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HETA 94-0390-2822
Anaheim Fire Department
Anaheim, California

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PREFACE

The Hazard Evaluations and Technical Assistance Branch (HETAB) of the National Institute for Occupational Safety and Health (NIOSH) conducts field investigations of possible health hazards in the workplace. These investigations are conducted under the authority of Section 20(a)(6) of the Occupational Safety and Health (OSHA) Act of 1970, 29 U.S.C. 669(a)(6) which authorizes the Secretary of Health and Human Services, following a written request from any employer or authorized representative of employees, to determine whether any substance normally found in the place of employment has potentially toxic effects in such concentrations as used or found.

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ACKNOWLEDGMENTS AND AVAILABILITY OF REPORT

This report was prepared by Allison Tepper and Charles Mueller of HETAB, Division of Surveillance, Hazard Evaluations and Field Studies (DSHEFS) and Joseph J. Hurrell, Jr., Office of the Director, DSHEFS. Daehee Kang, former HETAB medical officer, was the project officer who led the evaluation. Douglas Trout, MD, reviewed and interpreted the electrocardiograms. Desktop publishing was performed by Pat McGraw. Review and preparation for printing were performed by Penny Arthur.

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Highlights of the NIOSH Health Hazard Evaluation Heart Problems, Mental Health, and Job Stress in the Anaheim Fire Department

NIOSH responded to a request for a health hazard evaluation from the International Association of Fire Fighters. The requestors asked NIOSH to learn if job stressors were related to heart problems and psychologic changes among fire service personnel.

What NIOSH Did

- # We reviewed EKGs (electrocardiograms) done during annual physical exams.
- # We handed out a questionnaire to learn about job stressors and mental health.

What NIOSH Found

- # No one reported having depressive symptoms or anxiety “very often.”
- # Depressive symptoms were related to uncertainty about career, lack of support from coworkers, disharmony among coworkers, work effort, self-reported participation in fires with multiple burn victims, and years in the fire department.
- # Anxiety was related to uncertainty, disharmony, work effort, and self-reported hazardous materials exposure and participation in fires with multiple burn victims.
- # The EKGs of 48 participants were rated as abnormal by the NIOSH physician. Sinus arrhythmia, the most common abnormality, was found in 23 participants. Sinus arrhythmia is a normal variant, and is harmless in most people.

What Anaheim Fire Department Managers Can Do

- # Provide mandatory annual medical evaluations and periodic physical examinations following the NFPA Standard on Medical Requirements.
- # Ensure that EKGs are reviewed by a physician, and that the medical record includes the physician’s interpretation. Provide appropriate medical follow-up for findings of clinical significance.
- # Provide a mandatory wellness/fitness program to reduce risk factors for cardiovascular disease and improve cardiovascular capacity.
- # Implement a program to reduce job stress.

What Anaheim Fire Department Employees Can Do

- # Participate in annual medical evaluations and periodic physical examinations, and a wellness/fitness program offered by the Fire Department.
- # Report concerns about job stressors to your supervisor, and get involved in work stress prevention programs.



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**Health Hazard Evaluation Report 94-0390-2822
Anaheim Fire Department
Anaheim, California
September 2000**

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SUMMARY

On August 24, 1994, the National Institute for Occupational Safety and Health (NIOSH) received a request for a health hazard evaluation (HHE) from the International Association of Fire Fighters (IAFF) Local 2899. Local 2899 represents fire service personnel in the Anaheim Fire Department (AFD) in Anaheim, California. The request concerned psychologic changes and cardiac abnormalities possibly related to job stress from long work hours, night work, sleep deprivation, and other job stressors.

On November 16, 1994, NIOSH investigators met with AFD and IAFF representatives to discuss the HHE request and to visit three fire stations. The meeting and visits were held for NIOSH investigators to learn about AFD work practices and work organization. On May 31, 1995, NIOSH representatives returned to Anaheim to obtain electrocardiogram (EKG) results from annual physical examinations and to carry out a health survey.

NIOSH investigators conducted a questionnaire survey of full-time AFD employees. Participants filled out a questionnaire about personal characteristics, job history, medical history, cardiovascular symptoms, mental health (including depressive symptoms and anxiety), and job stress. For all study participants, NIOSH investigators obtained EKG results from the most recent annual physical examinations. A NIOSH occupational physician read the EKGs using standard clinical criteria. We did statistical modeling to learn whether job stressors were related to depressive symptoms, anxiety, and sinus arrhythmia.

Two hundred ten (81%) of 260 full-time employees participated in the questionnaire survey. For this evaluation, we analyzed the data for the 196 participants who worked in one of the 10 fire stations. All but three participants were male, and the majority (75%) were in their 30s and 40s. Most participants were in one of the following four job titles: firefighter (66 persons, 34%), firefighter/paramedic (31 persons, 16%), fire engineer (31 persons, 16%), and fire captain (30 persons, 15%).

On average, participants reported that depressive symptoms occurred “occasionally” during the past month. None of the participants reported having depressive symptoms “very often.” Depressive symptoms were related to uncertainty about career, lack of support from coworkers, disharmony among coworkers, work effort, participation in fires with multiple burn victims, and years in the fire department.

On average, participants reported that anxiety symptoms occurred “occasionally” during the past month. None of the participants reported having anxiety “very often.” Anxiety was related to uncertainty about career, lack of support from coworkers, disharmony among coworkers, work effort, self-reported hazardous materials exposure, and participation in fires with multiple burn victims.

EKGs were available for 179 of the 196 participants working in a fire station. The NIOSH physician reported that 73% (131 persons) were within normal limits and 27% (48 persons) were abnormal. The NIOSH physician noted several EKG abnormalities; the most common was sinus arrhythmia, occurring in 23 participants. The only other abnormalities noted in more than five participants were sinus bradycardia (11 persons) and conduction delay (10 persons). Due to the small number of participants with any single condition other than sinus arrhythmia, we focused further analysis on this finding. We did not find a meaningful linear relationship (that is, more job stress associated with more sinus arrhythmia) between sinus arrhythmia and any of the job stressors studied.

Our evaluation found neither severe psychological problems nor a consistent pattern of clinically significant cardiac arrhythmias. We did, however, find evidence that certain aspects of the job affected the psychologic well-being of employees. These included the job stressors of uncertainty, disharmony, and work effort, and involvement in specific critical incidents, including fires with multiple burn victims and self-reported hazardous materials exposure. Recommendations are offered to ensure that Anaheim Fire Department personnel are receiving appropriate medical surveillance and to address concerns about job stress.

KEYWORDS: SIC 9224 (Fire Protection), job stress, cardiovascular disease, arrhythmia, anxiety, depressive symptoms, depression

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INTRODUCTION

On August 24, 1994, the National Institute for Occupational Safety and Health (NIOSH) received a request for a health hazard evaluation (HHE) from the International Association of Fire Fighters (IAFF) Local 2899. Local 2899 represents fire service personnel in the Anaheim Fire Department (AFD) in Anaheim, California. The request concerned psychological changes and cardiac abnormalities possibly related to job stress from long work hours, night work, sleep deprivation, and other job stressors.

On November 16, 1994, NIOSH investigators met with AFD and IAFF representatives to discuss the HHE request and to visit three fire stations. The meeting and visits were held for NIOSH investigators to learn about AFD work practices and work organization. On May 31, 1995, NIOSH representatives returned to Anaheim to obtain electrocardiogram (EKG) results from annual physical examinations and to carry out a health survey.

BACKGROUND

At the time of the NIOSH investigation, the AFD had 260 full-time employees. AFD facilities comprised administrative offices, a dispatch center, a training facility, and 10 fire stations. These stations housed 12 engine companies (nine of which were paramedic) and five truck companies. The AFD served more than 293,000 people in a 49.5-square-mile area. Fire service personnel responded to more than 23,000 emergency services calls per year. The AFD classified these calls as medical (61%), false alarms (22%), service (8%), fire-related (6%), and hazardous conditions (3%). AFD employees also conducted approximately 14,000 fire inspections and more than 6,000 fire hydrant tests.

METHODS

We conducted a questionnaire survey of full-time AFD employees. We handed out the questionnaire to employees who reported to a central location in groups of 20-40, and we were present to answer questions and assure that questionnaires were completed correctly. Questionnaires were left at the site for distribution to employees not present during the NIOSH visit; employees who completed the forms mailed them to NIOSH.

The questionnaire addressed personal characteristics, job history, medical history, cardiovascular symptoms, mental health (including depressive symptoms and anxiety), and job stress. Questions about mental health and job stress were from the NIOSH generic job stress questionnaire.¹

The health outcomes we considered were depressive symptoms and anxiety. Individual questions (described below) used to measure these outcomes were rated on a five-point scale, where 1=never and 5=very often. Responses to individual questions were summarized to create a scale for each of these outcomes. We used factor analysis to identify items for each scale, then computed coefficient alpha to describe how well the items in each scale were related to each other. Scales with an alpha coefficient of at least 0.70 are considered to be reliable for the type of study we did.²

- The scale for depressive symptoms included seven items. Respondents were asked how they experienced each of the following during the past month: “could not shake off the blues,” “trouble keeping my mind on what I was doing,” “felt depressed,” “felt fearful,” “felt lonely,” “felt sad,” and “talked less than usual.” The alpha was 0.89.

- The scale for anxiety included 10 items. Respondents were asked how often they experienced each of the following during the past month: “flushing of your face,” “dry mouth,” “clear your throat often,” “choking lump in your throat,” “tight and tense muscle,” “headache,” “trembled hand,”

“damp and clammy hand,” “poor appetite,” and “sleep was restless.” The alpha was 0.79.

The general job stressors we considered (described below) included uncertainty, disharmony, task control, job control, work effort, work threat, work variance, and mental demands. Individual questions used to measure these stressors were rated on a scale of 1-5 (for all except mental demands, which was rated on a 1-4 scale), and responses were summarized to create a scale for each stressor, as above.

- The scale for uncertainty included six items. Respondents were asked whether they agreed or disagreed with each of the following items: “certain about what my future career picture looks like,” “certain of the opportunities for promotion and advancement,” “certain that I am valued by the staff members,” “certain that the staff members will help to solve problems,” “certain that the staff will help and protect me if I am injured on duty,” and “certain that staff will help me achieve my goals.” The alpha was 0.82.

- The scale for disharmony included seven items. Respondents were asked whether they agreed or disagreed with each of the following items: “harmony within my fire station on my shift,” “harmony within my fire station on all shifts,” “clashes between units at my station,” “clashes between crew and staff,” “disputes between my station and other stations,” “other stations create problems for my station,” and “problems working with other city fire units.” The alpha was 0.75.

- The scale for task control included two items. Respondents were asked how much influence they had over each of the following items: “the amount of work” and “the pace.” The alpha was 0.77.

- The scale for job control included three items. Respondents were asked how much influence they had over each of the following items: “decisions concerning which individuals...do which tasks,” “policies, procedures that affect your unit,” and

“work and work-related factors.” The alpha was 0.79.

- The scale for work effort included four items. Respondents were asked how often the job required them to do each of the following items: “work very fast,” “work very hard,” “think and react very fast,” and “be alert continuously.” The alpha was 0.73.

- The scale for work threat included two items. Respondents were asked how often the job exposed them to each of the following items: “threat of physical harm or injury” and “threat of violence.” The alpha was 0.80.

- The scale for work variance included four items. Respondents were asked how often each of the following happened: “great deal of work,” “marked increase in the workload,” “marked increase in the amount of concentration,” and “receive extra projects.” The alpha was 0.76 .

- The scale for mental demands included three items. Respondents were asked whether they agreed or disagreed with each of the following items: “job requires a great deal of concentration,” “job requires me to remember many different things,” and “keep my mind on my work at all times while on call.” The alpha was 0.77.

We also considered job stressors specific to firefighters and paramedics, that is involvement in certain types of critical incidents. These included fires with multiple burn victims, injury of co-workers on duty, hazardous materials and infectious agents exposures, motor vehicle accidents with fatalities, sudden infant death, and friends or relatives as victims, among others.³ Participants were asked whether they had experienced each of these events during the past year. Independent, objective information was not obtained.

NIOSH investigators obtained EKG (electrocardiogram) results from the most recent annual physical examinations for all study

participants. These EKGs were done under contract to the AFD; a machine reading classified the results as within normal limits, abnormal, or borderline. A NIOSH occupational physician, who is also certified in internal medicine, read the EKGs using standard clinical criteria.⁴ EKG abnormalities were classified as sinus arrhythmia, sinus bradycardia, conduction delay, ischemia, arrhythmia, hypertrophy, right axis deviation, and left axis deviation.

We did statistical modeling to learn whether job stressors were related to depressive symptoms, anxiety, and sinus arrhythmia. We used one type of model, linear regression, for the depressive symptoms and anxiety outcomes and used another type of model, logistic regression, for the sinus arrhythmia outcome. The statistical significance of the relationship is gauged by the p value. A p value less than or equal to 0.05 is considered statistically significant and indicates that one can be confident that a relationship exists between the stressor and the outcome. For each outcome, we began our modeling by examining the relationship between that outcome and the job stressors, taken one at a time, while taking into account nonoccupational factors (age, race, marital status, primary responsibility for child care). Next, any job stressors which appeared to be related to the outcome in our initial models were studied further in models that evaluated their combined effects.

RESULTS

Two hundred ten (81%) of 260 full-time employees participated in the questionnaire survey. One hundred ninety-seven participants worked in one of the 10 fire stations, with the rest working in administrative offices, the dispatch center, training, and fire prevention. The following results include only the 196 assigned to a fire station. All but three were male. Ten % (20 persons) were in their 20s, 47 % (93 persons) in their 30s, 28% (54 persons) in their 40s, and 15% (29 persons) in their 50s. Participants worked an average of 14 years in the AFD (range: 10 months - 32 years). Seventy-eight %

of participants were in one of the following four job titles: firefighter (66 persons, 34%), firefighter/paramedic (31 persons, 16%), fire engineer (31 persons, 16%), and fire captain (30 persons, 15%). Other job titles with 10 or more participants each were engineer/paramedic and fire captain/paramedic.

The average and range for the job stressor scales is shown in Table 1. Twenty-eight % (54 persons) agreed moderately or strongly that they had uncertainty about career and support from coworkers and had disharmony among coworkers. While 15% (29 persons) reported little or very little task control, 53% (104 persons) reported little or very little job control. Seventy-four % (145 persons) reported experiencing hard or fast work often or very often, 68% reported on-the-job-threats often or very often, and 48% (93 persons) reported increased work load or need for concentration often or very often. Eighty-three % (160 persons) strongly agreed about the presence of mental demands.

Information about involvement in critical incidents is shown in Table 2. The frequency of encountering these incidents in the past year was high, ranging from 36% (sudden infant death, fire with multiple burn victims) to 98% (drug overdose).

The mean score for depressive symptoms was 1.86, that is, on average, participants reported that depressive symptoms occurred “occasionally” during the past month. Individual scores ranged from 1.0-4.4; none of the participants reported having depressive symptoms “very often.” In the final statistical model, depressive symptoms were related to uncertainty ($p<0.01$), disharmony ($p=0.04$), work effort ($p=0.03$), fire with multiple burn victims ($p<0.01$), and years in the fire department ($p<0.01$). When we included the nonoccupational factors in the statistical model, these findings were very similar.

The mean score for anxiety was 1.9, that is, on average, participants reported that anxiety symptoms occurred “occasionally” during the past month. Individual scores ranged from 1.0 to 3.3; none of the

participants reported having anxiety “very often.” In the final statistical model, anxiety was related to uncertainty ($p < 0.01$), disharmony ($p = 0.02$), work effort ($p < 0.01$), hazardous materials exposure ($p = 0.01$), and fire with multiple burn victims ($p = 0.06$). When we included the nonoccupational factors in the statistical model, these findings were very similar.

EKGs were available for 179 of the 196 participants working in a fire station. According to the machine reading of the EKG, 37% (67 persons) were within normal limits, 27% (48 persons) were abnormal, 35% (63 persons) were borderline, and 1% (one person) had inadequate data. The NIOSH physician reported that 73% (131 persons) were within normal limits and 27% (48 persons) were abnormal. Of those classified as normal by the machine reading, 87% were rated similarly by the NIOSH physician. In contrast, of those classified as abnormal by the machine reading, 54% were rated similarly by NIOSH physician. The NIOSH physician noted several EKG abnormalities; the most common was sinus arrhythmia, occurring in 23 participants. The only other abnormalities noted in more than five participants were sinus bradycardia (11 persons) and conduction delay (10 persons). Due to the small number of participants with any single condition other than sinus arrhythmia, we focused further analysis on this finding. We did not find a meaningful linear relationship (that is, more job stress associated with more sinus arrhythmia) between sinus arrhythmia and any of the job stressors studied.

DISCUSSION

The initial concerns raised in the HHE request related to cardiovascular effects, specifically cardiac arrhythmias, and psychologic changes among AFD personnel. Our evaluation found neither severe psychological problems nor a consistent pattern of clinically significant cardiac arrhythmias. We did, however, find evidence that certain aspects of the job affected the psychological well-being of employees.

The fire service is recognized as a high stress job, as firefighters and emergency medical personnel routinely are placed in demanding situations and high-risk environments.⁵ In addition, fire service employees typically work long hours involving complex shift schedules. While much attention has been paid to the psychological effects of acute stressors in traumatic fire and rescue responses (critical incidents), some evidence suggests that chronic stressors such as sleep disruption, concerns about wages and benefits, labor/management issues, and personal safety, among others, may be more important elements of perceived stress in fire service personnel.⁶ We found that both types of job stressors were predictors of depressive symptoms and anxiety.

Job stresses, in addition to exposure to hazardous agents such as carbon monoxide and the physical requirements of the work, may pose a risk for the development of cardiovascular disease.⁷ No studies, however, have looked at the long-term effects of job stress on cardiovascular disease in firefighters. Several different types of studies have been done to look in general at the association between firefighting and cardiovascular disease; most have been studies of firefighter deaths. As discussed in the review by Melius, some studies have found an increased risk of cardiovascular deaths in firefighters, but others have not.⁷ The differences may be due to varying study methods and to the difficulties inherent in epidemiologic studies that compare the mortality experience of working populations to that of the general population.^{7,8}

Arrhythmia is a general term that includes many specific abnormalities of heart rhythm, including normal variants. Some are serious, others are not. Sinus arrhythmia, the condition we found in the greatest number of participants usually is a normal variant.⁹ Sinus arrhythmia is one of the most common arrhythmias and, in the majority of people, is harmless.¹⁰ While the NIOSH physician also found other types of electrocardiogram abnormalities, their relative frequency did not appear to be unusual. The apparent discrepancy between the machine readings and those of the NIOSH physician is, in part, due to differences in criteria

used to define abnormality. It is likely that the machine is set up to pick up any aberration in cardiac electrical activity so that an individual can be referred to a physician for followup. Many of those EKGs identified as abnormal by the machine reading may turn out not to represent a clinically significant condition, but the machine reading would presumably have a low likelihood of missing someone who does have a clinically significant condition. Other factors contributing to the discrepancy could not be determined.

Researchers have looked at the effects of various types of stress on sinus arrhythmia, and have used specific characteristics of sinus arrhythmia as an index of stress.^{11,12} The clinical significance of this approach, however, and its use in explaining how stress effects cardiovascular disease, particularly in healthy persons, however, is not well established. We did not find that the occurrence of sinus arrhythmia was related to any of the stressors we measured in AFD personnel.

CONCLUSIONS

Our evaluation found neither severe psychological problems nor a consistent pattern of clinically significant cardiac arrhythmias among Anaheim fire service personnel. We did find, however, evidence that certain aspects of the job affected the psychologic well-being of employees. These included the job stressors of uncertainty, disharmony, and work effort, and involvement in specific critical incidents, including fires with multiple burn victims and hazardous materials exposure.

RECOMMENDATIONS

The following recommendations address health and safety in the fire service generally. These recommendations should be reviewed to assess whether current AFD programs are consistent.

1. Fire fighters should have mandatory annual medical evaluations and periodic physical examinations to determine their medical ability to perform duties without presenting a significant risk to the safety and health of themselves or others.

Guidance regarding the content and frequency of periodic medical evaluations for fire fighters can be found in NFPA 1582, Standard on Medical Requirements for Fire Fighters and Information for Fire Department Physicians,¹³ and in the report of the IAFF/International Association of Fire Chiefs (IAFC) wellness/fitness initiative.¹⁴ These recommendations have not been evaluated by NIOSH, but represent published research or of consensus votes of Technical Committees of the National Fire Protection Association or labor/management groups within the fire service.

EKGs machine-read as abnormal or borderline should be reviewed by a physician, and the medical record should include the physician's interpretation. Findings of clinical significance should trigger appropriate medical follow-up.

2. The Fire Department should offer a mandatory wellness/fitness program for fire fighters to reduce risk factors for cardiovascular disease and improve cardiovascular capacity.

NFPA 1500, Standard on Fire Department Occupational Safety and Health Program, requires a wellness program that provides health promotion activities for preventing health problems and enhancing overall well-being.¹⁵ In 1997, the IAFF and the IAFC began an initiative to improve fire fighter quality of life and maintain physical and mental capabilities of fire fighters.¹⁴ Ten fire departments across the United States joined this effort to pool information about their physical fitness programs and to create a practical fire service program. They produced a manual and a video detailing elements of such a program. This program can serve as a model for a comprehensive wellness program.

3. The Fire Department should implement a program to reduce job stress. Generally, a program that addresses organizational change and stress management is most useful for preventing stress at work.¹⁶ Before a program is established, it is essential to raise awareness about job stress, secure management commitment and support, incorporate employee involvement, and provide for appropriate technical support (through training of existing staff, or the hiring of consultants). The process for stress prevention programs involves three steps: problem identification, intervention, and evaluation. Job stress prevention should be seen as a continuous process.

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TABLE 1
 Summary of General Job Stressors in Anaheim Fire Department Personnel^a
 May 1995
 HETA 94-0390-2822

Job Stressor	Score	
	Average	Range
<u>Uncertainty</u> about future, advancement opportunities, value to coworkers, support from coworkers ^b	2.9	1.0 - 5.0
<u>Disharmony</u> between coworkers at my station and with workers at other stations ^b	2.5	2.4 - 4.6
<u>Task control</u> , that is, influence over amount or pace of work ^c	3.3	1.0 - 5.0
<u>Job control</u> , that is, influence of job assignments, policies, procedures ^c	2.5	1.0 - 5.0
<u>Work effort</u> , that is, job often requires me to work very hard or fast, think and react fast, and be continuously alert ^d	3.8	2.0 - 5.0
<u>Work threat</u> , that is, job exposes me to the threat of physical harm or injury, or violence ^d	3.6	1.5 - 5.0
<u>Work variance</u> , that is, there is often a great deal of work or a marked increase in workload or in the concentration needed for the job ^d	3.3	1.3 - 5.0
<u>Mental demands</u> , that is, requires a lot of concentration or remembering many things ^e	1.3	1.0 - 4.0

^aBased on a questionnaire survey of 196 fire service personnel

^bScale ranged from 1 (strongly disagree) - 5 (strongly agree)

^cScale ranged from 1 (very little) - 5 (very much)

^dScale ranged from 1 (rarely) - 5 (very often)

^eScale ranged from 1 (strongly agree) - 4 (strongly disagree)

TABLE 2
 Summary of Self-reported Fire Service Job Stressors in Anaheim Fire Department Personnel^a
 May 1995
 HETA 94-0390-2822

Stressor	Persons Having the Experience at Least Once in the Past Year		Stressor	Persons Having the Experience at Least Once in the Past Year	
	No.	%		No.	%
Drug overdose	192	98	Homicide	112	57
CPR with family present	182	93	Victim resembles self or kin	104	54
Failed resuscitation	181	92	Assaulted by patient	97	50
Seriously injured child	169	87	Failed resuscitation on child	97	49
Injury of coworker on duty	170	87	Sexual assault	89	45
Hazardous materials exposure	167	86	Victim is friend of relative	77	39
Suicide	155	79	Sudden infant death	70	36
Infectious agents exposure	148	77	Fire with multiple burn victims	71	36
Fatal motor vehicle accident	144	73			

^aBased on a questionnaire survey of 196 fire service personnel

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