Abschlussbericht

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Allgemeine Angaben

Projektantrag	6/13
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Wissenschaftlicher Teil

1. Introduction

Over the past years, numerous national and international studies have investigated acute and chronic work-related stress, its long-term health effects and individuals' coping abilities with potential traumatic events (McFarlane, Van Hooff, & Goodhew, 2009; Westgard, Jensen, & Nilsen, 1993). Especially the stress-related disorders rise stronger and stronger and present themselves as one of the biggest health problems of the 21st century (WHO, 2001). For example the results of the `Stress report Germany` in 2012 (Lohmann-Haislah, 2012) demonstrate that mental disorders are responsible for more than 53 million days of sick leave and 41 percent of the early retirement have psychic causes. The illness rate of the emergency service employees is exceptionally high just as the stress load (Badura, Ducki, Schröder, Klose, & Meyer, 2012). In view of the stressors as well as the quantification of the stress load in the occupational group of emergency service, only studies are given to firefighters (Wagner, Heinrichs & Ehlert, 1998), nurses (Alexopoulos, Burdorf, & Kalokerinou, 2003), ambulance service workers (Clohessy & Ehlers, 1999) and surgeons (Shanafelt et al., 2009). A special and less researched occupational group in regards to these topics are the emergency physicians (EPs) of helicopter emergency medical service (HEMS).

In view of the work profile with i.a. long working days, change of shifts, variety of missions and less recovery phase EPs bearing an increased risk for the development of acute and chronic stress in regard to the *general adaptation syndrome* (Selye, 1983). Also concerning the *job demand-control*

model (Karasek, 1979) EPs with high job demand (e.g. time-pressure, risk of taking the wrong decisions) and low job control (e.g. unpredictability, constant alert) can be characterized as a high-strain job. The stress research concentrated up to now mainly upon the long-term stress effects or secondary diseases of emergency physicians. The survey of German EPs (Pajonk, Cransac, Müller, Teichmann, & Meyer, 2012) found clues of stress-related disorders in 16.8%, burnout in 4.1% and clinical depression in 3.1% of the participants. Previous studies indicate that the perceived stress of EPs on air ambulance workdays is not congruentially with the physiologically measured stress load (heart frequency), the symphatic activation during the missions is caused by the huge psychic pressure in the exceptional situation (Benzer, Niebergall, Posch, & Flora, 1991) and psychological stressors are presented especially in the alarm situation and the interaction with the patients (Carchietti, Valent, Cecchi, & Rammer, 2011). Also the physical and environmental characteristics of the air ambulance emergency missions with i.e. intermittent hypoxia, turbulence in flight, the type and altitude off light represented a stress load. Other Studies focused on clinical workdays of EPs and exhibited changes of hormonal and physiological stress parameters (raised serum cortisol, decreased HRV i.e. LF/HF) which are mainly influenced by day/night-shift, 14-/24-hour shift and number of life-and-death emergencies (Adams, Roxe, Weiss, Zhang, & Rosenthal, 1998; Baig et al., 2011; Dutheil et al., 2012, 2013; Machi et al., 2012).

Against the background of the quantification of the stress load the question positions itself after the influence of the stress level on the performance and security in the clinic and flight rescue service. Richard Thompson (1994) shows in his theory that the efficiency and the stress level behave like a reverse U function to each other, so that with very elevated stress level the efficiency decreases. First experimental studies present no unequivocal data situation concerning this question. Hence, it is important, according to the regulation of the stress load of the EPs of HEMS to determine clear training and intervention fields to guarantee an improvement of decision-making processes, safety standards and physiological recovery.

In order to prevent sick leave and to minimize security risks, the amount of stress must be determined on the basis of multidimensional parameters. Therefore the aim of this study was to measure and compare the stress load of EPs of HEMS on air ambulance and clinical workdays. We hypothesize that the CAR and the HRV of EPs of HEMS differs on working days in comparison to the rest day with higher cortisol levels and stronger sympathetic activation of the autonomic nervous systems (ANS) on working days. With the help of the study results clear statements should be met to security risks in the clinic and air emergency medical service as well as to training and intervention fields to the improvement of decision-making processes and standard of safety.

2. Methods:

2.1 Study Participants

The recruitment occurred in cooperation with the clinic of trauma and reconstructive surgery at the Dresden university hospital (Germany). All of the participants were healthy EPs and crewmembers of

the helicopter emergency medical service (HEMS) of Dresden (Christoph 38 helicopter). The participation followed on voluntary basis and in order to control factors that influence the cortisol level we request information of smoking, medication, oral contraceptive intake etc. by anamnesis questionnaire. Table 1 described the characteristics of the 17 male and three female EPs who completed the study. The study protocol was approved by the local Ethics Committee of the Medical Faculty of the Technical University of Dresden, Germany (No#EK348092011).

Table 1. Characteristics of participants

Total, N	20
Females, n	3
Males, n	17
Age (years), M (SD)	44.95 (4.80)
Cigarettes/day, M (SD)	7.25 (3.43)
Contraceptive pill, n (%)	13 (66.6)
Medication intake, n (%)	3 (14.3)
$PASA_{PRIMARYAPPRAISAL}$, M (SD)	3.09 (0.55)
$PASA_{SECONDARYAPPRAISAL}$, M (SD)	5.18 (0.57)
$PASA_{STRESSINDEX}$, M (SD)	-2.09 (0.80)
$TICS_{SSCS}$, M (SD)	13.70 (7.81)

2.2 Design and procedure

The field study (*within-subjects design*) was designed to recorded hormonal, physiological and self-perceived stress levels at different workdays of 20 EPs of HEMS. The measurement of the salivary cortisol after waking up on a working day and the recording of the heart rate variability during working hours were carried out by each subject within a time window of two weeks at an air ambulance and clinical workday as well as on rest day at home. Figure 1 illustrates the measurements and samples times on the three testing days. Additionally to assess the subjective cognitive situational appraisal and chronic stress perception we collected the two psychological questionnaire PASA (Gaab, 2009) and TICS (Schulz et al., 2004) before the first testing day. The choice of standardized test conditions and uniform examination procedures served to ensure the best possible assessment of the stress load. Because of this we orientated by implementation and analysis of the CAR and HRV to recommendations of the International Society of Psychoneuroendocrinology (ISPNE) (Stalder et al.,

2016), Task Force of The European Society of Cardiology(ESC) and The North American Society of Pacing and Electrophysiology (NASPE) (Task Force of The European Society of Cardiology and The North American Society of Pacing and Electrophysiology, 1996).

2.3 Cortisol awakening response (CAR)

For the quantification of the hormonal stress load, the cortisol awakening response (CAR) based on salvia samples is a frequently used method in research. It is a stable comparison value and in addition to stress diagnosis also has connections with various risk factors (Powell & Schlotz, 2012; Wüst et al., 2000). On the three testing days, the saliva samples were collected after waking up, and 15 and 30 minutes later by moistened a cotton roll for 1-2 minutes in the mouth and then placed it into a salivette® (Sarstedt, Germany). Because the cotton roll was taken from a plastic bottle with integrated chip (MEMS cap, AARDEX Group Ltd., Switzerland) we were able to control time intervals of the three cortisol samples. In order to avoid possible contamination of the samples, the subjects were advised not to eat, not to smoke, not to brush their teeth and to wash their hands before sampling in the 30 minute period after standing up (Buchtal, 2007). After thorough processing, the salivettes® were stored at 2-8 °C and protected from heat or direct sunlight (IBL International, 2016). Before the analysis, the saliva was isolated from the cotton roll by centrifugation. Subsequently, the cortisol concentration was analyzed by using the test method *luminescence immunoassay* (LIA).

2.4 Heart Rate Variability (HRV)

By monitoring the HRV, we were able to quantify the activity of the autonomic nervous system (ANS) with his sympathetic and parasympathetic regulation due to the workload. While the ability to various short-term external and internal stress stimuli in the form of changes in HRV is regarded as healthy and important (Curic, Meißner, Männer, & Morawetz, 2008), a permanent reduced HRV can be a sign of persistent psychological stress. HRV was recorded during the three testing days by the monitoring system *BioHarness 3.0* (Zephyr technology, USA). For this the EPs wore a chest strap with integrated sensor. The software *BioHarness Bluetooth* was used to make the readout process of the measuring devices with subsequent output of selected time-based and frequency-based HRV-parameters. In order to eliminate extra beats or erroneous values of the R-R interval data, the software *Polar ProTrainer 5* (Polar, Germany) was used to post process the recordings by an automatic filtering process method (filter power: moderate, minimum protection zone: 6 sqm).

2.5 Psychological assessments

The perceived chronic stress and anticipatory cognitive appraisal of the workload were measured by two instruments: (1) Schulz, Schlotz & Becker (2004) constructed the trier inventory of chronic stress (TICS) within the context of the interaction-related stress concept of Richter & Hacker (1998). It consisted 57-items with a five-point rating scale and evaluate nine interrelated factors of the psychosocial chronic stress retrospectively on the last three months. There is a representative sample of N = 604 persons (314 women and 290 men) as well as the fulfillment of psychometric requirements

of all scales by the ordinal *Rasch model*. (2) The questionnaire 'primary appraisal secondary appraisal' (PASA; Gaab, 2009) was developed on the basis of the transactional stress theory of Lazarus & Folkman (1984). The four cognitive appraisal processes 'threat', `challenge', `self-concept of own abilities' and `control expectancy' can be assess by answering 16 items using a six-point rating scale. Additionally the individual total load can be determined by using the tertiary scale ´stress index'. The factor analysis confirmed the distribution of the items on the scales and internal consistency exhibited good homogeneity values of Cronbach's α between .61 and .83 at the primary scale (Gaab, Rohleder, Nater, & Ehlert, 2005).

2.6 Statistical analysis

A power analysis showed that expecting a medium effect size of Cohen´s f = .25 and using an ANOVA for repeated measures as statistic test to prove within-factors of three testing days (significance level of p = .05; power of 80%) a total sample size of n = 27 subjects is needed. Therefore the small sample size must be taken into account when testing the hypotheses. Before inferential statistical analyses we prove that the data are normally distributed and used the natural log transformation in case of no normality of distributions.

First (1), for the quantification and comparability of the CAR, (1a) the area under the curve with respect to ground (AUC_G) and increase (AUC_I) as well as (1b) the delta between peak and baseline (Δ Peak-Base) were calculated (Fekedulegn et al., 2007; Pruessner, Kirschbaum, Meinlschmid, & Hellhammer, 2003). In order to analyze the hormonal stress parameters, ANOVA with repeated measurements (factor: testing-day) as well as post-hoc tests (Bonferroni correction) were applied. The homogeneity of variances was controlled by Mauchly's test of sphericity. The ANOVA results were corrected by Greenhouse-Geisser whenever necessary.

Second (2), to reflect the effects during the three testing days on the ANS we conducted the heart frequency and the HRV-parameters RDMSSD, LF/HF, SDNN and SD2. The data of parameter SD2 was subjected to natural log transformations because of no normally distributed data. Just as in the analysis of the CAR (1) we used ANOVA with repeated measurements (factor: testing-day) as well as post-hoc tests (Bonferroni correction).

Third (3), Pearsons´s correlations were carried out to specify the relationship between the objective stress parameter (CAR- and HRV-parameters) and the cognitive appraisal of workload (PASA) as well as the perceived chronic stress (TICS).

3. Results

(1) The morning salivary cortisol concentration of the EPs show large differences between the two working days and the rest day after waking up, and 15 and 30 minutes later (figure 2). The overall measurement results and the calculated values are summarized in table 2.

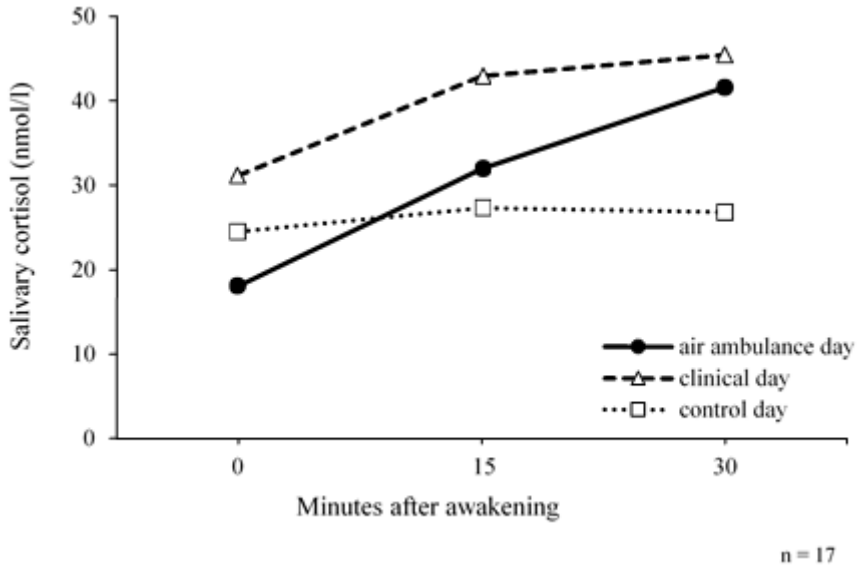

Fig. 2. Mean salivary cortisol levels on the three testing days at 0, 15 and 30 minutes after awakening

In regard to the CAR highly significant difference could be elucidated for the parameter AUG_G ($F(2, 38) = 12.809$, $p < .01$), AUC_I ($F(2,38) = 10.305$, $p < .01$) and delta ($F(2,38) = 10.802$, $p < .01$) between the three testing days as shown in table 2 + 3. Further post-hoc tests show that there are significant higher values on the clinical day compared to the rest day and the increase of the morning salivary cortisol concentration is stronger on air ambulance day than on rest day.

Table 2. Awakening salivary cortisol levels and derived parameters on the three testing days

parameter	**M (SD)**		
	air ambulance day	**clinical day**	**rest day**
Salivary cortisol (nmol/l) 0 minutes after awakening	18.09 (13.23)	31.17 (19.71)	24.49 (10.36)
Salivary cortisol (nmol/l) 15 minutes after awakening	31.98 (14.70)	42.93 (16.44)	27.32 (12.09)
Salivary cortisol (nmol/l) 30 minutes after awakening	41.61 (14.07)	45.45 (13.40)	26.80 (14.42)
Peak (nmol/l)	43.83 (14.26)	50.17 (14.40)	31.66 (13.63)
Δ Peak-Base (nmol/l)	25.74 (14.65)	19.00 (14.74)	7.16 (11.14)
AUC_G	61.82 (24.39)	81.24 (29.31)	52.96 (21.68)
AUC_I	25.65 (18.45)	18.90 (16.48)	3.98 (15.54)

Table 3. Results of ANOVA for repeated measurements with derived cortisol parameters (three testing days)

parameter	ANOVA time effect				post-hoc-tests (Bonferroni-Holm correction)		
	F	*df*	*p*	*η2*	*Air-D. vs. Clinical-D.*	*Air-D. vs. Control-D.*	*Clinical-D. vs. Control-D.*
AUC_G	12.809	2	.000***	.445	s.*	n.s.	s.***
AUC_I	10.305	2	.000***	.392	n.s.	s.***	n.s.†
Peak	17.132	2	.000***	.517	n.s. †	s.*	s.***
Δ peak-base	10.802	2	.000***	.403	n.s.	s.***	n.s. †

(2) As shown in figure 3 and table 4 the records of the HRV indicate high significant differences between the three testing days in the parameters LF/HF ($F(2,38) = 6.215$; $p < 0.01$) and SDNN ($F(2,38) = 6.369$; $p < .01$). Further post-hoc tests show that there were significant lower values in the parameter SDNN and significant higher values in the parameter LF/HF on clinical days compared to the air ambulance and rest day.

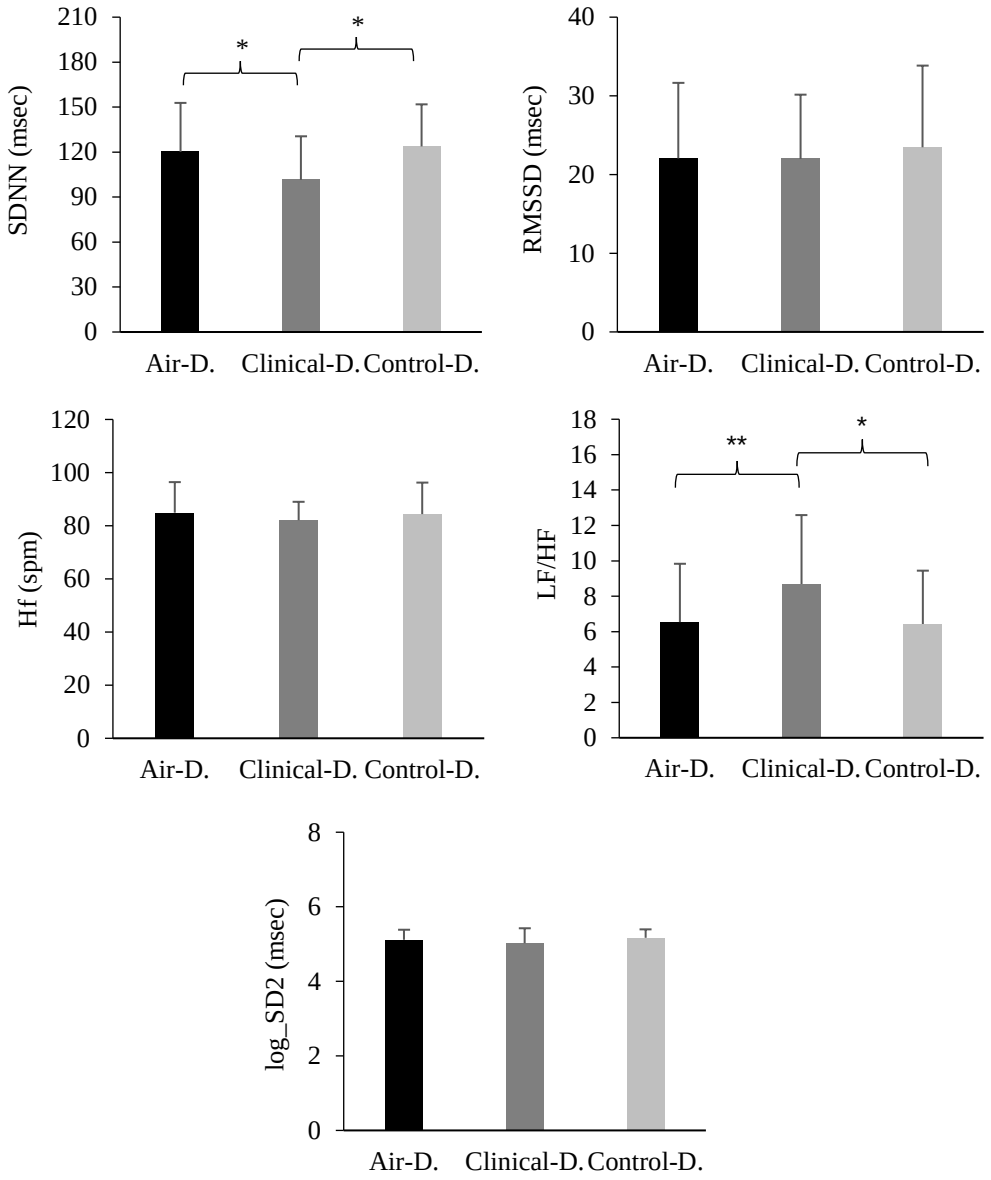

Fig. 3. Heart rate and heart rate variability (± SD) during the three testing days

Table 4. Results of ANOVA for repeated measurements with HRV parameters (three testing days)

parameter	**ANOVA time effect**				**post-hoc-tests** (Bonferroni-Holm correction)		
	F	*df*	*p*	*η2*	*Air-D. vs. Clinical-D.*	*Air-D. vs. Control-D.*	*Clinical-D. vs. Control-D.*
Hf	0.488	2	.618	.025	n.s.	n.s.	n.s.
RMSSD	0.314	2	.733	.016	n.s.	n.s.	n.s.
LF/HF	6.215	2	.005**	.246	s.**	n.s.	s.*
SDNN	6.369	2	.004**	.251	s.*	n.s.	s.**

log_SD2	1.685	2	.199	.081	n.s.	n.s.	n.s.

(3) Results of the questionnaire TICS indicate that the EPs have the strongest values in the scales 'work overload', 'social overload' and 'pressure to perform' with a large difference to the representative German sample. In regard to the relationship between the objective stress parameter (CAR- and HRV-parameters) and the cognitive appraisal of workload (PASA; Gaab, 2009) as well as the perceived chronic stress (TICS; Schulz, Schlotz & Becker, 2004) on the both working days there were no significant correlations (table 5).

Table 5. Pearsons correlations (r) between derived awakening cortisol parameters, HRV parameter and psychological assessment PASA, TICS

			PASA stressindex	*TICS WO*	*TICS SO*	*TICS PP*
air ambulance day	cortisol-parameter	AUC_G	-.122	-.097	-.226	-.074
		AUC_I	-.286	-.317	-.185	-.068
	HRV-parameter	HR	-.196	.125	.189	.451*
		LF/HF	-.169	.202	.012	.322
		RMSSD	-.095	-.343	-.192	-.415
		log_SD2	-.064	-.069	.144	.084
		SDNN	.020	-.076	.024	-.057
clinical day	cortisol-parameter	AUC_G	.176	.032	-.205	.020
		AUC_I	-.436	.054	.224	.448
	HRV-parameter	HR	-.150	-.248	-.185	.062
		LF/HF	-.170	.162	-.061	.129
		RMSSD	.114	.054	.154	-.016
		log_SD2	-.073	-.018	.143	.045
		SDNN	-.133	-.304	-.076	-.125

4. Discussion

This is the first study to analysis stress load on the basis of multidimensional parameters at different workdays of EPs of HEMS that shows an unexpected striking stress pattern. The present study has addressed not only the comparison of working and resting day but also specify the stress effect of air ambulance and clinical day.

The results showed significant differences between the three testing days in the salivary morning cortisol concentrations and calculated parameters of the CAR. Compared to the resting day, the EPs had markedly higher cortisol values and a stronger increase on both working days.

With regard to the physiological stress load the measurements indicated significantly lower HRV values on clinical days in the time-based parameter SDNN and the frequency-based parameter LF/HF compared to the Compared to the resting day but also to the air rescue work day. As expected, there were no significant correlations between the physiological or hormonal stress parameters (HRV & CAR) and the psychological assessments (TICS & PASA).

The EPs assessed their coping capacities higher than the burden of work and indicated ‘work overload’, ‘social overload’ and ‘pressure to perform’ as the most significant chronic stressors.

Only two other studies, to our knowledge, has come up with investigate the hormonal stress load of EPs but did not focus on the CAR. However, EPs had higher serum cortisol concentrations than physicians at the end of a clinical day (Baig et al., 2011) and they indicated higher IL-8 level after a 24-hour shift compared to 14-hour shift and a free day (Dutheil et al., 2013). The hormonal stress parameters significantly correlated with perceived stress, sleep duration as well as number of life-death missions. Because the hormonal stress parameters and their collection times differ from this study, further studies are added to the comparison of the results of the CAR. Compared to the normal values of Wüst et al. (2000) with a sample of N = 509 healthy participants, the EPs showed significantly higher values of the CAR as well as the initial and peak values in the first 30 minutes after awakening. It must be taken into account that the EPs also had high initial values on their resting day, which is clearly above the achieved values of the healthy sample. Similar results with regard to an increased morning cortisol concentration could also be detected in US police officers with peritraumatic and acute stress reactions (Inslicht et al., 2011) or in chronically stressed individuals due to work overload (Schulz, Kirschbaum, Pruessner, & Hellhammer, 1998). Besides the association between chronic stress and the CAR, the anticipation process of demands of the upcoming day (CAR Anticipation Hypothesis) can also have an influence on the CAR (Rohleder, Beulen, Chen, Wolf, & Kirschbaum, 2007). This effect is particularly noticeable in the cortisol concentration on the working days compared to the resting day of the EPs. The results of this study strengthen the CAR Anticipation Hypothesis so that it can be assumed that the anticipation of demands of working days has an influence of the CAR.

The recorded HRV parameters RMSSD, LF/HF and SDNN independent of the day showed significant differences compared to the normal values of the Task Force of NASPE & ESC (1996) and indicate a reduced HRV of the EPs. No difference can be observed for the RMSSD of the EPs between the three

testing days but they are 12 to 18 % lower compared to the normal values of the Task Force. With regard to the study by Dutheil et al. (2012), which examined the HRV of EPs at clinical, clerical, and free days, overall markedly reduced RMSSD values can be determined. It should be emphasized that the RMSSD values of the EPs of HEMS were even lower compared to the 24-hour shift of EPs from the clinical day (Dutheil et al., 2012). Overall, the reduced RMSSD values indicated a low activation of the parasympathetic and a slight recovery of the ANS. Also there are clear differences in the HRV-parameters SDNN and LF/HF to the normal values of the Task Force. However, lower values in the SDNN and higher values in the LF/HF are shown at clinical days compared to the other two testing days. Two other studies measured similar increased LF/HF ratios on clinical working days of EPs (Adams et al., 1998; Dutheil et al., 2012). Therefore, with regard to the differences between the two working days, it can be assumed that on clinical days a higher sympathetic activation took place due to the stronger working intensity in the form of the numerous missions compared to air ambulance days. Based on the findings of Benzer, Niebergall, Posch & Flora (1991) it can be argued that a better assessment of the stress load on air ambulance days should be made by distinguishing between mission and resting phases.

In conclusion, significantly higher increases or higher initial cortisol concentration as well as a low HRV were found in the investigated EPs of the HEMS on air ambulance and clinical days. The elevated CAR showed an increased activation of the HPA axis and indicated an adaptation of stress axis regulation to chronic stress induction and a lack of recovery. The low HRV with sympathetic dominance and lack of recovery suggests that due to the chronic stress induction and the lack of recovery an adaptation of the ANS took place in the form of a vegetative imbalance with sympathetic dominance. It can be concluded that, with respect to the psychobiological stress model of McEwen (McEwen & Lasley, 2003) work-related stressors persist too long or the stress response exaggerates (allostatic load) due to the chronic stress induction and lack of recovery. As a consequence, this prolonged response without recovery can lead to harmful effects on the organism. The assumption is supported by the general adaptation syndrome of Selye (1983), so that the described work stress profile of the EPs with i.a. working-time stressors of long working days, change of working shifts and a large number of missions does not offers sufficient recovery phases. Especially the high demands of the everyday burden of the EPs can be quantified by the questionnaire TICS, so that the scales ‘work overload’, ‘social overload’ and ‘pressure to perform’ showed clearly high values.

Dutheil et al. (2012) observed in their study a positive coping mechanism in the HRV from working day to resting day for EPs, and still asked what long-term impact this mechanism has on health. This recovery mechanism cannot be ascertained in this study by the EPs of HEMS. Additionally the increased CAR values show a stronger activation of the HPA axis and indicate an adaptation of the stress-axis regulation to chronic stress induction and a lack of recovery. Therefore, with regard to the results of this study, the question of Dutheil et al. (2012) should be modified in: what might be the long-term effects of the increased activation and lack of recovery on the health of EPs? In many studies, reduced HRV is considered as a risk factor for cardiovascular and stress-related diseases (Cygankiewicz & Zareba, 2013; Mück-Weymann, Moesler, Joraschky, Rebensburg, & Agelink, 2002). Furthermore, people with severe depression have increased CAR values compared to a healthy control group (Dedovic & Ngiam, 2015), and there is an association of elevated CAR values with cardiovascular risk factors (Kuehl et al., 2015). Against the background of the quantification of the stress load the question positions itself after the influence of the stress level on the performance and security in the clinic and flight rescue service. The theory of Richard Thompson (1994) shows that the efficiency and the stress level behave like a reverse U function to each other, so that with very elevated stress level the efficiency decreases. First experimental studies present no unequivocal data situation concerning this question. Hence, it is important, according to the regulation of the stress load of the EPs of HEMS to determine clear training and intervention fields to guarantee an improvement of decision-making processes, safety standards and physiological recovery.

The strengths of this study are first, the determination of the stress load on the basis of multidimensional parameters with the distinction of the HPA axis and the ANS system. Second, the use of standardized, reproducible and frequently used methods in research lead to the reliable quantification of hormonal, physiological and psychological stress parameters. However, the main limitation of the experimental result is the small sample size of N = 20 EPs, so that it requires a replication of a statistically proven sample of N = 24 (Bortz & Döring, 2006). Concerning the objective control of cortisol sampling for CAR in the present study the control of the time intervals of the three cortisol samples was secured by MEMS cap. However, for an objective control of awakening time actigraphy should be used to insure the wake up time. Furthermore, the analysis does not enable us to determine a differentiation between the stress load and the anticipation of demands of the respective working day so that the CAR should be collected on the respective working day and the following day.

In conclusion, it is evident that this study has shown that EPs of HEMS showed elevated CAR and low HRV with sympathetic dominance, which indicates an adaption of stress axis regulation to chronic stress induction and lack of recovery. With regard to the rising health costs, early screening and preventive interventions play an important role, especially in stress-related diseases, since they can prevent and minimize cost explosion. In the same way mistakes and wrong decisions have drastic consequences in the clinical and air ambulance work day, so that safety risks in emergency service due to the high stress load and stress axis regulation must also be considered in the context of work safety. Therefore in future research one should concentrate on how intervention can reduce increased hormonal reactivity and improve HRV as well as whether stress-induced cortisol affects performance and decision-making processes of EPs.

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Programmspezifischer Teil

a) Wurden die im Antrag formulierten Forschungsziele erreicht oder gab es Änderungen? Wenn ja, welche?

Im Antrag wurden sowohl Testungen bei Mitarbeitern der DRF Luftrettung gAG als auch bei bodengebundenen Rettungspersonal beantrag. Zum Zeitpunkt des Projektbeginns wechselten teilweise die Betreiber im Rahmen der öffentlichen Ausschreibung des Rettungsdienstes. Somit fand eine Umstrukturierung statt, so dass zum Teil die Betreiber von Rettungsdiensten, die ein LOI unterschrieben hatten, zunächst aus organisatorischen Gründen sich nicht mehr an der Studie beteiligt werden konnten. Aus diesem Grund wurde mit der Untersuchung bei den Mitarbeitern des Luftrettungsdienstes in Dresden begonnen. In dieser Studie wurden dann alle Mitarbeiter des Luftrettungsstützpunktes Dresdens (Notärzte, Rettungssanitäter und Piloten) untersucht. Um den stress load besser spezifizieren zu können, wurden Daten sowohl im Rettungsdienst, im Klinikdienst und an einem freien Tag erhoben. Als Parameter wurde die morgentliche Cortisolaufwachreaktion, subjektive Beurteilung via Fragebogen sowie die HRV über den gesamten Dienst untersucht.
Durch die auffallend hohen Morgencortisolwerte (Konsultation mit Prof. Dr. Clemens Kirschbaum) wurden die Morgencortisolwerte am Rettungstag noch ein zweites Mal wiederholt, um den Einfluss von Messfehlern ausschließen zu können. Allerdings blieben die Morgencortisolwerte so hoch auffällig, was ein interessantes Ergebnis der Studie darstellt.
Durch die Kooperationen mit den bodengebundenen Rettungsstellen in Bielefeld und des Spitalhospital Bern (entstanden auf dem Euphoria Kongress) können die ursprünglich beantragten bodengebundenen Rettungsdienstmitarbeiter jetzt noch in den nächsten Monaten erhoben werden.

b) Welcher wissenschaftliche Zugewinn wurde durch den Verbund erzielt? Wurden strukturelle Maßnahmen ergriffen, durch die die Zusammenarbeit gestaltet und der Verbund gestärkt wurde?

Der Luftrettungsstützpunkt in Dresden setzt sich aus nur 24 Personen zusammen. Diese Power ist ausreichend, um die Messwiederholungsverläufe über den Tag zu untersuchen. Um allerdings detailliertere Subanalysen durchzuführen, ist die Power nicht stark genug. Daher wurde eine Kooperation mit der Luftrettungs- und bodengebundenen Rettungsstation vom Inselspital Bern initiiert. Dort haben die ersten Testungen schon begonnen. So dass so eine größere Stichprobe für die Luftgestützte Rettung untersucht werden kann. Da in der Schweiz die Tätigkeit als Notarzt in der Luftrettung Teil der Facharztausbildung/der Rotation ist, können dadurch ferner Vergleiche der sehr erfahrenen Notärzte aus Dresden mit den jungen Notärzten aus Bern untersucht werden. In Dresden werden in der Luftrettung ausschließlich Fachärzte mit mindestens 5 Jahren Erfahrung im bodengebundenen Rettungsdienst eingesetzt.

Darüber hinaus konnte, neben dem bodengebundenen Rettungspersonal aus Bern, die bodengebundene Rettungswache in Bielefeld zur Teilnahme gewonnen werden. So kann eine große Stichprobe auch an bodengebundenen Rettungspersonal hinsichtlich des stress load untersucht werden.

Ebenfalls durch den Vortrag auf dem europäischen Kongress Euphoria konnten Kontakte zu dem Institut für Notfallmedizin in München hergestellt werden. Mit diesem Institut ist ein reger wissenschaftlicher Austausch entstanden. So werden momentan die Simulationstrainings in den

Ausbildungen der Rettungsteams in Kooperation gemeinsam untersucht. Ferner ist darüber hinaus ein DFG-Antrag in Bearbeitung, in dem die Simulationstrainings unter hoch-/niedrig Cortisolkonzentration (Gabe von Cortisone) untersucht, um den Effekt dieser hohen Cortisolkonzentrationen der Notärzte (gefunden in unser Studie) auf die Performanz und Sicherheit zu betrachten.

Durch diese Vernetzung und Bildung eines Forschungsverbundes (Dresden, Bern, München) konnten strukturelle Maßnahmen geschaffen werden, die eine exzellente Datenerhebung und interessante Forschung ermöglichen.

c) In welcher Form fand eine thematische oder örtliche Schwerpunktsetzung statt?

Angeregt durch die Forschungsförderung und das vorliegende Forschungsprojekt ist eine Trauma-Forschungsgruppe entstanden. Diese setzt sich aus den Kollegen der DRF Luftrettung gAG Dr. Jörg Braun (Fachbereichsleiter Medizin der DRF Luftrettung und Dr. Ulf Aschenbrenner (Leiter des Bereichs QM der DRF Luftrettung), Dr. Mark Frank (Leiter der interdisziplinären Notaufnahme Görlitz, Ärztlicher Leiter des DRF-Stützpunkt Dresden), Dr. Jaroslaw Pyrc (Leiter der Chirurgischen Notaufnahme, UKD Dresden) und Prof. Dr. Katja Petrowski (Psychosomatik, UKD Dresden). In diesem Team werden die deutschlandweiten Daten der DRF Luftrettung aus unter den Gesichtspunkten Suizide, Performance und Stress ausgewertet und publiziert.

d) Wie schätzen Sie die internationale Sichtbarkeit der Forschergruppe ein?
Die internationale Sichtbarkeit der Ergebnisse ist hoch, da alle Ergebnisse international publiziert werden. Ferner wurden schon erste Ergebnisse auf dem Europäischen Kongress zur Luftrettung (EUPHORIA) präsentiert. Weitere Ergebnisse sollen auf dem internationalen Kongress ISPNE (International Society of Psychoneuroendocrinology) im September 2017 vorgestellt werden

e) Durch welche Maßnahmen wurde der wissenschaftliche Nachwuchs gefördert?
Im Rahmen des Projektes konnte ein Masterstudent seine Qualifikationsarbeit absolvieren sowie zwei Doktorarbeiten geschrieben werden.

f) Welche Maßnahmen zur Gleichstellung von Wissenschaftlerinnen und Wissenschaftlern wurden umgesetzt?
In dem Forscherteam und in den untersuchten Probanden befanden sich leider nur Männer und so konnte in diesem Projekt keine Maßnahme umgesetzt werden.

g) Ggf. Transferaspekte: Wurden aus Anwendungssicht Fortschritte gegenüber dem Stand der Technik erreicht und wenn ja, welche? Lassen sich daraus Folgeprojekte ableiten?

Die hohen Cortisolkonzentrationen bei den Notärzten vor Beginn des Dienstes waren das auffälligste Ergebnis dieser Studie. Vor diesem Hintergrund stelt sich die Frage für die Praxis: Inwiefern diese hohen Cortisolkonzentrationen bei den Notärzten die Performance oder die kognitive Leistungsfähigkeit beeinflussen? Dadurch ist ein DFG-Antrag/-Studie in Bearbeitung, in dem die Simulationstrainings unter hoch-/niedrig Cortisolkonzentration bei den Notärzten (Gabe von Cortisone) untersucht, um den Effekt dieser hohen Cortisolkonzentrationen der Notärzte (gefunden in unser Studie) auf die Performanz und Sicherheit in der realen Situation zu betrachten.

Übersichten und Verzeichnisse

Promotionen:

Name, Vorname	Alter zum Zeitpunkt d. Promotion	Abschluss der Promotion in welcher Förderphase des Projektes
Fröbisch, Daniela	23	Abschluss geplant Ende 2017
Schöniger, Christian	28	Abschluss geplant Ende 2017

Masterarbeiten:

Name, Vorname	Alter zum Zeitpunkt d. Masterarbeit	Abschluss der Promotion in welcher Förderphase des Projektes
Herhaus, Benedict	26	August, 2016

Veröffentlichungen und Patente aus der Forschergruppe

1. Katja Petrowski, Christian Schöniger, Benedict Herhaus, Mark Frank & Jaroslaw Pyrc: Stress Load in Emergency Service: effects on CAR and HRV of emergency physicians of HEMS at different working days.
   (Veröffentlichung submitted in Emergency Medicine)
2. Christian Schöniger, Mark Frank, Jaroslaw Pyrc & Katja Petrowski: Continuous analysis of HRV of emergency physicians of HEMS over the different working days to specify the work load.
   (Veröffentlichung geplant)
3. Christian Schöniger, Mark Frank, Jaroslaw Pyrc & Katja Petrowski: Comparison of HRV of emergency physicians of HEMS for the different amounts of emergency operations to specify the work load.
   (Veröffentlichung geplant)
4. Daniela Fröbisch, Christian Schöniger, Mark Frank, Jaroslaw Pyrc & Katja Petrowski: Comparison of HRV of emergency physicians of HEMS and clinic physician over the different working days to specify the work load.
   (Veröffentlichung geplant)
5. Benedict Herhaus, Christian Schöniger, Mark Frank, Jaroslaw Pyrc, Katja Petrowski: Vergleich der physiologischen Stressbelastung von Notärzten des luftgebundenen Rettungsdienstes an Klinik- und Flugrettungstagen
   (Vortrag auf dem Deutschen Kongress für Psychosomatische Medizin und Psychotherapie am 23.03.2017)