Journal of Safety Research 60 (2017) 21–27

Contents lists available at ScienceDirect

Journal of Safety Research

journal homepage: www.elsevier.com/locate/jsr

Implementing risk management to reduce injuries in the U.S. Fire Service

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ARTICLE INFO

Article history:
Received 2 May 2016
Received in revised form 31 August 2016
Accepted 17 November 2016
Available online 1 December 2016

Keywords:
Fire service
Risk management
Implementation
Process evaluation

ABSTRACT

Introduction: Risk management, a proactive process to identify and mitigate potential injury risks and implement control strategies, was used to reduce the risk of occupational injury in a fire department. The objective of this research was to study the implementation of the risk management process for future replication. A second objective was to document changes in fire personnel's knowledge, attitudes, and behaviors related to the selected control strategies that were implemented as part of the risk management process. *Method:* A number of control strategies identified through the risk management process were implemented over a 2-year period beginning in January 2011. Approximately 450 fire personnel completed each of the three cross-sectional surveys that were administered throughout the implementation periods. Fire personnel were asked about their awareness, knowledge, and use of the control strategies. *Results:* Fire personnel were generally aware of the control strategies that were implemented. Visual reminders (e.g., signage) were noted as effective by fire personnel who noticed them. Barriers to use of specific control strategies such as new procedures on the fireground or new lifting equipment for patient transfer included lack of knowledge of the new protocols, lack of awareness/access to/availability of the new equipment, and limited training on its use. Implementation challenges were noted, which limited self-reported adherence to the control strategies. *Conclusions:* Fire personnel generally recognized the potential for various control strategies to manage risk and improve their health and safety; however, implementation challenges limited the effectiveness of certain control strategies. The study findings support the importance of effective implementation to achieve the desired impacts of control strategies for improving health and safety. *Practical applications:* Employees must be aware of, have knowledge about, and receive training in safety and health interventions in order to adopt desired behaviors.

1. Introduction

1.1. Problem

Firefighting is a risky occupation, posing risks to firefighters while fighting fires, during rescue and response, or when training for their job (U.S. Fire Administration, 2014). According to data from the National Fire Protection Association, there are over 1.1 million firefighters in the United States. In 2014, a total of 64 firefighters died and over 63,350 injuries occurred to firefighters while on-duty (Fahy, LeBlanc, & Molis, 2015). Nearly 43% of these injuries occurred during fireground operations (Haynes & Molis, 2015). According to data from the National Institute of Standards and Technology, the estimated cost in 2002 dollars of addressing firefighter injuries and of efforts to prevent them was estimated to be upwards of $7.8 billion (TriData Corporation, System Planning Corporation, 2005).

Around the world, proactive risk management is being adopted as a strategy to identify and mitigate potential injury risks, and implement control strategies. Risk management is a formal proactive approach to improving workplace safety and health. It creates a structure for employees to develop solutions to the risks faced, based on the surrounding work environment, conditions and contexts, equipment, and personnel involved (Joy, 2004; Poplin et al., 2015). One defining characteristic of risk management is the involvement of workers in identifying the risks and resulting control strategies. In several places, including the United Kingdom (U.K.) fire service, proactive risk management is required by regulation (Burgess et al., 2014; Poplin et al., 2015). Although proactive risk management is not required by legislation for the U.S. fire service, even a voluntary approach could have significant benefits.

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http://dx.doi.org/10.1016/j.jsr.2016.11.003
0022-4375/

1.2. Background to risk management intervention

In 2009, researchers partnered with a metropolitan fire department to introduce and apply a risk management approach for workforce health and safety (Poplin et al., 2015). This process led to the identification of 45 hazard-specific interventions, several of which were later implemented. Results from a process evaluation of the risk management approach revealed that the process was well accepted by the fire department (Poplin et al., 2015). Fire personnel who participated in the process emphasized the value of risk management, especially the participatory approach; usefulness of risk management for identifying potential risks; and the potential of risk management for reducing firefighter injury (Poplin et al., 2015).

In order to realize the potential of risk management to reduce injury in the fire service, it is critical to understand how the risk management process was implemented, in addition to the specific identified control strategies. Currently, there is a dearth of literature on the implementation of risk management overall, and especially in the U.S. fire service. Addressing this gap in knowledge will generate important lessons for acceptability, sustainability, and future replication. In this study, multiple cross-sectional surveys were administered to fire personnel from a single department to document knowledge, attitudes, and behaviors related to the selected control strategies that were implemented as part of risk management.

2. Methods

2.1. Design

The study design and methods of the risk management process applied to the specific fire department has been previously described (Poplin et al., 2015). In summary, the risk management process involved three-phases: hazard scoping, risk assessment, and implementation of prevention controls. These phases were systematically conducted over a three-year period, followed by a one-year observation period to document impacts. Approximately 34 individuals were part of three teams, each involving a full cross-section of fire personnel (firefighters and medics) from all ranks, to assess the hazards and injuries related to three specific tasks: physical exercise, patient transport, and fireground activities and operations (Poplin et al., 2015). These tasks were selected because they accounted for a significant proportion of injuries during the six year pre-intervention period (Poplin, Harris, Pollack, Peate, & Burgess, 2012). At the conclusion of the risk assessment phase, nine of 45 potential controls were recommended for implementation. Ultimately, eight controls were selected by the risk management teams and department leadership for implementation. These control strategies were implemented over a 24-month period, beginning January 2011.

2.2. Control strategies

Control strategies to address physical exercise included updating exercise equipment, removing equipment not meeting department standards, and conducting monthly maintenance inspections on a standardized form. The role of Peer Fitness Trainers (PFTs) was also expanded to assist recruits and probationary officers, as well as commissioned individuals to promote appropriate exercise. The standard operating procedure describing the requirements for physical fitness was also updated. These new changes to physical exercise were intended to promote being "fit for duty" via mobility exercises (as opposed to static stretching), for example, and conditioning exercises.

A slide board, introduced in collaboration with investigators at the Ohio State University (Weiler et al., 2013), and a carry strap for patient lift assist were implemented as control strategies to improve access to and help reduce lifting loads and risk of strain injuries during patient transfer. In addition, as part of a separate, but related effort, ambulances were outfitted with new electronic lift assist gurneys to further reduce the repetitive strains of vertical lifting of increasingly heavier patients. The learning module for patient transfer was also updated to provide probationary firefighters and medics with instruction on the new equipment earlier in their training. Finally, changes were made to cardiopulmonary resuscitation (CPR), which was viewed as fatiguing activity, often performed in awkward and prolonged static positions. The standard operated procedure was updated to include rotating CPR responsibility every 200 compressions (approximately 2 min) when appropriate personnel are available and prepared.

Control strategies addressing activities on the fireground emphasized personal protective equipment (PPE), including empowering the safety officer to remove a firefighter from scene if not wearing appropriate PPE. In addition, the standard operated procedure for rehab (a period of rest and recovery from fire suppression activities), including empowering the rehab paramedic, and positioning the rehab location further away from the on-scene activities so that firefighters undergoing rehab remain separated from the tactical operations. Additional changes to the procedures included adding paramedics in the rehab area for multi-alarm fire responses, and employing active cooling using forearm immersion in cold water for 15 min for heat-stressed firefighters.

Visual reminders (e.g., posters, placards, and signage) were implemented to reinforce awareness of some of the identified fireground risks, and to help improve adherence to the new procedures. For example, one of these reminders promoted hydration awareness, and a "urine hydration chart" was placed in all fire station bathrooms (Fig. 1). Another visual reminder stated, "Save your joints, use 3-points"

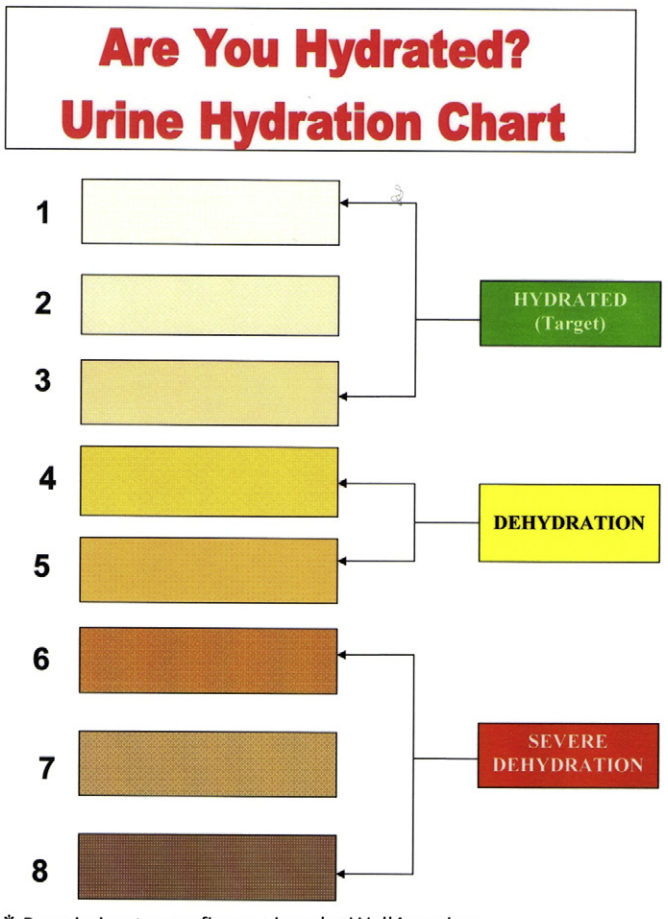

Fig. 1. Hydration chart visual reminder.*

to remind fire personnel to use three points of contact when entering or exiting the vehicle (Fig. 2). A sticker with this reminder was placed on the inside of all fire apparatus doors.

Various strategies were used to educate the department about this specific project and each of the control strategies, as well as to improve adherence to their individual implementations. These strategies included updates delivered during the morning "roll call" where relevant notes and news from department headquarters are relayed; a new project-specific website; regular updates delivered to the department safety committee and senior staff briefings; station visits from battalion chiefs, the PFTs, especially when working with fire personnel, and the department safety captain, who was a key ambassador for the project.

2.3. Data collection

Three cross-sectional surveys of department personnel were delivered to the entire department during the department's regular continuing education (CE) training sessions. CE training was selected as the best time to administer the survey because all of the relevant field personnel regularly attend these training sessions. The entire department was surveyed because one of the goals of this project was to expand knowledge about the control strategies beyond the groups that were more closely involved with the risk management process.

The surveys were developed using an iterative process and focused on the awareness of the control strategies, attitudes toward the control strategy, use of the control strategy, and barriers to implementing the control strategy. The surveys were finalized by the study team and shared with department leadership to support face validity.

The first survey was collected January–March, 2012 and evaluated knowledge, skills, abilities and behaviors on the topic of exercise equipment and facilities, PFTs, patient transfer devices (specifically a folding slide board and lift strap designed by Ohio State University and implemented in 2011), and the updates to the department's rehab protocols. The second survey was administered April–June 2012 and evaluated exercise behaviors and attitudes about the PFTs, knowledge about proper hydration, and general health-related information. The third survey was administered March–June 2013and was used to collect information about exercise and the PFTs, follow up questions about the patient transfer devices mentioned in the first survey, update to rehab protocols, proper hydration, visual aide for "3-points of Contact," infectious disease (e.g., MRSA), the department's electrically powered stretchers, and other health and safety information.

Fig. 2. Visual reminder: 3-point exit.

Surveys were administered at the beginning of various CE trainings during the previously mentioned time periods. Respondents provided written consent prior to completing each survey. The surveys were anonymous but demographic data including age, gender, rank, and years in the fire service were collected from each respondent at all three time points. Data collection procedures were approved by the University of Arizona.

2.4. Data management and analysis

Data were collected via hardcopy and double data entry procedures were used by research assistants to enter responses into an electronic database. The data entries were then compared and all discrepancies were corrected and verified by a study team member using the original hardcopy. Data cleaning consisted of labeling and coding the data and clarifying vague responses. For example, survey respondents provided their age as "40–50 years" to which a value of 45 years was assigned. Because identifiers were not collected, results from each survey could not be linked by respondent. Thus, the surveys were analyzed separately at each time point, and when possible, differences across time points were assessed across the entire respondent group. Data were cleaned and analyzed using Stata 13 (College Station, TX) to explore knowledge, attitudes, and self-reported behaviors for the control strategies.

3. Results

3.1. Participation rate

A total of 468/589 (79%) of fire personnel completed the first survey; 433/589 (74%) completed the second survey; and 427/590 (72%) completed the third survey. Based on previously published demographics for this department (Poplin et al., 2015), the respondents who completed the survey were similar to the entire department by age, tenure, sex, and job title.

3.2. Demographics

Demographic data for each sample were consistent across the three time points (Table 1). On average fire personnel were about 40 years of age, and had been in the fire service for approximately 12 years at the time the survey was administered. The sample reflected the fire service as a whole in that it was overwhelmingly male (approximately 95% of the survey respondents). Respondents were from all ranks within the fire service, with the largest categories of respondents classified as firefighters (31.2%), paramedics (23.9%), engineers (20.5%), and captains (19%).

Table 1
Description of sample of respondents of the three cross-sectional surveys.

	Survey #1 (January–March 2012) (n = 468)	Survey #2 (April–June 2012) (n = 433)	Survey #3 (March–June 2013) (n = 427)
Mean age (SD)	39.7 (8.8)	39.6 (8.3)	39.7 (8.6)
Average years with the TFD (SD)	12.1 (7.7)	12.0 (7.2)	12.3 (7.4)
	N (%)	N (%)	N (%)
Job title[a]			
Chief	5 (1.1)	6 (1.4)	3 (<1.0)
Captain	89 (19.0)	88 (20.3)	89 (20.8)
Engineer	96 (20.5)	78 (18.0)	84 (19.7)
Firefighter	146 (31.2)	124 (28.6)	129 (30.2)
Paramedic	112 (23.9)	120 (27.7)	115 (26.9)
Inspector	17 (3.6)	13 (3.0)	5 (1.2)
Other	3 (< 1.0)	2 (< 1.0)	0
Males	449 (95.9)	407 (94.0)	403 (94.4)

[a] Chief includes Fire Chief, Assistant Chief, Deputy Chief, Battalion Chief.

The surveys provided important information about the level of awareness of and perceptions about the control strategies. Below the findings are highlighted for the patient transfer devices, two visual reminders, and updates to the fireground rehab protocols (a period of rest and recovery from fire suppression activities). These interventions were selected to highlight in this paper because they were developed to impact key work circumstances that result in increased risk of injury or negatively impact firefighter physical health.

3.3. Patient transfer device

Results from the first survey indicated that approximately 51% of the respondents were aware of the change regarding the use of new patient transfer devices (Table 2). Fire personnel learned about the devices mainly from one of the captains who spoke about the device during training and the medics during a class or a presentation at the station. Nearly 59% of the respondents stated that they were not using the new patient transfer devices. Among these individuals not using them, the main reason for nonuse was that they did not know the devices were available. Another reason reported for nonuse was that the patient slide board was not accessible (i.e., not on the gurney), even though the folding nature of the slide board was designed for storage on the gurney.

Table 2
Reported knowledge, attitudes, and behaviors collected during three cross-sectional surveys for select control strategies.[a]

	Patient transfer devices n (%)	Hydration chart n (%)	3–Points n (%)	Fireground rehab n (%)
Survey one (January–March 2012; n = 468)				
Awareness of the intervention/awareness improved since the intervention was implemented	231 (50.6)	N (62)		395 (85.5)
Training use of the intervention or new procedures	188 (41.2)	N/A[b]		N/A[b]
Use of the intervention or new procedures[e]	162[d] (41.5)	188[c] (43)		89 (51.3)
Survey two (April–June 2012; n = 433)				
Awareness of the intervention/awareness improved since the intervention was implemented		270 (62.4)		
Training use of the intervention or new procedures		N/A[b]		
Use of the intervention or new procedures		N[c] (43.4)		
Survey three (March–June 2013; n = 427)				
Awareness of the intervention/awareness of desired behavior improved since the intervention was implemented		252 (60.0)	184 (43.8)	358 (85.2)
Training on use of the intervention or new procedures	298 (70.9)	N/A[b]	N/A[b]	N/A[b]
Use of the intervention or new procedures	N/A[b]	192[c] (45.7)	206[f] (49.0)	62 (14.6)

[a] Cells with a diagonal line reflect that the questions were not included on that specific survey.
[b] N/A: question not applicable for the particular control strategy or not included in the specific survey.
[c] Use for Hydration Chart indicates if hydration improved. Use for 3-points indicates the percent of time that 3-points are being used.
[d] Represents the percent of calls that the person is using the slide board.
[e] Percent of medics who reported that they used the new rehab guidelines when setting up rehab.
[f] Represents percent who always enter/exit the fire apparatus using 3 points of contact.

As shown in Table 2, only 41% reported that they received training on the patient slide board (i.e., one type of patient transfer device). Among all respondents, regardless of whether they received training or not, when asked if the new patient slide boards would improve firefighter safety, roughly 88% of the fire personnel thought they would improve safety. Open-ended responses indicated that a majority of fire personnel believed that safety would be improved because it was less of a hazard to slide patients than to lift them, which would reduce the risk of back injury and back strains. They also perceived that the most likely circumstances when the sliding device would be used are when someone who needs to be moved is in an awkward space or position, or for an obese patient, or when only two medics are available to move the patient. In addition, many firefighters stated that the potential for the device to improve safety would only be realized if "firefighters use it" or "remember to use it."

Questions specifically about the folding slide board were included on the third survey (administered a little less than 1 year after survey one and about a year and a half after implementation of the new devices) to determine its continued use (Table 2). By this point, nearly 71% of the fire personnel said that they had received instructions on the new device (a 20% increase over the percent reported during the initial survey). When asked why the devices were still not being consistently used, approximately 34% said that they preferred using the "speedsheet" over the slide board, which is a disposable patient transfer and barrier sheet that provides a fluid barrier between the patient and mattress and significantly reduces the force required for patient transfer. Other responses included that the patient transfer devices were not accessible or not available (29%), people were not trained on how to use them (15%), and that other medics or firefighters were not supportive of them and did not want to use them (9%).

3.4. Visual reminders

Fig. 1 illustrates the visual reminder that was used to educate fire personnel proper hydration. These Hydration Charts were laminated and posted in all bathrooms in all stations and in the exercise areas in some stations. Over two thirds of survey respondents from the second survey (68%) reported experiencing symptoms of dehydration while on duty. Of these respondents, they felt dehydrated when exercising (52%), returning from a call (31%), going to a call (21%), during post-suppression rehab (51%), and during an active fire suppression situation (40%).

The vast majority of fire personnel (95%) reported that they did see the hydration chart in their station (Table 2). In addition to the Hydration Chart, fire personnel reported also learning about hydration from the department Daily Bulletin (written document that summarizes safety and administrative topics sent from Headquarters to all fire stations), continuing education course, during line-up (where crew/shift-specific obligations for the day are presented), or from their peers. Since the Hydration Charts were posted, 62% reported that their awareness about hydration improved and 43% reported that their actual hydration improved since the Charts were posted. By the time that survey three was administered, about 94% of the respondents still reported seeing the Hydrating Charts, again mainly in the bathroom and also in the exercise area. Again, about 60% reported that their awareness about hydration improved and 46% reported that their actual hydration improved since the Charts were posted.

Fig. 2 illustrates a second visual reminder that was placed on the inside of all fire apparatus doors: "Save your joints, use 3-points" reminded fire personnel to use three points of contact when entering or exiting the vehicle. Based on the responses to survey three, nearly 90% of the respondents reported noticing the reminder. Forty-four percent of the fire personnel reported said that they were more aware of how they enter/exit the fire apparatus since these "3-points" signs were posted (Table 2). Forty-nine percent reported that they

always enter/exit the apparatus using three points of contact since the "3-points" signs were posted.

Further insights about this specific control strategy were gained when respondents were asked what else could be done to promote use of three points of contact when entering or exiting a vehicle. Approximately 33% reported that the reminders were useful, 24% said that nothing could be done to change behavior, and 18% said that the visual reminders needed to include information about the risks of not using three points of contact. A few respondents used the narrative to state that they felt that the illustration was childish and encouraged other ways of communicating risks, including during trainings, at the academy, and at lineup. They also noted that the culture needed to change the norms regarding how people enter and exit vehicles.

3.5. Fireground rehab

The standard operating procedure for rehab was updated to include empowering the rehab paramedic, positioning the rehab location farther away from the on-scene activities so that firefighters undergoing rehab remained separated from the tactical operations, adding paramedics in the rehab area for multi-alarm fire responses, and employing active cooling using forearm immersion in cold water for 15 min for heat-stressed firefighters. Questions about this change were included in surveys one and three.

Table 2 presents the survey results. Of the respondents who completed the first survey, 86% reported that they were aware of the update to rehab. They learned about the change from a Master Memo (document describing more official procedural changes from Headquarters to all personnel), during line-up, or a Daily Bulletin. Fifty percent of the respondents reported that their most recent rehab experience was *not different* from their prior experiences; a majority of these respondents had not been in rehab for a while or since the change took place. Of those who reported changes, they mentioned that they had to have vitals taken before they could leave the rehab area, the use of new forms, and that the new the rehab area was stricter than it had been in the past in that they could not depart until their levels were below required thresholds. Most of the fire personnel (57%) reported that the updated Rehab Report Form is an efficient way to help rehab firefighters; another 38% reported that they had not seen the form.

The medics (n = 183) were asked about the changes pertaining to them, and 64% said that they were not aware that the fire department adopted and adapted national standards for medical and site criteria for rehab (NFPA 1584). For those who were aware of the change, they learned about it by word of mouth or training. Among the medics, 84% reported that the updated Rehab Report Form is an efficient way to help rehab firefighters, especially because they can show the firefighters the protocols and concrete data about their vitals before they are allowed to return to the fireground. Fifty-two percent of the medics stated they refer to the NFPA 1584 medical and site criteria (or TFD's adaptation) when setting up the rehab site. Most of the medics (86%) also felt that having the rehab site criteria in front of them helped them to set up the rehab area when one is needed.

Among all of the respondents who completed the third survey, 85% reported that they were aware of the update to rehab. Approximately 57% of the respondents said that the rehab experience *was different* from prior ones. The medics (n = 185) were asked specific questions about rehab and only 14% said that they were not aware that the fire department adopted and adapted national standards for medical and site criteria for rehab (NFPA 1584); this is compared to 64% of the respondents on the first survey who said they were not aware of the change. As was the case for respondents for the first survey, the medics reported learning about the change by training or word of mouth, in addition to a Master Memo or Daily Bulletin. Fifty-seven percent of the medics noticed a change in the procedures compared to only 26% who reported that the procedures had not changed. Among the medics, 92% reported that the updated Rehab Report Form is an efficient way to help rehab firefighters. Fifteen medics stated they refer to the NFPA 1584 medical and site criteria (or TFD's adaptation) when setting up the rehab site; 19% were uncertain. Most of the medics (84%) also felt that having the rehab site criteria in front of them helped them to set up the rehab area when one is needed.

4. Discussion

Implementation refers to the process of putting a plan, policy, or project into place. The field of implementation research has grown exponentially and is a priority for federal agencies because knowing how health interventions are being implemented can improve effectiveness, impact, and sustainability (Department of Health and Human Services, 2013). To date, there is little published research about implementing safety interventions in the fire service. This paper addresses this gap and is significant for the field because it investigates the implementation of several control strategies.

In this research, patient transfer devices were implemented as a control strategy because this activity is a significant source of injury for the fire service (Poplin et al., 2012). However, when asked about the devices, only about half of the fire personnel said they were aware of them, which suggests that there could have been better communication about the new device. Most of the fire personnel stated that they learned about the devices mainly from one of the captains who spoke about them during training, as well as the medics during a class or a presentation at the station. Other strategies to share information, which were also commonly used for other interventions like the visual reminders, could have included written information shared via the Department's Master Memo or Daily Bulletin.

Although fire personnel believed that the device could help reduce injury, they noted that those reductions were only possible if the devices were used. Nearly 60% of the personnel reported that they were not using the new patient transfer devices. Some of the fire personnel reported not being able to access the patient transfer device even if they wanted to use it. Knowing that fire personnel were not able to access the new devices limited the regular use of the devices. Learning that the fire personnel lacked awareness or access to the devices is important for future work to increase their use, and emphasizes a need for effective communication strategies to increase knowledge.

Over 90% of the respondents reported noticing the Hydration Chart visual reminders. Although the data we collected were cross-sectional, the level of awareness was sustained from survey one to three. Fire personnel also reported increased awareness and actual levels of hydration since the reminders were posted. The message on the Hydration Awareness reminders was clear — the color of your urine directly correlates with the how well the amount of water consumed aligned with the body's demands. The images were located in the restrooms, which provided a straightforward way for fire personnel to assess their hydration levels. These data indicate the importance of clear and effective signage to reinforce behavior change, which has been effective for improving transportation-related safety (Thompson, Sleet, & Sacks, 2002).

Fire personnel also noticed the "3 Points" reminder, but these were found to be less impactful than the reminders for hydration. Nearly 90% of the respondents reported noticing the reminder but only 44% of the fire personnel reported increased awareness and 49% improved behavior since the "3-points" signs were posted. Narrative responses suggest that about a third of the respondents felt that the reminders were useful and about 18% felt that they would be more useful if they included information about the injury risk from not safely entering/exiting vehicles.

Moving forward, these safety messages could benefit from two approaches that are grounded in the extant literature. First, future work could consider the application of behavioral change models, such as the Theory of Planned Behavior (Ajzen, 1985). Using theory to inform the development of these reminders may help create more tailored and effective reminders that can sustain behavior change (Gielen &

Sleet, 2003). Second, there is a role for formative research in developing these interventions. Prior literature demonstrates the utility of formative work to understand target audience attitudes and knowledge of target populations, and subsequently inform the development of messages and strategies for intervention development (Frattaroli et al., 2013).

Because of the importance of fireground injuries and cardiac risks to fire personnel (Kales, Soteriades, Christophi, & Christiani, 2007; Poplin, Roe, Peate, Harris, & Burgess, 2014), rehab was also emphasized as a control strategy. Most of the fire personnel reported being aware of the change to rehab. While awareness was high, 50% of the fire personnel reported that their most recent rehab experience was not different from their prior experiences because many of the respondents had not been in rehab for a while or since the change took place. Determining the impact of rehab interventions is difficult because setting up rehab is fairly infrequent. A majority of fire personnel's responses are medical in nature, thus it was not surprising that many of the survey respondents could not report if rehab was different. However, for the fire personnel who reported that rehab was different, they noted the benefits of having concrete guidance about required levels needed before returning to the fireground.

4.1. Study limitations

While this research fills an important gap in implementation research for fire personnel, there are some methodological limitations that should be noted. Ideally, we would have collected longitudinal individual-level data to measure changes in knowledge, attitudes, and behavior over time; however, for feasibility reasons, we collected data using three cross-sectional surveys of the same population. Because we included questions about a few control strategies on more than one survey, we were able to report changes in aggregate. However, we could not be sure if the sample of respondents was the same across the three time points that the survey was administered. Because the surveys were administered during the tail end of the recession, fewer recruit classes were initiated, so there was not much gain in the total workforce. Thus, although we could not confirm if the sample of respondents was the same across the three time points, because of low turnover, it seems likely that the sample was stable over time.

We also chose to modify the surveys based on feedback received from the respondents. For example, survey one had several open-ended questions, which we turned into multiple choice questions in survey three. While these changes improved interpretation, we were unable to look at changes over time for many of the questions.

Also, the data on adherence to control strategies were all self-reported and may have been influenced by social desirability bias (i.e., fire personnel may have been more likely to report that they followed the behaviors). After looking at the data, the influence of response bias is likely minimal for two reasons: (a) there was variation in terms of the percent of respondents who reported the behavior; and (b) narrative responses indicated how candid and at times critical some of the respondents were of the intervention (i.e., the visual reminder for "3-points" was described as childish). We also did not have any structured observational periods to confirm the self-reported behaviors. Observational efforts for the project were more catered toward informing the risk management process, rather than validating self-reported behaviors.

Finally, while we asked respondents about their knowledge and awareness of specific control strategies, the survey did not include a specific question about the risk management process. Thus, we are unable to state with certainty that the entire department was aware that risk management was being utilized to identify and implement these controls. However, based on the previously mentioned array of strategies used to educate the department, it seems that most had the opportunity to learn about the project and broader intervention over the two-year period.

5. Summary and practical application

This study presents new findings on the implementation of risk management generated control strategies in the fire service. These data highlight the importance of studying the implementation process to identify barriers to the impact of an intervention. There is a tremendous gap in implementation research for interventions aimed at improving the health and safety of fire personnel, which limits the uptake of interventions. It is important that employees are aware of, have knowledge about, and receive training in safety and health interventions in order to adopt desired behaviors.

In addition, the overall process of risk management is attractive because of its ability to engage the fire personnel to identify the risks during their jobs and possible control strategies (Poplin et al., 2015). Based on these data, departments that are interested in utilizing this approach should consider ways to fully integrate the risk management approach so everyone is aware of its intent and approach. While we used a variety of ways to communicate with the department, other strategies should be considered. For example, when departments have a safety committee, they should be fully engaged as ambassadors and taught how to lead the risk management process. Also, connecting with new personnel is important. Larger departments may have resources to fully integrate risk management training in the recruit academy so that everyone learns of its intents and methods. Finally, departments that utilize a risk management approach may consider creating a CE series on risk management that utilizes examples from their own department.

Acknowledgements

This work was supported by the National Institute for Occupational Safety and Health [grant number R01OH009469].

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John Gulotta is the Health and Safety Captain for the Tucson Fire Department. He began his career in the fire service in 1988 with the Rural Metro fire department. John obtained a National Certification in Paramedicine in 1992. In 1997 he was hired by Tucson Fire as a recruit firefighter, promoted thru the ranks to Captain in 2005. John held Captain positions in medical and recruit training. In 2009 he began his role as Health and Safety Captain. Captain Gulotta has his associates' degree in fire science and paramedicine and is certified in Health and Safety Officer (HSO) and Incident Safety Officer (ISO) through the Fire Department Safety Officers Association (FDSOA) and Pro Board. Throughout the years Captain Gulotta has received many notable achievements which include two merit awards, an award of service, four unit citations and Fire Fighter of the Year in 2012. Also, he works closely with the University of Arizona for a number of fire service related studies. He is dedicated to the health and safety of not just Tucson Fire but the fire service overall.

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