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**Project Title:** Does Quality of Teamwork Mediate the Relationship between Partner Familiarity and EMT Injuries?

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**List of Terms and Abbreviations**

| Term/Abbreviation | Defined |
|---|---|
| EMS | Emergency Medical Services |
| NIOSH | National Institute of Occupational Safety and Health |
| IRR | Incidence Rate Ratio |

**Abstract**

**BACKGROUND:** Teamwork is vitally important in high-risk occupations such as Emergency Medical Services (EMS). Previous research links lack of familiarity between teammates to poor performance and negative safety outcomes. Most EMS workers are deployed in crews of two and work extended shifts of 12 or 24 hours. Prior research with small study samples suggest greater than two-thirds of EMS teams are unfamiliar and at risk of a workplace injury due to lack of familiarity. There is reason to believe that positive teamwork behaviors (e.g., frequent communication) may mediate the relationship between teammate familiarity and injury.

**METHODS:** From January 2011 to November 2013 we abstracted a mean of 29-months of shift records and Occupational Safety Health Administration injury logs from 14 EMS organizations with 37 total bases located in four U.S. Census regions. Total teammate familiarity was calculated for each dyad as the total number of times a dyad worked together over the study period. We used negative binomial regression to examine differences in injury incidence rate ratios (IRR) by familiarity. We then randomly selected and surveyed 1,000 EMS workers to determine perceptions of teamwork with recent teammates. We tested a hypothesized role of teamwork as a mediator in the relationship between familiarity and injury.

**RESULTS:** We analyzed 715,826 shift records, representing 4,197 EMS clinicians and 60,701 unique dyads. We determined the mean shifts per dyad was (5.9, SD 19.7), and quartiles of familiarity were 1 shift worked together over the study period, 2-3 shifts, 4-9 shifts, and $\geq$10 shifts worked together. More than half of all dyads worked one shift together (53.9%, n=32,739), 24.8% of dyads 2-3 shifts, 11.8% worked 4-9 shifts, and 9.6% worked $\geq$10 shifts. The overall incidence rate of injury across all organizations was 17.5 per 100 FTE, range 4.7 to 85.6 per 100 FTE. The raw injury rate was 33.5 per 100 FTEs for dyads with one shift of total familiarity, 14.2 for 2-3 shifts, 8.3 for 4-9 shifts, and 0.3 for $\geq$10 shifts. Negative binomial regression confirmed that dyads with $\geq$10 shifts had the lowest incidence of injury (IRR=0.03; 95%CI 0.02-0.04). We received 2,566 surveys from 333 out of 1,000 sampled EMS workers. Our hypothesis that increased teammate familiarity protects against adverse safety outcomes through development of positive teamwork behaviors was not supported.

**CONCLUSIONS:** We provide benchmarking / base-rate data for teammate familiarity in dyadic EMS teams. Familiarity between teammates varies in the EMS setting, and less familiarity is associated with greater incidence of workplace injury. In select samples of EMS workers with a high degree of teammate familiarity, higher levels of ‘back-up assistance’ to teammates can increase the likelihood of injury. Findings may impact policies that guide formation of new work teams. The dangers of providing too much ‘back-up assistance’ to teammates and neglecting one’s own tasks in high-risk settings should be emphasized during training and education.

**Significant (Key) Findings / Translation of Findings**

- Many EMS workers have limited familiarity with assigned teammates.

There is limited research of team formation, team deployment, teamwork behaviors and outcomes/performance of teams in the high risk prehospital occupation. Prior research suggest that two-thirds of EMS teams may be classified as unfamiliar. In this NIOSH funded study, with nationally representative data, we determined that EMS clinicians work with a mean of 18.6 unique partners/teammates annually. The proportion of shifts that EMS clinicians work with their most common co-worker/partner was 41%. This percentage varies by and within EMS organizations.

- Risk of workplace injury is highest amongst EMS worker teammates with 1 or no prior shifts working together. Risk of injury is lowest for worker dyads with ≥10 shifts together.

The risk of injury is lower for EMS clinician dyads with a greater number of shifts and shared work experiences over time than in teams with fewer shifts together. The EMS industry may use our descriptive findings as base-rate data for purposes of determining the potential risks that their scheduling practices may pose for select crews. These data may also be used for comparing teammate familiarity between EMS organizations.

- It is widely believed that positive teamwork behaviors can reduce the risk of negative safety outcomes. In a select group of EMS worker dyads, we determined that most teammates have a positive perception of teamwork with recent partners. Findings suggest that in some EMS teams with higher levels of familiarity, the risk of injury may be elevated when teammates attempt to provide high-levels of back-up assistance.

Prior studies of selected teamwork behaviors in high-risk settings show that in the presence of good quality communication and other teamwork behaviors contributes to better safety outcomes. We hypothesized that increased teammate familiarity amongst EMS worker teammates would lead to a maturing of teamwork behaviors (e.g., communication and adaptation), and ultimately protect against adverse safety outcomes. Our hypothesis was not supported. Analyses in addition to a priori tests revealed that more positive perceptions of partner adaptation and back up behavior increased the association between teammate familiarity and on-the-job injury. This finding was unexpected given the results of prior studies with different occupational groups, including healthcare workers.

**Sources of the above listed significant (key) findings include:**

1: Patterson PD, Weaver MD, Landsittel DP, Krackhardt D, Hostler D, Vena JE, Hughes AM, Salas E, Yealy DM. Teammate familiarity and risk of injury in emergency medical services. Emerg Med J. 2015 Nov 27. pii: emermed-2015-204964. doi: 10.1136/emermed-2015-204964. [Epub ahead of print] PubMed PMID: 26614096.

2: (UNDER REVIEW as of December 11, 2015) Patterson PD, Hughes AM, Weaver MD, Gregory ME, Sonesh SC, Landsittel DP, Krackhardt D, Hostler D, Lazzara EH, Vena, JE, Salas E, Yealy DM. Teammate familiarity, teamwork, and risk of workplace injury in EMS teams.

**Outcomes/Impact**

- Findings provide base-rate data on teammate familiarity in dyadic EMS worker teams. The directors, supervisors, and other administrative personnel of EMS organizations may use these data for comparison purposes and examination of familiarity of their EMS crews.

- We provide evidence of a link between the familiarity of individuals in work teams and workplace injury, with increased cumulative familiarity associated with lower risk of injury. The administrators of EMS organizations may use these findings to determine risk of injury in their crews. Policies and procedures for deploying EMS crews may be modified based on study findings. Administrators should also consider promoting positive teamwork behaviors in newly formed teams such as frequent communication as a plausible mechanism for reducing risk of injury.

- There is reason to believe that the risk of injury may be elevated in dyadic EMS work teams with higher levels of familiarity and higher levels of select team behaviors such as back-up assistance. Caution should be exerted when interpreting these findings; yet administrators should be aware of the multitude of teamwork behaviors and how some may be helpful and others harmful in certain crew configurations and situations.

**Scientific Report**

**Background for the project as proposed:** The annual mortality rate for Emergency Medical Technicians (EMTs) while at work is more than twice the national average (12.7 out of every 100,000). On the job illnesses, back sprains, needle sticks, and other non-fatal injuries affect between 3.0 and 8.1 out of every 100 EMTs nationwide. The annual rate of non-fatal injuries has risen to over 34% in some Emergency Medical Services (EMS) agencies.

Depending on the location, EMTs may work with more than 50 different partners annually. In these situations, EMTs may have never trained together and work with a limited understanding of their partner's expertise. Prior research in aviation links this type of configuration to accidents, errors, and poor teamwork engagement. Similar research in EMS does not exist. We believe a clear understanding of EMT partnerships and teamwork in the workplace is a key step to reducing injury and improving safety. Safety interventions absent this insight may fail to reduce injuries.

We hypothesized that EMT injuries occur more frequently among less familiar partners and among partners that fail to engage in positive teamwork behaviors such as frequent communication. We seek to accomplish the following aims:

**Original Specific Aim 1: To examine the relationship between partner familiarity and non-fatal injuries among EMTs.** Methodology: Our approach is summarized in our recent publication in the Emergency Medicine Journal (2015). Briefly, we were successful in collecting archival shift records and standardized injury records from 14 large EMS organizations with 37 total base sites spread across all four major U.S. Census regions. We collected multiple years of data with a mean of 29 months across EMS organizations and completed the analyses as planned and outlined in the EMJ publication. Key findings are listed elsewhere in this report (see Significant (Key) Findings / Translation of Findings and our recent publication). Challenges experienced during this component of our study include: 1) timely receipt of archival data from participating organizations; 2) additional time committed to editing collected data to fit a uniform format for analysis purposes; and 3) the inability of participating organizations to provide comprehensive and accurate demographic data in addition to the requested shift and injury record data.

**Original Aim 2: To examine the relationship between partner familiarity and EMT perceptions of teamwork.**

**Original Aim 3: Examine the relationship between partner familiarity, perceptions of teamwork, and non-fatal injuries.** Methodology for Specific Aim 2 and 3: We randomly selected 1,000 EMS clinician workers affiliated with the 14 large EMS organizations included in our study sample. We used a psychometrically sound survey tool to capture perceptions of teamwork in order to test the hypothesized relationships between teammate familiarity, teamwork, and injury. Findings have been prepared in manuscript format and are currently under review (as of December 11, 2015). A summary of our findings appear elsewhere in this report (see Significant (Key) Findings / Translation of Findings. Briefly, we hypothesized that increased familiarity promotes development of positive teamwork behaviors and protects against adverse safety outcomes. Our hypothesis was not supported. Analyses in addition to a priori tests revealed that more positive perceptions of partner adaptation and back up behavior increased the association between teammate familiarity and on-the-job injury. Challenges experienced during this component of our study was the lower than desired participation amongst sampled EMS clinicians.

Additional research unplanned in the original proposal that became a doctoral thesis topic for the Dr. Patterson's graduate research assistant (Dr. Matthew Weaver).

1) Objective/Aim: To determine the relationship between shift length and occupational injury. Key findings include detecting a near linear relationship between the length of a shift and risk of occupational injury. Findings from this focused analysis were published in the journal *Occupational Environmental Medicine*. See section of Publications for the detailed citation.

2) Objective/Aim: To determine if occupational injury is associated with weekly work hours for EMS clinician workers after controlling for familiarity between EMS teammates. Key findings revealed no statistically significant relationship between weekly work hours and injury in this sample of EMS workers, shift records, and injury records. Findings from this focused analysis were published in the *American Journal of Industrial Medicine*. See section of Publications for the detailed citation.

**FINAL Enrollment Table for Originally Proposed Specific Aims 2 and 3**

**Total Enrollment:** Among 333 EMS workers who participated in the teamwork survey component of our study, 297 answered questions on race and ethnicity.

| **FINAL ENROLLMENT: Number of Subjects** | | | |
|---|---|---|---|
| **Ethnic Category** | **Sex/Gender** | | |
| | **Females** | **Males** | **Total** |
| Hispanic or Latino | 2 | 8 | 10 |
| Not Hispanic or Latino | 69 | 212 | 281 |
| Declined to Answer | 2 | 4 | 6 |
| **Ethnic Category: Total of All Subjects *** | 73 | 224 | 297 |
| **Racial Categories** | | | |
| American Indian/Alaska Native | 1 | 1 | 2 |
| Asian | 0 | 3 | 3 |
| Native Hawaiian or Other Pacific Islander | 0 | 0 | 0 |
| Black or African American | 1 | 7 | 8 |
| White | 70 | 209 | 279 |
| Declined to Answer | 2 | 5 | 7 |
| **Racial Categories: Total of All Subjects *** | 73 | 224 | 297 |

**Publications**

We have submitted four manuscripts to peer-reviewed journals. Three have been accepted and published as of December 11, 2015.

1) Weaver MD, Patterson PD, Fabio A, Moore CG, Freiberg MS, Songer TJ. An observational study of shift length, crew familiarity, and occupational injury and illness in emergency medical services workers. *Occupational Environmental Medicine*. Epub ahead of print September 14, 2015. doi: 10.1136/oemed-2015-102966. PMID: 26371071.

2) Weaver MD, Patterson PD, Fabio F, Moore CG, Freiberg MS, Songer TJ. The association between weekly work hours, crew familiarity, and occupational injury and illness in emergency medical services workers. Under review at the *American Journal of Industrial Medicine*, April 9, 2015. ACCEPTED on July 13, 2015. Published Early Online on August 25, 2015, doi: 10.1002/ajim.22510

3) Patterson PD, Weaver MD, Landsittel DP, Krackhardt D, Hostler D, Vena JE, Hughes AM, Salas E, Yealy DM. Association between co-worker familiarity and workplace injury. Submitted to *Emergency Medicine Journal* on April 23, 2015. Accepted November 6, 2015. PMID 26614096.

One additional manuscript is under review (as of December 11, 2015).

1) Patterson PD, Hughes AM, Weaver MD, Gregory ME, Sonesh SC, Landsittel DP, Krackhardt D, Hostler D, Lazzara EH, Vena, JE, Salas E, Yealy DM. Teammate familiarity, teamwork, and risk of workplace injury in EMS teams. *Journal of Emergency Nursing*

Two additional manuscripts are in preparation (as of December 11, 2015)

1) Patterson PD, Weaver MD, Krackhardt D, Landsittel D, Salas E, Yealy DM. How should we measure familiarity between teammates? In Preparation.

2) A Hughes, Patterson PD, et al. The measurement of teamwork in the EMS Setting: A psychometrically valid tool. In Preparation.