STRESS AND JOB PERFORMANCE OF AEROMEDICAL CREWMEMBERS: THE ROLES OF SALIVARY CORTISOL AND SOCIAL SUPPORT

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ABSTRACT

Perceived stress may negatively affect job performance. Perceived stress is known to alter physiological responses, including cortisol response. Cortisol affects working memory and may explain how stress affects performance. Aeromedical crewmembers transport wounded soldiers in the austere aeromedical environment. The demands of the Aeromedical Evacuation (AE) may lead to stress and impact job performance. The AE training mission simulates real world operational missions and this setting was used to examine the effects of perceived stress on job performance among aeromedical crewmembers at different time points during the mission (Time 1- baseline, Time 2 - pre-flight, Time 3 - in-flight, Time 4 - post-flight).

The specific aims for this study were to: (1) determine the effect of perceived stress (Times 1, 2 & 3) on salivary cortisol response (Times 1, 2, 3, & 4) and individual and team job performance (Times 2, & 3) after controlling for covariates; (2) assess if salivary cortisol response (Times 2 & 3) mediates the relationship between perceived stress and individual and team job performance (Times 2 & 3); and (3) assess if perceived coworker social support (Times 1, 2, & 3) moderates the relationship between perceived stress and salivary cortisol response (Times 1, 2, & 3).

A convenience sample of 75 aeromedical crewmembers was enrolled as 15 distinct 5 person crews, selected from six aeromedical evacuation units in the United States. Data were analyzed using Pearson correlation coefficients, followed by
regression modeling using Generalized Estimating Equations (GEE) to control for the potential effect of team membership. Findings of this descriptive, cross-sectional study indicated that higher levels of perceived stress were not associated with higher levels of salivary cortisol response at any time point considered. Similarly, perceived stress did not have a main effect on job performance (individual or team) at any time point. Finally, perceived social support from co-workers did not moderate salivary cortisol response at any time point. The lack of control for several confounders for salivary cortisol may have affected the findings in this study. Future studies are needed to understand how perceived stress affects individual and team job performance in aeromedical personnel.

Keywords: aeromedical evacuation, perceived stress, salivary cortisol, job performance (individual and team)
DEDICATION

This dissertation is dedicated to my parents, Sherman and Lula Shamburger. Although they did not live to see me achieve this accomplishment, both called me “Dr. Tracy” long before I enrolled in doctoral studies. I know you would be proud!. To my Sister Sharon and her husband, Ronald, thank you for helping with my daughters, Jana and Jada, while I was consumed with work, school, and military obligations. Thanks does not seem enough for you for helping me protect my gifts in my absence! To my family, and close friends, thank you for your encouragement. Finally, to my daughters, I am especially grateful for your love, patience and understanding during this journey. The two of you have been my inspiration and the reason, I did not give up!! I love you!
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CHAPTER 1
INTRODUCTION

Statement of the Problem

Stress is a common and significant workplace hazard in the United States (US) (Specter, 2002), with 80% of U.S. workers reporting that they had experienced some level of stress at work according to a 2000 Gallup Poll by the Marlin Company (American Institute of Stress, n.d.). Stress is the result of the individual’s perception of stressors in their work environment as taxing or exceeding available resources (Cohen & Wills, 1985; Lazarus & Folkman, 1984). Stressors in the work environment include noise, workload, and hazardous conditions that may be perceived as stressful based on the individual’s appraisal. High levels of job stress have been reported in military personnel, which has been associated with a variety of mental health and job performance outcomes including depression, anxiety, increased mistakes and accidents, and decreased productivity at work (Hourani, Williams, & Kress, 2006; Pflanz & Ogle, 2006).

With increased wartime and disaster missions following 9/11, high levels of stress may be more pervasive among military personnel. Higher levels of stress among military personnel are not limited to those who are deployed or exposed to combat (Pflanz & Ogle, 2006) but extend to all military personnel. All military personnel are exposed to less personal control and certainty; frequent and extended deployments; long and unpredictable work hours; being on call for unexpected problems or emergencies; and meeting the expectation that the military mission comes first (Hopkins-Chadwick &...
Ryan-Wenger, 2009; Vinokur, Pierce, & Buck, 1999). Both military women and men are exposed to a wide range of stressful events as a part of military training and work assignments. Recent survey data showed that 27% of military personnel suffered from significant job stress during their present noncombat military jobs and that 54.7% reported that job stress further decreased their function on the job (Bray et al., 2009). It is clear that job stress is a potential threat to optimal job performance in the military work environment (Driskell, Johnston, & Salas, 2001; Driskell, Salas, & Johnston, 1999).

In civilian populations, it is well documented that increased stress at work can reduce productivity; add to mistakes and accidents at work and absenteeism; amplify conflict with others; and cause physical and emotional problems (Spector, 2002; The National Institute for Occupational Safety and Health [NIOSH], n.d.), which then may lead to poor life satisfaction (Pawar & Rathod, 2007). Many of these studies focused on health care professionals including nurses and physicians (AbuAlrub, 2004; Arora, et al., 2010; Kashani, Eliasson, Chrosniak, & Vernalis, 2010; Langelotz, Scharfenberg, Haase, & Schwenk, 2008; Miliken, Clements, & Tillman, 2007). In military populations, however, relatively few studies have been conducted on the effect of stress on job performance. The results of civilian studies may have limited generalizability to the military population (Hourani et al., 2006) due to the unique stressors and work environments that military personnel face. Therefore, more attention and research on the effect of stress on job performance are warranted in military populations and settings.

One of the major reasons for limited evidence on the stress-job performance relationship in military populations may be due to the limited feasibility of doing this type of study in military work environments, considering their unpredictable and urgent
nature. Training programs using simulations of challenging and realistic job task
scenarios may provide alternative settings for military research. It is also notable that
many civilian studies used self-appraisal of individual job performance (Regehr,
LeBlanc, Jelley, & Barath, 2008), but not an objective assessment of job performance in
both individual and team aspects, partly due to the lack of appropriate measurement tools.
Given the fact that team performance, in addition to individual performance, is
instrumental to military missions, it is essential to understand both individual and team
job performance and their relationships with stress using objective assessments of
individual and team job performance.

Stress appraisals by an individual trigger various physiological responses such as
the production of cortisol (Habib, Gold, & Chrousos, 2001; Kemeny, 2003). An
increased release of cortisol, as a biomarker for activation of the hypothalamic-pituitary-
adrenal (HPA) axis, is found to be associated with impaired cognitive function and
working memory (Dickerson & Kemeny, 2004; Lupien, Gillin, & Hauger, 1999; Oei,
Everand, Elzinga, Well, & Bermond, 2006). These findings imply that cortisol response
may be one of the underlying physiological mechanisms in the stress-performance link
(Hayne, Smith, & Vijayasarathy, 2005). Specifically, the impairment of cognitive
function and working memory resulting from increased cortisol production due to stress
may lead to decrements in performance.

In addition, social support has been identified as a buffer of individual stress
response at work (Haber, Cohen, Lucas, & Baltes, 2007; Karlin, Brondolo, & Schwartz,
2003). Perceived social support is based on the individual’s perception that quality
assistance or behaviors that are matched to the person’s perceived needs will be available
when needed (Cohen & Wills, 1985; Cutrona & Russell, 1990). The belief that resources are available when needed may increase the perception of the individual’s ability to cope with a demand, thereby buffering the stress response (Cohen & Wills, 1985).

Social support is thought to act as a buffer on the stress continuum at several points (Cohen & Wills, 1985). First, social support may decrease the stress appraisal by enhancing one's perception of coping abilities. Secondly, social support may eliminate or dampen physiological responses to the perceived stressful event (Cohen & Wills, 1985). In the workplace, perceived social support from co-workers has been shown to moderate perceived stress appraisals by the individual (AbuAlRub, 2004). Interestingly, the impact of social support on workers may vary based on gender, with women noted to have greater benefit from social support than men (Barbee, et al., 1993). However, no published studies to date have examined the relationships among stress, cortisol response, social support, and individual and team job performance simultaneously in military settings.

Aeromedical Evacuation (AE) involves the transport of wounded soldiers and civilians during combat and noncombat missions by aeromedical crewmembers in the United States Air Force (Active Duty and Reserve) and Air National Guard (Pierce & Evers, 2003) and is considered a critical link in the safe transport of the wounded soldiers (Brannon, 2005). The aeromedical evacuation environment exposes patients and crewmembers to the “stresses of flight,” which include decreased partial pressure of oxygen, barometric pressure and thermal changes, decreased humidity, noise, and vibration (Air Force Instruction [AFI] 41-307, 2003, p. 18; Pierce & Evers, 2003). AE missions also include resource limitations, time pressures, multitasking requirements, and
uncertainty of patient numbers and conditions (Pierce & Evers, 2003). The stressors in the unique and complex aeromedical environment require crewmembers to think of the “worst case scenario” (Pierce & Evers, 2003, p. 223) to ensure an effective mission and may lead to feelings of stress on the job.

The United States Air Force incorporates simulated training missions to train aeromedical crewmembers for real world operational missions using realistic patient care and mission management scenarios. These simulations use actual military aircraft and include all phases of real world operational missions, including pre-flight, in-flight and post-flight. Both active and reserve aeromedical crewmembers are required to complete recurrent training using challenging AE training missions or actual real world missions at least every 90 days to maintain their qualification (Air Force Instruction [AFI] 11-2AE-1, 2010). Five crewmembers, two flight nurse officers and three enlisted medical technicians, are assigned a crew role for each training mission. The Aeromedical Evacuation checklist and expanded checklist (AFI 11-2AE-3, 2010) provides guidance for mission planning for crewmembers during the mission, allowing qualified crewmembers to perform individual and team performance tasks without instruction through each phase of the mission, and to respond to the mission demands embedded in the mission scenario. A sixth aeromedical crewmember, the mission crew coordinator (MCC), is also designated for all AE training missions to initiate scenarios including simulated emergencies, and evaluate performance of the five person crew. Only the five persons designated in crew roles for the training mission were recruited for this study.

A challenging aeromedical training mission was operationalized as a mission during which there are unexpected changes in the mission such as a patient surge
resulting in requiring changes to the patient load plan; calculations of oxygen and
electrical requirements for patients with complex problems that may require Advanced
Cardiac Life Support (ACLS) during flight, and management of aircraft emergencies,
such as a fuselage fire in-flight. Because of its close reflection of real missions and worst
case scenarios, the challenging simulated AE training mission provides an opportunity to
examine the effect of stress on job performance and the roles of salivary cortisol response
and social support on stress response and job performance in a very complex work
environment. Moreover, the challenging simulated AE training mission is well structured
to develop objective assessments for both individual and team job performance.

For this study, individual job performance was defined as the effectiveness by
which critical observable tasks are completed independently by an individual
crewmember in response to a challenging scenario embedded during various phases of
the aeromedical mission (pre-flight and in-flight). Team job performance was defined as
the effectiveness by which critical observable team processes such as communication,
coordination, adaptation, and back-up behaviors are completed interdependently by the
aeromedical team in response to a challenging scenario embedded during various phases
of the aeromedical mission (pre-flight and in-flight). Aeromedical crewmembers are
trained on the effective use of team performance behaviors including communication,
coordination, leadership, back-up behaviors, adaptability, and situational awareness under
worse case scenarios at least every 90 days through classroom facilitated Crew Resource
Management (CRM) training (AFI 11-2AE-1, 2010). CRM is based on principles that
performance (individual and team) may decrease under crisis (LeBlanc, 2009). The
recurring requirement of CRM training for all qualified aeromedical crewmembers
ensures that qualified crewmembers have been exposed to the effective job performance processes under challenge.

Although Salas, Sims, and Burke (2005) identified key aspects of team performance processes such as communication, backup behaviors, and adaptability, not all of the team processes may be needed to complete a specific task. Additionally, individual tasks, as noted in AFI 11-2AE-3 (2010), vary based on specific tasks and phases of the mission. Therefore, distinct measurements of individual and team job performance were developed for this study based on the specific job tasks required at each time point of the study based on the Air Force Instructions (AFIs) and later validated by a team of aeromedical content experts.

There are several potential covariates that needed to be controlled in this study. Lower ratings of chronic background stress have been noted to affect responses to acute stress demands, which may influence performance (Matthews, Gump, & Owens, 2001; Schaubroeck & Ganster, 1993; Taylor, et al., 2009). Job experience (Lieberman et al., 2005; Wetzel, et. al. 2006), age (Matthews, Davies, Westerman, & Stammers, 2000), gender (Matthews et al., 2000), and rank (Driskell, & Salas, 1991) also have been noted to influence individual and team performance. Therefore, perceived background stress, job experience, age, gender, and rank were included in the analyses as potential covariates for the relationship between acute stress and job performance.
Purpose of the Study

The purpose of this study was to examine the effects of perceived stress, salivary cortisol response, and coworker social support on individual and team job performance among aeromedical crewmembers during a challenging simulated AE training mission. During the training mission, data were collected four times during a 2.5-3.5 hour training mission: before the mission brief (baseline or Time 1); at the end of the pre-flight configuration of the aircraft (Time 2); at the end of the in-flight emergency (Time 3); and post-flight at the end of the mission brief (Time 4). Perceived stress and co-worker social support ratings were collected at Times 1, 2, and 3. Salivary cortisol was collected at Times 1, 2, 3, and 4. Individual and team performances were examined during the mission brief and configuration, corresponding with Time 2, and during the in-flight emergency, corresponding with Time 3.

Specific Aims and Hypotheses of the Study

The specific aims and hypotheses of this study were to:

1. Determine the effect of perceived stress (Times 1, 2 & 3) on salivary cortisol response (Times 1, 2, 3, & 4) and individual and team job performance (Times 2, & 3) after controlling for covariates (perceived background stress, experience, rank, gender, and age).

Hypothesis 1a: Crewmembers with higher levels of perceived stress at Times 1, 2, and 3 will have higher levels of salivary cortisol response at Times 1, 2, 3, and 4.

Hypothesis 1b: Crewmembers with higher levels of perceived stress at Times 1, 2, and 3 will show lower levels of individual job performance at Times 2, and 3.
Hypothesis 1c: Crews with higher perceived stress scores at Times 1, 2, and 3 will show lower levels of team job performance at Times 2 and 3.

2. Determine if salivary cortisol response (Times 2 & 3) mediates the relationship between perceived stress and individual and team job performance (Times 2 & 3) after controlling for covariates (perceived background stress, experience, rank, and age).

Hypothesis 2a: Salivary cortisol response at Times 2 and 3 will mediate the relationship between perceived stress and individual job performance at Times 2 and 3.

Hypothesis 2b: Salivary cortisol response at Times 2 and 3 will mediate the relationship between perceived stress composite score and team job performance at Times 2 and 3.

3. Determine if perceived coworker social support (Times 1, 2, & 3) moderates the relationship between perceived stress and salivary cortisol response (Times 1, 2, & 3.)

Hypothesis 3: Perceived coworker social support will moderate the relationship between perceived stress and salivary cortisol response at Times 1, 2, and 3.

Significance of the Study

Perceived stress is a common experience in the workplace. Aeromedical Evacuation (AE) exposes crewmembers to the aeromedical environment that is characterized by unique and challenging stressors that may result in perceived stress. Perceived stress may negatively affect job performance (individual and team) (Driskell & Salas, 1991) which are essential to the aeromedical evacuation mission. Limited research is available regarding military aeromedical crewmembers that represent the disciplines of
nursing, aviation, and the military. The findings of this study may provide further understanding on the relationship between stress and job performance of aeromedical crewmembers in the challenging AE environment. Furthermore, this study may suggest a need for the development of effective stress management interventions and coworker social support, which could improve performance and ultimately improve military patient care.

Conceptual Framework

This study was guided by the physiological model of stress (Selye, 1956) and the transactional model of stress and coping (Lazarus & Folkman, 1984). The physiological model of stress explains how various forms of stress alter neuroendocrine and immune responses, triggering local and general adaptations but leading to negative health consequences when adaptation is exhausted. Selye (1956) defined stress as the nonspecific response of the body to any stressor, which has been criticized because different stressors can elicit different neuroendocrine responses, and psychophysiological responses to the same stressor greatly differ among individuals (Lazarus & Folkman, 1984).

In the transactional model of stress and coping, a person-environment relationship is explained to be dynamic and is determined by perception or cognitive appraisal and coping of the person in his/her transaction with the environment. An event itself in the environment is neutral. It is up to the person’s appraisal through which the meaning of the event is determined. Thus, through primary and secondary cognitive appraisals, the same event can be appraised differently among individuals. Once a person appraises the
event to be stressful (i.e., primary appraisal), further appraisal will occur, at which time
coping efforts can be employed to reduce or eliminate the threat (i.e., secondary
appraisal; Lazarus & Folkman, 1984). The process is interactive and the reappraisal of
the event may feed back to primary appraisal unless the stressful event is resolved.

In this study, a challenging simulated AE training mission may be a stimulus or
stressor to AE crewmembers. One crewmember may appraise the stressor differently
from the other crewmembers (i.e., perceived stress), which represents primary appraisal
of a stressor. Depending on appraisal of a stressor, each crewmember may show different
physiological responses, such as salivary cortisol response, through the activation of the
hypothalamic-pituitary-adrenal (HPA) axis. These stress-induced physiological
responses may lead to adverse behavioral and health outcomes, such as decreased job
performance in this study. Coworker social support is also posited to moderate the stress-
induced salivary cortisol response because social support may function as a coping
resource. Therefore, the major purposes of this study were to examine: (1) the effect of
perceived stress on individual and team job performance; (2) the mediating role of
salivary cortisol response in the stress-job performance relationship; and (3) the
moderating role of coworker social support in the stress-salivary cortisol relationship
among aeromedical crewmembers during a challenging simulated AE training mission
(see Figure 1).
Figure 1. Conceptual framework of the study
CHAPTER 2

REVIEW OF THE LITERATURE

Introduction

The content in this section will describe relevant findings in the literature regarding perceived stress and job performance. The sections are organized in the following order: Stress in the Military; Stress, the AE Mission, and AE Crewmembers; Stress and Job Performance; Methodological Issues of Measuring Perceived Stress; Methodological Issues of Measuring Job Performance; Task Specific Individual and Team Job Performance and Perceived Stress; Stress and Physiological Response (Salivary Cortisol); Social Support: Moderator in the Stress-Cortisol Relationship; Covariates to Job Performance; and Summary.

Stress in the Military

Stress is one of the biggest health-related problems in the workplace (Spector, 2002). Various studies have investigated job-related stress occurrence among various professions, including nurses, and found that 10 to 40% of civilian working populations reported suffering from serious job stress (Pflanz & Ogle, 2006). Similarly, military personnel are known to be under unique and significant stressors due to the extremely demanding characteristics of the military work environment (Hourani, et al., 2006; Ikin, et al., 2005). Considering the current ongoing deployment for combat operations including Iraq and Afghanistan, increased levels of stress may be more pervasive among...
military personnel. The increased level of stress among military personnel not only includes those who are deployed or exposed to combat, but also those in noncombat military jobs (Pflanz & Ogle, 2006).

Recent survey studies have identified that about 27% of military personnel in their present noncombat military jobs reported suffering from significant job stress (Bray et al., 2009; Pflanz & Ogle, 2006) requiring further mental health evaluation (Pflanz & Ogle, 2006). Data from the 1995 Department of Defense Survey of Health Related Behaviors among military personnel showed that both military men and women were nearly twice as likely to report higher levels of stress at work (39%) than in their family or personal lives (22%) (Bray, Camlin, Fairbank, Dunteman, & Wheeless, 2001), indicating the uniquely stressful military work environment and mission (Bray et al., 2001). In addition, job stress was noted to be highest among military personnel who were 25 or younger, married with spouses not present, and women (Bray et al., 2001; Hourani, et al., 2006). Additionally, high levels of job stress were related with mental health problems including depression, which was found to result in lower levels of job functioning (Bray et al., 2001; Hourani et al., 2006; Pflanz & Ogle, 2006). These reports together demonstrate the significance of job stress as an occupational health hazard in the routine military work environment, suggesting that prevention and intervention efforts for stress management should be a priority for the U.S. military to protect mental health and to enhance the productivity and efficiency of job performance of military personnel (Hourani et al., 2006; Pflanz & Ogle, 2006).
Stress, the AE Mission, and AE Crewmembers

Aeromedical evacuation (AE) is a system within the Air Force designed to provide patient care in the air during transport from the battlefield to higher levels of care (Cornelius, 2009). In military operations other than war, global mobility enables the medical team to be a primary part of missions involving humanitarian and civil assistance (AFI 41-307, 2003; Pierce & Evers, 2003). The aeromedical medical team is typically composed of two flight nurses and three aeromedical technicians (AFI 11-2AE-1, 2010). Flight nurses and aeromedical technicians can be active duty or members of the Reserve or National Guard; each having varying perceived background stress ratings, flight hours (job experience), age, gender, and rank. Reserve and Guard members hold civilian jobs (Cornelius, 2009) and serve in the military part-time. The members' civilian jobs may or may not involve healthcare. Active duty AE crewmembers also face increased operational deployments. It is an ambitious commitment and requires additional time to perform training and accomplish training and operational missions (Pierce & Evers, 2003).

The AE operational mission takes place in the unique and complex aeromedical environment, including the stresses of flight such as decreased partial pressure of oxygen, barometric pressure changes, thermal stresses, decreased humidity, noise, vibration, and fatigue (Pierce & Evers, 2003). While the decreased partial pressure of oxygen may have more of an influence on patients with respiratory compromise, leading to hypoxia and additional oxygen requirements (AFI 41-307, 2003); the potential implications of other stresses of flight on crewmembers are more obvious. Noise and vibration have been noted as stressors that lead to subjective appraisals of stress and diminished performance.
(Mellert, Baumann, Freese, & Weber, 2008); additionally, exposure to vibration may result in impaired visual acuity and muscle coordination (AFI 41-307, 2003). Barometric pressure changes may lead to trapped gas in cavities such as the stomach and ears (AFI 41-307, 2003) leading to gas or feelings of fullness in these cavities. During aeromedical evacuation missions humidity is diminished over time resulting in loss of moisture less than 1% after only four hours and needs for extra hydration (AFI 41-307, 2003), and finally thermal changes may result in hyperthermia and/or hypothermia (AFI 41-307, 2003). The contribution of these stresses of flight may cumulatively lead to fatigue, which is noted as an “inherent stress” of aeromedical evacuation (AFI 41-307, 2003, p. 21).

Another important characteristic of the AE mission is unpredictability. Pierce and Evers (2003) notes that the mission requires that “at any time, one can be called on to fly to remote areas and hostile sites where the environment is austere, threatening, and unfamiliar” (p. 223). During the flight, the crew administers medications, treatments, and comfort care to wounded soldiers or civilians, just as they would in a fixed facility. However, the absence of typical resources found routinely in most medical facilities such as a pharmacy, central supply, physicians, or other specialized staff during most aeromedical evacuation missions requires that aeromedical crewmembers be prepared for the “worst case scenario” (Pierce, & Evers, 2003, p. 223). Additionally, the mission is often wrought with the uncertainty of patient numbers and patient condition types. Teamwork is an essential attribute during the AE mission, requiring communication and coordination (Pierce & Evers, 2003) of efforts to accomplish mission goals. The high expectations and demands place AE crewmembers under stressful conditions similar to or
greater than other military settings, may compromise the integrity of AE missions if the
effects of stress are not addressed adequately.

Given the growing body of literature on stress and performance, there is a need to
explore the effect of stress on job performance among aeromedical crewmembers that are
exposed to high levels of job-related stress. However, the ethics of observation of
potential errors in performance during operational missions precludes conducting this
type of study. A number of studies have examined the effects of perceived stress on job
performance in healthcare (Grugle & Kleiner 2007; Leblanc et al., 2005) and military
populations (McNeil, 2007). There were no previous published studies identified in the
literature that have examined the effect of stress, especially mission-specific stress, on
individual and team job performance among aeromedical crewmembers. The present
study was designed to address this gap in the literature.

The Air Force has developed specialized training for aeromedical crewmembers.
The aim is to increase crewmembers ability to function successfully in such stressful
environments by incorporating challenging simulated AE training mission scenarios
during which performance is observed by a trained observer, the Mission Crew
Coordinator (MCC). Such simulations could be useful in exploring the effect of stress on
job performance. Moreover, the well scripted mission scenarios give the principal
investigator (PI) of this study the ability to implement triggers requiring critical AE
mission specific performance that would be expected during real world operations.
These trigger points provide defined measurement times for performance within the
specific mission scenario.
Stress and Job Performance

Stress is recognized as a significant factor affecting performance in various work settings including aviation (Hickman & Mehrer, 2001; McNeil, 2007), the military (Bray, et al., 2001; Hourani, et al., 2006; Pflanz & Ogle, 2006), healthcare, and other emergency settings (Fisher, Calame, Dettling, Zeier, & Fanconi, 2000; Milliken, Clements, & Tillman, 2007). Many civilian research studies related to job stress were focused on health care-related professionals including nurses, surgical teams, and medical staff in emergency situations (Sluiter, van der Beek, & Frings-Dresen, 2003). For example, high job stress was noted to lead to low job performance among nurses (Motowidlo, Manning, & Packard, 1986; Siu, 2002; Welker-Hood, 2006; Westman & Eden, 1996). Similarly, high levels of job stress among military personnel have been associated with a variety of mental health concerns including depression and anxiety. These mental health concerns in turn are significantly related with impaired job performance outcomes, including decreased productivity due to tardiness and missed work, injury at work, poor physical health, and increased interpersonal problems (Bray, et al., 2001; Hourani, et al., 2006; Pflanz & Ogle, 2006).

Much of the aviation stress research has focused on flight-related environmental stressors such as noise and vibration, which has been found to impair subjective performance appraisals, and diminish appraisals of health (Mellert et al., 2008). McNeil (2007) also found that altitude-induced hypoxia and aircraft noise negatively influenced individual performance during critical care delivery in a laboratory setting. Based on the description of AE missions and responsibilities of aeromedical crewmembers, aeromedical crewmembers could be a group extremely susceptible to job-related stress
because their duties are a combination of all three stressful fields including healthcare, military, and aviation. However, no published studies to date have been conducted to examine the relationship between stress, cortisol response, and job performance among military aeromedical crewmembers.

There were a few other researchers that reported conflicting findings on the stress and performance relationship. In some military stress research, stress appraisal was considered as a motivator to action (Hsieh, Huang, & Su, 2004) and improved performance (Kowalski-Trakofler, Vaught, & Scharf, 2003). Civilian studies also suggest that stress can help to improve performance by enhancing alertness, concentration, focus, or efficiency of actions unless that stress is so high as to be detrimental to various aspects of performance (Wetzel et al., 2006). However, it is important to note that these discrepancies in the literature may stem from the differences in measuring perceived stress and job performance.

Methodological Issues of Measuring Perceived Stress

In general, perceived stress in the literature was largely conceptualized as either general stress (e.g., depression, anxiety, and mood disturbance; LeBlanc et al., 2005; Lieberman, et al., 2005; Wetzel, et al., 2010) or job-related stress (AbuAlRub, 2006; McNeil, 2007). Whereas some researchers used multi-item structured instruments such as the Perceived Stress Scale (Kashani, et al., 2010; Martin, et al., 2006; Taylor et al., 2009) and the Profile of Mood States (Harris, Hancock, & Harris, 2005; Lieberman et al., 2005; Lieberman, Tharion, Shukitt-Hale, Speakman, & Tulley 2002), which were psychometrically validated, others used a single-item tool such as asking how much
stress participants experienced at work using simple descriptions of stress levels (a lot, some, a little, none at all) (Hourani et al., 2006). Some investigators used the visual analog scale (VAS) to quantify individual’s perceived stress rating (Langelotz, et al., 2008; Lindahl, Theorrell, & Lindblad, 2005; Takahashi et al, 2005). Perceived stress levels on the VAS have shown a positive correlation with physiological responses including salivary cortisol (Metzenthin, et al., 2009; Takahashi et al., 2005), indicating the ability of the VAS to reliably measure the perceived stress levels. For the purposes of this study with AE crewmembers in which both stress and salivary cortisol were variables of interest, the VAS was selected to allow assessment of the level of mission-specific perceived stress repeatedly over short periods of time during the AE training mission. In addition, perceived background stress was assessed, using the Perceived Stress Scale-10, as a potential covariate for this study.

Methodological Issues of Measuring Job Performance

Job Performance has been conceptualized and operationalized in many different ways in previous studies. Job performance in the literature was largely regarded as an aspect of productivity of performance or cognitive performance. Productivity of performance was assessed mostly by focusing on being late at work and missed work, injury at work, and poor physical health (Hourani et al., 2006), which does not reflect the task-specific performance required on the job. Additionally, cognitive performance was demonstrated by mistakes or errors by the individual during cognitive tasks or tests mostly in laboratory settings or removed from naturalistic work settings (Lieberman, et al., 2005; McNeil, 2007). However, cognitive function that may be performed
independently by an individual is only one aspect required for performance on the job; other components of performance such as communication, and coordination that require interaction with others or teamwork processes were not included. These separate approaches may not represent the complexity of the job performance concept. Specifically, in complex work environments such as the military and AE mission, teamwork is essential for ensuring effective task/mission completion, with communication and coordination noted as key processes for successful AE missions (Pierce & Evers, 2003). Additionally, many researchers used self appraisal of job performance (Wallenius, Larsson, & Johansson, 2004) although self appraisal of performance may not match with objective evaluation of performance (Eva, Cunnington, Reiter, Keane, & Norman, 2004). Few researchers have employed observational evaluation of job performance (Keijser, Schauteli, LeBlanc, Zwerts, & Miranda, 1995; McNeil, 2007, Grugle & Kleiner, 2007) and most observations occurred in laboratory settings. Only a few researchers employed both observational and self evaluations (Regehr, et al., 2008), noting the lack of match between observed and self performance ratings. For the purposes of this study, individual and team performance were evaluated using observation during actual AE training.

Task Specific Individual and Team Job Performance and Perceived Stress

Current evidence shows that both individual and team performance can be compromised by severe stress (Driskell & Salas, 1991). To better understand these relationships, some researchers have used simulations specific to the job/task. McNeil (2007) examined individual cognitive performance of 60 nurses from the military Critical
Care Air Transport Teams in performing advanced cardiac life support (ACLS) to a high fidelity mannequin with ventricular defibrillation in the simulated patient laboratory. The laboratory provided the stressors of flight including noise of 54 decibels and altitude at 8,000 feet, which was simulated with 15% oxygen administered via a mask. Participants were randomized to one of four groups by noise and altitude, and individual cognitive performance was videotaped. The videotaped performance was evaluated by one evaluator using a critical care checklist yielding a critical care score; calculating the critical care reaction times; and observing errors and omissions. Nurses under high noise and high altitude conditions demonstrated a lower critical care score and more errors than those under low noise and ground altitude. Another interesting finding was that altitude-induced hypoxia was related with physiological stress responses such as increased heart rate and respiratory rate (McNeil, 2007). However, missing was the appraisal of perceived stress in response to the environmental stressors and other physiological responses such as salivary cortisol. Additionally, the usual critical care transport team is composed of a nurse, physician, and a respiratory technician; therefore team performance could not be assessed because the study participants only included nurses and not the entire critical care transport team.

Civilian studies also have used realistic simulations consistent with actual job performance tasks to examine the effect of stress on job performance. For instance, Leblanc et al., (2005) examined the effect of stress on individual job performance among 30 non-military paramedics using a challenging scenario with a programmed high fidelity mannequin. In the scenario, the paramedics were required to treat a patient with respiratory distress in an ambulance setting, which was the high stress condition. The
low stress condition took place in a quiet classroom. Paramedics in the low and high stress conditions were asked to calculate dosages of emergency medications within one minute. Accuracy of drug dosage calculation was better in the low stress condition than in the high stress condition. Leblanc et al., (2005) also reported that the advanced paramedics performed better on the drug calculation task compared with the novice counterparts (61% vs. 40%), indicating the effect of experience on individual job performance. Again, this study did not assess perceived stress levels and physiological stress responses. Since simply being in a stressful condition or environment does not imply that the individual will perceive stress and trigger physiological responses, it is critical to include perceived stress measures as a component variable. Considering the nature of emergency response involving teams, including paramedics and AE teams, there is a great need for understanding team performance in relation to perceived stress.

A growing body of literature indicates that the appraisal of stress may lead to team performance decrements by lowering the quality of decisions; shifting to an individual focus from a team focus; decreasing the offerings of social supportive behaviors by team members (Driskell, et al., 2001); and decreasing effective communication among team members (Cannon-Bowers & Salas, 1998). These findings suggest that team performance is a complex concept focusing on team processes. However, there is relatively little research on the stress-team performance relationship. Grugle and Kleiner (2007) examined team performance of 10 Emergency Management Services (EMS) personnel under wearing chemical protective equipment, also known as Hazmat gear. Using simulation scenarios, five two-person EMS teams performed Cardiopulmonary Resuscitation (CPR) and spinal injury management (SIM) in Hazmat
gear and not in Hazmat gear. Team performance was assessed by evaluating adaptability, communication, and coordination using an event-based team performance measurement methodology (Fowlkes, Lane, Salas, Franz, & Oser, 1994). Team performance was assessed by noting the completion or absence of the team process, the individual team member completing the task was also noted, as well as errors and deviations. The researchers found that teams subjectively rated their overall performance as good regardless of the number of errors or error severity suggesting a need for objective performance measures. Moreover, certain team job performance tasks during a patient care emergency requiring CPR and SIM varied. For example the coordination performed by the team was significantly better than communication for the CPR task, whereas adaptability performance was better than communication and coordination for the SIM task (Grugle & Kleiner, 2007), indicating that team process tasks required within a job may be different across tasks.

The study findings by Grugle and Kleiner (2007) suggest many important points in conducting the proposed study. Most of all, there is a need to assess perceived stress appraisals because an environmental stressor, such as wearing Hazmat gear, does not imply that the individual will perceive stress and thereby trigger physiological and behavioral changes. Also the levels of perceived team performance may not be consistent with the actual quality of team performance, suggesting the potential bias by self-appraisal of job performance. Within the teamwork environment, individuals may perceive their performance better or worse than as it really is, showing the benefit of objective and observational evaluation of performance. No previous study was identified that examined both individual and team performance based on objective evaluations and
their relationships with perceived stress levels in AE. Therefore, this study examined the effect of perceived mission-specific stress on both individual and team job performance evaluated by two observers, the MCC and PI, during a challenging simulated AE training mission. Since different performance tasks are required during each phase of the AE mission (pre-flight and in-flight), separate tools were used to assess both individual and team performance during the pre-flight and in-flight phases of the mission.

Stress and Physiological Response (Salivary Cortisol)

It is widely accepted that psychological stress in an individual could produce physiological effects. One of the many and varied physiological responses resulting from the appraisal of stress include the activation of the hypothalamus-pituitary-adrenal (HPA) axis. The activation of the HPA axis produces a cascade of endocrine events. When an individual perceives or experiences stress, the hypothalamus may increase the release of corticotrophin-releasing hormone (CRH), which then stimulates the pituitary to release the adrenocorticotropic hormone (ACTH) into circulation. ACTH then stimulates the adrenal cortex to secrete the glucocorticoid hormones, most predominantly cortisol in humans (Charmandari, Tsigos, & Chrousos, 2005).

Cortisol is usually referred to as the “stress hormone” as it is involved in response to acute (Al’Absi et al, 1997; Kirschbaum, Wolf, May, Wippich, & Hellhammer, 1996) and chronic (Vedhara, Hyde, Gilchrist, Tytherleigh, & Plummer, 1999) stress. However, cortisol is one of the essential hormones always present in the blood and is known to have predictable pattern of circadian fluctuations and demonstrates diurnal (light and dark) variations in adults and children (Kiess et al., 1995; Kirschbaum & Hellhamer, 1994;
Kudielka, Schommer, Hellhammer, & Kirschbaum, 2004). Normally, cortisol levels peak in the early morning and drop to the lowest concentration at night (King & Hegadoren, 2002). Following acute stress, salivary cortisol levels peak within 10-40 minutes and drop to the baseline levels within 40-90 minutes after the cessation of stress (Kemeny, 2003; Kudielka & Kirschbaum, 2005). While most (85-95%) of cortisol in blood is bound to proteins, a small portion of the cortisol, 5-15%, is unbound and is therefore small enough to enter cells and body fluids such as saliva (Kirschbaum & Hellhammer, 1999). Valid and reliable non-invasive methods are available for measuring the free (unbound) fraction of the cortisol in saliva, which is biologically active (Kalman & Grahn, 2004; Kirschbaum & Hellhammer, 1994). Salivary cortisol offers advantages for collecting multiple samples repeatedly in a noninvasive manner, particularly in a stressful field setting.

Stress, Cortisol, and Individual and Team Job Performance

Recently, the relationships between cortisol and impaired cognitive function and working memory have emerged from study findings (Dickerson & Kemeny, 2004; Lupien et al., 1999; Lupien & Lepage, 2001; Oei, et al., 2006), indicating the potential impact on individual and team job performance. There are some studies in which the influence of cortisol on memory affecting individual performance was examined. For example, Oei and colleagues (2006) examined the relationship between salivary cortisol levels and working memory in 20 psychology students under stress using the Trier Social Stress Test. Salivary cortisol levels were measured at baseline and 30 minutes after the test. The results included that salivary cortisol levels were increased after the stress
challenge and that higher cortisol levels were associated with decreased memory recall (Oei et al., 2006). Perceived psychosocial stress was not addressed in that study. Similarly, Buchanan, Tranel, and Adolphs (2004) found that the memory performance of healthy women during a laboratory cold pressor task was negatively correlated to cortisol levels ($r = -0.4$, $p = 0.03$), noting the differentiating effect of cortisol on memory performance among participants. The effects were noted to be independent of sex and sympathetic nervous system activation.

Wetzel and colleagues (2010) examined perceived stress (state anxiety), salivary cortisol, and surgical performance of 30 surgeons in a crisis and non-crisis simulation. Perceived stress and salivary cortisol were assessed immediately past each scenario, allowing 35-45 minutes for a cortisol response. Surgical performance was based on technical skills of the individual surgeon and teamwork including operative planning tasks, communication, and other interdependent team behaviors during surgery. During the surgical crisis scenario, the perceived stress levels were significantly elevated compared to the non-crisis condition. Also, experienced surgeons with low stress during the crisis were noted to have better performance in all measures. However, the study participants only included surgeons, not all members of the surgical team such as nurses. Furthermore, salivary cortisol levels were lower during the simulation than at baseline and were not associated with performance. One possible explanation is that the surgical procedures in both crisis and non-crisis simulations may not have been sufficiently stressful to evoke physiological responses in salivary cortisol. In addition, the lack of notation of the time of day for the salivary cortisol samples precludes the assessment of the potential interaction with circadian variability of cortisol.
Lacking in the stress and job performance relationship is an understanding of the mechanisms by which stress affects individual and team performance. Given the separate lines of literature on stress, salivary cortisol, and job performance, it is very plausible that salivary cortisol response may be one of several underlying physiological mechanisms in the stress-performance relationship (Hayne et al., 2005). However, there have been no previous studies that examined salivary cortisol as a mediator in the stress and individual and team job performance relationship. Considering the gaps identified through the literature review, the major objectives of this study, therefore, were to determine the main effect of perceived stress on salivary cortisol response and to examine the potential mediating role of salivary cortisol in the relationship between perceived stress and individual and team job performance among AE crewmembers during a challenging simulated AE training mission.

Social Support: Moderator in the Stress-Cortisol Relationship

Social support is a multidimensional concept known for buffering effects on the stress response (House, 1981). Social support is the transactions between individuals that are perceived by the recipient to facilitate coping with situations that could be taxing (Sarason, Sarason, & Pierce 1990). Social support can be offered from many sources including family, friends, and co-workers.

In many military studies involving stress, social support from family during deployment has been the focus (Limbert, 2004). However, the buffering or moderating effect of social support is best noted when the support perceived to be available is matched to the task or need of the individual at that time. Since the AE training mission
may elicit the need for instrumental support such as providing assistance with a task or problem or informational support such as giving advice, the proposed study was focused on social support from co-workers/crewmembers. For this study, co-worker social support was operationalized as the assistance from crewmembers/co-workers that is perceived to be available to facilitate coping with situations occurring during the mission. The perceived availability of social support that is thought to be available when needed may be a stronger buffer to stress than the actual receipt of social support (Cohen, 1988; Cohen & Wills, 1985; Wills & Shinar, 2000). Perceived social support is also noted to be related to job performance (AbuAlRub, 2004). However, perceived social support appraisals may deteriorate over time in lieu of certain stressors (Norris & Kaniasty, 1996) suggesting the importance of received support or lack of enacted social support in the time of stress on future appraisals of social support. Additionally, individuals may not accept socially supportive behaviors offered (Hobfoll & Stephens, 1990). To consider the influence of received social support on perceived social support appraisals over the course of the aeromedical mission, perceived social support appraisal ratings were assessed at baseline, pre-flight and in-flight during the study.

Social support is thought to act as a buffer on the stress continuum at several points (Cohen & Wills, 1985). Social support may decrease the stress appraisal by enhancing one’s perception of coping abilities and eliminate or dampen physiological responses to the perceived stressful event (Cohen & Wills, 1985). Turner-Cobb, Sephton, Koopman, Blake-Mortimer, & Spiegel (2000) found that higher levels of perceived tangible social support were associated with lower salivary cortisol levels in patients with metastatic breast cancer independent of the quantity or quality of the social networks.
Similarly, Karlin, et al., (2003) revealed a moderating effect of perceived social support from coworkers on blood pressure under high stress conditions.

There is a benefit in identifying modifiable concepts that may moderate the effect of stress on the physiological response (i.e., cortisol), especially when considering the possible detrimental role of cortisol as a mediator in the stress-job performance relationship. While a number of studies have found social support as a moderator in the stress-job performance relationship, very few studies have examined the role of social support in moderating stress on physiological stress responses such as cortisol (Kirschbaum, Klauer, Flipp, & Hellhammer, 1995). Therefore, the proposed study examined the moderating role of coworker social support on salivary cortisol among AE crewmembers during their AE training mission. The knowledge gained from this study may suggest strategies for promoting supportive behaviors in the military and AE mission.

Covariates to Job Performance

Several covariates collected from demographic data and measurement tools were considered for this study due to their potential effect on job performance. The covariates included in analyses include perceived background stress, job experience, age, gender, and rank. The effects of mission-specific perceived job stress on job performance are of interest in this study. However, ongoing background stress appraisals (i.e., chronic stress arising from home, school, and work) are prevalent (Taylor, et al., 2009). Chronic stress represented by depressive symptoms, anxiety, and mood disturbance has also shown negative influences on job performance (Matthews et al., 2001; Schaubroeck & Ganster,
Furthermore, it has been noted that higher ongoing stress at home that carried over to work lead to higher ratings of job stress ($r = .81$, $p < .01$) and lower self ratings of job performance ($r = -.47$, $p < .05$) among military pilots (Fiedler, Rocco, Schroeder, & Nguyen, 2000). Similarly, greater negative mood during task performance was associated with chronic stress ($p < .01$) and diminished perceived competence to perform the task despite actual performance was insignificant, but only slightly ($p < .09$) among participants volunteering for the study (Matthew, et al., 2001).

Chronic stress is also associated with dampening of the activation of the HPA axis, and subsequent release of cortisol (Heim, Elhart, & Hellhammer, 2000; Matthew et al., 2001). The diminished cortisol response is not only noted in individuals with post traumatic stress, burnout, or other chronic health disorders, including chronic fatigue and fibromyalgia, but also healthy individuals experiencing chronic stress (Heim, Elhart, & Hellhammer, 2000). The maladaptive responses to ongoing stress, including habituation to cortisol, have health consequences including impaired immunity, inflammatory disorders, and heart disease (McEwen, 1998). Considering the potential effect of perceived background stress on job performance, perceived background stress ratings collected at baseline were controlled for in the current study. For this study, chronic stress or perceived background stress was measured using the Perceived Stress Score-10 representing ratings of stress experienced over the last month. The U.S. norms for the PSS-10 ratings are based on three samples; the means and standard deviations are noted as 23.18 (7.31), 23.67 (7.79), and 25.0 (8.00), respectively (Cohen, Kamarck, & Mermelstein, 1983); and subsequent studies have reported a mean of 12.7 (8.0) among white collar workers (Eck, Berkhof, Nicolson, & Sulon, 1996) and 21.9 (5.9) among

Job experience is most often noted as years on the job, although various modes of measuring job experience have been noted in the literature, including amount of experience performing a task, and type of experience (Quinone, Ford, & Teachout, 1995). A meta-analysis using these three job description measurements, various types of workers and various performance evaluations found a positive relationship between job experience and job performance (Quinone, Ford, and Teachout, 1995). However, job experience measured as the amount of times a task was performed, is posited to be most strongly correlated to performance.

LeBlanc, et al., (2005) used the limitations in training and performance of certain basic and complex healthcare tasks to distinguish advanced and novice paramedics performing dosage calculations under various stress conditions. The advanced paramedics demonstrated better performance on the dosage calculations than the novice paramedics [61.1% vs. 39.8% (95% CI: 50.6%–71.6% and 31.2%–48.4%) respectively, \( p < 0.01 \)]. In the same study, job experience using the length of experience at the advanced or novice level did not predict dosage calculation scores \( r^2 = 0.14, p = .13 \). Therefore, job experience for this study was operationalized as the amount of flight hours accumulated for the individual crewmember. Flight hours include the performance of aeromedical tasks and not just time as a flight nurse or technician.

Experience is also considered to be associated with age. That is, as one’s age increases, experience on the job also potentially increases, potentially resulting in improved job performance (Matthews, et al., 2000). Additionally, performance of
complex activities has been shown to improve with age as experience also increases; although other findings have suggested that job performance decreases with age (Salthouse, Babcock, Skovronek, Mitchell, & Palmon, 1989). Considering the potential effect, positive or negative, of age on performance, age was controlled in this study for the potential influence on individual and team job performance.

Gender may influence the performance of specific task type, such as those involving spatial tasks or those involving memory; memory tasks may favor females and spatial tasks may favor males (Matthews et al., 2000). However this is not thought to be based on intellectual differences among males and females (Matthews et al.). Since the aeromedical evacuation mission is made up of males and females, the potential influence of gender on job performance is a consideration for this study. Additionally, males and females may perceive and receive social support differently. Since job performance, especially, team performance, requires interaction among individual including providing socially supportive behaviors, gender is considered a potential covariate for this study.

Finally, in the military, rank is used to determine an officer or enlisted member’s status and authority compared to that of other military members. Higher rank indicates higher status and authority, and is symbolized by insignia worn on the uniform, even during AE missions. Driskell and Salas (1991) noted a main effect of rank/status in making decisions necessary to complete a task based on the interactions of small groups under varying conditions of stress. Persons in the lower status conditions were noted to be more willing to defer to task choices asserted by others than those in high status conditions \[F (1,73)=25.46, p<.001\]. Additionally, participants in the high status conditions viewed their partner as less capable \(M = 3.76\) vs. \(M = 5.03\); \(t(72) = 5.90\),
than did subjects in the low status conditions. However, under stress, the group members in the high and low status conditions were noted to become more receptive to task inputs \((F(1, 73) = 18.35, p < .001)\)

Officers and enlisted ranks are included in the AE crew: two officer nurses and three enlisted medical technicians. Rank was included as a covariate in this study considering the importance of interactions of crewmembers for effective team performance; interactions which may be affected by rank/status and stress. Participants were asked to indicate their rank on the demographic survey using a grading system used by the United States Air Force, where a letter is used to indicate officer (O) or enlisted (E) followed by a number, also referred to as grade (e.g., O-4, for Major or E-4 for Technical Sergeant). Higher numbers for officer and enlisted ranks indicate greater status and authority. Officers at any grade/number have higher status and authority than enlisted personnel; although enlisted with higher rank may have more experience. For example, an O-1 is ranked higher than an E-13. However, most E-13’s have more than 20 years of military experience as opposed to most O-1’s with less than 2 years of experience.

**Summary**

In the current military environment, high levels of perceived stress are common among military personnel. High levels of stress may result in diminished job performance on the individual and team performance level during critical missions, and thus the effects of stress on job performance can be costly. Increases in cortisol level are
typical responses to psychological stress that may affect the cognitive functioning. Therefore, determining salivary cortisol levels during a critical military mission training may provide insight into a mechanism underlying the influence of stress in military job performance. Additionally, the moderating role of perceived social support from coworkers in cortisol responses may also provide insights on the significance of establishing support strategies for the military personnel.

While there is a vast amount of civilian and military studies involving stress and performance in the literature, many studies occurred in laboratory settings or relied solely on subjective appraisals of individual or team performance. Rarely, studies have been conducted to examine the relationships among stress, cortisol response, social support from coworkers, and job performance (individual and team) simultaneously in military populations, using objective performance appraisals.

Aeromedical evacuation provides a unique platform to examine the stress-job performance relationship under a setting relevant to military, nursing and aviation stressors. The aeromedical training mission includes all phases of real world operational missions, including the exposure to stressors of flight at altitude, challenging patient care, and related mission management tasks based on actual operational missions. Therefore, the findings of this study may bridge gaps in knowledge regarding stress and job performance in a previously understudied population of the military whose performance directly impacts the care of our most precious military cargo, wounded soldiers.
CHAPTER 3

METHODS

Research Design

This study was proposed based on the physiological model of stress by Selye (1956) and the transactional model of stress and coping by Lazarus and Folkman (1986). A prospective, cross sectional, and descriptive study design was used to examine effects of perceived stress, salivary cortisol response, and coworker social support on observational measures of individual and team job performance over four time points of baseline (Time 1), pre-flight (Time 2), in-flight (Time 3), and post-flight (Time 4) phases during a challenging simulated AE training mission among AE crewmembers. The specific aims of this study were to: 1) Determine the effect of perceived stress on salivary cortisol response and job performance (individual & team) while controlling for covariates of age, gender, rank, flight hours, and perceived background stress; 2) Examine the mediating role of salivary cortisol response in the relationship between perceived stress and job performance (individual & team) while controlling for covariates of age, gender, rank, flight hours, and perceived background stress; and 3) Examine the moderating role of coworker social support in the relationship between perceived stress and salivary cortisol response at each time point.
Sample Size and Sample

The sample size was calculated based on a power analysis with three predictor variables, perceived stress, salivary cortisol response, and perceived social support from co-workers to give 80% power at alpha = .05, assuming a moderate effect size of 0.15 (Cohen, 1988) and was determined to be 63. To ensure adequate study power, the sample size was set at the higher value of 75 qualified aeromedical crewmembers. The data were collected at multiple time points during a 2.5 to 3.5 hour challenging simulated AE training mission. While attrition of participants during the procedure of data collection was expected to be minimal, it was anticipated that some specimens might be lost or unusable for analyses, and this larger sample size allowed some flexibility in maintaining the proposed power of this study.

A convenience sample of 75 qualified aeromedical crewmembers (15 five person crews) was recruited to participate in the study. The inclusion criteria for this study were active or reserve AE crewmembers: a) with a successful current qualification as flight nurse or AE technician; b) with qualification training on the C-130 aircraft; and c) who could participate in AE training mission scheduled on the proposed dates. The exclusion criteria included AE crewmembers without qualification on the C-130 aircraft. The unqualified crewmember is not considered in the actual crew position during upgrade training. This alters their performance requirements for that mission, which may change the perceptions of stress and individual performance and then actual team job performance.
Procedure

Recruitment and Settings

Study participants were recruited from six active and reserve AE units of Air Force Bases (AFBs) and Air National Guard (ANG) Bases in the Eastern United States, including Dobbins AFB (GA), Maxwell AFB (Montgomery, AL), Pittsburgh AFB, (Pittsburgh, PA), Pope AFB (Alexandria, NC) active duty and Pope AFB (Alexandria, NC) reserve duty units, and Tennessee ANG (Nashville, TN). These Air Force and Air National Guard units were selected because of their recent participation in AE deployments and willingness to support the study. Each of these military bases has aeromedical evacuation units that typically include 5-10 AE crewmember teams (25-50 potential participants), participate in real world operational missions, and participate in recurrent training sessions based on Air Force standards and requirements. Except for differences in the aeromedical crewmembers assigned to each of the units, and location of the units, there were no expected or reported differences among the units. Support letters were requested and received from designees of each base. The principal investigator (PI) asked the chief nurses or designees for the dates of scheduled AE training mission during the proposed study period to plan recruitment process in advance.

The major recruitment strategy was public announcement within the base. Flyers, brochures, and posters were posted at the AE unit conference rooms and bulletin boards to publicize the study. The chief nurses or designee informed the PI of the names and contact information of crewmembers that showed interest in the study and had questions during the sign up process of the AE training mission scheduled for the proposed study period. The PI contacted the potential participants to confirm their willingness to
participate in the study, identify their eligibility for the study, and answer questions as needed. During the correspondence, the PI provided the purpose of study, proposed study dates, and the PI’s contact information. Crews were assigned by personnel at each unit. On the day of the study, aeromedical crewmember participants were confirmed and written informed consent obtained. To minimize the possibility of coercion of lower ranking enlisted crewmembers, consent of enlisted and officers were conducted separately.

Job Performance Observers during the Study

The Mission Crew Coordinator (MCC) is a qualified aeromedical crewmember that has undergone training to evaluate and facilitate AE training missions (AMC, 2010; AFI 11-2AE-1, 2010). During all AE training missions, the MCC is responsible for the evaluation of performance of AE crewmembers and is not considered a part of the five person crew and therefore was not recruited as a participant in this study. Although the Principal Investigator (PI) is a qualified flight nurse and trained MCC, for this study, a MCC was designated for the mission at each unit as usual for all AE training missions, which also allowed for an additional observer of individual and team job performance for the purposes of this study. Performance was evaluated during all phases of the AE mission: pre-flight, in-flight, and post flight by the MCC using the Aeromedical Evacuation MCC Checklist; as required during all military AE training missions. In addition, the PI used the Modified Aeromedical Evacuation Crewmember Job Performance Evaluation Tool. The MCC was informed of the purpose of the study, the
study protocol, and the instruments to be used during the mission prior to the mission to ensure consistency of the data collection.

Protocol of Challenging Simulated AE Training Mission

The use of simulated training missions is a staple in the training of aeromedical crewmembers for operational missions throughout the United States Air Force. The standardized nature of the phases of the AE mission is consistent across all training and operational missions, and includes pre-flight, in-flight, and post-flight phases. The protocol of the simulated AE training mission was used for this study, except for the addition of an additional observer, the PI.

The pre-flight phase includes the mission brief, equipment transport, and configuration, taking 90 minutes. During the pre-flight, crewmembers prepared for the AE mission by reviewing and discussing specific duties to be performed by each crewmember during the mission brief based on the mission scenario presented by the MCC/PI. The mission brief occurred in a quiet mission brief room and lasted for about 30 minutes. During the mission brief the MCC/PI described the patients, standardized and mannequins, included on the mission. The patient care and mission management scenarios were not revealed during the brief. Crewmembers were expected to ask questions regarding patient care requirements based on the report received from the MCC/PI by reviewing AE patient care standards guided by Air Force Instruction (AFI) 41-307 (2003). Additionally, crewmembers were responsible for the calculation of the required oxygen and electrical amperage for medical equipment based on the patient care requirements noted by the crew during the mission brief. Following the mission brief,
equipment was prepared by the crewmembers and transported to the aircraft during a 30 minute period. During this time, the MCC/PI or crewmember announced time hacks indicating time to take-off to maintain a sense of urgency during the mission. Once at the aircraft, the AE crewmembers started the configuration of aircraft based on patient and mission requirements noted during the brief. The configuration of the aircraft occurred in the back of the C-130 aircraft while engines were off and the plane remained on the ground (flight line), which took 30 minutes or less. During the aircraft configuration, crewmembers positioned stanchions/poles and straps for the positioning of litters, ran oxygen lines and electrical access for patients and equipment based on the patient load plan established during the mission brief. Patients were then enplaned onto the aircraft prior to take-off, ending the pre-flight phase. Once the aircraft takes off, the in-flight phase began.

During the in-flight phase the aircraft achieved attitudes of up to 30,000 ft. Crewmembers performed patient care responsibilities based on the patient care requirements, monitored and maintained aircraft systems required for patient care and managed potential aircraft emergencies such as a fuselage fire. It was during the in-flight phase that the MCC/PI initiated the patient care and aircraft emergencies. The post-flight phase began when the aircraft landed. During the post-flight phase, the crewmembers prepared patients to be deplaned from the aircraft, de-configured the aircraft, and completed the post mission debrief.

Among other designated opportune aircrafts (e.g., C130, KC135, and C17), the C130 aircraft is chosen for this study because it is one of the commonly used aircraft for operational AE transports in the U.S. Air Force, and is the primary aircraft used for AE
training mission at the selected AE units for this study. This approach allowed consistent environmental conditions in configuration capabilities, altitude restrictions, oxygen and electrical systems, and available amenities for AE crewmembers, which could influence crewmembers’ team and individual job performance requirements.

Data Collection Plan

The study procedures were approved from the Institutional Review Board (IRB) at the University of Alabama at Birmingham, Wright Patterson Air Force Base IRB and the United States Air Mobility Working Group. AE crewmembers agreeing to participate in the study were asked to meet 10-15 minutes prior to the mission briefing. Before collecting data, the informed consent was obtained in front of the investigator and the witness after clarifying any questions the participant may have had. Each participant was assigned a code for each time point (i.e., A001G), as an individual unique identifier. Only this code was used to identify specimens and questionnaire data.

Self-Report Questionnaires

Self-report data were collected during the mission using the Perceived Stress Visual Analog Scale (PS-VAS), Perceived Social Support Scale (PC-SS), Perceived Stress Scale-10 (PSS-10), and an investigator-developed Demographics sheet. The PS-VAS, PC-SS, and PSS-10 were administered at baseline prior to the mission brief to each of the crewmembers. Additionally, crewmembers completed brief measures of the PS-VAS and PC-SS at Time 2 and 3 during the pre-flight and in-flight emergencies respectively.
Perceived Stress

Perceived mission-specific stress was measured by a visual analog scale (VAS). Crewmembers were asked to mark a 100 mm horizontal line anchored by the words “Not stressful” and “Extremely stressful”. The perceived stress VAS (PS-VAS) score was determined for each individual crewmember at each time point by measuring in millimeters from the left hand end of the line to the point that the crewmember marks. Possible scores ranged from 0-100, with higher scores on the PS-VAS used to indicate higher levels of perceived mission-specific stress for the individual. The level of perceived current mission-specific stress was assessed using the PS-VAS at three time points during the mission. The time points during the pre-flight and in-flight phases of the mission represent times when the crewmembers actually perform patient care and mission management tasks following simulated scenarios, which may be considered as greatly challenging and stressful. Because AE crewmembers’ tasks during the mission are urgent and time-sensitive in nature, it is difficult to use multi-item Likert-type scales during pre-flight configuration (Time 2) and in-flight (Time 3) phases. The simplicity of the VAS and reported validity and reliability allows investigators to be able to measure psychosocial characteristics repeatedly over short periods of time (Gallagher, Bijir, Latimar, & Silver, 2002; Wewers & Lowe, 1990), providing increased feasibility of the study. Several studies have reported high correlations between psychosocial properties (e.g., anxiety, depression) and the related VASs, supporting its validity on the relevant concept (Kindler, Harms, Amsler, Inde-Scholl, & Scheidegger, 2000; Di Benedetto, Lidner, Hare, & Kent, 2005). For this study, the validity of PS-VAS was determined by examining the concurrent correlation with cortisol at Times 1, 2, and 3.
Perceived Coworker Social Support

Perceived coworker social support was defined as the extent to which employees believe their coworkers are willing to provide them with work-related assistance to aid them in carrying out their job-related duties (Susskind, Kacmar, & Borchgrevink, 2003). For this study, social support from coworkers was assessed by using a 3-item Likert-type scale, the Perceived Social Support Scale, developed by Susskind, Kacmar, and Borchgrevink (2007). Because the scale was designed to assess co-worker support of employees in the restaurant business, the investigator modified the scale for this study, with permission of the author, by replacing some terms (e.g., guest service, ) with ones more appropriate for and specific to AE crewmembers.

The following are the three items included in the measure: I feel that: (a) My coworkers will be very helpful in performing my AE crewmember duties; (b) When performing my AE crewmember duties, I feel that I will be able to rely heavily on my coworkers; and (c) My coworkers will provide me with important work-related information and advice that will make performing my job easier. The crewmembers were asked to rate their perceived coworker support on a 5-point rating format from 1 (strongly disagree) to 5 (strongly agree), yielding total scores ranging from 3 to 15. Higher total scores indicate higher levels of perceived coworker social support. The scale demonstrated a Cronbach’s alpha of .94 (Susskind et al., 2007) in a study with employees in restaurant business, indicating good internal consistency reliability. The modified tool was also used during an aeromedical training mission prior to this study, with a Cronbach’s alpha of .808, also indicating good internal consistency reliability.
Demographics

Prior to the start of the mission, aeromedical crewmembers agreeing to participate in the study were asked to complete the demographic sheet. The demographic sheet was specifically designed for the study and included information about deployment history and experiences, flight hours, years experience in the military, years of experience in aeromedical evacuation, and nursing/medical experience. The demographic sheet also captured several covariates which were included in this study; specifically the covariates included on the demographic sheet were experience, age, and rank.

Potential Covariates

Perceived background stress was measured once at baseline by using the Perceived Stress Scale 10 (PSS-10) (Cohen, et al., 1983). The PSS-10 is a 10-item inventory with a 5-point Likert-type scale from 1 (never) to 5 (very often) that measures feelings and thoughts during the last month. Items are designed to tap into how unpredictable, uncontrollable, and overloaded respondents found their lives. Positively worded items were reverse coded before scoring and then scores of were summed to compute a total perceived background stress score ranged from 0 to 50. Higher total scores at baseline indicate higher levels of perceived background stress during the past month. Empirical evidence supports the reliability of this global stress measure with community samples, with Coefficient alpha reliability scores of .84, .85, and .86 among three samples of college students (Cohen, et al., 1983). The test-retest reliability was reported as.84 in previous studies (Cohen, et al., 1983). In the same study, the validity of the PSS-10 was noted to be correlated with the Cohen-Hoberman Inventory of
Physical Symptoms (CHIPS) (0.16, p<0.01) (Cohen, et al., 1983). The CHIPS includes symptoms such as backache, diarrhea, and headache but excludes psychological symptoms of anxiety and depression (Cohen, et al., 1983). Additionally, the correlation of the PSS-10 to the Impact of Life Events was .35 and .34 (p<0.01) respectively for sample 1 and 2 (Cohen, et al., 1983). The Impact of Life Events measures the individual's rating of occurrences in their life over the last 6 months.

Potential covariates of age, gender, rank and experience were also captured from the demographic sheet. Age was coded as a numeric variable corresponding to an age category. For example a person aged 21-25 was coded as a 1. The actual age of participants was not solicited to decrease the amount of written requirements on the demographic sheet considering the time constraints of the mission. Age is thought to be associated with experience and improved job performance; however, cognitive changes in age may also be associated with decreased job performance (Matthews et al., 2000). The conflicting role of on job performance suggests a need to include the variable as a potential covariate in this study. Gender was coded as a numeric variable also, with males coded as 1 and females as 2. The influence of gender on job performance is thought to be due to specific task types (Matthews et al., 2000) and was considered a covariate for the present study. Experience was represented in this study as the number of flight hours reported by the crewmember. In the literature, experience has been noted to represent the length of time on a job, or the number of times a task has been performed. Flight hours of aeromedical crewmembers represents both of these approaches, in that flight hours represents the amount of times crewmembers participated in an aeromedical mission, and due to flight requirements, flight hours increase the longer
the individual works on the job. Indeed, experience is noted to enhance performance (Quinones, Ford, & Teachout, 1995) and was included as a potential covariate in the current study. Finally, rank was also coded numerically, with a 1 for Officers and 2 for Enlisted crewmembers. Rank may influence the interactions of members of a group (Driskell, & Salas, 1991) and thus was also included as a potential covariate for this study.

**HPA Activation: Salivary Cortisol Response**

Salivary cortisol levels, as an indication of HPA axis activation in responding to a stress appraisal by the individual, was collected using cotton swabs and Salimetrics collection tubes. Salivary cortisol has also been shown to be strongly correlated with serum cortisol (Kirschbaum & Hellhammer, 1999). Participants were asked to provide saliva samples at four time points (Time 1, Time 2, Time 3 and Time 4), which were planned during the time frame of 10:00 AM - 4:00 PM to minimize the potential influence of circadian variability on cortisol levels. Due to some mission delays or other real world incidents, a few samples collected outside of this timeframe during the study dates were included in the study. Participants were asked to rinse their mouths past eating and instructed to place the oral cotton swabs in the mouth (under tongue) for 1-2 minutes or until saturated. The swabs were placed in a tube and secured with a cap.

To ensure sufficient time for cortisol to return to baseline between each saliva cortisol sample collection, the saliva collection and scenario initiations was carefully timed. The first cortisol collection occurred at baseline. The second salivary cortisol sample was collected just before take-off, 40 minutes past the initiation of an emergency/surge, triggered 10 minutes into the start of the aircraft configuration (pre-
flight). The approximate length of time from the mission brief to the start of configuration, 60 minutes, ensured 90 minutes between Time 1 and Time 2. Allowing 90 minutes between cortisol collection times allowed for the cortisol response to return to baseline (Kemeny, 2003; Kudielka & Kirschbaum, 2005). The third salivary cortisol sample was collected 40 minutes past the initiation of the in-flight emergency triggered 50 minutes into the in-flight phase; again allowing 90 minutes between Time 2 and Time 3. The fourth salivary cortisol sample was collected just past the mission debrief. Since the in-flight phase is at least 120 minutes, the end of the post-flight/debrief also allowed 90 minutes between each time point. Salivary cortisol samples that did not allow for 40-90 minutes between data collection points were not included in the study. Figure 2 depicts the salivary cortisol collection time points and embedded emergencies that were used for this study at a glance.

<table>
<thead>
<tr>
<th>Pre-flight Phase (Total 90 min)</th>
<th>In-flight Phase (120 min)</th>
<th>Debrief</th>
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</thead>
<tbody>
<tr>
<td>Mission Brief (30 min)</td>
<td>Equipment Transport to Aircraft (30 min)</td>
<td>Deplaning/ Deconfiguration/ Debrief</td>
</tr>
<tr>
<td>Equipment Transport to Aircraft (30 min)</td>
<td>Configuration of Aircraft (30 min)</td>
<td>Time 4</td>
</tr>
<tr>
<td>Pt surge at minute 10</td>
<td>In-flight Scenario (120 min)</td>
<td>Time 3-40 min past start of Emergency</td>
</tr>
<tr>
<td>Time 2-40 min past start of configuration/surge</td>
<td>Emergency-50min</td>
<td>Time 3-40 min past start of Emergency</td>
</tr>
<tr>
<td>Baseline/ Time 1</td>
<td>Patient/emergency surge-10 min</td>
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</table>

*Figure 2. Data collection time points at a glance*
The salivary cortisol samples were kept at room temperature until all samples were collected for a given day, and were refrigerated or kept cool using an insulated container with ice packs until the samples were delivered to the lab in the University of Alabama at Birmingham (UAB) School of Nursing within one week of collection. It has been shown that saliva samples are stable at room temperature up to 4 weeks without significant changes in cortisol levels (Kirschbaum & Helhammer, 1989). Uncentrifuged samples were maintained at -80°C in the UAB School of Nursing lab until batch assayed within five months from the first sample collection. Once all samples were collected, the coded frozen samples were shipped overnight with dry ice to the University of Texas at Houston School of Nursing Bioscience Laboratory for analysis of salivary cortisol by a high sensitivity enzyme immunoassay. Samples were thawed and centrifuged to obtain clear saliva. Using 25 microliters (μL) of saliva, samples were assayed in duplicate following the standardized protocol. The mean of the duplicate cortisol assays was used for analyses, and reported in μg/dL (micrograms per deciliter). The manufacturer sensitivity of the assay is reported to be < .003 μg/dl, with a mean intra-assay coefficient of variation (CV) of 3.35 and 3.65 and inter-assay CV of 3.75 and 6.41 (Salimetrics, 2011). Salivary cortisol response was determined for each individual at each time point. The individual's cortisol response variable was used to indicate the HPA axis activation in responding to stress appraisal for the individual at each time point.
Individual and team job performance was evaluated twice (Times 2 and 3) by two observers, the PI and MCC independently. The performance for the pre-flight phase (mission brief, equipment transport, and configuration) was evaluated at Time 2; and the performance during the in-flight phase was evaluated at Time 3. Due to the close physical proximity of the crewmembers' performance to the observers and the nature of the training of the MCC and PI in evaluating team performance during AE missions, the two observers were able to evaluate team performance independently. Similarly, the individual performance of the five crewmembers was observed by the PI and MCC at each time. The MCC used the Aeromedical Evacuation MCC Checklist as required by Air Mobility Command for all AE training missions to rate performance during the mission.

The Aeromedical Evacuation MCC Checklist

The Aeromedical Evacuation MCC checklist includes a 5-point Likert rating system to rate overall performance by crewmembers during each phase of the mission and to guide performance feedback during the mission debrief. The MCC checklist does not include specific performance tasks required during a patient care or mission management event. However, ratings above 4, indicating above average performance or below 3, indicating below average performance, require written comments by the MCC, providing detail of hits or misses in individual and team performance. A summative score is not provided. Since the Aeromedical Evacuation MCC checklist is required to be completed for all AE training missions, the instrument was used to establish concurrent
validity for the Modified Aeromedical Crewmember Job Performance Evaluation Tool specifically developed for this study. The PI used the modified AE Crewmember Job Performance Evaluation Tool for individual and team performance at Times 2 and 3. The MCC was asked to rate individual and team performance during random missions using the modified AE crewmember Job Performance Evaluation Tool to establish inter-rater reliability of the instrument for this study.

The Modified AE Crewmember Job Performance Evaluation Tool

The Modified AE Crewmember Job Performance Evaluation tools were developed by the PI to include the distinct, and specific individual cognitive tasks and team critical behavioral tasks for each phase of AE training mission based on the Air Force Instructions (AFI). Therefore, four distinct tools, two for individual performance at Time 2 and Time 3, and two for team performance at Time 2 and Time 3, for a total of 36 items were developed for the study. The PI is a qualified flight nurse, Mission Crew Coordinator (MCC), and Aeromedical Evacuation Instructor with over 500 flight hours and therefore has knowledge of individual and team performance requirements during the mission. The matrix of 36 behavioral tasks thought to be critical behavioral responses for the scenario considering Air Force Instructions and manuals were provided to three content experts. Each of the content experts worked in healthcare, had over 700 flight hours, was trained as an aeromedical evacuation instructor or evaluator, and represented both enlisted and officer ranks. The three content experts were provided with the conceptual and operational definitions for individual and team performance for this study, asked to mark their agreement or disagreement with the designation of critical tasks for

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individual or team performance processes based on the scenarios, and to add any additional tasks considered relevant. Only one of the possible 36 items was noted as questionable by one reviewer. The content validity was calculated by dividing the total item agreements noted by the experts (107) divided by the product of the total number of items from the performance checklists (36) and number of raters (3); resulting in .99 agreement for the checklists between the three raters. No revisions were required for the instrument based on the expert feedback.

The Modified AE Crewmember Job Performance Evaluation tools were formatted using the Targeted Accepted Responses to Generate Events and Tasks (TARGETs) methodology (Dwyer, Fowlkes, Oser, Salas, & Lane, 1997; Fowlkes, et al., 1994). The TARGETs methodology is an event-based team performance measurement methodology and allows the observer to evaluate team performance in complex and dynamic environments (Fowlkes et al., 1994) and evaluates the number of hits (1) or misses (0) of team performance achieved based on the cues embedded in the scenario on a two-point Likert scale (0 = not performed & 1 = performed); where higher scores indicate higher performance. The dynamic AE mission includes multiple cognitive critical tasks for an individual AE crewmember (McNeil, 2007), therefore while the TARGETs method was intended for team performance, the same format was used in this study for individual performance.

Using the Modified Aeromedical Crewmember Job Performance Evaluation Tools, individual and team job performance were assessed twice during the mission; once during the pre-flight configuration phase (Time 2) and during the end of the in-flight mission phase (Time 3). Individual performance at Time 2 (8 items) was involved with
cognitive tasks such as preparation of personal oxygen and calculation of oxygen and electrical requirements for all AE training missions; whereas individual performance at Time 3 (7 items) involved the individual responses to a challenging mission management emergency following an aircraft emergency, such as a fuselage fire, which reflects critical thinking skills and decision making also required for each training mission. At each time, the PI observed individual performance of crewmembers. The total number of hits (i.e., “being performed”) was calculated: the possible ranges of total score for individual performance for Time 2 and Time 3 were 0-8 and 0-7, respectively. Higher total scores meant better individual job performance.

For this study, team performance involved the observable and critical team process behaviors such as communication, coordination, backup behaviors, and adaptability accomplished by the AE crewmembers of each team to achieve the effective configuration of the aircraft (Time 2, 10 items) and in-flight patient care following an aircraft emergency (Time 3, 13 items). Bowers, Braun, and Morgan (1997) described the team process behaviors of communication, coordination, back-up behaviors and adaptability which were operationalized in this study. Communication was defined as the exchange of unspoken and spoken verbal interactions among team members intended to provide information and coordinate team actions; coordination was defined as behaviors that focus on balancing the activities of the team to achieve a goal. Back-up behaviors included the assistance provided to fellow crewmembers. Adaptability was defined as the ability to alter the course of behaviors in responding to the tasks, demands, environment, or other team members. The scenario embedded in the mission at Times 2 and 3 required each of these team processes. The total number of hits (i.e., “being
performed”) and misses (i.e., “not performed”) were calculated. The possible ranges of total score for team performance for Time 2 and Time 3 were 0-10 and 0-13, respectively. Higher total scores meant better team job performance. Table 1 represents the measures at each time point.

Table 1

Measurments at Each Time Point

<table>
<thead>
<tr>
<th></th>
<th>Time 1 Baseline</th>
<th>Time 2 Pre-flight</th>
<th>Time 3 In-flight</th>
<th>Time 4 Debrief</th>
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</thead>
<tbody>
<tr>
<td>Perceived Mission Stress(PS-VAS)-Predictor Variable</td>
<td>X</td>
<td>X</td>
<td>X</td>
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<tr>
<td>Salivary Cortisol-Predictor Variable</td>
<td>X</td>
<td>X</td>
<td>X</td>
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<tr>
<td>Coworker Social Support (CSS)-Predictor Variable</td>
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<td>X</td>
<td>X</td>
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<tr>
<td>Job Performance Individual/Team-Outcome Variable</td>
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<td>X</td>
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<td></td>
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<tr>
<td>Demographics &amp; Covariates</td>
<td>X</td>
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Data Management and Analysis

A codebook was developed based on the scoring instructions, and a data file was generated using Microsoft Excel software. The data files and records for this study were stored using a password-protected computer database. Only the PI had the password to
access the database. The coded identifiers used for questionnaire data and specimens would prevent anyone from linking to clinical or personal data. The data entry was double-checked and imported to the file for the statistical analysis software. The Statistical Package for Social Science (SPSS) for Windows (Chicago, IL) version 19 was used for statistical analyses. All analyses were tested at a statistical significance of .05.

Analyses began with descriptive statistics. Frequencies and percentages were calculated for the categorical data, including age, gender, rank. Means, standard deviations, and ranges were used to describe the continuous variables of perceived stress ratings, perceived social support ratings, job performance (individual and team), and flight hours. Next, bivariate correlations using Pearson correlation coefficients were used to identify the relationship among study variables and potential covariates. In addition, Cronbach’s alpha coefficients were computed and reported for the instruments used in this study.

Inter-assay and intra-assay Coefficients of Variance (CV) were calculated for the study. The inter-assay and intra-assay CVs are used to determine precision of the salivary cortisol data during the laboratory analysis (Hanneman, Cox, Green, & Kang, 2011). The inter-assay was determined by first calculating the average of the CV values for the individual assays per plate. The average CVs per plate were summed and divided by the number of plates, which totaled 7. The inter-assay CV for the study was 2.51%. The intra-assay was determined by taking the sum of the CV values for the individual assays for all plates and dividing by the number of individual assays (n =245). The derived intra-assay CV was 2.34%. The CV values were less than 10%, indicating high precision.
Diagnostics and Remediation

Descriptive statistics were also used to screen data for missing and out-of-range data points. Before performing inferential data analyses, study variables were examined for outliers and conformance with multiple linear regression assumptions and appropriate actions were taken to address issues identified. The salivary cortisol variable was noted to be severely positively skewed. The variable was log transformed by multiplying the salivary cortisol variable by the natural logarithm ($\ln$). After performing the transformation, the skewness was noted to be closer to zero and the test for normality became non-significant. The transformed cortisol data were used in all subsequent analyses. Additionally, the job performance (individual and team) outcomes were noted to be severely negatively skewed. The individual and team job performance variables were dichotomized as a one if the highest score was achieved, or a zero for all scores less than perfect at each time point. The dichotomized variable of job performance was selected since 61.3%, and 68% of the participants had perfect individual performance scores at Time 2 and Time 3, respectively, and 46.7%, and 40.0% of the sample had perfect team performance scores at Time 2 and Time 3, respectively.

Specific Aim 1

The first specific aim 1, with Hypotheses 1a, 1b, & 1c, was examined with linear and logistic regression models using Generalized Estimating Equations (GEE), to separately test the main effect of perceived stress on salivary cortisol and job performance (individual and team). GEE was selected for this study as it allows for the estimate of parameters using linear or logistic regressions when the observations are
unknown (Ghisletta, 2004; Statistical Package for the Social Sciences [SPSS], 1993), or may be correlated with observations of other crewmembers belonging to the same team. The Quasi Likelihood Criterion generated in GEE was used to compare models with different working correlation structures; the smallest Quasi Likelihood Criterion generated using a particular working correlation structure was considered the best fitting model. The working correlation structures in GEE are independent, exchangeable, autoregressive and unstructured. An independent working correlation structure assumes no correlation between observations; an exchangeable working correlation assumes an equal correlation between observations; an autoregressive working correlation assumes that the correlation of the observations are time dependent; while with unstructured, there is no assumption about the correlation (Ghisletta, 2004; SPSS, 1993). For this study, the independent or exchangeable working correlation structures were considered the only plausible correlation structures. The autoregressive working correlation was not considered since the matrix structure was observations of individual team members at each separate time point rather than repeated measures on the same individual that would be subject to change over time. Additionally, the unstructured working correlation was not considered since the observed matrix was unordered observations of individual team members versus repeated measures.

The salivary cortisol response variables at times 1, 2, and 3 were considered as the dependent variable in separate models for each time period. The transformed variable of cortisol was used in all analysis. Considering the known effects of age, gender, rank, job experience (flight hours), and perceived background stress (PSS-10) on job performance, these variables were examined as potential covariates in each model. Bivariate
correlations were used to identify those showing significant correlations at p < .05 with salivary cortisol response. Then, identified potential covariates were entered into the GEE model of each salivary cortisol variable as appropriate. Perceived stress at Times 1, 2, and 3 were also entered as the independent variable corresponding to the respective salivary cortisol response time.

A Generalized Estimating Equations (GEE) approach was also used to predict the main effect of perceived stress on job performance (individual and team) at Times 2 and 3 separately. Due to the negatively skewed distribution of the job performance variables, the job performance variables were dichotomized and binary logistic regression GEE was selected. Again due to the known effects of age, gender, rank, experience (flight hours), and perceived background stress (PSS-10) on job performance, these variables were examined as potential covariates. Potential covariates were entered into the GEE model of each job performance outcome as appropriate. Those showing significant contribution to the model were used as covariates for each performance variable. Finalized covariates were entered in the final model to determine main effects of perceived stress on individual and team performance.

Specific Aim 2

The second specific aim, with Hypotheses 2a and 2b, was to determine if salivary cortisol response at Times 2 and 3 would mediate the relationship between perceived stress and individual and team job performance at Times 2 and Time 3, while controlling for covariates of age, gender, rank, flight hours and perceived background stress.
For testing the mediation of salivary cortisol response at Times 2, and 3 in the stress-individual job performance relationship, GEE was used to perform the methodology described by Baron and Kenny (1986). The log transformed variable salivary cortisol was regressed on the predictor variable, perceived stress at Times 2 and 3, as noted in specific aim 1. If step one was significant, then the outcome variable (individual job performance) at Time 2 and 3 would be entered separately on the corresponding predictor variable (perceived stress) at Time 2 or 3. Finally, the outcome variable of individual job performance at Time 2 and 3 would be regressed on the corresponding perceived stress and salivary cortisol variables. Again, due to the known effects of age, gender, rank, experience, and perceived background stress on job performance, those covariates that were significant in aim 1 would be included in the model if appropriate at steps 2 and 3.

For testing salivary cortisol as a potential mediator of perceived stress on team performance at Time 2 and Time 3, the log transformed salivary cortisol variable was regressed on the corresponding predictor variable, perceived stress at Times 2 and 3, again as noted in specific aim 1. If step one was significant, then the outcome variable (team job performance) at Time 2 and 3 would be entered separately and regressed on the corresponding predictor variable (perceived stress) at Time 2 and 3. As with individual performance, the final step was that the outcome variable of team job performance at Time 2 and 3 would be regressed separately on the corresponding perceived stress and salivary cortisol variables. Again due to the known effects of age, gender, rank, experience, and perceived background stress on job performance, those covariates that were significant in aim 1 would be included in the model if appropriate.
For a mediating effect to be supported in the stress-individual or team job performance relationship, the following statistical conditions must have been met. The first and second regression models must be significant in the direction as expected; and, in the third equation model, the mediator, salivary cortisol, must be significantly associated with the outcome variable, individual or team job performance, after controlling for the main effect of predictor (perceived stress) on the outcome variable. At the same time, the relationship between the predictor and outcome variables must be significantly reduced after controlling for the effect of the mediator variable on the outcome variable (Baron & Kenny, 1986).

Specific Aim 3

For specific aim 3 with Hypothesis 3, a GEE approach was used to determine whether perceived coworker social support (Times 1, 2, & 3) moderated the relationship between perceived stress and salivary cortisol response at Time 1, Time 2, and Time 3. The methodologies described by Baron and Kenny (1986) for testing the moderation model of coworker social support in the stress-salivary cortisol relationship at Times 1, 2, and 3 were used, with “team” as the subject variable in the GEE models. Only independent and exchangeable working correlation structures were considered. Again, the unstructured and autoregressive working correlations were not considered since the elements in the matrix were individual team members rather than repeated measures on the same individual. Both predictor (perceived stress) and potential moderator (coworker social support) variables on continuous scales were centered or standardized by subtracting the sample mean from all of the subjects scores on the variable to produce a
revised sample mean of zero. Centering these continuous variables reduced potential problems associated with multicollinearity among the variables in the regression model (Frazier, Tix, & Barron, 2004). A product term was computed by multiplying both centered predictor and moderator variables, representing an interaction effect between two variables. Then, the predictor and moderator variables, and the interaction term of both were entered simultaneously into the regression model of the log transformed variable of salivary cortisol response separately for each respective time. The predictor and moderator variables do not have to show significant associations with the outcome variable (salivary cortisol). The moderating effect was supported if a statistically significant interaction effect of predictor and moderator variables (i.e., a significant stress x coworker social support interaction term) on the outcome variable, while their independent or main effects are controlled (Baron & Kenny, 1986).

Summary

This study included 75 participants, comprising 15 crews, from six aeromedical units across the US. The major study variables were perceived stress, salivary cortisol response, perceived co-worker support, and job performance (individual and team). While repeated measures were obtained in this study, the data was analyzed based on a cross sectional approach for each time point of baseline (Time 1), pre-flight (Time 2), in-flight (Time 3), and post-flight (Time 4). Generalized Estimating Equations (GEE) were used to test the specific aims of this study based on the regression analysis described by Baron and Kenny (1986). Job performance was observed by the PI for all missions and
the Mission Crew Coordinator for selected missions during the study using distinct performance scales developed for the study, using a hit or miss format.

The data were screened prior to inferential analysis and psychometric analysis performed for instruments used in the study. The variable of salivary cortisol was positively skewed and therefore, the variable was log transformed, and the log transformed variable used in all subsequent analysis. The job performance variables of individual and team performance were also negatively skewed, with many participants with perfect scores, and thus the job performance variables were dichotomized with 1 as perfect and 0 as less than perfect. Potential covariates of age, gender, experience, perceived background stress, and rank were considered for inclusion in the statistical models due to their known relationships with job performance.
CHAPTER 4

FINDINGS

The findings of the study are presented in this chapter. Sample characteristics of total military years, work in healthcare, previous deployments, length of deployments, years as an AE crew, and Advanced Cardiac Life Support (ACLS) certification status are described. The potential study covariates of age, gender, rank, flight hours derived from the demographic survey, and perceived background stress measured from the PSS-10 further capture the sample demographics obtained at baseline. The reliability for the study instruments used for the collection of major study variables for the study are also noted. Next, the major study variables of perceived stress, perceived coworker social support, and job performance (individual and team) are described using descriptive statistics. Additionally, the relationships among the major study variables and between major study variables and significant study covariates are examined using results from the bivariate correlations and GEE analyses. Finally, the summary of the findings for each specific aim and hypothesis are presented.

Sample Characteristics

A convenience sample of 75 aeromedical crewmembers who self-reported they were eligible for this study was recruited from six Aeromedical Evacuation (AE) squadrons within the United States. Before participants were enrolled in this study and
signed an informed consent form, the PI screened participants according to the inclusion and exclusion criteria. It was found that all of the participants who were enrolled and screened for this study were eligible. Missing data on the demographic survey due to uncertainty of the information by the participant, failure to return forms, or insufficient saliva obtained resulted in n’s less than 75 on several variables. Missing data were coded as missing and with pair-wise deletion techniques built into software were excluded from analyses.

Sample characteristics including total military years, work in healthcare, prior deployment experience, years as a crewmember, and Advanced Cardiac Life Support certification status are presented in this section. In this sample, 45.8% of the crewmembers reported more than 11 years of military experience, with the range from 2-30 years, and 33.3% of the members reported working as AE crewmembers for greater than 10 years, again with a range of 1-26 years. Many of the participants, 61.1%, reported that they currently work in a healthcare setting such as a hospital or clinic. Only six (8.0%) of the 72 participants providing data reported that they had never deployed. Fifty-three (72.6%) of the participants reported 1-4 deployments. The remaining 27.4% reported up to 8 deployments. The mean length of the deployments reported was 4.15 months. Additionally, 50% of the participants had current Advanced Cardiac Life Support (ACLS) certification, while only 9.7% had never received ACLS training. The other 40.3% of the 72 participants responded that they had previous ACLS certification, but were no longer current.
Potential Study Covariates

The study covariates of age, gender, rank, experience measured in flight hours were also noted from the demographics survey, in addition to perceived background stress using the PSS-10. The demographics captured from potential categorical study covariates of age, gender, and rank are presented in table 2. The demographics from potential continuous study covariates of flight hours and PSS-10 ratings are summarized and presented in table 3.

Participants were asked to mark one of the nine, age categories best describing their age in years. Study participants were noted to fit into eight age categories ranging from 21 to 60 years of age. The 75 participants, mostly female (68.1%), represented both Enlisted personnel (58.9%) and Officers (41.1%). Of the sixty-six participants reporting flight hours on the demographic survey, forty-eight (60.6%) had greater than 400 flight hours. The mean and standard deviations were 540.32 (292.13); the range was 1-1500. The 31 distinct flight hours noted by crewmembers were summarized into four categories for presentation in table 4. The perceived stress background stress measured with the PSS-10 revealed a mean and standard deviation of 19.15 (9.25) with a range of 1-40. The perceived stress (PSS-10) ratings, representing background stress over the last 30 days, were summarized into four categories to represent the 31 distinct PSS-10 ratings noted in this study for presentation of the data; the continuous variables of flight hours and PSS-10 were used in all regression analysis.
Table 2

*Sample Characteristics of Potential Categorical Covariates (N=75)*

<table>
<thead>
<tr>
<th>Variable</th>
<th>( f )</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Age</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>21-25</td>
<td>7</td>
<td>9.9</td>
</tr>
<tr>
<td>26-30</td>
<td>14</td>
<td>19.7</td>
</tr>
<tr>
<td>31-35</td>
<td>12</td>
<td>16.9</td>
</tr>
<tr>
<td>36-40</td>
<td>13</td>
<td>18.3</td>
</tr>
<tr>
<td>41-45</td>
<td>7</td>
<td>9.9</td>
</tr>
<tr>
<td>46-50</td>
<td>10</td>
<td>14.1</td>
</tr>
<tr>
<td>51-55</td>
<td>6</td>
<td>8.5</td>
</tr>
<tr>
<td>56-50</td>
<td>2</td>
<td>2.8</td>
</tr>
<tr>
<td>Missing</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td><strong>Gender</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>23</td>
<td>31.9</td>
</tr>
<tr>
<td>Female</td>
<td>49</td>
<td>68.1</td>
</tr>
<tr>
<td>Missing</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td><strong>Rank</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Enlisted</td>
<td>43</td>
<td>58.9</td>
</tr>
<tr>
<td>Officer</td>
<td>30</td>
<td>41.1</td>
</tr>
<tr>
<td>Missing</td>
<td>2</td>
<td></td>
</tr>
</tbody>
</table>
Table 3

Sample Characteristics of Potential Continuous Covariates Summarized in Categories (N=75)

<table>
<thead>
<tr>
<th>Variable/Category</th>
<th>f</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Experience (Flight Hours)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt; 400</td>
<td>26</td>
<td>39.4</td>
</tr>
<tr>
<td>401-800</td>
<td>31</td>
<td>47</td>
</tr>
<tr>
<td>801-1200</td>
<td>8</td>
<td>12.1</td>
</tr>
<tr>
<td>&gt;1201</td>
<td>1</td>
<td>1.5</td>
</tr>
<tr>
<td>Missing</td>
<td>9</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Background Stress Ratings (PSS-10)</th>
<th>f</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-10</td>
<td>11</td>
<td>15.3</td>
</tr>
<tr>
<td>11-20</td>
<td>33</td>
<td>45.8</td>
</tr>
<tr>
<td>21-30</td>
<td>18</td>
<td>25.0</td>
</tr>
<tr>
<td>31-40</td>
<td>10</td>
<td>13.9</td>
</tr>
<tr>
<td>Missing</td>
<td>3</td>
<td></td>
</tr>
</tbody>
</table>

Instrument Reliability

Self report instruments were used to assess major study variables of perceived stress, and perceived coworker social support and the potential study covariate of PSS-10. For the single item instrument of perceived stress using the visual analog scale at Time 1, Time 2, and Time 3, cortisol response samples obtained concomitantly at times 1, 2, and 3 were used to examine concurrent validity. The findings are presented in table 4.
Table 4

*Pearson Correlation Coefficients between Perceived Stress Ratings and Salivary Cortisol (N=75)*

<table>
<thead>
<tr>
<th></th>
<th>Time 1</th>
<th>Time 2</th>
<th>Time 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pearson $r$</td>
<td>-0.108</td>
<td>-0.145</td>
<td>-0.211</td>
</tr>
<tr>
<td>$p$-value</td>
<td>0.401</td>
<td>0.288</td>
<td>0.097</td>
</tr>
<tr>
<td>Missing (n)</td>
<td>12</td>
<td>19</td>
<td>12</td>
</tr>
</tbody>
</table>

Cronbach’s alpha coefficients were used to assess the internal consistency for PSS-10 at Time 1, and perceived coworker social support at Times 1, 2, and 3. Cronbach’s alpha coefficients ranged from .784 to .937 for all instruments, indicating acceptable reliability (See table 5). Finally, inter-rater reliability was established for the items of individual performance at Times 2 and 3 based on the observations of two observers (the MCC and PI) and the items of team performance at Times 2 and 3 based on the observations of two observers during selected missions during the study. Only the PI remained consistent for each training mission; the MCCs changed for each of the study missions. The instrument reliabilities are noted in table 6.
Table 5

*Cronbach's Alpha Coefficients for Self Report Variables of Perceived Stress Scale-10 and Perceived Coworker Social Support*

<table>
<thead>
<tr>
<th>Instrument</th>
<th>Number of items</th>
<th>Possible score</th>
<th>Cronbach's $a$ Coefficient</th>
</tr>
</thead>
<tbody>
<tr>
<td>Perceived Stress-10 Time 1</td>
<td>10</td>
<td>0-40</td>
<td>.933</td>
</tr>
<tr>
<td>Perceived Co-Worker Social Support Time 1</td>
<td>3</td>
<td>0-15</td>
<td>.932</td>
</tr>
<tr>
<td>Perceived Co-Worker Social Support Time 2</td>
<td>3</td>
<td>0-15</td>
<td>.937</td>
</tr>
<tr>
<td>Perceived Co-Worker Social Support Time 3</td>
<td>3</td>
<td>0-15</td>
<td>.784</td>
</tr>
</tbody>
</table>
Table 6

*Inter-Rater Reliability for Individual and Team Job Performance (2 Observers)*

<table>
<thead>
<tr>
<th></th>
<th>Number of items</th>
<th>Possible score</th>
<th>Number of Observations</th>
<th>Cohen's Kappa</th>
</tr>
</thead>
<tbody>
<tr>
<td>Individual Job Performance Time 2</td>
<td>8</td>
<td>0-8</td>
<td>320</td>
<td>.719</td>
</tr>
<tr>
<td>Individual Job Performance Time 3</td>
<td>7</td>
<td>0-7</td>
<td>280</td>
<td>.728</td>
</tr>
<tr>
<td>Team Job Performance Time 2</td>
<td>13</td>
<td>0-13</td>
<td>104</td>
<td>.758</td>
</tr>
<tr>
<td>Team Job Performance Time 3</td>
<td>10</td>
<td>0-10</td>
<td>80</td>
<td>.736</td>
</tr>
</tbody>
</table>

Descriptive Analyses of Study Variables

Perceived Stress

Descriptive statistics for the major study variables are presented in table 7. The participants’ ratings of their perceived stress at the present time were noted at Time 1 (baseline), Time 2 (pre-flight), and Time 3 (in-flight). Each of the participant’s perceived stress was denoted by a mark on a 100 millimeter perceived stress visual analog scale (PS-VAS) which was measured by the PI using a millimeter ruler. The possible scores ranged from 0-100 with higher scores indicating higher perceived stress at that time. The mean scores and standard deviations for this study at Times 1, 2, and 3 were 30.68
Some crewmembers also provided unsolicited written comments on the PS-VAS noting frustration, feeling hot, uncomfortable, and tired. These additional mood states were not included in the present analysis. Missing individual PS-VAS ratings by some of the five individual crewmembers making up each team were noted. Several participants reported that they would complete it later, or did not have time to complete it at that time; such data were excluded from the analysis.

Salivary Cortisol Response

As shown in table 7, cortisol responses were measured at four times. The means and standard deviations for cortisol responses were noted as .258 (.44), .207 (.50), .197 (.38), and .169 (.29), at Times 1 to 4 respectively. Median scores of .164, .106, .197, and .169 were noted, and inter-quartile ranges (i.e., the difference between the 75th percentile and the 25th percentile) were .18, .09, .12, and .11. The cortisol data were severely positively skewed and the variable was log transformed for use in subsequent analyses.

Perceived Social Support from Coworkers

Perceived social support from co-workers at Times 1, 2, and 3 were rated using a 5-point Likert scale in response to three statements. The perceived social support from co-worker scores ranged from 6-15 out of possible 0-15 points. A mean score of 13.67 (2.00); 13.41(2.16), and 13.1(1.94) were noted at Times 1, 2, and 3 respectively, with higher scores on the scale meaning higher perceived social support from co-workers. The perceived social support ratings at time points 1, 2, and 3 were noted to be severely
negatively skewed (-1.579, -1.573, and -1.421) respectively. Median scores for social support were 15.00 at Times 1 and 2, and 14.0 at Time three. The inter-quartile ranges were 3.0, at Times 1, 2, and 3. See table 7 for perceived stress, cortisol and social support ratings from co-workers.

Table 7

*Descriptive Statistics for Continuous Major Study Variables before Transformations, (N=75)*

<table>
<thead>
<tr>
<th>Variable</th>
<th>Mean</th>
<th>Median</th>
<th>SD</th>
<th>Minimum</th>
<th>Maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Perceived Stress Time1</td>
<td>30.68</td>
<td>30.00</td>
<td>24.76</td>
<td>0</td>
<td>100</td>
</tr>
<tr>
<td>Missing: 2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Perceived Stress Time2</td>
<td>33.89</td>
<td>30.00</td>
<td>25.99</td>
<td>1</td>
<td>100</td>
</tr>
<tr>
<td>Missing: 2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Perceived Stress Time3</td>
<td>30.89</td>
<td>25.00</td>
<td>26.49</td>
<td>1</td>
<td>86</td>
</tr>
<tr>
<td>Missing: 3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cortisol Time1</td>
<td>.258</td>
<td>.164</td>
<td>.440</td>
<td>.03</td>
<td>3.42</td>
</tr>
<tr>
<td>Missing: 11</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cortisol Time2</td>
<td>.207</td>
<td>.106</td>
<td>.497</td>
<td>.02</td>
<td>3.79</td>
</tr>
<tr>
<td>Missing: 18</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cortisol Time3</td>
<td>.197</td>
<td>.075</td>
<td>.383</td>
<td>.01</td>
<td>2.37</td>
</tr>
<tr>
<td>Missing: 9</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cortisol Time4</td>
<td>.169</td>
<td>.088</td>
<td>.290</td>
<td>.02</td>
<td>1.86</td>
</tr>
<tr>
<td>Missing: 16</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Social Support Time1</td>
<td>13.67</td>
<td>15.00</td>
<td>2.00</td>
<td>6</td>
<td>15</td>
</tr>
<tr>
<td>Missing: None</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Social Support Time2</td>
<td>13.41</td>
<td>15.00</td>
<td>2.16</td>
<td>6</td>
<td>15</td>
</tr>
<tr>
<td>Missing: 2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Social Support Time 3</td>
<td>13.41</td>
<td>14.00</td>
<td>1.94</td>
<td>6</td>
<td>15</td>
</tr>
<tr>
<td>Missing: 3</td>
<td></td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>
Job Performance (Individual and Team)

Job performance included the individual performance (IP) of each the 75 crewmembers during Time 2 (pre-flight) and Time 3 (in-flight). Mean IP scores were 7.13 (SD 1.3) and 6.12 (SD 1.4) respectively. Mean team performance (TP) scores were 12.27 (SD 1.0) and 8.73 (SD 1.3) respectively. Median scores for IP were 8.0, and 7.0 at Times 2 and 3 respectively. The inter-quartile ranges were 2.0 at each time-point. Similarly the median scores for TP at times two and three were 12 and 9 respectively. The inter-quartile ranges for TP were one and two at Time 2 and 3. The individual and team performance scores were severely negatively skewed and log transformations did not result in skewness values close to zero. The individual job performance scores were perfect for 61% of the participants at Time 2, and 68% of the participants at Time 3. Likewise, team performance scores were perfect for 46.7% of the teams at Time 2 and 40% of the teams at Time 3. The job performance values were therefore dichotomized for the GEE analysis, where a one was used to represent 100% achievement of the job performance (individual and/or team) performance tasks, and a zero represented less than 100% achievement of the job performance tasks.

Correlations with Major Study Variables

Bivariate correlations were calculated to describe the relationship between major psychosocial study variables of perceived stress (PS-VAS), perceived social support (SS) at Times 1, 2, and 3; and salivary cortisol (CORT) at Times 1, 2, 3, and 4. Job performance (individual and team performance) at Times 2 and 3 were not included in the bivariate correlations as the variable was dichotomized for analysis in this study. Correlations are noted in table 10. PS-VAS at Time 2 was noted to be negatively
correlated with SS at Times 2 and 3 ($r = -.504, p < .001; r = -.442, p < .001$, respectively); likewise, PS-VAS at Time 3 was also negatively correlated with SS at Times 2 and 3 ($r = -.460, p < .001; r = -.433, p < .001$). Salivary cortisol was not correlated with any major study variables except at Times 3 and 4. At Time 3, salivary cortisol response was positively correlated with individual performance at Time 2 ($r = .258, p = .036$). Salivary cortisol response at Time 4 was positively correlated with team performance at Time 2 and negatively correlated with team performance at Time 3 ($r = .309, p = .017; r = -.279, p = .033$ respectively). See table 8 for the significant bivariate correlations between major study variables.
Table 8

*Correlations with Major Study Covariates*

<table>
<thead>
<tr>
<th></th>
<th>Perceived Stress T1</th>
<th>Perceived Stress T2</th>
<th>Perceived Stress T3</th>
<th>Cortisol T1</th>
<th>Cortisol T2</th>
<th>Cortisol T3</th>
<th>Cortisol T4</th>
<th>Social Support T1</th>
<th>Social Support T2</th>
<th>Social Support T3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Perceived Stress T1</td>
<td>1</td>
<td>.706(.000)</td>
<td>.545(.000)*</td>
<td>-.108(.573)</td>
<td>-.075(.582)</td>
<td>-.020(.878)</td>
<td>.109(.415)</td>
<td>.066(.579)</td>
<td>-.127(.290)</td>
<td>-.116(.330)</td>
</tr>
<tr>
<td>Perceived Stress T2</td>
<td>.706(.000)*</td>
<td>1</td>
<td>.744(.000)*</td>
<td>-.072(.573)</td>
<td>-.145(.288)</td>
<td>-.203(.107)</td>
<td>.030(.825)</td>
<td>-.151(.204)</td>
<td>-.504(.001)*</td>
<td>-.442(.001)**</td>
</tr>
<tr>
<td>Perceived Stress T3</td>
<td>.545(.000)*</td>
<td>.744(.000)*</td>
<td>1</td>
<td>.056(.664)</td>
<td>-.154(.260)</td>
<td>-.211(.097)</td>
<td>.102(.456)</td>
<td>-.049(.685)</td>
<td>-.460(.001)*</td>
<td>-.433(.001)*</td>
</tr>
<tr>
<td>Perceived SS T1</td>
<td>.066(.579)</td>
<td>.151(.204)</td>
<td>.049(.685)</td>
<td>.067(.601)</td>
<td>.016(.900)</td>
<td>.103(.422)</td>
<td>-.054(.685)</td>
<td>1</td>
<td>.505(.000)*</td>
<td>.492(.000)*</td>
</tr>
<tr>
<td>Perceived SS T2</td>
<td>.127(.290)</td>
<td>.504(.001)*</td>
<td>.460(.001)*</td>
<td>.196(.144)</td>
<td>.038(.782)</td>
<td>.152(.262)</td>
<td>.033(.809)</td>
<td>.505(.000)*</td>
<td>1</td>
<td>.677(.000)*</td>
</tr>
<tr>
<td>Perceived SS T3</td>
<td>-.116(.330)</td>
<td>-.442(.001)*</td>
<td>-.433(.001)*</td>
<td>-.061(.627)</td>
<td>.085(.503)</td>
<td>.074(.560)</td>
<td>.078(.565)</td>
<td>.492(.000)*</td>
<td>.677(.000)*</td>
<td>1</td>
</tr>
<tr>
<td>Individual Perf. T2</td>
<td>-.203(.085)</td>
<td>-.192(.103)</td>
<td>-.271(.020)*</td>
<td>.150(.218)</td>
<td>.130(.337)</td>
<td>.258(.036)*</td>
<td>-.081(.542)</td>
<td>.060(.610)</td>
<td>.103(.384)</td>
<td>-.074(.534)</td>
</tr>
<tr>
<td>Individual Perf. T3</td>
<td>.063(.594)</td>
<td>.163(.169)</td>
<td>.108(.366)</td>
<td>-.061(.632)</td>
<td>.143(.289)</td>
<td>.015(.908)</td>
<td>-.053(.688)</td>
<td>.101(.389)</td>
<td>-.173(.144)</td>
<td>-.177(.134)</td>
</tr>
<tr>
<td>Team Perf. T2</td>
<td>.134(.260)</td>
<td>-.088(.462)</td>
<td>-.038(.748)</td>
<td>.021(.866)</td>
<td>.183(.172)</td>
<td>.231(.062)</td>
<td>.309(.017)*</td>
<td>.022(.848)</td>
<td>.1419.233)</td>
<td>.172(.146)</td>
</tr>
<tr>
<td>Team Perf. T3</td>
<td>-.011(.928)</td>
<td>-.091(.422)</td>
<td>-.129(.280)</td>
<td>-.064(.615)</td>
<td>.032(.813)</td>
<td>-.046(.715)</td>
<td>-.279(.033)*</td>
<td>.139(.242)</td>
<td>.041(.726)</td>
<td>.213(.071)</td>
</tr>
</tbody>
</table>

* Significant; SS-Social Support; Perf.-Performance
Specific Aims and Hypothesis Testing

Specific Aim 1: Determine the effect of perceived stress (Times 2 & 3) on salivary cortisol response (Times2 & 3) and individual and team job performance (Times 2 & 3) after controlling for covariates (perceived background stress, experience, rank, gender and age).

The first specific aim of this study was to determine the main effect of perceived stress on salivary cortisol response and individual and team job performance at each respective time point. Due to known effects on job performance, age, gender, rank, flight hours, and perceived background stress were examined as potential covariates. The bivariate correlations between potential covariates and the study variables were examined. Gender was noted to be significantly correlated with cortisol at Time 2 ($r = -.286, p=.033$), that is being male was associated with lower cortisol at Time 2. Perceived background stress was significantly correlated with cortisol at Time 3 ($r =.258; p=.041$), and finally, rank was significantly correlated with individual performance at Time 2 ($r =-.232, p=.048$). The potential covariates noted to be significant with the study variable using bivariate correlations were then regressed on the outcome variables (job performance or salivary cortisol response) using GEE regression analysis. The significant covariates identified using GEE were maintained in the final models, revealing gender with cortisol at Time 2 ($\beta = .540, p=.029$) and PSS10 with cortisol at Time 3 ($\beta = -.028, p=.014$) as significant. They were included in the respective models as covariates. Rank did not remain significant in the model and was not used as a covariate in any subsequent analysis.
GEE was used to test Hypothesis 1a, that higher levels of perceived stress would be associated with higher levels of salivary cortisol response and Hypotheses 1b and 1c, that higher levels of perceived stress would be associated with lower individual and team job performance, respectively. The GEE linear regression models used for testing the main effects of perceived stress on salivary cortisol response are summarized in Table 9. Independent working correlations were employed since the goodness of fit at each time point (53.180; 44.310; and 64.370) was the smallest when compared to the exchange models (53.708; 44.395; 64.391) in that order. There was no significant main effect of perceived stress at Times 1, 2 or 3 on salivary cortisol response at any corresponding time point ($\beta = -.004, p=.445; \beta = -.005, p = .373; \beta = -.008, p = .177$), while controlling for covariates as appropriate. Hypothesis 1a was not supported.

Table 9

_GEE Linear Regression Analyses for Testing Main Effects of Perceived Stress on Salivary Cortisol Response While Controlling for Covariates (N=75)_

<table>
<thead>
<tr>
<th>Final Models</th>
<th>QIC Goodness of Fit (Working Correlation)</th>
<th>Beta</th>
<th>df</th>
<th>Sig</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Time 1</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Perceived Stress $\rightarrow$ Cortisol a</td>
<td>53.180(I)</td>
<td>-.004</td>
<td>1</td>
<td>.445</td>
</tr>
<tr>
<td>Missing 12</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Time 2</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Perceived Stress $\rightarrow$ Cortisol a</td>
<td>44.310(I)</td>
<td>-.005</td>
<td>1</td>
<td>.373</td>
</tr>
<tr>
<td>Gender</td>
<td></td>
<td>.549</td>
<td>1</td>
<td>.029</td>
</tr>
<tr>
<td>Missing 20</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Time 3</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Perceived Stress $\rightarrow$ Cortisol a</td>
<td>64.370(I)</td>
<td>-.008</td>
<td>1</td>
<td>.177</td>
</tr>
<tr>
<td>PSS-10</td>
<td></td>
<td>-.026</td>
<td>1</td>
<td>.026</td>
</tr>
</tbody>
</table>

*a Natural log transformed data used; I-Independent
For testing the main effect of perceived stress on the dichotomized variable of job performance (individual and team) at each time point, GEE binary logistic regression models were employed. There were no significant main effects of perceived stress at Times 2 or 3 on individual job performance. Similarly, there were no significant main effects of perceived stress at Times 2, or 3 on team job performance. Table 10 provides the final models, including the working correlation with the smallest goodness of fit for testing the main effects of perceived stress on salivary cortisol and job performance (individual and team). In summary, perceived stress was not associated with increased salivary cortisol or decreased individual or team job performance when controlling for covariates as appropriate. Therefore, neither hypothesis 1b nor 1c was supported for this study.
Table 10

*GEE Logistic Regression Analyses for Testing Main Effects of Perceived Stress on Dichotomized Job Performance (N=75)*

<table>
<thead>
<tr>
<th>Final Models</th>
<th>Goodness of Fit (Working Correlation Matrix)</th>
<th>Beta</th>
<th>df</th>
<th>Sig</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time 2</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Perceived Stress ← Individual Job Performance*</td>
<td>99.436 (I)</td>
<td>-.015</td>
<td>1</td>
<td>.170</td>
</tr>
<tr>
<td>Missing: 2</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Time 2</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Perceived Stress ← Team Job Performance*</td>
<td>110.508 (EX)</td>
<td>2.682</td>
<td>1</td>
<td>.491</td>
</tr>
<tr>
<td>Missing: 2</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Time 3</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Perceived Stress ← Individual Job Performance *</td>
<td>91.00 (I)</td>
<td>-.007</td>
<td>1</td>
<td>.342</td>
</tr>
<tr>
<td>Missing: 2</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Time 3</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Perceived Stress ← Team Job Performance*</td>
<td>106.53(Ex)</td>
<td>3.185</td>
<td>1</td>
<td>.384</td>
</tr>
<tr>
<td>Missing: 2</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* Dichotomized ; (I)-Independent; (Ex)-Exchangeable

Specific Aim 2: Assess if salivary cortisol response (Times 2 & 3) mediates the relationship between perceived stress and individual and team job performance (Times 2
& 3) after controlling for covariates (perceived background stress, experience, rank, and age).

The second aim of this study was to examine whether salivary cortisol would mediate the association between perceived stress at Time 2 and 3 on individual and team performance at times 2 and 3 respectively. For testing the mediation of salivary cortisol response at Times 2, and 3 in the stress-individual job performance relationship, GEE was used to perform methodologies described by Baron and Kenny (1986). First, the log transformed potential mediator, salivary cortisol, was regressed on the predictor variable, perceived stress, at Times 1, 2 and 3 as noted in specific aim 1. Because there was no main effect of perceived stress on salivary cortisol response, the first condition necessary for mediation could not be established for any other time point, and no further mediation analyses were performed. Therefore, Aim 2 was not supported.

Specific Aim 3: Assess if perceived coworker social support (Times 1, 2, & 3) moderates the relationship between perceived stress and salivary cortisol response (Times 1, 2, & 3).

For specific aim 3, with Hypothesis 3, a series of regression equations were employed to determine whether perceived coworker social support (Times 1, 2, & 3) moderated the relationship between perceived stress and salivary cortisol response at Time 1, Time 2, and Time 3, respectively. GEE was used to guide the analyses described by Baron and Kenny (1986) for the testing a moderation model of coworker social support in the stress-salivary cortisol relationship at Times 1, 2, & 3 with “team” as the subject variable. The working correlations noted to produce the smallest goodness of fit for the models was the independent working correlation structure at time 1(54.284) and
the exchangeable working correlation structure at Times 2 and 3, respectively (47.209, 69.324). Table 11 includes the summary of the findings for testing the moderating effect of perceived social support on cortisol at each corresponding time point.

Table 11

*Testing Moderating Effect of Perceived Coworker Social Support on the Relationship between Perceived Stress and Salivary Cortisol Response, (N=75)*

<table>
<thead>
<tr>
<th>GEE Regression Model</th>
<th>Working Correlation</th>
<th>Beta</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Model 1: Cortisol Time 1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>VAS: Centered Perceived Stress</td>
<td>Independent</td>
<td>-.004</td>
<td>.004</td>
</tr>
<tr>
<td>SS: Centered Social Support</td>
<td></td>
<td>.033</td>
<td>.337</td>
</tr>
<tr>
<td>VAS x SS</td>
<td></td>
<td>.033</td>
<td>.127</td>
</tr>
<tr>
<td>Missing 12</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Model 2: Cortisol Time 2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>VAS: Centered Perceived Stress</td>
<td>Exchangeable</td>
<td>-.005</td>
<td>.312</td>
</tr>
<tr>
<td>SS: Centered Social Support</td>
<td></td>
<td>-.010</td>
<td>.871</td>
</tr>
<tr>
<td>VAS x SS</td>
<td></td>
<td>.000</td>
<td>.875</td>
</tr>
<tr>
<td>Missing 19</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Model 3: Cortisol Time 3</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>VAS: Centered Perceived Stress</td>
<td>Exchangeable</td>
<td>.005</td>
<td>.116</td>
</tr>
<tr>
<td>SS: Centered Social Support</td>
<td></td>
<td>-.009</td>
<td>.949</td>
</tr>
<tr>
<td>VAS x SS</td>
<td></td>
<td>.000</td>
<td>.882</td>
</tr>
</tbody>
</table>
Summary

In summary, a total of 75 participants were enrolled in this study, however not all of the participants completed all of the data samples at each time, resulting in samples of less than 75 at many of the data collection time points. For Specific aim 1 using GEE regression analysis, higher levels of perceived stress were not associated with higher salivary cortisol response while controlling for appropriate covariates at any each time point. Additionally, for Specific Aim 2 using regression analysis, the first condition was not met, that is there was no significant positive effect of perceived stress on salivary cortisol. Therefore no further analysis was conducted to test for a mediating effect of salivary cortisol on the perceived stress job performance relationship and Hypothesis 2 was not supported. For Specific Aim 3, perceived social support from co-workers did not show a moderating effect on the perceived stress salivary cortisol relationship at any time point. Therefore, Hypothesis 3 also was not supported by the data from this study.
CHAPTER 5
DISCUSSION

The purpose of this study was to examine the effects of perceived stress, salivary cortisol response, and coworker social support on individual and team job performance among aeromedical crewmembers during a challenging simulated AE training mission. Findings of this cross-sectional descriptive study indicated that higher levels of perceived stress were not related with higher levels of salivary cortisol response at any time point. Similarly, perceived stress did not have a main effect on job performance (individual or team) at any time point as hypothesized. Finally, perceived social support from coworkers did not moderate the relationship between perceived stress and salivary cortisol response at any time point. Therefore, none of the study hypotheses were supported. In the following section, major findings and limitations of the study, and implications for nursing practice, education and research are discussed, along with recommendations for further research.

Sample Characteristics and Correlations of Study Variables

The demographic characteristics, including characteristics obtained from the potential study covariates, provided many considerations for this study. The aeromedical crewmembers in this study represented very experienced crews, with 45.8% of the participants having greater than 11 years in the military. Only 8% of the participants had never deployed, suggesting that 92% of the participants had experienced operational
missions, including real world worst case scenarios. Additionally, 60.6% of the participants had greater than 400 flight hours again suggesting that the participants had experience in flying both operational and training missions. Crewmembers that have accumulated experience with real world and training missions may not have been challenged by the training missions in the same way as less experienced crews.

A large majority of the participants in this study, 61.1%, worked in healthcare settings in their civilian jobs. The requirement to work in healthcare is not required for aeromedical crewmembers, although ongoing readiness skills training is required. Additionally, the nurse officers are required to work in a job that requires the person to be a registered nurse for at least 180 hours per year (Air Force Instruction, [AFI] 46-101,2011). The healthcare experience of the crewmembers may imply that the crewmembers were well suited for patient care emergencies during the training mission. However, working in healthcare may need to be further defined to ensure the term implies clinical experience performing patient care activities versus non-patient care activities that may also be involved in healthcare jobs. Finally, Advanced Cardiac Life Support (ACLS) training was required for only the nurse officers, representing 41.1% of the study sample. However, 90.3% of the sample had current or previous training in ACLS. The ACLS training prepares crewmembers for the worst case scenario, of a cardiac arrest in flight, and may ensure greater resources in handling this challenge. Again, crewmembers in this sample may function differently than less experienced crews or with only the required crewmembers possessing advanced training such as ACLS.

Also interesting were the correlations of study variables in this study. Higher ratings of perceived social support from co-workers at Times 2 and 3 were associated
with significantly lower perceived stress ratings at Times 2 and 3 among participants. This finding is consistent with the literature, suggesting that social support may decrease the appraisal of stress by enhancing one's perception of coping abilities and resources (Cohen & Wills, 1985). The lack of correlation of perceived stress and perceived social support from co-workers at baseline, Time 1, may imply that the benefits of social support on perceived stress are not automatic, even among crewmembers that are from the same unit as in this study, and may fly together routinely. Indeed, the role of enacted socially supportive behaviors and perceived support have been noted in previous studies, with both of the distinct concepts of perceived and received social support being beneficial in performance (Freeman & Rees, 2008). There is a need to understand those socially supportive behaviors and barriers in implementing those behaviors that are perceived to be needed during the AE mission to enhance coping with challenges in AE.

Finally, the lack of correlation between perceived stress and cortisol response noted in this study was not expected. The implications of the lack of correlation between perceived stress and salivary cortisol noted were examined during the analysis of specific aim 1, examining the main effect of perceived stress on salivary cortisol response. These implications are discussed in the next section.

Main Effect of Perceived Stress on Salivary Cortisol Response

Perceived Stress Ratings Considerations

The perceived stress ratings of aeromedical crewmembers did not have a significant positive main effect on salivary cortisol response after controlling for significant covariates as appropriate. This finding is contrary to findings noted in the
literature, which suggests higher levels of perceived stress would result in higher physiological response of cortisol (Kudielka & Kirschbaum, 2005).

To further examine this conflicting finding, the responses to the instruments used for assessing perceived stress ratings and the salivary cortisol collection protocol used in this study were evaluated. In this study, a single item Visual Analog Scale was used for measuring perceived stress ratings to minimize interruption of performance tasks during the mission. Indeed, the fast pace of the AE mission required consideration of time constraints prior to and during the mission. A single item instrument may not have captured the actual construct of perceived stress. The mean perceived stress ratings at Times 1, 2, and 3 were 30.68, 33.89, and 30.89, respectively, based on a scale of 0 to 100. While it could be argued that the perceived stress scores are low since the highest rating possible was 100, the ratings are indeed higher than studies involving other high stress professions. A study involving well trained surgeons working in a high volume inner city hospital during a long work day, revealed perceived stress ratings with median scores of 20 with an inter-quartile range of 10-30 at the beginning of the shift using a visual analog scale ranging from 0-100; and a median of 20 at the end of the 12-hour shift, with an inter-quartile range of 10-45 (Langelotz et al., 2008). While the study involving surgeons did not measure salivary cortisol response, the training and experience of the surgeons was suggested as a possible reason for the perceived stress ratings (Langelotz et al., 2008). Indeed, the training and experience of the aeromedical crewmembers in this study, may also account for the perceived stress ratings. However, it could also be argued that the perceived stress ratings in the current study do represent some variation of perceived stress ratings despite similar experience levels and training.
requirements, and thus the examination of differences in high, moderate, and low stress groups would be valuable in future studies.

The lack of correlation between perceived stress and salivary cortisol at each time point as evidenced by bivariate correlations \( r = -0.108, p = 0.401; r = -0.145, p = 0.288; r = -0.211, p = 0.097 \), respectively) and the lack of a main effect of perceived stress on salivary cortisol was noted in this study. Previous studies have found significant positive associations of perceived stress and salivary cortisol using a single item instrument when administered concurrently (Metzenthin, et al., 2009), which supports the use of the single item instrument for this study. Regehr et al., (2008) employed the State Anxiety (STAI) scale as offered by Speilberger (1983) to measure perceived anxiety/stress of police recruits. The STAI is a multi-item instrument that taps into various emotions perceived at that time (Regehr et al., 2008). The additional items included on the STAI may have added to the understanding of the emotions of the police recruits more than what was available in the current study using the perceived stress visual analog scale. Certainly, there were numerous unsolicited mood reports by participants during the conduct of this study that were not captured with the single item instrument. While the visual analog scale is supported by other studies in the literature, as noted previously, consideration of additional measures such as the STAI at baseline and post-mission could have added to the current study. Future studies should consider the examination of other mood states, such as fatigue, confusion, anxiety.

Salivary cortisol response was noted to be higher at baseline than at any other time point. Previous studies have also noted higher baseline stress ratings and salivary cortisol at baseline beyond those of later time points involving performance under
varying stress (Takahashi, et al., 2005; Wetzel, et al., 2010), suggesting a possible role of anticipatory stress. Indeed, the perceived stress ratings at the beginning of the mission may not have reflected the baseline stress ratings of the aeromedical crewmembers. While salivary cortisol was measured at Time 4, post-mission, perceived stress ratings were not measured at Time 4 to diminish the number of evaluations during the mission. Evaluation of perceived stress ratings at Time 4 with the cortisol response at Time 4 would have added to the usefulness of the post mission data in further interpreting this finding. Considering previous findings supporting a main effect of perceived stress using a single item instrument and cortisol response (Metzentihin, et al., 2009), we carefully examined other explanations for this finding, which are discussed in detail below.

Salivary Cortisol Response Collection Challenges in AE

Salivary cortisol collection has been posited as a simple, convenient and valid method for assessing physiological responses to perceived stress (Kalman & Grahn, 2004; Regehr, 2008), however, it is not without challenges (Granger et. al., 2007). In this study, the large number of missing cortisol samples was surprising (Time 1 = 11; Time 2 = 18; Time 3 = 9, and Time 4 = 16) and this may have possibly limited the detection of a main effect of perceived stress on salivary cortisol as expected. Most of the missing data were due to insufficient salivary samples, although 82% was useful. The unexpected finding of inadequate or randomly missing salivary cortisol samples resulted in sample sizes of less than 64 at Times 2 and 4 that represented the minimum sample needed to produce the moderate power desired for this study. Many participants complained of the dryness of the cotton swabs, in addition to reporting an offensive taste, with some
suggesting a need for flavored swabs. The offensiveness of certain types of saliva collection devices compared to cotton balls (Hanrahan et al., 2006; Kalman & Grahn 2004), and the potential for the type of swab used for the collection of saliva leading to dry mucous membranes (Granger et al., 2007) have been noted in the literature. Indeed the offensive taste and increased dryness exaggerated by the decreased humidity in the AE environment may have played a role in the willingness of participants to keep the cotton swabs in their mouths until saturated at the four different time points. To our knowledge, no previous study has suggested a protocol for the collection of salivary cortisol in an aeromedical environment. While Granger et Al., (2007) discussed special consideration with various types of saliva collection materials, further study is needed to determine differences in tolerance of salivary cortisol methods, including the type of swabs in this population during aeromedical missions.

Salivary Cortisol Response Analysis Considerations

This study employed a cross sectional approach to examine how perceived stress may affect salivary cortisol at different time points, although the repeated measures were obtained in a short time period during the mission. The need to examine repeated measures of salivary cortisol to enhance the detail in detecting the possible influence of perceived stress on physiological responses has been reported (Eck, Berkhof, Nicloson, & Sulon, 1996); however, the number of saliva samples to be collected in austere environments such as aeromedical evacuation should be considered to enhance compliance. Future studies should also consider a repeated measures approach for the
evaluation of perceived stress on salivary cortisol response, which may have significantly added to the robustness of the study findings.

The inter-assay and intra-assay Coefficients of Variance (CV) for salivary cortisol results for this study were 2.52%, and 2.43% respectively, suggesting the high precision of the reported values, and provided confidence in the salivary cortisol response findings. In examining the main effects of perceived stress on salivary cortisol response, potential study covariates of age, gender, rank, flight hours, and perceived background stress using the PSS-10 were examined. Significant correlations of perceived background stress using the PSS-10 and gender with salivary cortisol response were noted.

Chronic Background Stress and Salivary Cortisol Response Considerations

Perceived background stress was noted to be negatively correlated with cortisol response at Time 3. That is, persons with higher perceived background stress or chronic stress over the last 30 days had lower salivary cortisol response at Time 3, later in the mission. Blunted acute physiological response of cortisol has been noted in the literature following chronic stress using the perceived stress scale (Evans & Steptoe, 2001; Matthews et al., 2001; Takahashi, et al., 2005). Considering that the mean PSS-10 rating for this study was 19.15, which was slightly lower than the US mean scores (23.18, 23.67, and 25.00) representing three different groups of students and persons in a smoking cessation group (Cohen et al., 1983), and in previous studies of military personnel (21.59) as noted by Taylor et al., (2009), it is not certain if the lack of a main effect of perceived stress on salivary cortisol response at each time point represented a blunted HPA response among the crewmembers. Indeed, it also cannot be overlooked
that perhaps the experienced crewmembers did not experience acute stress during the training mission.

Perceived Stress and Salivary Cortisol Response Considerations

Novelty and uncertainty of tasks are hallmarks in the activation of the HPA axis in response to perceived stress (Kemeny, 2003). During AE training missions, the uncertainty includes the timing of aircraft emergencies, patient care emergencies and time pressures sprinkled throughout the various phases of the AE mission. Considering that AE crewmembers must fly at least every 90 days to maintain currency, including training missions (AFI, 2005), there is a possibility that despite the stresses of flight, uncertainty, and time pressures characteristic of the AE training mission, the novelty for this study mission was not sufficient to challenge the crewmembers enough to elicit HPA axis activation.

The findings in this study also suggests that the participants in this study represented very experienced crews, with 60.5% reporting greater than 400 flight hours and a mean of 9.8 years as AE crewmembers. Additionally, 91.7% of the crewmembers had previous deployment experience in AE and 61% reported that they work in a healthcare setting. While only the AE nurses (41.1%) are required to have Advanced Cardiac Life Support training, 50% of sample reported current ACLS certification and another 40.3% reporting previous training in the management of cardiac arrest using ACLS protocols. ACLS training prepares participants to manage life threatening events, and may influence perceptions of control during worst case scenarios encountered during
the mission. However, there was no correlation between deployment experience, Advanced Cardiac Life Support, or healthcare work experience with salivary cortisol.

In contrast Regehr et al., (2008) included new police recruits with less than 9 weeks of experience in their study of perceived stress on job performance. However, 20% of the police recruits had prior background experience in emergency services, which would allow for some decreased novelty in the performance tasks requirements and may possibly account for the lack of effect of acute stress on performance in their study. Again, the possible lack of novelty in this study could also explain the lack of variation in cortisol sufficient to understand the relationship of perceived stress to salivary cortisol response.

For the purpose of examining the effects of stress during training missions, the use of centrally based Air Force exercises such as Global Medic or Air Force Rodeos, versus AE training missions occurring at various units should be considered. During such Air Force exercises, aeromedical crewmembers interface with crewmembers from various units at a neutral base location, and may fly with crewmembers outside of their unit as they would in real world deployments. The use of crews made up of crewmembers with limited background flying with crewmembers they know, similar to real world missions, may affect social support appraisals from co-workers and may impact perceived stress ratings and subsequent physiological response as well as performance.
Gender and Salivary Cortisol Response Considerations

The other significant potential covariate to salivary cortisol was gender. Gender was noted to have a significant negative correlation with cortisol at time 2 ($r = -.286, p=.033$). This finding suggests that being male was correlated with lower salivary cortisol response at Time 2 but not at other time points. The role of gender in the hypothalamic-pituitary axis activation (HPA) has resulted in conflicting in other studies. Some studies have noted greater cortisol response in men (Kudielka & Kirschbaum, 2005) or no gender influence on cortisol at all (Evans & Steptoe, 2001; Dickerson & Kemeny, 2004). Again, this may be due to the lack of control for confounders of salivary cortisol; previous studies have implicated variances in salivary collection for failures to detect physiologic response to perceived stress (Evans & Steptoe, 2001).

Possible Confounders to Salivary Cortisol Response Considerations

Previous studies have implicated the lack of control for confounders in salivary collection for failures to detect physiologic response to perceived stress (Evans & Steptoe, 2001). For this study the effects of circadian rhythm on cortisol were controlled by collecting samples during 1000 -1600 hours. Samples outside of this time range due to mission delays were excluded from the analysis. Several studies have shown that the sensitivity of cortisol samples taken early in the day, may be more robust in detecting physiological changes in response to work stress (Evans & Steptoe, 2001).

Other studies also controlled for additional confounders that affect cortisol response such as smoking, birth control, illnesses, and sleep through self-report at the end of a work shift (Metzenthin & et al., 2009); or exclusion of participants such as females.
and instructions of pre-study restrictions (Takahashi & et al., 2005). All aeromedical crewmembers have restrictions on alcohol intake before flight, activity restrictions, such as diving or giving blood, as well as medications that can be taken by crewmembers, including over-the-counter medications in accordance with AFI 11-2AE -3 (2010). However, considering that 68% of the participants in this study were female, and that many of the participants fit within reproductive age categories of 21-45, there is a real likelihood that female participants in this study may have used birth control, which could result in an altered cortisol response (Kudielka & Kirschbaum, 2005). Specifically, birth control medications can result in blunted cortisol response, as well as other medications. In contrast, alcohol, smoking and protein intake may result in elevated cortisol response (Nicholson, 2008).

Future studies should consider the voluntary reporting of specific medications, alcohol and caffeine use, smoking habits, and sleep quality and duration as potential confounders of salivary cortisol. However, considering the existing restrictions of certain medications and practices such as use of alcohol prior to the mission based on Air Force Instruction 11-2AE-1(2010), there may be some hesitation in reporting data conflicting with these restrictions. Also, with consideration for real world time constraints for data collection prior to and during the mission, instructions for restrictions to be followed during the study should be provided before the day of the mission and demographics should be administered post mission to allow for thorough completion.
Main Effect of Perceived Stress on Job Performance

Despite mean levels of perceived stress of 31, 34 and 31 on a scale of 0-100 at Times 1-3, respectively, perfect achievement of individual performance at Times 2 and 3 were approximately 61% and 68%, and perfect achievement of team performance was 46% and 40% respectively. The job performance ratings indicating less than perfect team job performance were most often due to communication and coordination for team performance, and technical tasks such as positioning of the purge valve on the personal oxygen in regards to individual performance. However, there were no significant main effects of perceived stress on job performance (individual and team) at any time point.

Perceived stress at Time 3 was noted to be negatively correlated with individual performance at Time 2 ($r = -0.274$, $p = 0.020$), that is, crewmembers with better individual performance during Time 2, the pre-flight phase involving aircraft configuration, had lower stress ratings later in the mission. Such a positive reinforcement of perceived stress with job performance stress is not surprising, and has been reported in previous studies (Wetzel, et al., 2010). However, this finding further highlights the need to examine the effect of repeated measures not only on physiological responses, but also outcomes of job performance. Unexpectedly, there was no significant correlation of perceived stress with job performance (individual or team) at any other time point, however, similar findings were again noted in the literature among police recruits (Regehr et al., 2008). While some of the similarities and differences with the study by Regehr and colleagues (2008) have been discussed in the previous section, the differences in the examination of performance are also of interest to the present study.
Observation of Job Performance Considerations

A major issue in examining the main effect of perceived stress on job performance (individual and team) was capturing the critical behaviors of complex individual and team performance during the AE mission. Job performance for this study was assessed as the total hits or misses in individual or team performance tasks observed based on separate individual and team aeromedical evacuation crewmember checklists. Due to the severe negative skewness of the job performance scores at each time point, the variables of job performance were dummy coded as a one, if a perfect score was achieved, or zero if one or more tasks were missed. The dichotomized job performance variables may have further resulted in a loss of variation in performance scores. Again the experience of the crewmembers may also have accounted for the high performance observed during the mission, and the limited variation needed to make a testing of the hypotheses meaningful.

During the mission debrief, crewmembers reported details of issues and concerns of communication and coordination breakdowns, which were the major items missed during most team performance, or other individual performance items, and these comments would have provided greater details of the performance findings. AE crewmembers must complete Crew Resource Management training every 90 days in accordance with Air Force Instruction (2010). Crew Resource Management (CRM) emphasizes team performance behaviors, such as communication and coordination, under crisis situations. However, the tendency for communication and coordination breakdowns noted in the present study suggests the need for detailed evaluation of CRM during training missions. Qualitative data are needed to further examine those critical
characteristics of effective team and individual performance during the AE mission to be included in observational checklists. Regehr et al., (2008) included the subjective reports of police recruits along with the objective appraisal of experts to examine the effects of acute stress on performance. The inclusion of both subjective appraisals of performance along with detailed comments, although varying from actual performance, may have added to the robustness of the Regehr et al., (2008) study, although no significant correlation of perceived stress and performance was noted.

While the use of multiple observers during the AE mission added to the validity of the performance ratings, the additional observers changed for each mission. Other studies involving job performance have employed videotaping to allow for later review of performance with multiple and consistent reviewers using more complex instruments (Fischer, 2000; McNeil, 2007; Regehr et al., 2008). This could have resulted in greater variation in performance findings. Such videotapes could also be used in subsequent training with crewmembers.

Mediating Effect of Salivary Cortisol Response on the Relationship between Perceived Stress and Job Performance (Individual and Team)

Since the first condition of the main effect of perceived stress on salivary cortisol was not met in this study, further analysis to evaluate the mediating effect of salivary cortisol on the relationship between perceived stress and job performance (individual and team) was not performed. While the limitations of detecting main effects of perceived stress on salivary cortisol response have previously been noted, the need to examine how perceived stress potentially affects individual and team performance is critical in AE to ensure the quality and safety of patient care. The potential for cortisol to affect working
memory translates into naturalistic individual and team job performance tasks that are of particular importance for healthcare, including in AE, such as reporting details of the care of a patient during a patient hand-off (Fischer, et al., 2001); cardiac arrest/emergency management; and solving math problems, especially under stress (LeBlanc, 2009), such as oxygen requirements for patients during long AE missions. Examining whether salivary cortisol explains how stress affects job performance in this population will help to inform the military and healthcare of interventions and training needed to minimize this effect. Further study is needed to examine salivary cortisol as a mediator in the stress performance relationship. Again, the use of AE training missions which allow for crews consisting of members from other units and varying experience, which is consistent with real world deployments, is needed.

Moderating Effect of Social Support from Coworkers on Salivary Cortisol Response

The moderating role of social support on the perceived stress-salivary cortisol relationship was not supported in this study. No correlation between social support and cortisol was noted at any time point. Perceived co-worker social support ratings were found to be negatively correlated with perceived stress at Time 2 and Time 3. That is, higher perceived social support was correlated with lower perceived stress ratings at all time points except at baseline. The lack of correlation of perceived stress at baseline compared to Times 2 and 3 may suggest that enacted socially supportive behaviors may have influenced subsequent social support ratings. That is, the received social support from co-workers during the mission may have influenced lower subsequent perceived stress appraisals.
In this study, the mean social support ratings were 13.67, 13.41, and 13.41 at Times 1, 2, and 3, respectively, out of a possible 15, suggesting high perceived social support throughout the mission. The 3-item social support scale was noted to be reliable, with a Cronbach’s alpha of .933 indicating good reliability. In this study we did not examine the length of time that the crewmembers had flown together. Indeed, teams evolve over time, and the knowledge that crewmembers may be available if needed may also evolve over time. During unit AE training missions, crewmembers consistently fly and train with the same members of their unit. During deployments, crewmembers may or may not fly real world missions with crewmembers with whom they have trained. It is vital to inform military training of those socially supportive behaviors that aide in reducing stress and ultimately job performance during AE missions. Further study is needed to examine if social support from co-workers moderates the perceived stress-cortisol response relationship.

Conclusions

The major purpose of this study was to examine the effects of perceived stress, salivary cortisol response, and coworker social support on individual and team job performance during a challenging simulated AE training mission in aeromedical crewmembers. Findings from this study suggest that perceived stress, including chronic perceived stress, is experienced by AE crewmembers, however, there was no main effect of perceived stress on salivary cortisol or job performance (individual or team). Perceived social support from co-workers also did not moderate the relationship between perceived stress and salivary cortisol. However, the inability to detect the role of salivary
cortisol as hypothesized in this study may be due to the lack of control for potential confounders affecting cortisol response, such as medications, smoking, and alcohol. Higher social support ratings were noted to be correlated with lower perceived stress ratings at Time 2 and Time 3, but not at baseline, which may suggest the role of enacted socially supportive behaviors in influencing perceived stress ratings.

Limitations

There were several limitations to the present study. First, the use of a convenience sample limits generalizability of the findings. In the current study, convenience sampling resulted in participants that were highly experienced in terms of flight hours, which may have attenuated individual stress responses. It may be that inclusion of qualified crewmembers who were less experienced may have yielded different findings. Additionally, responses of participants during a training mission may not be generalizable to a real world mission. Crewmembers for the 15 crews used in this study were made up of crewmembers from the same unit. During real world operational missions, crews are often made up of crewmembers from varying units. Team performance of new versus well-established teams may be different as teams are known to evolve over time.

The cross-sectional approach to data analysis was also a limitation. Although data were collected prospectively that is, at specific time points, the analyses regarding job performance were cross-sectional because different task checklists were evaluated at the different time points. This limited the ability to establish a clear relationship between perceived stress and physiological responses of salivary cortisol, or perceived stress on
job performance (individual and team), or to evaluate the impact of the total mission on performance. Using the cross-sectional approach, details on the influence of study variables at each time point on outcomes even over short timeframes may have been lost. An additional data analysis limitation was the loss of statistical power due to missing data on salivary cortisol at each time point.

Several additional limitations were noted related to measurement of study variables. One issue noted in the previous section is that the use of a hit or miss checklist to evaluate performance may have resulted in the loss of useful information. Further work is needed to establish better methods for observation of job performance, such as videotaping in AE, that will allow for greater details in the observation of job performance and consistency of evaluations. While the instruments developed for the study to measure job performance were guided by input from content experts, the complexity of the concept of job performance (individual and team) would be strengthened by greater theoretical underpinnings including the evolution of teams over time to guide the instruments and study protocol.

Another issue was that data collection for the cortisol samples was challenging in the aeromedical environment and resulted in many missing samples, which may have affected power and effect size needed to detect statistical significance. Several methodological considerations for salivary cortisol collection in AE were learned through this study that may help guide future research.

Finally, we used a single item visual analog scale to measure perceived stress in this study. Anecdotal feedback revealed many unsolicited mood states, such as frustration, from crewmembers during the missions, which may suggest a need to include
additional measures in future studies. Again, due to time constraints during the mission, careful consideration is needed in determining the ideal time to solicit more complex instruments. Additionally, the manner by which perceived stress ratings are obtained among military members should be considered, since there may be a socially motivated incentive or disincentive from reporting actual subjective stress ratings among fellow crewmembers. In the present study, only the PI was provided with the stress scores, however since the PI is also a military officer and aeromedical crewmember, there may have been some reluctance in revealing true subjective stress scores.

Another limitation was that there was no control for various confounders known to affect cortisol response such as medications, caffeine, smoking and alcohol intake in the current study. This was due in part to severe time limitations for data collection on the day of the AE mission. The lack of control for these variables suggest that caution should be taken in interpreting the findings of a lack of main effects of perceived stress on cortisol and job performance and the lack of a moderating effect of social support on salivary cortisol response. In future studies, consideration should be given to assessing these data prior to the mission date.

Implications for Nursing

Perceived stress is a common experience in the work place. In this study, aeromedical crewmembers were found to experience perceived background stress and acute stress, however, no effect was noted on job performance in this study. It is important to understand the role of perceived stress in job performance (individual and team) involving patient care and how physiological responses may explain this
relationship. While this study was not able to determine a main effect of perceived stress on salivary cortisol or job performance (individual and team) as hypothesized, further investigations are needed considering the limitations in this study. Nursing is uniquely postured to examine the concept of perceived stress in the work place that may impact job performance (individual and team), with the potential for negative patient care outcomes.

Nursing curricula should emphasize the physiological responses to perceived stress that may explain how stress influences performance to ensure nurses understand the body-mind interactions impacting their practice, as well as the patients for whom they provide care, and their caregivers. Additionally, content on socially supportive behaviors and team performance should be a mainstay in nursing education. The long history of Crew Resource Management in the training of AE crewmembers allows for many lessons in healthcare. Nursing could benefit from the knowledge of key elements of CRM that will guide team performance training in healthcare and ultimately may reduce error.

Military Implications

Military Aeromedical Evacuation includes key elements of aviation, healthcare and the military, all of which include stressors that may lead to appraisals of stress. There is a need to identify the key elements of an effective AE team which may inform stakeholders regarding deployment strategies of AE crewmembers and the necessary socially supportive behaviors that are important to crewmembers in reducing perceived stress and physiological responses to stress that may negatively influence the quality and safety of job performance. Such behaviors could be infused into CRM training, and
evaluated during AE training missions. Additionally, there is a need to understand and explore possible barriers in reporting actual perceived stress appraisals among military aeromedical crewmembers and the implications of such reporting. Further study is also needed to understand and promote effective coping strategies employed by aeromedical crewmembers that may decrease chronic and acute stress. Finally, there is a need to identify the challenges encountered during operational missions as experienced by aeromedical crewmembers and provide evidence that current aeromedical readiness missions prepare crewmembers to meet those challenges.

Recommendations for Further Research

Based on the limitations identified in this study, several recommendations can be made for further research. First, a repeated measures analysis, instead of the cross-sectional approach used in this study, is needed to allow for a better picture of the relationship between perceived and physiological response. Second, a theoretically based protocol is needed to drive future stress and job performance research in the unique military aeromedical environment. Future studies involving the AE environment should consider the timing of cortisol sampling to enhance compliance due to the decreased humidity in AE. Consecutive training dates using the same crews should be considered to allow for multiple samples while promoting greater compliance. The assessment of cortisol on other than the date of the mission for the baseline samples may also be considered. Additionally, there is a need to concurrently examine and analyze the perceived stress ratings using a repeated versus cross-sectional analysis approach. Confounders for salivary cortisol should be assessed in future studies to determine if
certain individual practices of medications, alcohol, smoking, illness, and/or sleep may influence the cortisol response. Since the additional questions necessary to capture demographic information and study confounders will add to the length of the demographic survey and again influence time constraints prior to the mission, demographic data should be collected after the study and study restrictions provided days before the mission. Many crewmembers posited additional mood states (e.g., being frustrated, being hot) that should also be considered in future studies.

Qualitative data are also needed to identify the key characteristics of an effective aeromedical team and the socially supportive behaviors that are deemed essential by crewmembers during the AE mission. Additionally, the efficacy of CRM training and evaluation should be examined to inform CRM of needs in ensuring effective performance under stressful situations. However, in gathering sensitive information such as perceived stress and social support ratings, and even potential confounders, there is a need for consideration of the impact of the military “esprit de corps” and the possibility of socially desirable responses for self reported data from this population compared to civilian populations.

While the measurements used in this study for evaluating individual and team performance suggested acceptable validity, future studies should employ videotaping to perform a retrospective evaluation of performance using more complex instruments. AE crewmembers could also use the videotapes to review and evaluate effective training. Finally, the platform for future studies examining the effect of stress on AE job performance should consider Air Force Exercises instead of unit AE training to allow for
greater training resources such as high fidelity mannequins, interface with crewmembers from other units, and varying levels of experience.


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APPENDIX A

INSTITUTIONAL REVIEW BOARD APPROVALS
Form 4: IRB Approval Form
Identification and Certification of Research
Projects Involving Human Subjects

UAB's Institutional Review Boards for Human Use (IRBs) have an approved Federalwide Assurance with the Office for Human Research Protections (OHRP). The Assurance number is FWA00005960 and it expires on August 29, 2016. The UAB IRBs are also in compliance with 21 CFR Parts 50 and 56.

Principal Investigator: SHAMBURGER, TRACY M
Co-Investigator(s):
Protocol Number: X101119008
Protocol Title: Stress and Job Performance of Aeromedical Crewmembers: The Roles of Salivary Cortisol and Social Support

The IRB reviewed and approved the above named project on 12-2-11. The review was conducted in accordance with UAB's Assurance of Compliance approved by the Department of Health and Human Services. This Project will be subject to Annual continuing review as provided in that Assurance.

This project received EXPEDITED review.
IRB Approval Date: 12-2-11
Date IRB Approval Issued: 12-2-11

Marilyn Doss, M.A.
Vice Chair of the Institutional Review Board for Human Use (IRB)

Investigators please note:

The IRB approved consent form used in the study must contain the IRB approval date and expiration date.

IRB approval is given for one year unless otherwise noted. For projects subject to annual review research activities may not continue past the one year anniversary of the IRB approval date.

Any modifications in the study methodology, protocol and/or consent form must be submitted for review and approval to the IRB prior to implementation.

Adverse Events and/or unanticipated risks to subjects or others at UAB or other participating institutions must be reported promptly to the IRB.
MEMORANDUM FOR TRACY SHAMBURGER USAFR

FROM: 711 HPW/IR (AFRL IRB)

SUBJECT: IRB approval for the use of human volunteers in research


2. Protocol number: FWR20110031H

3. Protocol version: 2.0

4. Risk: Minimal

5. Approval date: 14 December 2011

6. Expiration date: 13 December 2012

7. Scheduled renewal date: 13 November 2012

8. Type of review: Continuing Review - Amendment – Expedited

9. Assurance Number and Expiration Date:
   - AFRL MPA50002: 14 March 2014
   - University of Alabama Birmingham FWA #00005960
     DoD N-A3122: 29 September 2013
   - IIA Tracy Shamberger

10. CITI Training: Completed

11. The above protocol was originally reviewed and approved by the AFRL IRB via expedited review procedures and is submitted for annual continual renewal/review. The purpose of the study is to determine effects of perceived stress, salivary cortisol, and the perceived social support from coworkers on the individual and team job performance among aeromedical crewmembers during a challenging training mission. Seventy-five (75) subjects who were qualified aeromedical crewmembers participated in the study. The only complaints were minor, in that five subjects stated that the cortisol swabs were too dry. These participants continued in the study, but the cortisol specimens from them were insufficient quantity for analysis. The study is closed to subject recruitment, but remains opened for data analysis which is why renewed approval is sought. This renewal of the protocol therefore meets the criteria for expedited review in accordance with 32
CFR 219.110 and U.S. Department of Health and Human Services category (8):
Continuing review of research previously approved where research is permanently closed
to the enrollment of subjects and the research remains active only for data analysis.

12. HIPAA authorization is not required, since no HIPAA protected information will be
recorded in the execution of this protocol.

13. FDA regulations do not apply since no drugs, supplements, or unapproved medical
devices will be used in this research.

14. This approval applies to human use research (as defined in 32 CFR 219 and AFI 40-402)
portions of this project only. Attitude and opinion surveys associated with this research
must be conducted IAW AFI 38-501, AF Survey Program. If the study is being
conducted under an IDE or IND, a copy of the FDA IDE or IND approval letter must be
submitted by the Principal Investigator to the IRB.

15. Any serious adverse event or issues resulting from this study should be reported
immediately to the IRB. Amendments to protocols and/or revisions to informed consent
documents must have IRB approval prior to implementation. Please retain both hard
copy and electronic copy of the final approved protocol and informed consent document.

16. All inquiries and correspondence concerning this protocol should include the protocol
number and name of the primary investigator. Please ensure the timely submission of all
required progress and final reports and use the templates provided on the AFRL IRB web

17. For questions or concerns, please contact the IRB administrator, Lt Danielle McCarty at
danielle.mccarty@wpafb.af.mil or (937) 904-8094. All inquiries and correspondence
concerning this protocol should include the protocol number and name of the primary
investigator.

KIM E. LONDON, CIP, USAF
Deputy Director, AFRL IRB

cc:
AFMSA/SGE-C
1st Indorsement to TRACY SHAMBURGER USAFR Memo, 14 December 2011, Continuing Review expedited approval FWR20110033H

MEMORANDUM FOR 711 HPW/IR (KIM LONDON)

I have reviewed the hardcopy and electronic records and found them to be complete and accurate.

[Signature]
DANIELLE MCCARTY, 2 LT, USAF
Lead Administrator, AFRL IRB

2nd Indorsement to TRACY SHAMBURGER USAFR Memo, 14 December 2011, Continuing Review expedited approval FWR20110033H

MEMORANDUM FOR AFMSA/SGE-C

This protocol has been reviewed and approved by the AFRL IRB. I concur with the recommendation of the IRB and approve this research.

[Signature]
THOMAS S. WELLS, SES
Director
711th Human Performance Wing

20 DEC 2011
APPENDIX B

LETTERS OF SUPPORT
MEMORANDUM FOR: Maj Tracy Shamberger

FROM: Lt Col Cynthia Bradford  
1552 Warehouse Road  
Dobbins, ARB, GA 30069

SUBJECT: Letter of Support

1. This letter is written in support of the project, Stress and Job Performance: The Roles of Salivary Cortisol and Social Support as proposed by Major Tracy Shamberger. In support of the project, Major Shamberger will be allowed to recruit crewmembers at Dobbins AFB to participate in the proposed study during Aeromedical Readiness Missions following Institutional Review Board Approval. The information gained from this study may provide valuable information that could enhance training. We look forward to participating!

Cynthia Bradford  
CYNTHIA BRADFORD, Lt Col. USAFR  
Commander
Jacqueline K. Jacobs, Lt Col
908th Aeromedical Evacuation Squadron
401 W. Maxwell Blvd
Maxwell AFB, Alabama 36112-6501

20 December 2010

To Whom It May Concern:

Subject: A letter of support for Research by Tracy Shamburger

Maxwell Air Force Base, 908th Aeromedical Evacuation Squadron will be available for recruitment of participants for the research Stress, Job Performance, of Aeromedical Crewmembers: Role of Salivary Cortisol, and Social Support. Major Shamburger is a Flight Nurse at our Squadron with years of experience in aeromedical evacuation and training. The proposed study may provide valuable information for training and ultimately the care we provide during operational missions.

We will allow for recruitment of crewmembers for the research at our unit following IRB approval. The project will only be scheduled for missions that include at least 5 participants that have consented to participate in the research. The appraisal of perceived stress will occur at three additional times during the mission, and ratings of perceived co-worker support, and salivary cortisol, the training mission will remain unchanged. The Mission Crew Coordinator (MCC) assigned from our unit to evaluate performance for training missions will also be identified in advance, and will also evaluate performance.

Sincerely,

[Signature]

Jacqueline K. Jacobs, Lt Col, USAFR, NC
908th AES Commander
DEPARTMENT OF THE AIR FORCE
AIR FORCE RESERVE COMMAND

30 July 2010

MEMORANDUM FOR Whom It May Concern

FROM: 911th Aeromedical Evacuation Squadron/CC
2551 Defense Avenue
Pittsburgh IAP ARS
Crawfordsville, PA 15108

SUBJECT: Letter of Support

1. This letter is written in support of the project, Stress and Job Performance: the Roles of Salivary Cortisol and Social Support. In support of the project, Major Shamburger will be allowed to place flyers at our unit to recruit participants in the project following Institutional Review Board Approval. Since the project will occur during actual aeromedical training missions, the consent of participants will occur in advance of the mission, allowing each crewmember a separate opportunity to consent to participate. The study will only be scheduled during missions with at least 5 crewmembers that have all consented in advance to participate. Except for the appraisal of perceived stress, at three additional times during the mission, ratings of perceived co-worker support, and salivary cortisol, the training mission will remain unchanged. We look forward to knowledge that may be gained from this study, and will gladly participate in this project.

MICHAEL J. ZMAEFF, LiCol, USAFR, NC
Commander
Name: Kimberley W. Coleman, Major, USAF, NC

Address: 1398 Surveyor Street
Pope AFB, N.C. 28308

Date: October 13, 2010

To Whom It May Concern:

Subject: A letter of support

This letter is written in support of the research planned by Tracy Shamburger during aero medical training missions. Our training missions are intended to prepare aeromedical crewmembers for realworld operational missions. During training, performance is evaluated by a person assigned to be the Mission Crew Coordinator for that mission. Our goal is to identify problems before they happen in the operational setting. There are many potential stressors in the aeromedical environment that may lead to stress. This study examines the effect of stress on both individual and team performance and seeks to explain how performance may be affected by the physiological response, and how this physiological response may be decreased by the perceived social support from co-workers. We look forward to the real world implications stemming from this project.

In support of the study, following IRB approval, flyers may be posted at our base for the recruitment of participants. The project will only be scheduled for missions that include at least 5 participants that have consented to participate in the research. Evaluation of performance by our Mission Crew Coordinator (MCC) assigned from our unit will continue during the research based on the same scenario planned for the research. I may be reached at 205-994-0322. For any further questions regarding my support for this research and our planned participation past IRB approval.

Sincerely,

Kimberley W. Coleman, Maj, USAF, NC
Good evening Maj Shamburger, I remember speaking briefly back on 11 Mar, and according to your original schedule you were going to fly with the 43d AES yesterday or today, I'm sorry we didn't get a chance to meet. I don't have any concerns and our Chief Nurse, Maj Anne Stacey is also aware of the study and should be on the mission. Please call me or may Hayes (910-394-7519) if you have any questions.

Lt Col Trezza

ANTHONY A. TREZZA, Lt Col, USAFR, MSC
Commander, 36 AES
DSN 424-7468
15 October 2010

To Whom It May Concern:

Subject: A letter of support for Research by Tracy Shamberger

The 118th Aeromedical Evacuation Squadron will be available for recruitment of participants for the research Stress, Job Performance, of Aeromedical Crewmembers: Role of Salivary Cortisol, and Social Support. Major Shamberger is a Flight Nurse that has experienced real world deployment and acts as the Officer in Charge of Mission Management. The proposed study may provide valuable information for training and ultimately the care we provide during operational missions.

We will allow for recruitment of crewmembers for the research at our unit following IRB approval. The project will only be scheduled for missions that include at least 5 participants that have consented to participate in the research. The appraisal of perceived stress will occur at three additional times during the mission, and ratings of perceived co-worker support, and salivary cortisol, the training mission will remain unchanged. The Mission Crew Coordinator (MCC) assigned from our unit to evaluate performance for training missions will also be identified in advance, and will also evaluate performance.

Sincerely,

[Signature]

JACQUELINE D. NAVE, Col, TNANG, MSC
Commander, 118th AES
APPENDIX C

QUESTIONAIRES
Aeromedical Crewmember Job Performance During a Challenging Simulated Aeromedical Evacuation Mission
Demographic/Experience Data Form

<table>
<thead>
<tr>
<th>What is your age? (circle one)</th>
<th>21-25</th>
<th>26-30</th>
<th>31-35</th>
<th>36-40</th>
<th>41-45</th>
<th>46-50</th>
<th>51-55</th>
<th>56-60</th>
<th>60-65</th>
</tr>
</thead>
<tbody>
<tr>
<td>What is your gender? (Circle one)</td>
<td>Male</td>
<td>Female</td>
<td></td>
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</tbody>
</table>

**Military Experience**

<table>
<thead>
<tr>
<th>What is your rank? (Circle one)</th>
<th>E1</th>
<th>E2</th>
<th>E3</th>
<th>E4</th>
<th>E5</th>
<th>E6</th>
<th>E7</th>
<th>E8</th>
<th>E9</th>
<th>O1</th>
<th>O2</th>
<th>O3</th>
<th>O4</th>
<th>O5</th>
<th>O6</th>
</tr>
</thead>
<tbody>
<tr>
<td>How many years have you been in the military? (Fill in)</td>
<td>Active</td>
<td>Reserve</td>
<td></td>
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</table>

**Healthcare Experience**

| Do you currently work in a healthcare setting: Y N | Y | N |
| Where: Hospital Teaching Clinic | Hospital | Teaching | Clinic |
| How long have you worked in this specialty? (Fill in) | _______ years and _______ months |
| What other types of experience do you have? (Fill in) |
| How long? (Fill in) | _______ years and _______ months |

**Deployment Experience**

| Have you ever been deployed? (Circle) | Yes | No |
| How many times? (fill in) | ____ |
| What year was your last deployment? (Fill in) | ____ |
| How long was your last deployment in months? (Fill in) | ____ months |
| What type of unit did you work in during your last deployment? (Fill in) |
| What type of job did you have during your last deployment? (Fill in) |
| If you transported patients, approximately how many did you transport? (Fill in) | ____ |

**Flight Experience**

| Flight hours: | |
| Years as Qualified Aeromedical Crewmember | |

**Training**

| When did you last complete Advanced Cardiac Life Support training? | (Fill in) | |
Perceived Stress VAS

Indicate on the line the level of stress you perceive at this time:

| ____________________________________ |
| No Stress                            | Extreme Stress |

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Perceived Stress Scale

The questions in this scale ask you about your feelings and thoughts during the last month. In each case, you will be asked to indicate by circling how often you felt or thought a certain way.

0 = Never 1 = Almost Never 2 = Sometimes 3 = Fairly Often 4 = Very Often

1. In the last month, how often have you been upset because of something that happened unexpectedly? ........................................ 0 1 2 3 4

2. In the last month, how often have you felt that you were unable to control the important things in your life? ...................................................... 0 1 2 3 4

3. In the last month, how often have you felt nervous and “stressed”? ........0 1 2 3 4

4. In the last month, how often have you felt confident about your ability to handle your personal problems? ................................................................. 0 1 2 3 4

5. In the last month, how often have you felt that things were going your way? .............................................................................................. 0 1 2 3 4

6. In the last month, how often have you found that you could not cope with all the things that you had to do? ................................................................. 0 1 2 3 4

7. In the last month, how often have you been able to control irritations in your life? .............................................................................................. 0 1 2 3 4

8. In the last month, how often have you felt that you were on top of things? ....0 1 2 3 4

9. In the last month, how often have you been angered because of things that were outside of your control? ................................................................. 0 1 2 3 4

10. In the last month, how often have you felt difficulties were piling up so high that you could not overcome them? ................................. 0 1 2 3 4
PERCEIVED SOCIAL SUPPORT FROM CO-WORKERS

Please rate the level of support you feel your co-workers provide you during the Mission.

**Legend:**  
SD-Strongly Disagree   D-Disagree   N-Neutral   SA-Strongly Agree   A-Agree

<table>
<thead>
<tr>
<th>I feel that:</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>(a) My coworkers are very helpful in performing my AE crewmember duties;</td>
<td></td>
<td></td>
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<tr>
<td>(b) When performing my AE crewmember duties, I can heavily rely on my coworkers;</td>
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<tr>
<td>(c) My coworkers provide me with important work-related information and advice that make performing my job easier.</td>
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</tbody>
</table>
**INDIVIDUAL JOB PERFORMANCE TIME 2**

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>1.</strong></td>
<td>Maintained checklist discipline during the mission brief.</td>
</tr>
<tr>
<td><strong>2.</strong></td>
<td>Correctly calculated the oxygen calculations and electrical amperage during brief.</td>
</tr>
<tr>
<td><strong>3.</strong></td>
<td>Performed personal oxygen check as first action once onboard aircraft.</td>
</tr>
</tbody>
</table>
| **4.** | Demonstrated correct oxygen check procedure.  
- Placed purge valve in correct position during oxygen check.  
- Placed purge valve in correct position for stowing |
<p>| <strong>5.</strong> | Correctly calculated patient medication and IV requirements as requested by MCC prior to enplaning pts. |
| <strong>6.</strong> | Prioritized individual assigned tasks with team tasks appropriately. |
| <strong>7.</strong> | Scanned to visualize if others needed assistance with tasks. |
| <strong>8.</strong> | Completed individual tasks assigned safely and momentary deviations in procedures and practices were corrected and did not impact safe aircraft operations. |</p>
<table>
<thead>
<tr>
<th>Team Performance Time 2</th>
<th>H or M</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Asked appropriate questions necessary to provide care and decide appropriateness of acceptance of pts on mission during the mission brief.</td>
<td></td>
</tr>
<tr>
<td>2. Developed and communicated plan for mission during brief with crew input.(Team task-communication, back-up behaviors)</td>
<td></td>
</tr>
<tr>
<td>3. Coordinated collection and thorough preflight of all equipment required for flight. (coordination, back-up behaviors)</td>
<td></td>
</tr>
<tr>
<td>4. Communicated time hacks to ensure on time, and safe take-off. (communication/back-up behavior/cognitive)</td>
<td></td>
</tr>
<tr>
<td>5. Coordinated tasks to accomplish safe, and urgent configuration of aircraft based on mission plan.(coordination)</td>
<td></td>
</tr>
<tr>
<td>6. Need to modify the aircraft configuration communicated to all crewmembers clearly and distinctly. (communication area)</td>
<td></td>
</tr>
<tr>
<td>7. Crewmembers provided input for configuration changes. (communication/back-up behaviors)</td>
<td></td>
</tr>
<tr>
<td>8. Crewmember input for configuration changes were solicited and acknowledged. (communication)</td>
<td></td>
</tr>
<tr>
<td>9. Clearly stated decisions for patient care and configuration responsibilities and received acknowledgement of understanding. (coordination/communication/cognitive)</td>
<td></td>
</tr>
<tr>
<td>10. Helped or asked to help another member when assigned tasks completed or noted other crewmember having difficulty with a task during the configuration solicited or nonsolicited.(back-up behavior)</td>
<td></td>
</tr>
<tr>
<td>11. Adapted aircraft configuration appropriately to meet demand for additional patient. (adaptation/cognitive)</td>
<td></td>
</tr>
<tr>
<td>12. Patient anti-hijacking statement confirmed and communicated prior to accepting patients on-board aircraft. (Communication Team task)</td>
<td></td>
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<tr>
<td>13. Coordinated safe and efficient enplaning of patients. (coordination)</td>
<td></td>
</tr>
</tbody>
</table>
### CM1 Individual Performance Time 3

<table>
<thead>
<tr>
<th>CM1 Individual Performance Time 3</th>
<th>HIT OR MISS</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. First action once aircraft emergency noted, oxygen on 100%.</td>
<td></td>
</tr>
<tr>
<td>2. Correctly positioned purge valve for the current emergency.</td>
<td></td>
</tr>
<tr>
<td>3. Scanned to see if other crewmembers donned oxygen.</td>
<td></td>
</tr>
<tr>
<td>4. Patients assisted as assigned for each crewmember.</td>
<td></td>
</tr>
<tr>
<td>5. Maintained checklist discipline during emergency.</td>
<td></td>
</tr>
<tr>
<td>6. Crewmember responded within 3 seconds of being notified of patient care emergency.</td>
<td></td>
</tr>
<tr>
<td>7. Assumed role as assigned during brief for patient care emergency without delay upon hearing assessment findings.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Team Performance Time 3</td>
</tr>
<tr>
<td>---</td>
<td>-------------------------</td>
</tr>
<tr>
<td>1</td>
<td>Assisted patients of other crewmembers solicited or unsolicited. (back-up behaviors)</td>
</tr>
<tr>
<td>2</td>
<td>Communicated patient emergency and actions clearly and timely for patient visibly displaying respiratory distress and not talking. (communication)</td>
</tr>
<tr>
<td>3</td>
<td>Communicated further assessment needs of the patient based on Standards. (communication/cognitive)</td>
</tr>
<tr>
<td>4</td>
<td>Coordinated movement of patient as discussed during the mission brief. (communication/coordination)</td>
</tr>
<tr>
<td>5</td>
<td>Coordinated and demonstrated effective patient care efforts. (communication/coordination)</td>
</tr>
<tr>
<td>6</td>
<td>Coordinated and demonstrated effective use of medical equipment (defibrillator) with other efforts(CPR). (communication/coordination)</td>
</tr>
<tr>
<td>7</td>
<td>Provided assistance with technical skills and equipment usage if delays or problems noted with any crewmember.(back-up behaviors,)</td>
</tr>
<tr>
<td>8</td>
<td>Communicated relevant patient history to aid in decision-making of causes for emergency (arrest). (Communication/cognitive)</td>
</tr>
<tr>
<td>9</td>
<td>Patient status updates communicated to crewmembers past each intervention.</td>
</tr>
<tr>
<td>10</td>
<td>Adapted to meet demand based on lack of change in patient status despite efforts(CPR).</td>
</tr>
</tbody>
</table>