Fire Fighters' Assessments of Fireground Risk

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Abstract

Fire fighters are often required to work in dynamic and hazardous environments involving a high level of uncertainty. The present study investigated 110 volunteer fire fighters' assessments of levels of risk associated with a photographic depiction of a typical grassland fire situation. The fire fighters used a standard fire agency risk-rating matrix procedure requiring them to specify the severity of the hazards depicted and the probability of a mishap in order to rate overall level of risk (1 = Low; 4 = Extreme). The risk ratings made by the fire fighters varied greatly. The overall rate of agreement with the risk level rating of the situation made by a panel of expert fire officers (=1, Low) was only 27%. It seems that use of a standard risk-rating matrix procedure by fire fighters at incidents, as recommended currently by many fire agencies, is likely to result in unreliable risk assessments, at least in the absence of effective training in the risk assessment procedure. The 110 volunteers were also asked to identify the total number of potential hazards apparent in five photographs depicting different kinds of emergency incidents. Identifying more hazards was found to be associated with (a) previous personal experience of a 'near-miss'; and (b) higher levels of education. The findings imply that when faced with identical fire ground situations, individual fire fighters are likely to differ in their situational awareness of hazards and consequent risk assessments.

Introduction

Accurate risk perception on the fireground is essential for the safe practice of firefighting. Arguably many deaths on the fireground are attributable to inaccurate perception of risk. There has been no previous research into the process of firefighter risk perception. Emergency services worldwide have adopted safety programs promoting the use of "Dynamic Risk Assessment" as a means of standardising emergency responders approach to workplace risks. The emergency response environment presents many challenges to the fire fighter; it is inherently risky with changing circumstances and unpredictability often taxing the fire fighters ability to manage hazards. Fire agencies typically respond to a myriad of incidents, which requires the application of many varied skills on the part of a fire fighter. Typically a volunteer firefighter could be expected to attend structure fires, industrial fires, fires in the rural environment including grass and bush, motor vehicle and industrial accidents, chemical spills and hazardous materials incidents as well as providing a range of other community services (Clancy, 2005).

Over the last 30 years significant progress has been made in making it safer for fire fighters when responding to incidents with much effort channeled into vehicles and equipment design. Fire trucks are much different to those of 25 years ago with improvements being added that include the use of roll-over protection, low water warning alarms, heat shielding, new training programs and the use of diesel engines to prevent fuel vaporisation. With the application of these types of controls significant progress has been made in making the equipment the fire fighter uses much safer, all of these types of controls however fail to take into account the limitations of how the fire fighter thinks, what they will see as risky and how they will respond to this. There have been many examples in recent years across the world of fire fighter fatalities in the wildfire environment and more recently in Australia the deaths of five volunteer fire fighters at Linton in Victoria created much discussion on the topic of safety.

It has only been in recent years that serious consideration has been given to what are the impacts of the human element in firefighting? Understanding the human element will not solve the problem fire agencies are faced without gaining a deeper understanding of the concept of risk. What risk is can often be confusing (Clancy, 2005) and this creates a problematic situation for those trying to accurately perceive it. A hazard is *"a source of potential harm"* and risk is *"the chance of something happening that will have an impact on the objectives"* (Standards Australia, 2004, p.4). In simple terms a hazard is 'what can harm you' and risk is the 'outcome of the hazard'.

Gaining this understanding of risk is often made more difficult due to a lack of commonality of definition of

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risk across health and safety disciplines which hampers progress in the field (Viner, 2003). Another problem is that the concept of risk has been found to be subjective and contextually driven (Adams, 1995. Reason, 1997). This only serves to increase the challenges to fire agencies in ensuring that fire fighters operate in the safest possible manner. Adams (1995) suggests that *"our anticipations are formed by projecting past experience into our future. Our behavior is guided by our anticipations. If we anticipate harm, we take avoiding action."* (p. 30). As has been seen on many occasions firefighters have not anticipated harm in an accurate fashion and this has increased exposure to risk. New ways of managing risk through an accurate assessment of the level of risk have been seen as the way forward in dealing with this problem and Dynamic Risk Assessment has been introduced as one way to standardise the risk assessment process.

Traditionally fire services have relied on standard operating procedures, standing orders, training, experience and a number of other methods to aid the fire fighter in managing risk on the fire ground. The mental thinking processes taught to assist in gaining accurate situational awareness have been 'size-up' which relies heavily on human information processing mechanisms such as attention and memory. An individual's risk perception will influence what is seen to be important and reflect on how risk will therefore be rated. Risk perception has been found to be important in the size-up process in ensuring the fire fighter has an understanding of the operating environment. In recent years fire services in Britain, New Zealand and Australia have introduced a process called the dynamic risk assessment. Dynamic risk assessment, like the size-up process is applied mentally, as opposed to completing a documented risk assessment as often seen in industry. It needs to be applied as a quick mental process to allow fire fighters to think on their feet and act accordingly in the often dynamic and chaotic environment of emergency response. Dynamic risk assessment comprises of 5 key areas, the first being to 'evaluate the situation'. This requires gaining an understanding of the environment. Based on the information obtained in the first area the fire fighter will then 'select tactics' that are appropriate to the task. The third stage requires fire fighters to 'carry out a risk assessment of the tactics'. It is this third stage that the fire fighter applies such methods as the use of the 'risk rating matrix'. The fire services have adopted a 4x4 matrix that is aimed at assisting the fire fighter in determining the level of risk present and once completed allows progression to the next level. Level four requires a determination, based on the risk assessment carried out in level three, to determine 'are the risks proportional to the benefits'? If not, progression to level five is required and that is to seek to apply 'additional control measures' which may simply be to add another line of hose or utilize more firefighters.

The risk-rating matrix provides a two dimensional assessment of the situation by identifying the likelihood of something occurring and what the consequences of that occurrence might be.

In the Dynamic Risk Assessment process firefighters are asked to rate whether risks are "low"; "medium"; "high" or "extreme" depending on the likelihood of an event occurring (rated from rare to certain) and the consequences of an event occurring (rated from insignificant to catastrophic). Guidance for risk management is given depending upon whether risks are assessed as low, medium, high or extreme. (For more detailed explanation please see Materials section below).

Although emergency services have provided examples to members of situations that might be assessed as low to extreme risk there is no standardised training in the use of the risk-rating matrix. The risk assessment model assumes that there will be some consistency in firefighter's assessment of risk.

Research on risk perception in dynamic environments is scant, however existing research literature makes it clear that risk perception is likely to vary considerably between individuals (Lupton, 1999; Reason, 1997; Slovic, 2000). Under the time pressure typical of firefighting risk perception is likely to be subject to errors and biases (Slovic, 2000). Those with greater experience in a domain have been found to have more accurate perception of risk (Barnett and Breakwell, 2001), it is likely therefore that firefighter's perception of risk will vary depending upon their experience on the fire ground. Previous research also suggests that more accurate risk perception is associated with higher education (Lupton, 1999).

Although the Dynamic Risk Assessment model has been adopted by fire agencies worldwide as a means of standardizing the risk assessment process there has been no previous empirical research as to how firefighters actually use the risk-rating matrix. The aim of this research was to gather systematic data on firefighter's perception of risk. This research also tested whether firefighter's perception of risk varied depending upon education and experience of a "near-miss" on the fire ground.

Method

Participants

Participants were 110 volunteer firefighters (105 male and 5 female) ranging in age from 18 to 77 years (M=38.75, SD = 14.25). Participants varied in the number of years they had been a CFA volunteer, varying from less than one year (12%), one to two years

(7%), two to five years (26%), six to ten years (24%), ten to twenty years (14%) and more than 21 years (17%). The majority of respondents (85%) had completed primary school, high school or trade/diploma and 15% had completed a degree or postgraduate qualifications. 53% of respondents reported that they had experienced a "near-miss" or an incident which had made them behave more cautiously on the fireground and 47% had not had such an experience.

Participants were sampled from 5 of the 20 CFA regions throughout Victoria with members of 11 fire brigades represented.

Materials

Respondents were shown five photographs, which depicted a variety of fire ground scenarios (a motor vehicle accident; a house fire; a hazardous chemical spill, a grassfire and a bushfire). Respondents were also shown a picture of a firefighter working the edge of a grassfire on foot.

Table 1 provides an overview of the risk-rating matrix. The likelihood rating definitions are 'rare' where something could occur only in exceptional circumstances, 'likely' could happen, 'very likely' will probably happen and 'certain' will happen.

Table 1: Risk-rating matrix

Likelihood	Consequence			
	1	2	3	4
A	Extreme	Extreme	High	Medium
B	Extreme	High	High	Medium
C	High	High	Medium	Low
D	High	Medium	Medium	Low

Legend to Table 1:

A = Certain	1 = Catastrophic
B = Very Likely	2 = Major
C = Likely	3 = Moderate
D = Rare	4 = Insignificant

The consequence rating definitions for 'insignificant' are minor injuries requiring on scene first aid or minor equipment loss or damage. 'Moderate' may be injuries requiring first aid or medical follow-up or damage to equipment that requires repair and may result in lost time. 'Major' may be loss of consciousness to an individual, injuries requiring time off work or loss of significant equipment. "Catastrophic" is death, multiple or excessive injuries or severe loss of operational capability. If a rating of certain and extreme is calculated as seen in Table 2 (below) the firefighter should determine alternate tactics and not proceed with the proposed course of action, however if a rating of rare and insignificant is achieved the firefighter would progress as planned as a low rating has been obtained and this would only require ongoing monitoring to ensure that changes in circumstances do not change the original rating.

Table 2: Recommended tactical responses to each risk rating.

E = EXTREME :	Do not proceed/alternative tactics required
H = HIGH :	Close supervision/back up required
M = MEDIUM :	Normal procedures should suffice
L = LOW :	Monitor for escalation

In order to gain a consensus on the "correct" risk-rating 15 expert firefighters (14 male; 1 female) were asked to provide a risk-rating for the same scenario. These experts were selected on the basis of their seniority in the CFA, 40% had 10-20 years experience and 60% had greater than 21 years experience in firefighting. The consensus of the experts was that the risk-rating was "low".

Procedure

Participants were asked to attend data-gathering nights at their local station held independently of other training or activities, which the brigade might hold. Data-gathering was administered by the first author.

Participants were seated and each fire ground scenario photograph was projected onto a screen. Participants were asked to write down as many hazards/risks in the scenario that they could see or anticipate may be present in the scenario shown in the photograph. In response to the photograph of the firefighter on foot participants were asked to rate the scenario for level of risk based on the likelihood/consequences model and to provide a risk assessment (from low to extreme) using the risk-rating matrix.

Data-analysis

Risks identified in response to the five scenarios were content analysed independently by the authors and five risk categories were identified. Two separate scores for risk perception were calculated for each participant: 1. the total number of risks/hazards identified across all scenarios; and 2. the total number of times each risk category was mentioned across all scenarios. Independent samples t-tests were calculated to compare mean total scores between groups. The percentage of participants who endorsed risk-rating categories of low, medium, high and extreme was calculated.

Results

From participant responses five categories of risk were identified: 1. potential for fire/explosion; 2. potential for human error; 3. failure to follow safe procedure; 4. environmental hazards and 5. instability of the situation.

Experience of a "near-miss" and risk perception

Independent samples t-test results showed that those respondents who had experienced a "near-miss" identified a significantly greater total number of risks/hazards across all scenarios (M=32.43, SD=11.59) compared to those who had not had a "near-miss" experience (M=28.25, SD=7.7) ($t(108) = 2.24$, $p < .05$). Participants who had experienced a "near-miss" were also significantly more likely to identify failure to follow procedure (M=2.77, SD=1.20) as a risk compared to those who had not had a "near-miss" experience (M=2.25, SD=1.18) ($t(108) = 2.4$, $p < .05$) and were significantly more likely to identify instability of the situation as a risk (M=4.24, SD =.97 compared to M=3.86, SD=1.02; $t(108) = 1.06$, $p < .05$).

Tertiary education and risk perception

Independent samples t-test results showed that participants with a tertiary education also identified a significantly greater total number of risks/hazards across all scenarios (M= 37.75, SD=11.34) compared to those without a tertiary education (M=29.21, SD= 9.41) ($t(108) = 3.25$, $p < .05$). Participants with a tertiary education also identified a significantly greater total number of risk categories across all five scenarios (M=17.81, SD=3.44) compared to those without a tertiary education (M=15.95, SD=2.66) ($t(108) = 2.05$, $p < .05$).

Risk-rating matrix

Of the 16 possible categories of response provided by the 4 x 4 risk-rating matrix respondents endorsed eleven. 2% rated the risk as "extreme"; 23% rated the risk as "high"; 47% rated the risk as "medium" and 27% rated the risk as "low". The correspondence between expert ratings of risk and the samples rating of risk was therefore only 27%.

Discussion

The only consensus in the limited empirical research into the processes of risk perception is that perceptions of risk, given the same scenario, are likely to vary widely between individuals (Lupton, 1999; Reason, 1997; Slovic, 2000). This research confirms that conclusion.

Findings suggest that the experience of a "near-miss" on the fire ground has a substantial effect in increasing awareness of risk. Firefighters who had experienced a "near-miss" had a greater perception of risk and had a more accurate comprehension of the elements in the environment and how they interacted. This is consistent with previous findings (Barnett & Breakwell, 2001) that those with greater experience in a domain are likely to show more accurate risk perception. Obviously it is not possible to put firefighters at risk in order to train them to become more aware of risk, however this finding suggests that training should be as in-vivo as possible and that training should include greater emphasis on an understanding of "near-miss" situations. Greater exposure in training to other firefighter's experiences of "near-misses" could also improve firefighter's risk perception.

Participants with tertiary education were found to be able to identify a significantly higher number of risks across all scenarios and a higher number of categories of risk across all scenarios. This indicates that the perception of risk was higher and would lead to more accurate situational awareness. This is consistent with the findings of Lupton (1999) that higher education is associated with more accurate perception of risk. By having a greater understanding of both actual and potential risks the firefighters in this category are much better positioned to assess risk in a more accurate fashion. Given that CFA volunteers are made up of a broad cross section of the community it would be both unreasonable and impractical to suggest that all volunteers must have a higher level of education in order to make firefighters safer. CFA is bound by the demographics of the communities in which they are based and these types of educational opportunities are not always available due to many varied circumstances.

Substantial variation was found in the application of the risk-rating matrix and in how participants scored the level of risk they perceived with participants ranging from "low" to "extreme" in their risk ratings. As training and experience varies between individual firefighters it is reasonable to expect that perceptions of risk will also vary. The extent of the variation found in firefighters risk-ratings, and the lack of concordance with expert risk-ratings, suggests that the risk-rating matrix is not a reliable tool to assist in accurate risk assessment.

This presents a problem to fire agencies and firefighters in trying to gain an accurate assessment of risk both present and anticipated. If a firefighter identifies a risk and rates this as high there is no guarantee that another firefighter will obtain the same rating or in fact identify the same risk. Use of the risk-rating matrix as a means to improve firefighter's risk assessment is potentially unreliable and to rely solely on its application will mean that there are potential gaps

in the rating to be achieved. Providing training in the use of the matrix may be one way of increasing accuracy, however the evidence is that training in risk assessment does no more than provide a systematic approach to assessing risk and that training efforts are better put into training actually on the fireground (Clancy, 2005). The results of this research suggest that fire agencies should be cautious about the use of Dynamic Risk Assessment as a means of improving firefighters' risk perception on the fireground. At the very least, it would seem that firefighters need to be exposed to many more examples and expert opinions regarding risk assessment before a consensus regarding risk-rating is likely to achieved.

Recommendations

Both understanding what risk is and how it should be assessed given the current tools available present many challenges to fire agencies. Our findings suggest that the risk-rating matrix and the process of Dynamic Risk Assessment needs further development if it to be of practical use in improving the accuracy of firefighter risk perception and firefighter safety in general.

The following recommendations are made:

1. A standardised set of scenarios based on expert firefighter risk-ratings should be developed as a training tool to provide examples to support firefighters risk assessments.
2. Review risk assessments in as close to real life scenarios as possible. Greater use should be made of "hot fire" training in a controlled environment to expose firefighters to in-vivo risk assessments.
3. Greater use should be made in firefighter training of case studies of "near-misses" as an aid to risk-rating assessments.

Further research into the variables which impact on risk perception on the fireground needs to be undertaken, particularly in regards to those factors which have greatest salience in impacting on firefighter's risk perception on the ground.

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