

Final Progress Report
Implementing Risk management Strategies to Prevent Injuries Among Firefighters
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Principal Investigator:

Jefferey L. Burgess, MD, MS, MPH
The University of Arizona
Mel and Enid Zuckerman College of Public Health
1295 N. Martin Rm A317C
PO Box 245210
Tucson, AZ 85724
jburgess@email.arizona.edu

Project Director and sponsors:

Arizona Board of Regents,
University of Arizona
P.O. Box 3308
Tucson, AZ. 85722-3308

Co-Investigators:

Wayne Peate, MD
1295 N. Martin Ave.
P.O. Box 245210
Tucson, AZ 85724
peate@email.arizona.edu

Chengcheng Hu, PhD
1295 N. Martin A228
PO Box 245211
Tucson, AZ 85724
hucc@email.arizona.edu

Keshia Pollack, PhD
624 N Broadway, Hampton House
Room 557
Baltimore, MD 21205

Tracy Regan, PhD
Boston College
140 Commonwealth Ave.
Maloney 320
Chestnut Hill, MA 02467
Tracy.regan@bc.edu

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List of Terms and Abbreviations

Term	Abbreviation
Fireground operations	FG
Patient transport	PT
Physical exercise	PE
Personal Protective Equipment	PPE
Tucson Fire Department	TFD
Workplace Risk Assessment and Control Form	WRAC

Abstract

Project Title: Implementing Risk management Strategies to Prevent Injuries Among Firefighters

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Jefferey L. Burgess, MD, MS, MPH

The University of Arizona, Mel and Enid Zuckerman College of Public Health

1295 N. Martin Rm A317C / PO Box 245210 Tucson, AZ 85724

jburgess@email.arizona.edu

Background

Formalized Risk Management (RM) is commonly used in high-risk industries to reduce the risk of occupational injury, though the implementation of RM in the US fire service has not previously been studied. The Tucson Fire Department (TFD) partnered with occupational health researchers to implement a formalized RM process aimed at reducing the frequency and severity of injuries associated with three operations and activities: patient transport (PT), fireground (FG) operations, and physical exercise (PE). The primary research aims were to: 1) implement task-specific, risk-based intervention strategies within TFD, and 2) evaluate injury rates and the effectiveness of the approach. The hypotheses underlying this research were that a RM model would be successfully adopted within TFD and would reduce the number, severity, and overall costs of injury specific to the targeted operations.

Methods

The RM process, including scoping, risk assessment and control implementation, was implemented at TFD over the years 2009-2013, using a team-based approach incorporating a cross-section of personnel from all levels of the organization. The study employed a quasi-experimental, controlled longitudinal intervention design. Injury rates were compared pre- and post-intervention within the TFD, and with a regional, non-intervention control fire department. Outcomes included all reported injuries for both intervention and control fire departments, as well as workers' compensation claims and workers' compensation costs for the intervention FD only. All reported injury rates were also evaluated for PE, PT and FG operations and activities for both departments. Process evaluation data were collected through a series of group and individual interviews, and cross-sectional surveys of department personnel.

Results

The RM process led to the identification of 45 hazard specific control strategies, of which 9 were selected by the RM teams and department leadership for implementation. Compared to the pre-intervention period, preliminary analyses indicate a 13% decline in the average number of injuries per year, a 30% decline in the average number of workers' compensation injury claims, and a 21% reduction in average workers' compensation claims costs.

Conclusions

Preliminary results indicate the RM process was well-received by department personnel, and was effective at reducing injuries and costs. The RM process may be a viable approach for other departments to employ in their injury prevention efforts.

Study Translation

The study findings can be used directly to prevent workplace injuries. The risk management process employed in the study was associated with a marked decrease in reported injuries and workers' compensation claims. The risk management process allows the organization to identify the most important health and injury hazards and to select interventions best suited for their workplace. In the case of TFD, this included injuries from physical exercise, patient transport, and fireground activities, which are also leading causes of injuries in other US and international fire departments.

Significant Key Findings

The primary research aims were to: 1) implement task-specific, risk-based intervention strategies within TFD, and 2) evaluate injury rates and the effectiveness of the approach. The hypotheses underlying this research were that a RM model would be successfully adopted within TFD and would reduce the number, severity, and overall costs of injury specific to the targeted operations, PT, FG and PE.

The study led to the identification of 45 possible control strategies targeted at PT, FG and PE operations and activities, of which nine were implemented during the period of the grant.

The RM process was favorably received by TFD personnel, including all ranks, as measured in process evaluation surveys, group and individual interviews.

Compared to the pre-intervention period, preliminary analyses indicate a 13% decline in the average number of injuries per year, a 30% decline in the average number of workers' compensation injury claims, and a 21% reduction in average workers' compensation claims costs. These results are being finalized this month and should be submitted for publication in the near future.

Translation of Findings

Due to the translational nature of the research, the study findings can be used directly to prevent workplace injuries. The risk management process employed in the study was instituted by our study partner, Tucson Fire Department, and was associated with a marked decrease in reported injuries and workers' compensation claims. The risk management process allows the occupational entity to identify the most important health and injury hazards and to select interventions best suited for their workplace. In the case of Tucson Fire Department, this included injuries from physical exercise, patient transport, and fireground activities. These same activities and operations are also leading causes of injuries in other US and international fire departments, based on our previous studies. Our current study findings are an important extension of our previous retrospective cohort and cross-sectional studies associating risk management systems with lower injury rates in the mining sector and fire service, respectively.

Outcomes/Impact

The current study led to important reductions in injuries and associated costs. TFD continues to use the RM process through their Safety, Health and Survival Committee. As one example outcome with marked impact, TFD has committed to providing funding for the integration of Peer Fitness Trainers (PFTs) into future recruit academies, based on a marked reduction of injuries during the combined new recruit and one year probationary period for new firefighters. Multiple other interventions, such as improved fireground rehabilitation and the introduction of power assist gurneys, have become a permanent part of TFD standard operating procedures and practices, which have resulted in a marked reduction in workplace hazards.

The positive results have also led to the submission of a second NIOSH R01 proposal to determine the cost effectiveness of RM interventions and increase sustainability of the RM process, among other outcomes. The proposal should be reviewed by the NIOSH study section next month. Based in part on the study results, the study Principal Investigator, Dr. Burgess, was successful in obtaining funding from the Federal Emergency Management Agency to use a RM approach to reduce fire service vehicle crashes in multiple US fire departments.

Scientific Report

Background

Risk management (RM) is a formal, proactive approach to improving occupational safety and health, commonly used in high-risk industries. RM creates a structure for individual operations to develop solutions to the risks faced, based on the surrounding environment, conditions, equipment, and personnel involved. Previous research has demonstrated that adoption of RM in the Australian mining industry was associated with marked decreases in lost-time injuries, as compared with the United States (US), which relies on a compliance-based system, consistent with the major occupational safety and health regulatory requirements (Poplin et al., 2008).

The RM approach (Figure 1) can be used at all levels of the management structure. The approach is cyclical: as resources are focused on particular tasks and their associated risks, the risk of an event will be reduced (i.e., there will be a decrease in the likelihood of an event resulting in injury). The risk ranking is then reorganized, and the RM efforts and resources are again focused on the highest priority areas. Successful implementation of RM implementation requires a systematic, yet flexible, approach that involves the full rank and spectrum of personnel working in teams to develop risk mitigation strategies. This RM approach relies heavily on input from the employees subject to the greatest risk, rather than relying solely on the input of those at the top of the organizational structure.

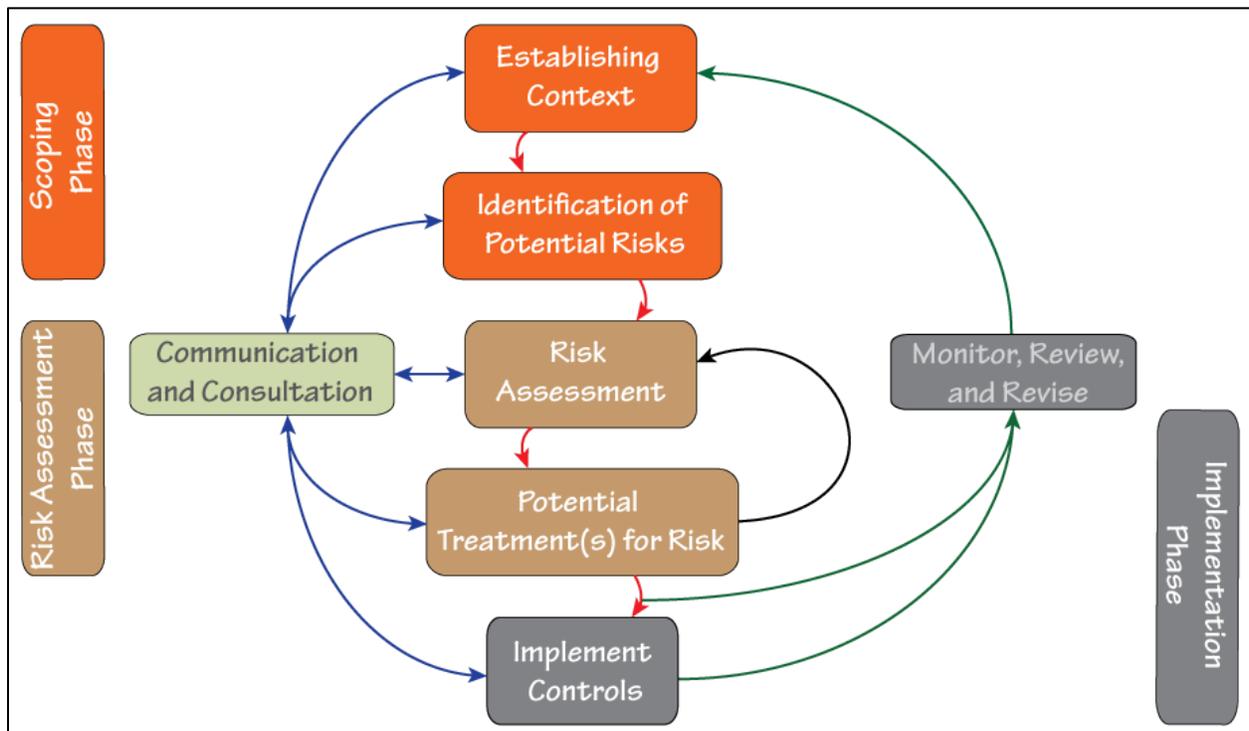


Figure 1. Risk management approach for occupational safety and health, adapted from the Minerals Industry Safety and Health Centre (MISHC), University of Queensland, Australia.

The U.S. fire service continues to have high injury rates compared to other industries (Poplin et al., 2012), and is in need of new strategies to aid in injury prevention. To our knowledge there are no published reports documenting the implementation of formalized RM in the fire service. Our previously published international comparison of fire service injuries showing that the United Kingdom fire service

with the most advanced proactive RM program (legislatively required for over 20 years), also had injury rates well below those of the US, Canada, and Australia (Burgess et al., 2014).

At the onset of this grant in early 2010, the Tucson Fire Department (TFD) partnered with occupational health researchers to implement a RM program targeting the frequency and severity of injuries to their workforce. RM teams were created around three focus areas: patient transport (PT), fireground (FG) operations, and physical exercise (PE).

Specific Aims

The primary research aims were to: 1) implement task-specific, risk-based intervention strategies within TFD, and 2) evaluate injury rates and the effectiveness of the approach. The hypotheses underlying this research were that a RM model would be successfully adopted within TFD and would reduce the number, severity, and overall costs of injury specific to the targeted operations, PT, FG and PE.

Methodology

The implementation of task-specific risk-based intervention strategies began with the introduction of the RM model at TFD. The RM process includes three phases: (1) scoping; (2) risk assessment; and (3) control implementation (Figure 1). The scoping phase is used to establish the context of the operation or job task, understand the potential hazards and identify unwanted events. The scoping phase helps inform specific risk assessment technique(s) that are applied during the risk assessment phase.

During the risk assessment phase, hazards are more formally detailed and understood so that a risk analysis, including measures of the likelihood and consequence of a particular event or injury, may be completed. Various instruments can be used to help analyze risk and will vary based on the type of unwanted event(s) being addressed, available data, and end-user goals. One instrument used in this study, the Workplace Risk Assessment and Control (WRAC) form, provides a semi-quantitative method for estimating risk that complements the process map generated in the scoping phase (Appendix A). Regardless of the specific RM tools employed, the goal of this phase is to focus attention and resources on the most significant risks.

The RM teams then consider control strategies for mitigating the identified risk(s). Once the controls are finalized and approved, the implementation phase is initiated, during which the teams develop and help apply the new controls (or modifications of existing controls). A regular review and process evaluation is also instituted to assess overall effectiveness and to ensure that no new unintended risks were introduced. Active revision and fine-tuning of the control strategies are made as deemed necessary.

The majority (~60%) of injuries occur in the TFD population during PT, FG and PE activities and operations. Three cross-sectional teams of 6-10 individuals – from the newly commissioned to upper management – were recruited to participate in the study, and were focused on completing the scoping and risk assessment phases of the RM model for PT, FG and PE over an eight month time span. Once risks were identified, described and (semi)quantified, existing control strategies were reviewed for their appropriateness and either re-emphasized, enhanced, or removed. Each team then identified several new control strategies that had the potential to mitigate the likelihood and consequences of the risks identified for the three focus areas. Individual crews, department administrators (who better understood costs) and researchers ranked control strategies according to five criteria: effectiveness, feasibility, cost feasibility, sustainability, and the potential for unintended risk. Each criteria was ranked

between 1 (lowest priority) to 5 (highest priority) and summed among the participants. Control strategies were selected and implemented using the priority scores, estimated department resources and costs, and the likelihood the control strategy could be developed, implemented and evaluated within the timeframe of the study.

Qualitative and quantitative data process evaluation data were collected to document the implementation of the RM process and determine which parts of the RM process worked well and which needed improvement. Focus groups were conducted with each of the three RM teams (PT, FG, and PE) after the scoping and risk assessment phases and explored the perceptions of the RM process. Key informant interviews were held with department leadership and two focus groups of eight firefighters were convened after the control strategy implementation phase. These explored perceptions of the RM process, facilitators of and barriers to implementation, sustainability of the selected control strategies, and recommendations for replication of the RM process at other departments.

Injury rates were compared pre- and post-intervention within the intervention FD, and with a regional, non-intervention control FD. Injury outcomes, including all reported injuries for both intervention (TFD) and control FD, were compared pre- and post-intervention in a quasi-experimental, controlled longitudinal intervention design over the years 2009-2013. In addition, all reported injury rates were evaluated for PE, PT and FG for both departments, and workers' compensation claims and workers' compensation costs were evaluated for the intervention FD only. Workers' compensation claims data for all injuries occurring over the study period, 2009-2013, were provided by the department's third party payer. Costs were transformed to constant 2013 U.S. dollars using the Consumer Price Index and analyzed using descriptive statistics.

A total of three cross-sectional process evaluation surveys of department personnel were delivered during the department's continuing education training sessions. The first was collected January-March, 2012 and evaluated knowledge, skills, abilities and behaviors on the topic of exercise equipment, patient transfer devices, and the department's rehab protocols. The second was delivered April-June 2012 and evaluated exercise behaviors and attitudes about the peer fitness trainers, and knowledge about proper hydration. The third survey was used to collect follow-up about exercise and the peer fitness trainers, patient transfer devices, fireground rehab protocols, and hydration, and also included questions about the department's electrically powered stretchers and the effectiveness of the posters was collected March-June 2013. The surveys were anonymous but demographic data including age, gender, race and ethnicity, rank, and years in the fire service were collected on all three surveys.

One injury prevention strategy developed during the RM process and implemented with support from the grant was the Probationary Firefighter Fitness Program (PFF-Fit). PFF-Fit was designed by University of Arizona researchers in partnership with TFD and implemented in the 2012 recruit academy. Measures of health and fitness, injury frequency and type, workers' compensation claim frequency and claims costs, were measured over 17 consecutive months for the intervention class, and compared to outcomes from controls comprised of the three most recent TFD recruit classes for the same time period.

Results and Discussion

A total of 34 participants were consented to participate in the focus groups. Table 1 summarizes the baseline demographics for the consented participants, which resembled the overall TFD workforce.

A process mapping approach was used during the scoping phase to better understand potential hazards and identify injuries associated with each task (Figure 2). During the risk assessment phase, use of the WRAC instrument (Appendix A) led to the identification of 45 potential control strategies (Table 2), the majority of which were educational in nature. Ultimately, nine control strategies were implemented, three for each focus area (highlighted by “SPIFi” in Table 2). The PT control strategies focused on ergonomic issues to reduce the risk of sprains and strains. FG controls were aimed at improving situational awareness and peer reinforcement of safety protocols, especially during the donning of personal protective equipment (PPE) during demobilization and clean-up following a FG response. Control strategies for PE focused on improving the structure, education and oversight of daily exercise practice, to better align these activities with the group’s stated goal of “retiring with function.”

Table 1. Baseline participant demographics (n=25)

Demographic	Value
Task Group	
Patient Transport	36%
Fireground	32%
Physical Exercise & Training	32%
Male	92%
Age (years)	Mean 39 Range 24-53
Self-reported race and ethnicity	
White, non-Hispanic	80%
Hispanic	12%
Other	4%
Missing	4%
Rank	
Deputy Chief	4%
Captain	24%
Engineer	12%
Firefighter	28%
Paramedic	28%
Inspector	4%
Time in current rank (years)	Median 4 *IQR 9

* IQR= interquartile range

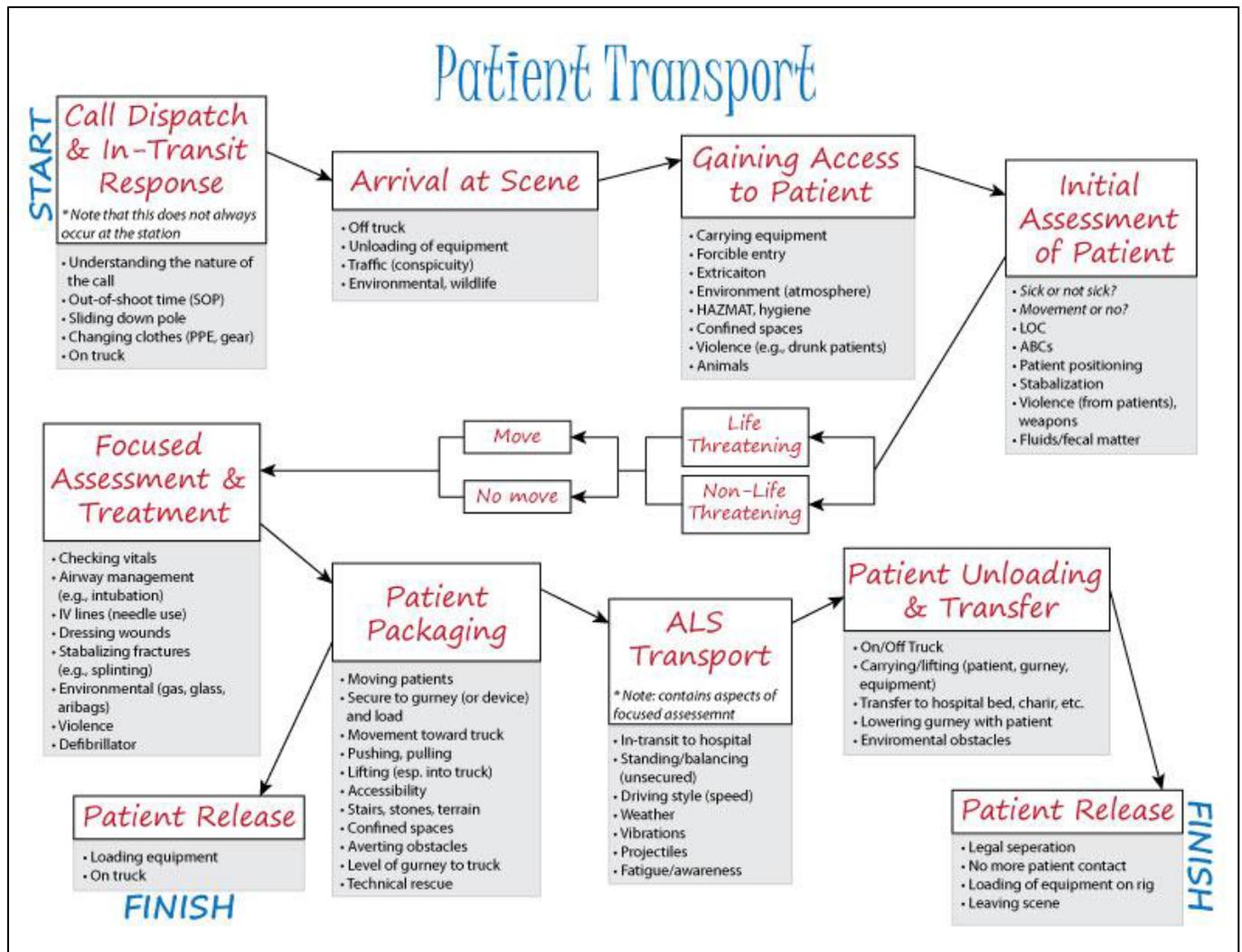


Figure 2. Example of a process map for PT

Table 2. Identified control strategies from participatory scoping and risk assessment phases

Control Strategy	Priority Rating	
Patient Transport		
Patient transport module for probationary firefighters	112	SPIFi
Apparatus placement for all scenes	109	
Review police request protocol	106	
Standardized in-station call review among crew	103	
Continuing education for patient packaging and lifting	100	
Establish chest compression rotation procedure during CPR	100	SPIFi
Improved communication for patient lifting assistance	100	
Review Clawson questions and format	97.5	
Emphasizing and improving fitness training	96.5	

Distribution of techniques for heaving patient lifting	96	
Station checklist and inventory for all equipment	94.5	
Testing patient transfer devices	91	SPIFi
Heart Saver and zone dispatching systems	88	
Continuing education for airbag deployment	87.5	
Combative Patients Training	84	
Investigate gurney design options	82	
<i>Physical Exercise</i>		
Update and revise exercise SOP	105	SPIFi
Better defined fitness standards and levels	104	
Mandatory workouts each workday	103	
Improved access to exercise information	101	
Improve structure and monitoring of 8-hour employees	101	
Explore new cadet point system for physical fitness	100	
Improve station exercise equipment and facilities	97	SPIFi
Increased role of Peer Fitness Trainers	96	SPIFi
Top-down advocacy of priorities	95	
Periodic “fitness checks” during the year	95	
Reinforce fitness progress and achievements	94	
Incentives for exercise adherence	91	
Structured exercise sessions	89	
<i>Fireground Operations</i>		
On-shift safety critiques about selected calls	71	
Enforce PPE use during demobilization and cleanup	70	SPIFi*
Enforcement through disciplinary matrix	69	
Improve rehab adherence	67	SPIFi†
Improve rehab protocols and details	67	SPIFi†
Peer safety check before post-suppression activities	67	SPIFi*
Visual reminders for health and safety	66	SPIFi
Prohibit cell phone use while in-transit to call	66	
Increase emphasis on maintaining fitness	65	
Improve access to health and safety information	64	
Increased CEs and trainings for Captains	64	
Rewards and incentives to improve compliance	63	
Communicate individual health status during lineup	60	
Improved utilization of 0700 “Wake up” call	56	
Collaborate with industry partners	54	
Improved communication and personnel tracking tech	51	

*† While individually identified by the group participants, these controls were combined

Results of the process evaluation interviews demonstrate that the vast majority of study participants valued the RM process, with praise given for the bottom-up approach that included input from firefighters of all ranks. Participants appreciated the organization and delivery of the scoping sessions, in particular the detailed way each task was broken down to allow for thorough examination of the risks. Many participants noted that it will take time to measure the impact of the RM process on injury in TFD, and noted the importance of a culture change within the organization to support and reinforce the selected control strategies. Another theme that arose in the surveys and interviews was sustainability of the control strategies. Participants questioned whether the other 36 strategies would be implemented, and if the department leadership could commit the necessary resources to do so.

The results of the cross-sectional process evaluation surveys are expected to be published in an upcoming manuscript this year. Preliminary results show that 468/589 (81%) of TFD personnel completed the first survey; 433/489 (74%) completed the second; and, 460/590 (78%) completed the third. The surveys provided important information about the level of awareness of and feelings about the RM interventions among TFD personnel. Examples include our evaluation of the knowledge of and behaviors surrounding use of patient transfer devices and hydration. The majority of TFD personnel (88%) thought the new patient slideboard would improve firefighter safety, though on average they only reported using the slideboard for less than 4% of patient transport responses. The number one reason respondents reported not using the slideboard was that the device was not accessible (i.e., not on the gurney) or they didn't know it was available. Over two thirds of survey respondents (68%) reported experiencing symptoms of dehydration on the fireground. The vast majority (95%) reported noticing a hydration chart in their workplace, and 43% said their hydration had improved following implementation of this educational RM intervention. Once fully analyzed, the survey results will provide the researchers and TFD important feedback from the workforce about how to successfully select and implement RM strategies.

Compared to the pre-intervention period, preliminary analyses indicate a 13% decline in the average number of injuries per year, a 30% decline in the average number of workers' compensation injury claims, and a 21% reduction in average workers' compensation claims costs. Analysis of the PFF-Fit program reveal that participants experienced statistically significantly fewer injuries, filed significantly fewer claims, and accrued aggregated claims costs approximately \$33,000 less than the controls with an estimated equivalent reduction in indirect costs for a total of \$66,000. The PFF-Fit program was perceived to be so valuable and important at reducing injuries among new recruits that the PFTs have continued to be integrated into the recruit academy, with hopes of expanding their efforts at managing and supervising exercise into the stations (provided dedicated funds are available).

One positive outcome of the RM process was the re-establishment of the TFD's internal safety committee, comprised of a cross-section of department employees (civilian and commissioned). The committee was tasked with assisting in the implementation and evaluation of the control strategies selected during the RM process, and identifying and implementing improvements to the overall health and safety of department personnel.

While we believe formalized RM could be valuable to the fire service, we acknowledge that one other departments may not have a relationship with academic researchers and/or the financial support provided by this grant. Therefore, the results of this study may not be generalizable to other departments. However, injuries remain a significant and preventable threat to firefighters, and RM is one approach that has the potential to reduce the risk of injury in this population. Future research of the effectiveness of different RM approaches and control interventions could help guide and inform the

dissemination of this process to other fire departments and industries. Given the important reductions in injuries and costs observed following implementation of RM at TFD, we are seeking additional funds to extend and expand our efforts in this area.

Conclusions

While results are being finalized it appears that the risk management intervention was effective in reducing fire department injuries and costs and may be a viable approach for other FDs to adopt and adapt.

Publications

One paper has been peer reviewed and published in the journal *Injury Prevention*, entitled “Beyond the Fireground: Injuries in the Fire Service” (see reference below). The paper describes the variation and associative factors of injuries within the Tucson Fire Department, in an effort to better understand the circumstances in which injury events occur, given all the dynamic environments emergency responses are directed. This was reported on by national and international press with mixed levels of accuracy.

A second paper was published in *The American Journal of Epidemiology*, “The Association of Aerobic Fitness with Injuries in the Fire Service,” explored the role in which fitness levels influence the incidence of injury among fire service personnel.

A third manuscript has been submitted for review to the *British Medical Journal*, “Establishing a Proactive Safety and Health Risk Management System in the Fire Service,” which describes the application of the risk management process in the fire service.

A fourth manuscript, “Efficacy of a proactive health and safety risk management system: results from the SPIFi project” will provide a general overall assessment of the effectiveness of the RM approach in terms of injury rates, costs and process evaluation surveys that measured knowledge, attitudes, beliefs and behaviors surrounding RM among TFD personnel. This manuscript is currently in draft with submission expected this year.

In addition, two student completed dissertations related to the grant. Other publications related to the PFF-Fit program that have been planned for the future include descriptions of program development and the results of the process evaluation, injury and workers’ compensation claims data analyses.

Published

Griffin SC: [2014] Economic Evaluation of Injury and Injury Prevention Interventions in the U.S. Fire Service, Ph.D. Dissertation, University of Arizona

Poplin GS, Harris RB, Pollack KL, Peate W, Burgess JL: [2012] Beyond the Fireground: Injuries in the Fire Service. *Injury Prevention* 18: 228-233.

Poplin GS, Roe DJ, Peate W, Harris RB, Burgess JL: [2014] The Association of Aerobic Fitness With Injuries in the Fire Service. *American Journal of Epidemiology* 179(2):149-155.

Poplin GS: [2012] Aerobic capacity and injury risk: Determining associative factors of injury among emergency service employees, Ph.D. Dissertation, University of Arizona.

Submitted for review

Poplin GS, Pollack KL, Mallett J, Hu C, Day-Nash V, Griffin SC, Burgess JL: *British Medical Journal*, “Establishing a Proactive Safety and Health Risk Management System in the Fire Service.”

Inclusion of gender and minority study subjects

Inclusion Enrollment Report

Study Title: Implementing risk management strategies to prevent injuries among firefighters

Total Enrollment: 47 **Protocol Number:** _____

Grant Number: 5R01OH009469-02

PART A. TOTAL ENROLLMENT REPORT:		Number of Subjects Enrolled to Date (Cumulative)		
by Ethnicity and Race				
Ethnic Category	Females	Males	Sex/Gender Unknown or Not Reported	Total
Hispanic or Latino	0	2	0	2 **
Not Hispanic or Latino	2	19	0	21
Unknown (individuals not reporting ethnicity)	4	20	0	24
Ethnic Category: Total of All Subjects*	6	41	0	47 *
Racial Categories				
American Indian/Alaska Native	0	0	0	0
Asian	0	0	0	0
Native Hawaiian or Other Pacific Islander	0	0	0	0
Black or African American	0	0	0	0
White	2	18	0	20
More Than One Race	0	1	0	1
Unknown or Not Reported	4	22	0	9
Racial Categories: Total of All Subjects*	6	41	0	47 *
PART B. HISPANIC ENROLLMENT REPORT: Number of Hispanics or Latinos Enrolled to Date (Cumulative)				
Racial Categories	Females	Males	Sex/Gender Unknown or Not Reported	Total
American Indian or Alaska Native	0	0	0	0
Asian	0	0	0	0
Native Hawaiian or Other Pacific Islander	0	0	0	0
Black or African American	0	0	0	0
White	0	0	0	0
More Than One Race	0	0	0	0
Unknown or Not Reported	0	2	0	2
Racial Categories: Total of Hispanics or Latinos**	0	2	0	2 **

* These totals must agree. ** These totals must agree.

Materials available for other investigators

The project website, <http://spifi.publichealth.arizona.edu/>, provides important information about the implementation of RM at TFD and is available not only to other investigators but to fire departments. In addition to providing a detailed description of the RM process and the target areas (PT, FG and PE), the website also includes a link to a video featuring TFD personnel sharing their experiences with RM.

References

Burgess JL, Duncan M, Mallett J, LaFleur B, Littau S, Shiwaku K: [2014]. International Comparison of Fire Department Injuries. *Fire Technology* 50(5):1043-1059.

Appendix A. Example WRAC Form, for PT

Project Title: Risk Management Strategies to Prevent Injuries among Firefighters - SPIFi			Date:
Operation Description: Patient Transport	Team Members:	Recorded By:	Relevant SOPs & Docs:
Team Facilitator:			

No	A Step in operation	B Potential Incident(s)	C Current Controls	D Likelihood	E Hazard Effect/ Consequence	F Risk Rating	G Possible New controls
1	Call dispatch						
2	Arrival at scene						

Appendix A. Example WRAC Form, for PT

3	Gaining Access to Patient						
No	A Step in operation	B Potential Incident(s)	C Current Controls	D Likelihood	E Hazard Effect/Consequence	F Risk Rating	G Possible New controls
4	Initial Patient Assessment						
5	Decisions: Life Threatening and Move/No Move						
6	Focused Assessment and Treatment						

Appendix A. Example WRAC Form, for PT

7	Patient Packaging						
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No	A Step in operation	B Potential Incident(s)	C Current Controls	D Likelihood	E Hazard Effect/ Consequence	F Risk Rating	G Possible New controls
8	ALS Transport						
9	Patient Release						