession. Almost one-third of ambulance staff showed signs of burnout, PTSD, or other psychosomatic manifestations.[1,7,14,15] Symptoms of PTSD could be linked to a low sense of context, low sense of coherence, and/or previous stressful experiences.[16,17] Ambulance staff, in comparison with other professions, seem to be at greater risk of profession-related illness, which may be due to poor management and/or lack of a supportive organization.[7,18,19]

Experiencing stress leads to biological responses such as increased blood pressure and heart rate. Therefore, the measurement of heart rate provides a clinical indicator of stress exposure.[20,21] Over time, high heart rates at rest are associated with the development of diabetes, obesity, and cardiovascular disease.[22–24] Other studies have shown more serious consequences with an elevated resting heart rate leading to increased risk of premature death from cardiovascular disease. It seems that a heart rate >80–85 beats per minute at rest is a significant risk factor; however gender differences may be observed in this regard.[25–27] Earlier cardiovascular complications do not seem to increase as much as heart rate elevated above these rates.[28,29] The purpose of this study was to investigate whether working as an ambulance professional has prolonged physiological arousal (stress) that can be measured by changes in heart rate in different situations. The instantaneous heart rate response to alarms, and heart rate during sleep at home and at work were compared. Heart rate between acute emergency alarms concerning children and other types of emergency alarms also were compared.

Methods

Study Design and Methodology

This observational study was conducted in an ambulance organization in southern Sweden. The ambulance response area is divided into one main station with three ambulances, one ambulance on duty for a 24-hour shift, one ambulance on duty 07:45–23:00 every day, and one ambulance on duty 07:45–17:00 Monday through Friday, and one ambulance that is stationed as an outpost elsewhere on duty for 24 hours. The main station receives an average of 11 dispatches per day. Each mission lasts an average of one hour and 46 minutes. The outpost has an average of 3.7 dispatches per day, with duration of about one hour and 40 minutes. The staff members choose their working shifts and have the opportunity to sleep during the night if not dispatched.

Participants

The conditions and extent of the study did not allow for random sampling. Therefore, a suitable sample was selected. Participants of the selected station were considered to be representative of the ambulance organization in relation to gender, age, and experience. It was not possible to make a randomized selection, there a convenience sample from one ambulance station was selected. Of 31 possible participants, 20 chose to participate in the study. Despite this, they exemplified the ambulance services with respect to gender, age, and experience.

Data Collection

The participants in the study were informed at a work meeting about the purpose and structure of the study, and indicated interest voluntarily. A sole exclusion criterion was that the participants could not take any drugs that affect their heart rate. The participants were assigned randomly into groups of five, and constantly carried a wristwatch for one week that logged their heart rate every 15 seconds. The logged pulse files from the monitored staff were collected and printed using Polar Pro Trainer 5™ (Polar RS 400, Polar Electro, Sweden). Pulse rate was monitored both at work and at home. During the week of measurements, the participants also wrote a diary with information about what could be causing the current heart rate. A copy of the journal related to the missions was printed to relate the heart rate measurement to specific assignments and time. Later, a survey of the background data and perceived stress were filled out by the participants. The pulse measurement equipment of five wristwatches consisted of Polar RS 400 with necessary computer programs.

Demographic Data

Twelve of the participants were men and eight were women. The men were between 29 and 56 years of age, (mean = 40.6 years). The women were between 27 and 45 years of age, (mean = 36.8 years). The experience within ambulance service for men ranged from 2 to 26 years, (mean = 11, median = 8 years), while the corresponding numbers for women were between 3 to 16 years, (mean = 9; median = 7.5 years). Six of the participants were paramedics, and 14 were registered nurses (eight with emergency medical specialist education).

Data Processing

There were 45 Priority 1 emergency alarms (91.8%) that could be analyzed, and 125 of 140 nights (89.3%) that could be analyzed. Of the 45 emergency alarms, eight concerned children from birth to 10 years of age, and the other 37 concerned adults >18 years of age. Each emergency alarm was divided into seven different phases based on the actual time reported to the emergency call-center via pressing of buttons on a mobile data terminal in the ambulance. All emergency responses included in the study (n = 45) included Phases 1–3 and 7, and those involving a patient (n = 31) included Phases 1–7. Phase 1 describes the average heart rate either at rest or during lighter activity at the station before the alarm. Phase 2 describes the instantaneous heart rate response to the alarm. The other phases are reported with a heart rate average for that phase (Phase 3: from alert to arrival to the patient or aborted mission; Phase 4: time at the location of the patient; Phase 5: medical care in ambulance between the patients original location and arrival at the hospital; Phase 6: time in hospital including reporting and writing journal; and

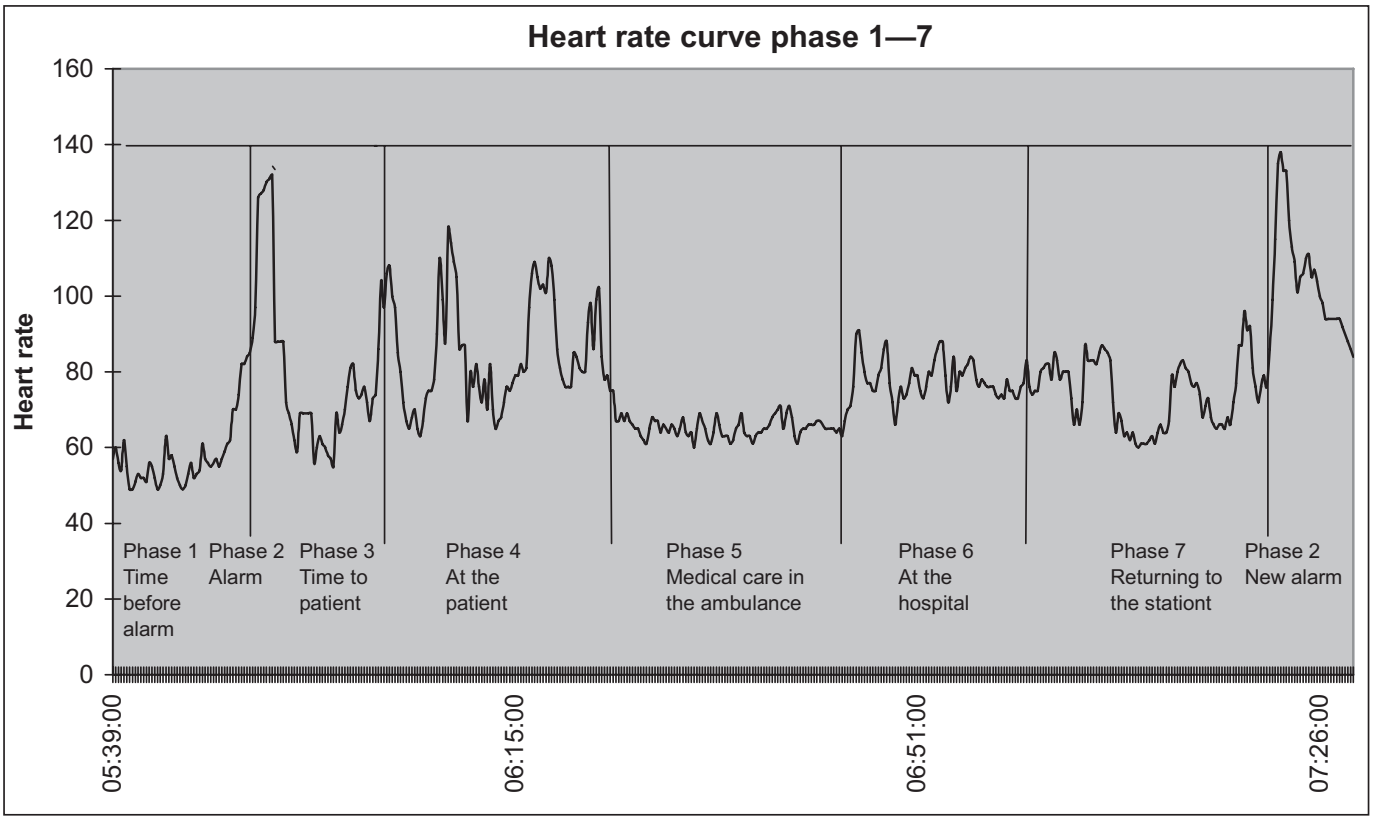

Figure 1—Heart rate during alarm phase 1– 7 concerning all alarms, children alarms and other alarms. Comparison between alarms concerning children and other alarms. The difference phases are marked for clarity with vertical lines to show the start of each phase.

Phase 7: time from hospital back to station or new assignment. Heart rate average of a complete mission, Phases 2 to 7, and a heart rate at home for two hours at lighter day time activity was used for comparison with heart rate during lighter work at the station for examining any differences at home, at work, or during a mission. All nights were examined separately to find the lowest heart rate during sleep. In order to avoid false low single values, the average heart rates were measured over 10 minutes. Analysis and processing were performed using SPSS 15.0 (SPSS, Inc., Chicago, IL)

Ethical Considerations

Ethical advisers at Borås University approved the study. Permission for the study implementation and printing of the journals was obtained from the ambulance organization's executive committee. Before the study, participants received information both in writing and verbally that participation was voluntary, and at any time, could be suspended. The Swedish Research Council's ethical principles were followed.[30]

Results

An example of heart rate data for an emergency alarm is in Figure 1. The alarm occurred during the journey back from another mission, and illustrates the variation of heart rate during the phases. The alarm concerned an acutely ill child.

The heart rates in Phases 1 and 2 for all alarms are statistically significantly different ($p < 0.05$; Table 1). When the average heart rates for Phase 1 are compared to the entire alarm period (Phase 2 to 7), a statistically significant rise of heart rate occurred ($p < 0.05$). When comparing Phases 1 and 2 for the subgroup involving acutely ill children, there is a statistically significantly different ($p < 0.05$) in rise of heart rates associated with Phase 2. A comparison between Phases 1 and 2 in other emergencies that did not involve children also were significantly different ($p < 0.05$). Although without statistical significance, alarms involving children generate a 21% greater increase in heart rate compared to other emergency alarms ($p > 0.05$; Table 2).

Heart Rate Average During Sleep and Easier Tasks at Home and Work

The lowest heart rate at sleep was compared between work and home. Of the participants, 18 worked night shifts. Eleven participants showed a higher heart rate during sleep at work, while seven showed a lower heart rate. This difference is not statistically significant ($p > 0.05$). When heart rates for light station work and light work at home were compared, no statistical significance was seen ($p > 0.05$).

Analysis of the Diary and Questionnaire

The analysis of the diaries and the questionnaires indicated that 17 out of 20 participants performed physical training several times per week. When the heart rate data were cross-referenced, it was discovered that those who train exhibit a lower heart rate

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Comparison	Mean	Median	SD	*t*-test	*p*-value
Phase 1, all (n = 45)	64,51	62, 00	11, 62	18, 44	<0.05
Phase 2, all (n = 45)	110,60	111, 00	16, 74		
Phase 1, (n = 45)	64,51	62, 00	11, 62	12, 23	<0.05
Phase 2–7, (n = 45)	84,04	84, 50	13, 17		
Phase 1, children (n = 8)	58,50	58, 00	7, 62	7, 70	<0.05
Phase 2, children (n = 8)	108,88	108, 00	13, 83		
Phase 1, other (n = 37)	65,81	63, 00	12, 00	16, 66	<0.05
Phase 2, other (n = 37)	110,97	112, 00	17, 45		
Sleep at work, (n = 18)	56,22	57, 00	9, 26	1, 86	NS
Sleep at home, (n = 18)	54,67	55, 00	8, 23		
Work on station, (n = 18)	65,76	65, 00	9, 58	0, 86	NS
Work at home, (n = 18)	67,41	68, 00	10, 31		

Table 1—Comparison of heart rate in Phase 1 and Phase 2 all alarms, between phase 1 and the entire alarm Phase (2–7), Phase 1 and 2 for children and other emergency alerts, heart rate during sleep at work and at home, and of heart rate during light work on the station and at home.
(Phase 1: Before alarm; Phase 2: Ambulance alarm; Phase 3: Driving to the patient; Phase 4: Patient care in patient's home; Phase 5: Patient care in the ambulance; Phase 6: Patient hand over in the emergency department; Phase 7: Return to ambulance station)

		All alarms		Children alarms		Other alarms
Phase 1	n = 45	48–90	n = 8	50–76	n = 37	48–90
Phase 2	n = 45	67–142	n = 8	96–138	n = 37	67–142
Phase 3	n = 45	58–116	n = 8	84–102	n = 37	58–116
Phase 4	n = 31	56–132	n = 4	81–100	n = 27	56–132
Phase 5	n = 31	56–119	n = 4	68–85	n = 27	56–119
Phase 6	n = 31	53–114	n = 4	76–90	n = 27	53–114
Phase 7	n = 45	53–108	n = 8	62–90	n = 37	53–108

Table 2—Variations in heart rate for the seven phases. Reported as beats per minutes, divided to all, children, and other alarms.

in Phases 1 and 2 (NS). In terms of perceived sleep, five of 20 stated that they had disturbed sleep either at work, at home, or both, and that they were experiencing work-related stress. One person indicated experiencing recurrent nightmares.

Discussion

There is a significant increase in heart rate when comparing heart rates before and during an alarm. Unlike a previous study, that interpreted rise of heart rate as less a physiological response unrelated to stress,[31] the instantaneous reaction to the alarm shown in this study is understood as a stress response to the alarm stimuli. This is in line with a study by Jonsson and Segesten,[17] in which they concluded that the ambulance profession is at risk for stress symptoms.

Increase in heart rate as a response to stress has been demonstrated in other studies.[20,21] It has been reported that this instantaneous reaction generally applies to all staff, regardless of gender, exercise habits, experience, or education. There were no differences between experienced and inexperienced personnel. This implies that personnel do not get accustomed to emergency alarms. In a recent study, it was found that staff with extensive experience assessed their vulnerability to stressors to be lower than those with less experience.[32] This was interpreted as experienced ambulance personnel no longer viewing the stress factors as a problem. The present study shows that experience does not entail an adaptation to physiological stress. A synthesis of these studies could be interpreted as experienced ambulance personnel think they handle stressors related to the profession better than less experienced staff (subjective perception), but that the body's physiological (objective perception) response remains the same regardless of experience. This contradicts, to some extent, that it is possible to cope with stress by experience, training, or stress vaccination.

In this study, heart rate is higher during sleep at work than during sleep at home. Some of those with a higher heart rates at home answered that this was due to having infants, and that

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they were up several times during the night. Other participants that had a lower heart rate during sleep at work were busy with alarms for much of the night, and thus, did not get adequate sleep. A possible interpretation of this is that once the opportunity to sleep is given, they fall into a deep sleep quickly with a low heart rate as a result.[33] Those with an increased work sleep heart rate are likely to be the most representative for physiological responses related to work stressors.

Throughout the phases of the emergency responses, until the return to the station, heart rate increased compared to during an lighter work at the station. The rise of heart rate during the alarm was greater than the average of the results previously reported to be at a pathological level in individuals at rest.[22–27] This occurred despite the fact that the workload during a mission usually did not entail major physical efforts besides moving patients, the stretcher, and other equipment. Additional time usually consisted of less physically strenuous activities, since it involves sitting in the ambulance, driving the vehicle, caring for the patient, and/or writing records at the hospital. This can be interpreted as an ambulance mission by its emergency nature creates stress that probably is not related to physical effort. This finding contradicts a previous study[32] that found that work experience provides a sense of reduced tension and stress. In the current study, subjectively perceived feeling of stress did not correlate with the physiological stress reaction as measured by heart rate.

When emergency alarms of acutely ill children are separated from other emergency alarms, a trend was found for a further increased heart rate. The number of alarms involving children in the study was too small to draw firm conclusions. Results obtained in previously studies[16,32] have shown that alarms in which children are involved are one of the strongest stressors that ambulance staff experience. If this trend is correct this could be proved physiologically by increased heart rate or increase in cortisol levels. The correlation betwen heart rate measured by the automatic pulse measurement and cortisol as a stress marker in the body should be established in future studies.

Implementation

There is an increased morbidity of cardiovascular diseases in ambulance personnel in Sweden. The study shows that ambulance call is a strong stressor as reflected in a marked increase in heart rate. One of the few avenues to alleviate this stress surcharge is to reduce the number of alarms per shift.

Strengths and Limitations

The number of emergency alarms included in this study was relatively small, and did not always provide significant results. Validity may be considered to be high when heart rate is an accepted measure of current stress level. Study reliability was considered to be high, since the study participants could not influence their heart rate during the alarms. The strength of this approach for automatically recording heart rate used in this study is that the participants were not able to control the measurements themselves.

Conclusions

Work experience does not affect the physiological response in the form of heart rate changes to stress among ambulance personnel. This applies both to the actual alarm and throughout the mission.

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