NEW SOLUTIONS, Vol. 24(4) 555-576, 2015

Features

FROM INFANCY TO ADOLESCENCE: THE DEVELOPMENT AND FUTURE OF THE NATIONAL FIREFIGHTER NEAR-MISS REPORTING SYSTEM

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ABSTRACT

The National Fire Fighter Near-Miss Reporting System (NFFNMRS) is a voluntary adverse event reporting system designed as a repository to which firefighters submit information on the hazards seen in their work, detailing the events that led to near-misses and injuries. This descriptive article discusses the development of the system since its inception, the strengths and limitations of the resultant data, and the improvements to be made to ensure the system's usefulness. Especially in their infancy, near-miss systems are very dependent on funding and sensitive to any reductions as they head toward steady-state reporting. This sustainability factor has significant implications for continued reporting to the system and the ultimate utility of the data. Very few such data systems exist for occupational health surveillance.

Keywords: firefighter, near-miss, injury

The call for this fire . . . had gone to about eight or 10 alarms. When our engine crew arrived, we passed dozens of engines from all over the county as well as

doi: http://dx.doi.org/10.2190/NS.24.4.h
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about five engines from [city deleted]. All had been on scene for many hours, including our ladder truck. The fire was at a high-tech plastics recycling plant less than a mile from our facility. By the time we arrived, most of the fire was done and the roof had already collapsed. Our crew was given an assignment to enter the building and seek out hot spots that were still smoldering and basically cover the hot spots with foam. Another firefighter and I entered with full PPE [personal protection equipment] and air. We made it 150 feet into the building walking on black melted plastic with metal shards sticking out everywhere. We laid down probably 400 to 500 gallons of foam without hardly any effect.

We reported in to the IC [incident commander] over the radio that the foam was of little use and we were coming out. About then, my partner fell through melted plastic that we were standing on, all the way to about mid-thigh. He screamed at me that it was burning his legs through his boots and turnouts [protective coat and pants]. I attempted to pull him out and he told me to stop because his boot was still stuck and his legs were coming out without his boots. The metal shards were also cutting into his legs. We decided that I was going to have to dig him out by hand so that I could get to the stirrups of his boots. That worked but it took me about two minutes to get him free. By this time we were both about out of air and wanted to get out of there. We started to make our exit, and while we were exiting, we heard this one sharp loud cracking sound and started running for the exit door. Just then the building's A/C unit came crashing down about where we had just been walking. So the end of this is that we were walking on top of two to four feet of semi-melted plastic and operating almost directly beneath an A/C unit that probably weighed 2,000 pounds. (Incident report filed with NFFNMRS)

THE SIGNIFICANCE OF NEAR-MISS REPORTS

Dangerous situations and human errors often lead to injury, but in some cases result in a "near-miss." A near-miss is an incident that had the capacity to cause injury but did not, due to either intervention or chance. The above narrative was taken from the National Fire Fighter Near-Miss Reporting System (NFFNMRS) and it highlights the numerous, simultaneous hazards that exist during a fire, with the high potential for injury and/or death to firefighters. The NFFNMRS defines a near-miss event as "an unintentional unsafe occurrence that could have resulted in an injury, fatality, or property damage. Only a fortunate break in the chain of events prevented an injury, fatality or damage" [1]. As seen in the above narrative, this system receives reports of injuries and near-misses, making it more of an adverse-event reporting system than a near-miss reporting system.

Adverse event data describing injuries and near-misses provide a powerful opportunity for hazard surveillance and risk reduction, identifying the types of hazards within an organization and their severity or impact. Near-miss data indicate problems upstream of an injury [2] and thus ameliorate the outcome bias

that results from studying only injury. The *common cause hypothesis* states that near-misses and injuries have the same relative causal patterns, and research has supported this hypothesis in fields including childhood injury, railway safety, and patient safety [3-5]. Further, near-miss events occur up to 300 times more frequently than injuries [6]. This sheer quantitative difference can enable analysis, identification of failure points in systems, and recognition of successful actions that prevented harm [4]. Near-misses identify successful countermeasures that prevent an incident from becoming harmful, or even deadly. Further, one need not capture every single near-miss in order to improve safety. As has been shown in health care, even a few voluntary reports can be sufficient to detect a new hazard [7].

The reporting of near-misses and of injuries requires participation. There will be a lower rate of reporting in a punitive culture than in a "just culture" [4]. In a punitive culture, the focus is on the blame and the punishment for making a mistake. In a "just culture," disciplinary action is taken only when an intentional error is committed, thereby shifting the focus to learning from mistakes rather than punishing all errors. An increase in reporting of near-misses and injuries results in a more comprehensive picture of potential dangers and is indicative of a culture committed to safety.

A BRIEF HISTORY OF ADVERSE EVENT REPORTING SYSTEMS

Adverse event reporting systems (including errors and near-misses) have been adopted by high-reliability organizations (HROs) including industries such as health care [6], pharmaceuticals [8], manufacturing [9], construction [10], nuclear power [11], petrochemical processing [12], and aviation [13]. HROs are organizations in which the work done is inherently risky and often dangerous. An error in an HRO has such catastrophic potential that a commitment to vigilant error detection is made by the organization. HROs strive for the prevention of error with the knowledge that perfection is unattainable because of the dynamic environments in which they operate [14]. Adverse event systems are imperative for effectively managing and mitigating errors and hazards as they arise. To illustrate the development and use of adverse event reporting in HROs, three different systems and their achievements are described here.

The Aviation Safety Reporting System (ASRS) was implemented in 1975 in response to the crash of TWA flight 514 [15]. Only days earlier, another flight crew had narrowly avoided the same fate due to internal near-miss reporting by that airline [13]. ASRS allows pilots, air traffic control, and crew members to report any incidents related to aviation operations and safety culture so that the aviation industry as a whole can benefit. For example, a report described an incident of crew interactions in the cockpit that constituted a deviation from the "sterile cockpit" protocol required during takeoff and landing. Study of this

deviation was then used for recommendations, training, and policy modification by the Federal Aviation Administration [16].

The United States Pharmacopeia (USP) established MEDMARX in 1998 as the first internet-accessible, anonymous, voluntary medication error reporting program [17]. Since its inception, over 1.2 million reports have been submitted. Through MEDMARX, the USP discovered that errors occur frequently among 1,400 commonly used medications of similar name and/or appearance. Several publications have stemmed from analysis of MEDMARX data, covering a broad range of topics: identification of medication administration errors by health care providers and malfunctions of medical devices, adverse patient reactions to particular drugs, drug dosage information, and failures within computerized physician order entry (CPOE) programs [8, 18, 19].

The railway industry also uses near-miss reporting to gather information about safety issues and potential hazards. In 2007, the Confidential Close Call Reporting System (C^3RS) was created as a pilot program for the United States rail system. In 2012, a report by the U.S. Department of Transportation and the Federal Railway Administration comparing C^3RS sites to two non-C^3RS sites found that the C^3RS sites had: 1) a 31 percent improvement in the number of railcars moved between incidents (fewer accidents, higher productivity); 2) improved labor-management relationships and employee engagement within the team of employees and out in the field; and 3) a reduction in discipline cases. Program participants at this site stated that C^3RS revealed safety issues and root causes that would have remained undetected without the reporting system in place [20].

AN ADVERSE EVENT REPORTING SYSTEM FOR THE U.S. FIRE SERVICE

In 2003, the International Association of Fire Chiefs (IAFC) was awarded a Fire Prevention and Safety Grant as part of the Assistance to Firefighters Grant Program managed by the U.S. Department of Homeland Security. The purpose of the grant was to create the National Fire Fighter Near-Miss Reporting System for the fire and emergency service. A supporting grant was awarded from Fireman's Fund Insurance Company. The mission of the Near Miss system is "to turn lessons learned into lessons that are applied by contributing to the common knowledge pool relating to operational safety and injury prevention, ultimately improving safety and saving lives" [1].

Development of the Adverse Reporting System

In December 2004, a task force of fire service and aviation safety experts was convened to develop the reporting system. The reporting form was modeled after the Aviation Safety Reporting System. It captures reporter information (e.g., department, rank, shift, experience, age), standard event information (e.g.,

event type, date and time, weather), and detailed event information via two narrative sections (event description and lessons learned). Preliminary testing of the form was conducted in local fire departments near the IAFC headquarters in Fairfax, Virginia, with only minor changes made to simplify the reporting form (Figure 1).

The reporting form was evaluated further through American Viewpoint, a company hired to conduct eight focus groups across the country. American Viewpoint strategically recruited participants to ensure that all aspects of the fire and emergency service were represented (i.e., all ranks, all department types, geographical diversity). The attendees were asked for feedback on their understanding of the definition and examples of a near-miss, items that they would and would not answer, and motivators and barriers to submitting a report. Attendees provided positive feedback on all aspects of the program and stressed the need to keep the reporting form brief because firefighters do not have a surfeit of time for paperwork.

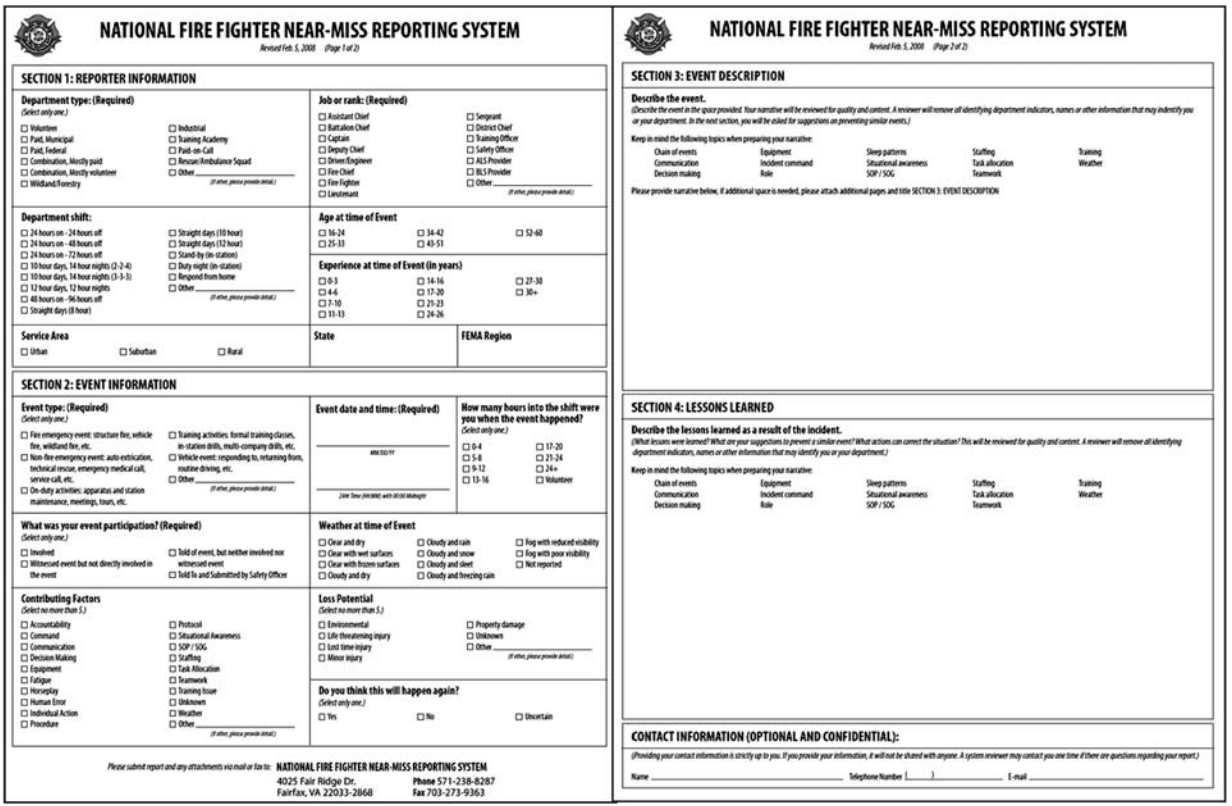
The testing phase of the program included 38 fire departments as pilot sites, which represented the diversity in size and scope of the fire and emergency services. Pilot sites included large metropolitan departments such as the Los Angeles County Fire Department and smaller rural volunteer departments such as the Cy-Fair Fire Department in Texas. A training meeting was held in April 2005 to teach representatives from each of the pilot sites about the benefits of near-miss reporting, how to market the program in their departments, and how to use the program. Program staff conducted site visits to the 38 pilot departments to provide additional training and to receive feedback on the usability of the program. No changes were made to the reporting form based on their positive feedback on both the reporting form questions and the website in general. Suggestions were made to help allay concerns about retaliation by superiors if someone submitted a report.

The national launch of the program occurred at IAFC's annual conference, Fire-Rescue International on August 12, 2005. The program was funded by the U.S. Department of Homeland Security's Assistance to Firefighter Grant Program from 2003 through 2012, and is currently funded internally by the IAFC and other donors.

Reporting Process

Firefighters and EMS personnel submit reports to NFFNMRS in paper form via fax, or using an electronic form through the website. The current reporting form has 22 fields, five of which are mandatory. Seventy-two percent of reporters take 20 minutes or less to complete a report.

Submitted reports are reviewed by two separate fire/EMS subject matter experts known as reviewers. The reviewers—active or recently retired fire service members with at least 15 years of experience—are contracted by the



NATIONAL FIRE FIGHTER NEAR-MISS REPORTING SYSTEM

Revised Feb. 5, 2008 (Page 1 of 2)

SECTION 1: REPORTER INFORMATION

Department type: (Required)
(Select only one.)

- ☐ Volunteer
- ☐ Paid, Municipal
- ☐ Paid, Federal
- ☐ Combination, Mostly paid
- ☐ Combination, Mostly volunteer
- ☐ Wildland/Forestry
- ☐ Industrial
- ☐ Training Academy
- ☐ Paid-on-Call
- ☐ Rescue/Ambulance Squad
- ☐ Other _____ (If other, please provide detail.)

Job or rank: (Required)

- ☐ Assistant Chief
- ☐ Battalion Chief
- ☐ Captain
- ☐ Deputy Chief
- ☐ Driver/Engineer
- ☐ Fire Chief
- ☐ Fire Fighter
- ☐ Lieutenant
- ☐ Sergeant
- ☐ District Chief
- ☐ Training Officer
- ☐ Safety Officer
- ☐ ALS Provider
- ☐ BLS Provider
- ☐ Other _____ (If other, please provide detail.)

Department shift:

- ☐ 24 hours on - 24 hours off
- ☐ 24 hours on - 48 hours off
- ☐ 24 hours on - 72 hours off
- ☐ 10 hour days, 14 hour nights (2-2-4)
- ☐ 10 hour days, 14 hour nights (3-3-3)
- ☐ 12 hour days, 12 hour nights
- ☐ 48 hours on - 96 hours off
- ☐ Straight days (8 hour)
- ☐ Straight days (10 hour)
- ☐ Straight days (12 hour)
- ☐ Stand-by (in-station)
- ☐ Duty night (in-station)
- ☐ Respond from home
- ☐ Other _____ (If other, please provide detail.)

Age at time of Event

- ☐ 16-24
- ☐ 25-33
- ☐ 34-42
- ☐ 43-51
- ☐ 52-60

Experience at time of Event (in years)

- ☐ 0-3
- ☐ 4-6
- ☐ 7-10
- ☐ 11-13
- ☐ 14-16
- ☐ 17-20
- ☐ 21-23
- ☐ 24-26
- ☐ 27-30
- ☐ 30+

Service Area

- ☐ Urban
- ☐ Suburban
- ☐ Rural

State

FEMA Region

SECTION 2: EVENT INFORMATION

Event type: (Required)
(Select only one.)

- ☐ Fire emergency event: structure fire, vehicle fire, wildland fire, etc.
- ☐ Non-fire emergency event: auto extrication, technical rescue, emergency medical call, service call, etc.
- ☐ On-duty activities: apparatus and station maintenance, meetings, tours, etc.
- ☐ Training activities: formal training classes, in-station drills, multi-company drills, etc.
- ☐ Vehicle event: responding to, returning from, routine driving, etc.
- ☐ Other _____ (If other, please provide detail.)

Event date and time: (Required)

MM/DD/YY

24-hr Time (HH:MM), with 00:00 Midnight

How many hours into the shift were you when the event happened?
(Select only one.)

- ☐ 0-4
- ☐ 5-8
- ☐ 9-12
- ☐ 13-16
- ☐ 17-20
- ☐ 21-24
- ☐ 24+
- ☐ Volunteer

What was your event participation? (Required)
(Select only one.)

- ☐ Involved
- ☐ Witnessed event but not directly involved in the event
- ☐ Told of event, but neither involved nor witnessed event
- ☐ Told To and Submitted by Safety Officer

Weather at time of Event

- ☐ Clear and dry
- ☐ Clear with wet surfaces
- ☐ Clear with frozen surfaces
- ☐ Cloudy and dry
- ☐ Cloudy and rain
- ☐ Cloudy and snow
- ☐ Cloudy and sleet
- ☐ Cloudy and freezing rain
- ☐ Fog with reduced visibility
- ☐ Fog with poor visibility
- ☐ Not reported

Contributing Factors
(Select no more than 5.)

- ☐ Accountability
- ☐ Command
- ☐ Communication
- ☐ Decision Making
- ☐ Equipment
- ☐ Fatigue
- ☐ Horseplay
- ☐ Human Error
- ☐ Individual Action
- ☐ Procedure
- ☐ Protocol
- ☐ Situational Awareness
- ☐ SOP / SOG
- ☐ Staffing
- ☐ Task Allocation
- ☐ Teamwork
- ☐ Training Issue
- ☐ Unknown
- ☐ Weather
- ☐ Other _____ (If other, please provide detail.)

Loss Potential
(Select no more than 5.)

- ☐ Environmental
- ☐ Life threatening injury
- ☐ Lost time injury
- ☐ Minor injury
- ☐ Property damage
- ☐ Unknown
- ☐ Other _____ (If other, please provide detail.)

Do you think this will happen again?
(Select only one.)

- ☐ Yes
- ☐ No
- ☐ Uncertain

Please submit report and any attachments via mail or fax to: **NATIONAL FIRE FIGHTER NEAR-MISS REPORTING SYSTEM**
4025 Fair Ridge Dr.
Fairfax, VA 22033-2868
Phone 571-238-8287
Fax 703-273-9363

NATIONAL FIRE FIGHTER NEAR-MISS REPORTING SYSTEM

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SECTION 3: EVENT DESCRIPTION

Describe the event.
(Describe the event in the space provided. Your narrative will be reviewed for quality and content. A reviewer will remove all identifying department indicators, names or other information that may indentify you or your department. In the next section, you will be asked for suggestions on preventing similar events.)

Keep in mind the following topics when preparing your narrative:

Chain of events	Equipment	Sleep patterns	Staffing	Training
Communication	Incident command	Situational awareness	Task allocation	Weather
Decision making	Role	SOP / SOG	Teamwork	

Please provide narrative below, if additional space is needed, please attach additional pages and title SECTION 3: EVENT DESCRIPTION

SECTION 4: LESSONS LEARNED

Describe the lessons learned as a result of the incident.
(What lessons were learned? What are your suggestions to prevent a similar event? What actions can correct the situation? This will be reviewed for quality and content. A reviewer will remove all identifying department indicators, names or other information that may identify you or your department.)

Keep in mind the following topics when preparing your narrative:

Chain of events	Equipment	Sleep patterns	Staffing	Training
Communication	Incident command	Situational awareness	Task allocation	Weather
Decision making	Role	SOP / SOG	Teamwork	

CONTACT INFORMATION (OPTIONAL AND CONFIDENTIAL):

(Providing your contact information is strictly up to you. If you provide your information, it will not be shared with anyone. A system reviewer may contact you one time if there are questions regarding your report.)

Name _____ Telephone Number (_____) _____ E-mail _____

Figure 1. National Fire Fighter Near-Miss Reporting System Form.

IAFC to confirm the validity and reliability of each report's content. The validity check is used to determine whether the reporter knows the work of firefighting (e.g., is the proper equipment being used in this particular situation? is the cited hose pressure compatible with the hose size?). Reliability checks ensured consistency within the narrative (e.g., if the reporter said a 2-in-2-out protocol was being followed, yet one firefighter was freelancing inside the structure, the reviewer would ask the reporter to clarify). Reviewers sign confidentiality agreements as a condition of employment and have a secure website to access reports. A reviewer selects a queued report for "First Review" status. Ideally, all reports enter First Review status within 72 hours after they are received. During this First Review, the reviewer de-identifies the report, ensures the readability of the report (grammar, spelling, etc.), and conducts follow-up calls with the reporter to ensure that the report is complete and accurate. During this process (Figure 2), the reviewer fills out approximately 20 more detailed data fields to help code and analyze the report. The reviewer can fill out the coding fields by reading the original report and/or by contacting the original report submitter if contact information was provided. The reporter provided contact information in over 90 percent of reports. Reviewers must make at least 3 attempts to contact the reporter before completing the First Review. Reviewers act as quality control for the system, ensuring that words are spelled correctly and the narrative is readable, but they make no edits that would change the reporter's account of the

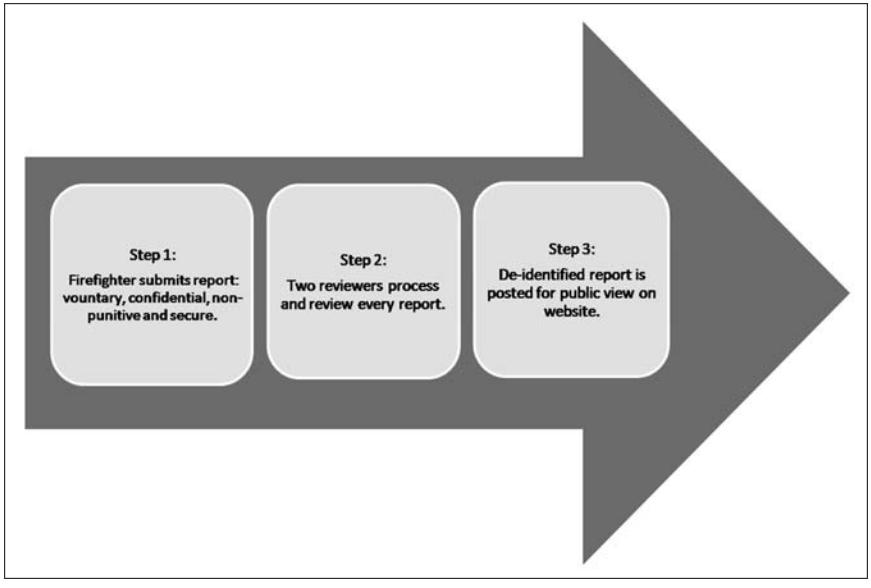

Figure 2. Flow chart: submission and review of near-miss reports.

event. The follow-up calls are an important piece of the process because, while they are useful for confirming the details of the report, they also help to establish a sense of trust and reciprocity through the "badge-to-badge" communication between the reviewer and reporter.

Once the First Review is completed, the report enters "Approval Pending" status, signaling to the other reviewers that it is ready for a "Second Review." The Second Review acts as a quality control process to ensure that all the previously described conditions are met. Once the Second Review is completed, the entire de-identified report is placed in "Posted" status and made viewable and searchable to the public on the program's website.

Since the creation of the NFFNMRS in 2005, the system has received more than 5,000 reports. In 2008, IAFC retained Drexel University's School of Public Health (Drexel) to assess the quality of the data and make recommendations regarding the near-miss reporting system as it reached an anticipated steady state of reporting. Data Quality Reports were completed by Drexel in 2009 and 2011.

ANALYSIS

Drexel analyzed the Reporter data fields and the reviewer data fields of the reporting system; 4,814 reports contained the information required for analysis. The analysis focused on both the quality of the data and the content of the data fields.

The exploratory analysis was done on all data fields. Frequencies and distributions were calculated for each variable using STATA-MP 12. Cross-tabulations were run for several variables.

RESULTS AND RECOMMENDATIONS

Eighty-one percent of the reports analyzed were near-misses, whereas 19 percent were injuries, affirming that this is an adverse event reporting system.

The number of reports submitted to the NFFNMRS has increased each year since its inception. However due to a 30 percent reduction in funding, a precipitous drop in the number of reports occurred between 2010 and 2011 (Figure 3a). This effect indicates how sensitive near-miss systems are at the early stages of their development and how dependent they are on funding to achieve the system's maturity at a steady state. A steady state is the point at which the number of reports to a system plateaus and is maintained at that same level over time. It took the ASRS 10 years to reach a steady state of 3,000 reports annually (Figure 3b) [21]:

Near-miss systems need time to reach a steady state, but they also need human resources. Eight reviewers conducted the callbacks for the NFFNMRS. The reviewers were from the following states: Colorado, California, Connecticut,

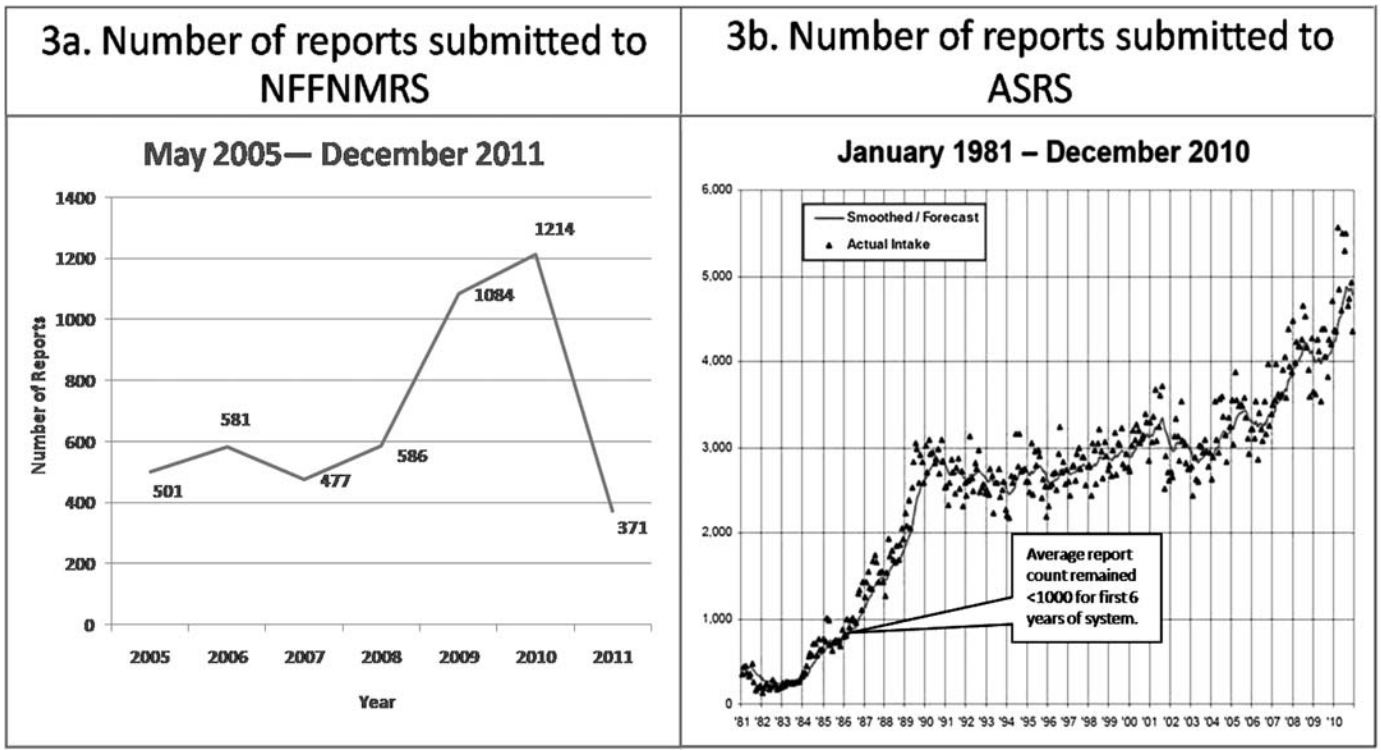

Figure 3. Comparison of numbers of NFFNMRS and ASRS reports, for overapping time periods.

Georgia, Maryland, New York, Oklahoma, and Virginia. Reviewers also conducted trainings to increase knowledge of the system and to encourage reporting. Of total reports to the system, four of the top six reporting states had a reviewer present (GA, CO, NY and MD). Figure 4 examines the possible effect of the presence of a reviewer within a state on reporting in that state. We calculated the percent of national near-miss reports in a state by dividing the number of reports from that state by the total number of near-miss reports for all states. This percentage was then subtracted from the percentage of active firefighters nationwide residing in that state (per the National Fire Department Census [22]). For example, 4.6 percent of Near-Miss reports (through 2012) came from the state of New York. The Fire Department Census found that 8.4 percent of active U.S. firefighters reside in that state. Subtracting the percent of firefighters from the percent of Near-Miss reports (4.6 minus 8.4) yields a difference of –3.8 percentage points. The implication is that New York is underrepresented in the Near-Miss System (falling into the –7 to –3.6 range in Figure 4). Similarly, 6.1 percent of all Near-Miss reports come from the state of Colorado, which, per the Census, holds 1.3 percent of active U.S. firefighters. Thus, 6.1 minus 1.3 yields a positive 4.8 point difference; Colorado appears to be overrepresented in the Near-Miss System (falling into the 3.6 to 7 range in Figure 4). White states are those for which the Near-Miss percentage and National Fire Department Census percentage match (within 0.5 percentage points), indicating neither over- nor underrepresentation in the Near-Miss System. Of the eight states with reviewers, five have higher than expected reporting. While not conclusive proof of the impact of state-based reviewers, the two states that had the highest percentage also had reviewers (Colorado and Georgia).

Data Quality

We evaluated missing data in the system: of 11 non-required data fields (excluding name, telephone, and email), three were left blank 26 percent and 64 percent of the time and six were left blank between 1.0 percent and 3.5 percent of the time. The missing data result because the majority of questions are optional (i.e., not required fields). It is not known whether the reporter intentionally left the field blank, or skipped it. Intentionally omitted data fields could mean that the questions are not understood, or that they are perceived as unimportant to the reporter.

Categorical Data Results

As depicted in Table 1, the majority of reports came from paid municipal fire departments (n = 2,234, 46.4%), with firefighters, captains and lieutenants reporting most frequently (36%, 15.1%, 13.8% respectively). Reporters primarily cited working shifts of 24 hours on, 48 hours off (1,752), while the second most common shift type selection was “Respond from home” (957). A uniform

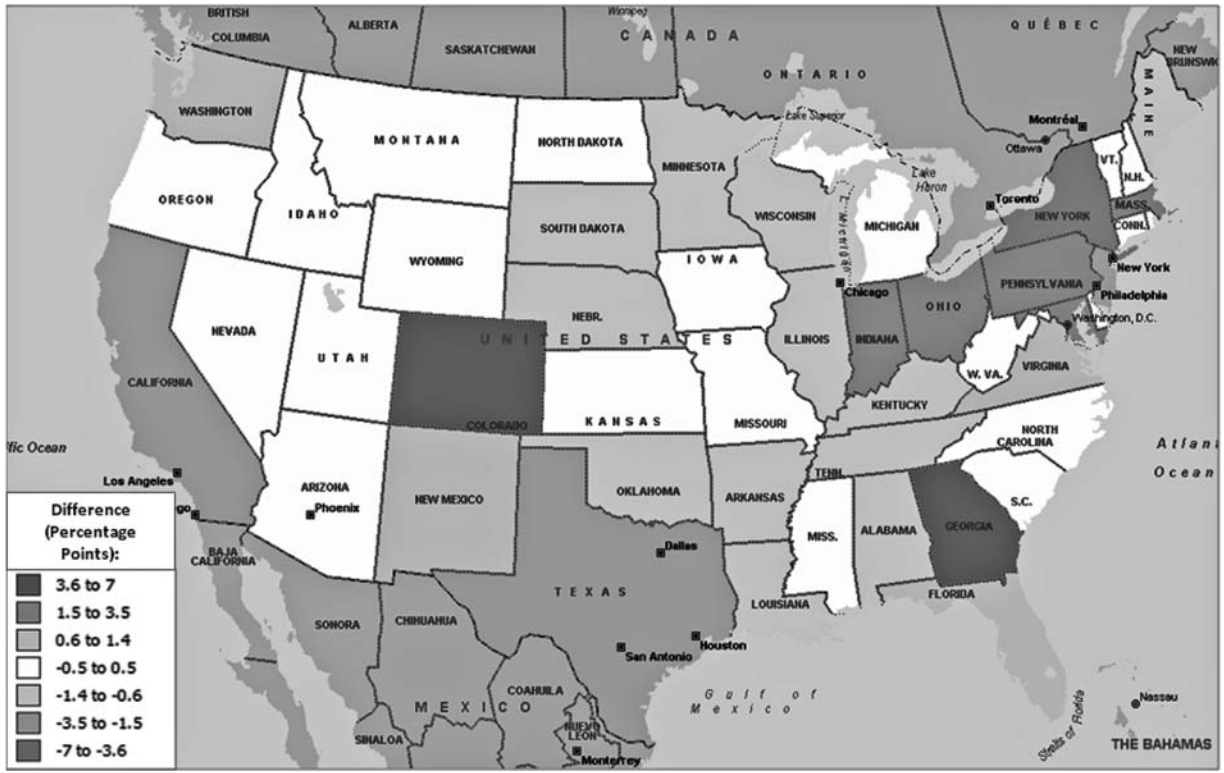

Figure 4. Difference between percentage of active firefighters nationwide and percentage of near-miss reports nationwide, by state.

distribution of frequencies was observed for the age and experience variables because they were constructed as categorical instead of continuous. This likely caused a masking effect of any potential differences. Suburban service areas reported with a higher frequency (44.6%) than either urban (33.4%) or rural areas (20.1%). Fire emergency events are reported most frequently to the system, representing 47.5 percent of all reports. Sixty-three percent of reports are left blank in the field Hours into shift (3,058). The paucity of complete reports in this field does not allow for the investigation of the relationship between incidents and duration into shift. The contributing factors most frequently cited were situational awareness (16.5%), decision making (14.4%), human error (14%), and individual action (9.8%). Thirty-four percent of reporters indicated the event had the potential to cause a life-threatening injury, with 25.7 percent suggesting it could have led to a lost-time injury.

Recommendations for the System

Overall, it was recommended that formatting of data collection become more rigorous:

- questions should be required, not optional, and therefore should include an "N/A" or "prefer not to answer" option;
- internal system checks should prevent errors (such as dates in the future) and incompatible selections;
- where possible, discrete answer categories should be used to simplify categorization and analysis;
- continuous variables should be captured as such and put into categories only for analytic purposes; and
- cognitive testing and confirmatory analysis should be done before any changes are implemented.

A more detailed summary of recommendations is provided in Table 2. A complete copy of the Data Quality Report can be obtained from IAFC.

DISCUSSION

As evidenced in the Data Quality Report, consultation with epidemiologists during the development of the system would have created more robust data. A review of the data from the period 2005-2011 showed the need for revisions to the system that will ensure stronger, more useful data as it grows. In 2011, IAFC convened the Near-Miss Data Working Group consisting of its IT (information technology) vendors, report reviewers, representatives of the International Association of Fire Fighters (IAFF), ASRS, and Drexel to formulate a plan to improve the data collection, quality, and dissemination of the NFFNMRS. Consensus was readily achieved and a plan for implementation created.

Since its inception through 2011, the number of reports to the NFFNMRS increased, but the system was dependent on sustained funding. In 2012, the NFFNMRS lost the funding it relied on since its inception.

In January 2014, the IAFC re-launched the NFFNMRS, incorporating both a new web reporting platform and an artificial intelligence data mining engine to leverage the data found in each report. The changes to the reporting system were based on the recommendations of the Drexel Data Quality Report and the Near-Miss Data Working Group. A more robust system allowing for detailed, in-depth analyses will be possible in the future once a sufficient number of new reports have been submitted.

The number of submitted near-miss reports is small relative to the population of U.S. firefighters (n = 1.1 million) [23], but reporting has historically increased when funding has been sufficient. ASRS required 10 years to reach a state of steady reporting. Similarly, it will take the NFFNMRS time to reach this milestone. Much of the success of the ASRS is due to the fact that reporting is mandated under the aegis of the Federal Aviation Administration. The NFFNMRS lacks both an enforcement agency and incentive program to promote reporting to the system and is highly dependent on funding to elicit reports. Government oversight of ASRS is only one of the differences between it and the NFFNMRS. For this reason, we recommend that industries building near-miss systems consider all available models including, but not limited to, ASRS. Each industry and organization has unique issues that may require an amalgamation of multiple models or creation of a new model entirely designed to suit their needs. For example, differences between surgery and aviation have been identified, suggesting the need for more research on the outcomes of ASRS model components as applied to surgery prior to routine adoption of the complete ASRS model [24].

The strengths of the NFFNMRS are many. Firefighters reporting to the system provide their contact information over 90 percent of the time, which indicates a willingness to talk about the hazards inherent to their work. Such entrée is rare in occupational health. Furthermore, the contact between the Reviewer and reporter post-submission is tangible evidence to the fire service that the data they provide are actually being used and are valued. In addition to the quantitative data, the NFFNMRS obtains detailed, substantive information about the hazards of firefighting through narratives. This particular aspect of the form is an excellent resource for identifying persistent and emerging hazards within the fire and emergency services, because narratives can provide key details to an event that would have otherwise not been captured [25]. Already, these narratives have been used to generate two new variables for the system: whether an injury occurred (yes/no) and the cause of the injury or near-miss [26].

The impact of the system is measured through intense dissemination activities. Since 2005, IAFC released approximately 300 issues of the Report of the Week

Table 1. Demographics of Reporters to the National Firefighter Near-Miss Reporting System

Demographic characteristics	Reports to the system	
	Number[a]	Percent
Department type		
Paid municipal	2,234	46.4
Combination, mostly paid	850	17.7
Volunteer	847	17.6
Combination, mostly volunteer	605	12.6
Other (forestry, paid-on-call, other)	278	5.9
Job/rank		
Non-command	3,544	73.6
Firefighter	1.733	36.0
Captain	728	15.1
Lieutenant	664	13.8
Other (sergeant, driver, emergency medical technician)	419	8.7
Command	926	19.3
Fire Chief	302	6.3
Battalion Chief/District Chief	253	5.3
Assistant Chief	239	5.0
Deputy Chief	132	2.7
Other (Instructor, Fire Marshal/Inspector)	178	3.7
Shift type		
24 hours on—24 hours off	1,752	36.4
Respond from home	957	19.9
24 hours on—24 hours off	563	11.7
Other (straight days, stand-by, 48 hours on—96 hours off)	1,441	29.9
Missing	101	2.1
Age at event		
16-24	480	10.0
25-33	1,375	28.6
34-42	1,461	30.3
43-51	1,008	20.9
52-60	316	6.6
60+	30	0.6
Missing	144	3.0
Experience at event	4,814	100.0
0-10 years	1,957	40.6
11-20 years	1,560	32.4
21+ years	1,129	23.5
Missing	168	3.5

Table 1. (Cont'd.)

Demographic characteristics	Reports to the system	
	Number[a]	Percent
Service area		
Suburban	2,146	44.6
Urban	1,609	33.4
Rural	968	20.1
Missing	91	1.9
Event type		
Fire emergency event	2,288	47.5
Vehicle event	783	16.3
Non-fire emergency event	754	15.7
Training activities	587	12.2
Other	402	8.4
Hours into shift		
0-4 hours	636	13.2
5-8 hours	402	8.4
9-12 hours	247	5.1
Other	483	10.0
Missing	3,046	63.3
Do you think this will happen again?		
Yes	1,003	20.8
No	177	3.7
Uncertain	555	11.5
Missing	3,079	64.0
Contributing factors[a]		
Situational awareness	2,153	16.5
Decision making	1,884	14.4
Human error	1,831	14.0
Individual action	1,272	9.8
Communication	858	6.6
Equipment	812	6.2
Training issues	676	5.2
Loss potential		
Life-threatening injury	3,070	34.3
Lost-time injury	2,306	25.7
Property damage	1,521	17.0
Minor injury	1,510	16.9
Other	298	3.3

[a]Total number of records is 4,814; more than one subcategory may be selected, and therefore total for category may be greater than 4,814 though the data comes from the same 4,814 records.

Table 2. Detailed Summary of Recommendations

Variable	Current format	Proposed change	Reason for change
Age at time of event	5 categories: 16-24, 34-42, etc.	Allow reporter to fill in exact age as a numeric field: Age _____	Age is a continuous variable.
Experience at time of event (in years)	10 categories: 0-3, 4-6, 7-10, etc.	Allow reporter to fill in years of experience as a numeric field: Experience (in years) _____	Experience is a continuous variable.
Hours into shift	8 categories: 0-4, 5-8, volunteer, etc.	Remove Volunteer category; Reporter to fill in number of hours into shift as a numeric field: Hours into shift _____	Volunteer is not a numeric value. Hours into shift is a continuous variable.
Event date and time	The online system allows reporters to enter any date; Date and Time together are one variable.	Reporters to choose only event dates that have occurred in the past. Separate Date and Time.	Reporting of future events is allowed. Date and Time should be separate variables.
Weather	12 categorical variables iwth paired conditions: Clear with wet surfaces, Clear with frozen surfaces, Cloudy and dry, Cloudy and rain, etc.	Allow reporter to select weather from a list of dscrete options: __Clear __Dry __Cloudy __Wet __Rainy __Fog __Wind __Icy/Frozen __Snowy __Sleet/Slush __Unknown	Reporters to select discrete conditions as necessary and applicable.

Contributing factors (CFs)	20 categorical variables: Procedure, SOP, SOG, Protocol, Situational Awareness, Individual Decision Making, etc.	To be determined after cognitive testing: Paring down of options into fewer categories. Possible open text field with prompts for reporter to consider human and systems factors.	Selections are redundant and ill-defined.
Loss potential (to address damage of incident)	7 categorical variables: Environmental, Minor Injury, Lost Time Injury, etc.	Change question to “What happened?” Change answer categories to those of Reviewer side-question “Report Type” (see below variable): __Near-Miss Event, no injury or property damage __Potential Hazard/Unsafe Act __Suggestion/Observation/Other __Injury only __Property damage only __Both Injury and Property Damage	Reporter asked to predict damage in event of near-miss. Same answer categories on Reporter and Reviewer side will enable direct comparison of both sides of the reports.
Report type (reviewer side)	6 categorical variables: 4 begin with “Near-Miss event,” yet only one is a true near-miss event.	Answer categories should reflect the actual event: __Near-Miss Event, no injury or property damage __Potential Hazard/Unsafe Act __Suggestion/Observation/Other __Injury only __Property damage only __Both Injury and Property Damage	Categories to be discrete.

Table 2. (Cont'd.)

Variable	Current format	Proposed change	Reason for change
Race*	No field exists	Addition of field to the reporter side Race: __Black __White; non-Hispanic __Hispanic __Other: __Prefer not to answer	Race provides information about elevated risk and opportunities for targeted prevention.
Gender*	No field exists	Addition of field to the reporter side: Gender: __Male __Female	Gender provides information about elevated risk and opportunities for targeted prevention.
How did the injury occur?*	To be a secondary question to revised question "Loss Potential"	Addition to reporter side: If an injury occurred, how did it happen? List of ICD9-CM codes provided for selection options	Asking the reporter to state how their injury occurred will help clarify such events in which the narrative does not explicitly describe the event.
Injury treatment*	No field exists	After the Report Type question: If injured, was the person __Treated at scene __Transported to Hospital __No treatment __Treatment not necessary	This will help to understand severity of the injury.

(ROTW) highlighting a significant topic such as communication, safe driving through intersections, or downed power lines. ROTW includes a brief segment of the Event Narrative portion of the report, directs readers to that particular report of interest, suggests reading similar reports in the system, and provides discussion points for departments so they can address this topic with their crews. The number of subscribers to ROTW has reached over 12,000. Between 2007 and 2009, IAFC traveled around the country, completing over 170 presentations about the NFFNMRS at fire departments, trade shows, meetings, training seminars, and conferences. Fire Chiefs and Training Officers have expressed the value of the NFFNMRS to the fire service:

> If reading just one of these incidents and taking just one thing from them—whether it is something as simple as a reminder to keep your seatbelt on or something as critical as having a back-up line in place—keeps a firefighter from becoming a statistic, then the program is doing invaluable justice to firefighters and emergency service personnel around the country [1].

Reports are used as educational and training tools to address the hazards seen by other firefighters:

> We responded to a gas leak at an apartment complex. On arrival we found a high-pressure gas line broken BEFORE the shut off in an underground parking area. I upgraded the response to a full first alarm. We suited up and then I remembered the "click, click, click" of a starter on a stove or water heater, like the report from the near-miss program. We evacuated the building with the gas leak then made an attempt to control the flow of gas. Remembering that report made me that much more aware of what was going on and changed my tactics a bit [1].

While comments like the ones above are illuminating, no rigorous process or program evaluation has been conducted. In addition to the data collection and quality recommendations contained herein, the system would benefit from an intense evaluation of its strengths, weaknesses, opportunities it may offer, and threats it may create—especially as they relate to its need for institutionalization.

CONCLUSION

The purpose of the NFFNMRS is to understand the circumstances of firefighter injury. The inclusion of both injury and near-miss reports in the system paints a clearer picture of how injuries occur, and of the sequence that led to the event.

As was realized in 2012 when federal funding was not available, movement of the reporting system towards a sustainable state was vital for the success of the program. In 2014, the IAFC implemented a private-public partnership to graduate the system from a federally funded grant program to a sustainable system. These efforts now create the foundation for the system to become integrated into the lives of firefighters and emergency services personnel so that

they report, read, and act on the lessons learned. This creates great potential for improving safety and reducing injuries within the fire service.

The implications for industry are significant in that the dataset is the only one of its kind for firefighters. Since near-miss systems give insight into upstream hazards that have the potential to harm workers, efforts to sustain them are critical.

ACKNOWLEDGMENTS

We would like to acknowledge the members of the NFFNMRS Working Group: Rob Clemons, Matt Tobia, Greg Lindsay, Bill Halmich, Linda Connell, Bob Meyer, Theresa Gorman, Scott Ostrovecky, Thomas Henry, Hillary Cooper, and Jenn Dietz. Also, deep appreciation for their review of this article goes to Mrs. Kelly Ameen and Mrs. Amy Tippett, previous Program Managers of the NFFNMRS. The authors thank Ms. Leah Roman, Ms. Andrea Davis, and Mr. Ravi Pandian of the Drexel University School of Public Health for their suggestions and edits to this manuscript. The views expressed in this article are expressly those of the authors and do not necessarily represent those of IAFC.

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