Blood Pressure in Firefighters, Police Officers, and Other Emergency Responders

Stefanos N. Kales[1,2], Antonios J. Tsismenakis[1–3], Chunbai Zhang[1] and Elpidoforos S. Soteriades[1,4]

Elevated blood pressure is a major risk factor for cardiovascular morbidity and mortality. Increased risk begins in the prehypertensive range and increases further with higher pressures. The strenuous duties of emergency responders (firefighters, police officers, and emergency medical services (EMS) personnel) can interact with their personal risk profiles, including elevated blood pressure, to precipitate acute cardiovascular events. Approximately three-quarters of emergency responders have prehypertension or hypertension, a proportion which is expected to increase, based on the obesity epidemic. Elevated blood pressure is also inadequately controlled in these professionals and strongly linked to cardiovascular disease morbidity and mortality. Notably, the majority of incident cardiovascular disease events occur in responders who are initially prehypertensive or only mildly hypertensive and whose average premorbid blood pressures are in the range in which many physicians would hesitate to prescribe medications (140–146/88–92).

Laws mandating public benefits for emergency responders with cardiovascular disease provide an additional rationale for aggressively controlling their blood pressure. This review provides a background on emergency responders, summarizes occupational risk factors for hypertension and the metabolic syndrome, their prevalence of elevated blood pressure, and evidence linking hypertension with adverse outcomes in these professions. Next, discrepancies between relatively outdated medical standards for emergency responders and current, evidence-based guidelines for blood pressure management in the general public are highlighted. Finally, a workplace-oriented approach for blood pressure control among emergency responders is proposed, based on the seventh report of the Joint National Committee on Prevention, Detection, Evaluation, and Treatment of High Blood Pressure.

Am J Hypertens 2009; **22**:11-20 © 2009 American Journal of Hypertension, Ltd.

Given the physical and psychological rigors of firefighting, law enforcement, and emergency medical services (EMS), elevated blood pressure among emergency responders presents a number of clinical and public health concerns. Unquestionably, elevated blood pressures convey increased risk for cardiovascular-related morbidity and mortality.[1–3] Also, strenuous work circumstances can precipitate on-duty cardiovascular disease events among hypertensive emergency responders. Additionally, such acute cardiovascular events can potentially jeopardize co-workers' and public safety by suddenly incapacitating the affected emergency responder. Moreover, state and federal laws unique to emergency responders and providing them with benefits when they develop cardiovascular disease create additional public health and policy rationales for improving blood pressure control among these workers.

This review provides a brief background on emergency responders, summarizes some of their occupational risk factors for hypertension and the metabolic syndrome, their prevalence of elevated blood pressure, and provides evidence linking hypertension with adverse outcomes in these professions. Next, discrepancies between relatively outdated medical standards for emergency responders and current, evidence-based guidelines for blood pressure management in the general public are highlighted. Finally, we suggest a workplace-oriented approach for blood pressure control among emergency responders, using the seventh report of the Joint National Committee on Prevention, Detection, Evaluation, and Treatment of High Blood Pressure.[3]

The review aims to provide the most comprehensive and balanced review of the "state of the science" on all three groups of emergency responders with respect to hypertension. To date, however, significantly more cardiovascular research has been focused on firefighters than on police officers. Although such investigations are more limited regarding EMS personnel. Thus, the balance of information provided in our review reflects the relative amount of science available on each group, as opposed to any intentional emphasis by the authors.

EMERGENCY RESPONDERS

In this review, the term "emergency responders" refers to firefighters, police officers, and EMS personnel. Together, these professions employ about 2.1 million persons, or almost 1.5% of the US workforce.[4–6] Although the three categories of

[1]Department of Environmental Health, Environmental & Occupational Medicine & Epidemiology (EOME), Harvard School of Public Health, Boston, Massachusetts, USA; [2]Employee & Industrial Medicine, The Cambridge Health Alliance, Harvard Medical School, Cambridge, Massachusetts, USA; [3]Boston University School of Medicine, Boston, Massachusetts, USA; [4]Department of Occupational and Environmental Medicine, Cyprus Institute of Biomedical Sciences (CIBS), Nicosia, Cyprus. Correspondence: Stefanos N. Kales (skales@challiance.org or skales@hsph.harvard.edu)

responders have somewhat unique workplace exposures and experiences, it is clear that they also share many common circumstances relevant to their emergency duties and the organization of their public safety work. Moreover, the significant medical and physical requirements related to the selection of candidates and their hiring process, as well as legislated disability provisions, are similar for all three categories. Likewise, all three categories require similar levels of cardiovascular fitness, have many common physical demands during emergency response duties, and often encounter similar challenging psychological stressors. Finally, all three professions continue to be comprised predominantly of men, and research on these groups has utilized mostly men as subjects.

Typically, the work of emergency responders involves long stretches of relative inactivity, punctuated by unpredictable and stressful bursts of high intensity, and potentially life-threatening activities.[7] The latter produce adrenergic surges and higher demands on the cardiovascular system.[8,9] Evidence that such strenuous stimuli can trigger acute cardiovascular disease events has been documented in a variety of contexts.[10–12] In this regard, additional evidence for the precipitation of cardiovascular events has come directly from epidemiologic investigations of on-duty coronary heart disease (CHD) events among firefighters.[13–15] For example, although fire suppression (activities related to mitigating and extinguishing fires) represents only 1–5% of annual professional time among firefighters, fire suppression accounts for over 30% of on-duty CHD deaths. Thus, the relative risk of on-duty events during fire suppression is 10–100 times higher than that of nonemergency duties. Likewise, alarm response, which results in elevated heart rates and blood pressure through a fight-or-flight response, carries risks of on-duty CHD events on the order of 3–15 times higher than nonemergency duty.[13–15] Accordingly, cardiovascular disease events account for about 45% of on-duty deaths among firefighters, 22% among police, and 11% among EMS workers, whereas the corresponding figures for construction laborers and all occupations combined are 10 and 15%, respectively.[13,16,17] The lower figures for EMS workers probably reflect their younger age distribution and that the relative risk of a cardiovascular event during EMS calls has been found to be consistently lower than during fire suppression or responding to an alarm.[13–15]

Although proportionate on-duty cardiovascular mortality is clearly higher among firefighters than other occupations, evidence for a definitive increase in lifetime risk of cardiovascular disease is lacking.[18] On the other hand, there have been several studies suggesting higher rates of cardiovascular morbidity among law enforcement officers compared to the general population.[19] It should be noted that epidemiologic studies comparing occupationally active cohorts to the population at large are always limited by the "healthy worker effect," especially when emergency responders are subjected to medical and physical exclusion criteria at job entry.[18] The healthy worker effect produces lower than expected morbidity and mortality due to the relative exclusion of persons with baseline disease and disability from the cohort.

It is also of paramount importance in considering the clinical and public health aspects of hypertension among emergency responders to understand special legislative provisions related to emergency responders and cardiovascular disease. Whether or not the scientific evidence is definitive, several types of legislation in the United States legally "presume" that emergency responders have an elevated risk of cardiovascular disease. More than 35 US states have passed laws entitling firefighters with heart disease to receive publicly funded death and/or disability awards.[14,20] In general, this type of benefit legislation creates the legal presumption that the affected worker's disease is causally related to occupational factors even in the presence of familial and/or other nonwork-related risk factors for cardiovascular disease. Eleven states explicitly mention hypertension as warranting the award of such benefits. In addition, at least 18 US States have passed similar legislation for cardiovascular disease in police officers.[20] Finally, the recently enacted Hometown Heroes Survivor Benefits Act provides federal aid to the families of firefighters, police officers, and EMS workers who die of on-duty heart attack or stroke.[21]

OCCUPATIONAL RISK FACTORS FOR ELEVATED BLOOD PRESSURE, METABOLIC SYNDROME, AND CARDIOVASCULAR DISEASE

Occupational factors likely to contribute to increased cardiovascular disease risk among emergency responders include: a lack of regular exercise, poor nutrition (sometimes attributable to limited opportunities for healthy food choices while on-duty), shift work (sleep disruption/deprivation), noise exposure, posttraumatic stress disorder (PTSD), and imbalance between job demands and decisional latitude.[22–28] These occupational risk factors are summarized in **Table 1**.

Irregular physical exertion

It is widely accepted that the lack of regular physical exercise leads to increased risk for both excess weight gain and cardiovascular disease. In addition, sedentary persons are at increased risk for acute cardiovascular events during activities requiring considerable physical exertion.[10,11,13–15]

Unhealthy diet and shift work

Shift work disrupts normal sleep and dietary patterns.[24,29,30] Emergency responders commonly perform two 24-h shifts per week or staggered rotating shifts.[24,31] Moreover, many spend their days off working second jobs or overtime and may thereby experience chronic sleep deprivation. In addition,

Table 1 | Occupational risk factors for blood pressure elevation among emergency responders

Risk factor	Comments
Irregular physical exertion[10,11,13–15]	Relative inactivity between emergencies, long sedentary periods, lack of formal exercise programs and fitness requirements at work. High prevalence of overweight and obesity.
Unhealthy diet and shift work[22–24,29–40]	Expediency, convenience of "fast food" as a choice during work-time. Tradition of communal meals at fire stations rich in saturated fats and simple, refined carbohydrates. Sleep disruption and sleep deprivation, alarms and dispatches during on-duty sleep, overtime work and second jobs, which can promote insulin resistance and the metabolic syndrome.
Noise exposure[26,41–45]	Alarms, sirens, vehicle engines, mechanized rescue equipment.
Posttraumatic stress disorder[27,28,46–49]	Increased resting heart rate, diastolic blood pressure and vaso-reactivity to traumatic stimuli (increased "startle response").
High job demand low decisional control[50–52]	In the 'Demand-Control' model of occupational stress, high demands and lower decisional latitude are associated with more stress. (Low demand and a high degree of control are associated with less stress.)

the psychologically stressful nature of public safety work may also increase the likelihood of inadequate sleep in emergency responders.[32] Although few studies have directly examined sleep hygiene and its relation to the metabolic syndrome in emergency responders, a growing body of literature has documented adverse associations between sleep disturbance/deprivation and insulin resistance, weight gain, hypertension, and cardiovascular disease.[33–40]

Noise exposure
Alarms, sirens, vehicle engines, and mechanized rescue equipment typically produce 8-h time-weighted average noise exposures in the 63–85 dBA range. Individual recorded exposures are very high in firefighters, who have consistently been documented to experience intermittent exposures over 90 dBA (the federal permissible exposure limit for an 8-h time-weighted average). The highest exposures reported exceed 100 dBA and can be as high as 116 dBA.[26] In a 2002 meta-analysis by van Kempen et al., it was estimated that, for each five decibel increase in occupational noise exposure, there is an increase of 0.51 mm Hg in systolic blood pressure.[41] As a result of siren noise,[26,42] for example, this corresponds to potential systolic blood pressure elevations of ~5.9–11.8 mm Hg. There is general agreement that the hemodynamic effects of intermittent occupational noise, such as that experienced by emergency responders, persist during active exposure.[43] However, whether these effects are longstanding[44] or relatively short-lived[45] has yet to be clearly elucidated.

PTSD
Emergency responders are often exposed to significant psychological trauma, which, in susceptible persons, can progress to PTSD.[27,28,46] Multiple studies have shown that patients suffering from PTSD have increased resting heart rates and a small (1–5 mm Hg) increase in diastolic blood pressure, compared to controls. They also display increased startle reaction, and increased heart rate and blood pressure reactivity when exposed to traumatic stimuli.[47,48] Violanti et al. found that police officers with the highest PTSD symptom scores had three times the age-adjusted risk of metabolic syndrome when compared to colleagues in the lowest PTSD score category.[49]

High job demand and low decisional latitude
In the "demand-control" model of occupational stress, increased demands and decreased decisional latitude on the job lead to elevated stress levels.[50] In a study of police officers, heart rate and the product of heart rate and systolic blood pressure were significantly higher under conditions of high demand and low control. Diastolic blood pressure and mean arterial pressure were also significantly higher in situations of low decisional latitude.[51] Similarly, Goldstein et al. demonstrated a 10 mm Hg average increase in paramedics' systolic blood pressure while riding in an ambulance as compared to riding in a car while off-duty.[52]

PREVALENCE AND TRENDS OF ELEVATED BLOOD PRESSURE
The prevalence of prehypertension and hypertension in these professions is also a significant concern (**Table 2**). Approximately three-quarters of emergency responders have elevated blood pressure (prehypertension or hypertension).[53–57] Mean resting systolic blood pressures in all three occupations have consistently been found in the prehypertensive or hypertensive range. As expected, older emergency responders have the highest average systolic blood pressure readings.[19,53,55,58–63]

Another very important factor affecting the prevalence of hypertension in emergency responders is obesity.[53,61,64,65] Over

Table 2 | Prevalence of prehypertension and hypertension in emergency responders

Population	Mean age (± s.d.)	Prevalence of prehypertension (%)	Prevalence of hypertension[a] (%)
Career firefighters[53]	39 (±7)	58	20–23
Volunteer firefighters[54]	Not available	47	30
Police[55]	37 (± 9)	—	21–23[c]
Police[56]	38	—	27[c]
Police[57]	47 (± 8)	—	24[b]
EMT and paramedic recruits (unpublished observations)	26 (± 4)	59	9

[a]≥140/90 mm Hg, diagnosis of hypertension, or antihypertensive medication use, unless otherwise noted. [b]≥160/95 mm Hg or antihypertensive medication use. [c]Self-reported hypertension.

75% of firefighters, police officers, and ambulance personnel are overweight or obese, by body mass index (BMI) criteria.[19,64] Given the obesity epidemic[66] and the close relationship between obesity and increasing blood pressure,[67] we would expect the distribution of blood pressure among emergency responders to progressively shift to higher measurements over time. In the 1980s and early 1990s, the average veteran firefighter had a BMI of 25.4–26.7 kg/m^2.[62,68] In 1996–97, the average veteran's BMI had increased to almost 29 kg/m^2,[61,69] and, by 2001, it was 29.7 kg/m^2.[64] Today, much younger firefighters and ambulance recruits (in their twenties) have an average BMI of 28.5 kg/m^2 (unpublished observations). Moreover, in the latter younger cohort, the relationship between obesity and blood pressure elevation appears especially pronounced, with obese subjects having an almost sevenfold greater prevalence of hypertensive blood pressure readings as compared to normal weight subjects (16 and 2.4%, respectively, $P = 0.004$).

Furthermore, given the current 30–40% prevalence of obesity (BMI ≥30 kg/m^2) in these populations, a significant number of obese responders have or is expected to develop obstructive sleep apnea.[70] Obstructive sleep apnea is highly linked to hypertension in both cross-sectional and prospective studies.[71–73] In fact, Peppard et al. found a dose–response increase in incident hypertension as the apnea–hypopnea index increased, with an almost threefold risk ratio for those with apnea–hypopnea index >15.[73]

In addition, the prevalence of hypertension is expected to increase over time because the prevalence of prehypertension among emergency responders is also currently high as shown in **Table 2**. Individuals with blood pressure in the prehypertensive range are at increased risk for progression and development of hypertension.[74]

Finally, in a prospective investigation of firefighters, almost 75% of those with hypertension were found to lack adequate

control[53] as similarly reported in the general population.[75–77] A particular finding with important policy implications from the above study was that, despite annual occupational medical examinations, the control of hypertension did not improve over the course of a 4-year period.[53] These hypertensive firefighters were provided with face-to-face and written follow-up recommendations to control their blood pressure and other cardiovascular disease risk factors however no workplace regulations required them to do so as a condition of continued employment. It is also notable that between 2 and 5% of the study population had stage 2 hypertension during the study period.[53] Surveys of volunteer firefighters have shown even higher percentage of stage 2 blood pressure readings, on the order of 4–9%.[54]

HYPERTENSION-ASSOCIATED OUTCOMES IN EMERGENCY RESPONDER POPULATIONS

Similar to the general population, elevated blood pressure has been associated with several adverse effects in these professions. First, obesity and elevated blood pressure in emergency responders are both associated with cardiovascular disease risk factor clustering, including older age, dyslipidemia, insulin resistance, and glucose intolerance.[53,57,61,64,65,78] Hence, total aggregate CHD risk is greater in the presence of such clustering, as opposed to with an isolated risk factor.

Second, retrospective case–control and prospective cohort studies of firefighters and police officers have shown strong and independent associations between hypertension and adverse employment outcomes, incident CHD and stroke, disability retirements due to heart disease, nonfatal myocardial infarction, and on-duty CHD fatalities (**Table 3**).[14,15,57,62,65,78–80] In the Helsinki, Finland, police cohort, an elevated systolic blood pressure was an independent predictor of all-cause mortality ($P = 0.004$), cardiovascular mortality ($P < 0.001$), and CHD death ($P < 0.001$).[78] Hypertension-related relative risk estimates reported in the medical literature regarding police officers are generally lower than those for firefighters (**Table 3**). Most likely this is due to different definitions of high blood pressure employed in the police studies, which by extension, change the definition of "normal blood pressure." When hypertension for police officers is defined at ≥160 mm Hg (systolic) or by self-report only, this leads to many hypertensive individuals being classified as NOT having hypertension. Thus, the "control" group includes a significant number of police officers with stage 1 hypertension. Therefore, the above misclassification of hypertensive police officers as "normotensives," would be expected to dilute the relative risk estimate.

There are several lines of evidence to suggest that hypertension-associated risks are concentrated among individuals with uncontrolled, rather than controlled, hypertension. Adverse job outcomes (combined outcome including: on-duty death, injured on-duty, termination of duty, resignation, premature retirement,

Table 3 | Adverse associations of hypertension with selected health outcomes in firefighters and police

Endpoint	Hypertension criteria	Unadjusted odds ratio or hazard ratio (95% CI)	Multivariable-adjusted odds ratio or hazard ratio (95% CI)	Study design/population
Adverse change in employment[65,a]	Stage 2 hypertension	NA	2.9 (1.1–8.1)	Prospective Cohort/ firefighters
	Stage 2 hypertension and no BP medication	NA	4.6 (2.1–10.1)	
Incident CHD[62]	SBP >140	6.1 (2.6–14.2)	NA	Prospective cohort/ firefighters
Incident CHD[62]	DBP > 90	4.9 (2.1–11.4)	NA	Prospective cohort/ firefighters
Incident CHD[57]	≥160/95 mm Hg or antihypertensive medication (multivariate hazard ratio based on 18 mm Hg increase in SBP treated as a continuous variable)	1.97 (1.34–2.89)	1.19 (1.03–1.38)	Prospective cohort/police
Incident stroke[79]	≥160/95 mm Hg or antihypertensive medication (multivariate hazard ratio based on 18 mm Hg increase in SBP treated as a continuous variable)	2.42 (1.35–4.33)	1.36 (1.18–3.06)	Prospective cohort/police
CHD retirement[14]	≥140/90 mm Hg, diagnosis of hypertension, or antihypertensive medication	5.4 (3.7–7.9)	1.2 (0.6–2.4)	Retrospective case–control/ firefighters
Non-CHD cardiovascular retirement[14]	≥140/90 mm Hg, diagnosis of hypertension, or antihypertensive medication	11.0 (6.1–20.0)	4.8 (1.3–17.9)	Retrospective case–control/ firefighters
Myocardial infarction[56,93]	Self-report of hypertension diagnosis	2.2 (1.6–3.2)	—	Retrospective case–control/ police
On-duty CHD death[15]	≥140/90 mm Hg, diagnosis of hypertension, or antihypertensive medication	12.0 (5.8–24.9)	4.7 (2.0–11.1)	Retrospective case–control/ firefighters
Case-fatality for on-duty CHD events[80]	≥140/90 mm Hg, diagnosis of hypertension, or antihypertensive medication	3.8 (2.0–7.1)	4.2 (1.8–9.4)	Retrospective case-fatality/ firefighters

CHD, coronary heart disease; DBP, diastolic blood pressure; SBP, systolic blood pressure.
[a]Combined outcome including: on-duty death, injured on-duty, termination of duty, resignation, premature retirement and incident cardiovascular event.

incident cardiovascular event) in firefighters were found primarily among those individuals with stage 2 hypertension who were not taking antihypertensive medications.[65] Likewise, among on-duty CHD fatalities in firefighters, LVH and/or cardiomegaly were found in 56% of those who had undergone an autopsy, suggesting chronically uncontrolled hypertension.[80] Among "heart presumption" retirements in Massachusetts, uncontrolled hypertension and hypertensive heart disease alone were found to be responsible for 8% of cardiovascular disability retirements among firefighters in Massachusetts, which represented a third of cardiovascular pensions awarded to firefighters for non-CHD causes.[14] In addition, hypertension was a major precursor and predictor of CHD and other non-CHD presumption retirements in the same study.

It is crucial to note, however, that, as is seen in the general population,[81] the majority of incident cardiovascular disease events occur in emergency responders who are initially prehypertensive or only mildly hypertensive. In **Table 4**, we show baseline mean blood pressures in firefighters and police officers who were later found in prospective follow-up to have an incident cardiovascular event or a clinical diagnosis compared with subjects who remained free of disease. Although the differences are highly significant on statistical comparison, the mean pressures observed in those who eventually developed disease were in the range of 140–146/88–92 mm Hg. Many primary care physicians still hesitate to prescribe medications for patients with such levels of blood pressure. This potential gap between the clinical and epidemiologic perception of risk is an

important consideration in developing effective guidelines for blood pressure screening and management among emergency responders.

OCCUPATIONAL GUIDELINES FOR BLOOD PRESSURE IN EMERGENCY RESPONDERS

One might expect that occupational standards for blood pressure control would be stricter and updated regularly, given legislated cardiovascular disease benefits and the documented associations between uncontrolled hypertension and cardiovascular disease. Unfortunately, however, existing guidelines for emergency responders appear to be weak and outdated (**Table 5**).[82–84] In addition to potentially contributing to imprudent decisions regarding fitness for duty, such occupational guidelines may also provide emergency responders with a false sense of security. Many occupational physicians

Table 4 | Baseline blood pressures for firefighters and police with and without later incident cardiovascular events

Endpoint	Event (mm Hg)		No event (mm Hg)		P value		Study design/population
	Mean SBP	Mean DBP	Mean SBP	Mean DBP	Mean SBP	Mean DBP	
Incident CHD[62]	140	92	125	82	<0.0001[a]	<0.0001[a]	Prospective cohort/firefighters
Incident CHD[79]	141	88	134	84	<0.01[b]	<0.001[b]	Prospective cohort/police
Incident stroke[79]	146	91	134	84	<0.01[b]	<0.01[b]	Prospective cohort/police

CHD, coronary heart disease; DBP, diastolic blood pressure; SBP, systolic blood pressure.
[a]Adjusted for age, race and BMI. [b]Adjusted for age.

Table 5 | Occupational blood pressure guidelines for firefighters and police officers compared to JNC 7

Organization/year	Population	Blood Pressure stage/levels in mm Hg	Determination/action
National Fire Protection Association, 2007[82]	Firefighters	<180 systolic and <100 diastolic	Acceptable blood pressure—controlled hypertension (if no target organ damage)
		≥180 systolic; ≥100 diastolic; 1/3 systolic + 2/3 diastolic >120 mm Hg; or presence of target organ damage	Severe uncontrolled hypertension, restricted from duty
Massachusetts Human Resources Division, 1998[83]	Firefighters and police officers	<160 systolic and <100 diastolic	Acceptable blood pressure
		≥160 systolic or ≥100 diastolic	Uncontrolled hypertension, restricted from duty
California Peace Officer Standards and Training, 2004[84]	Police officers	<160 systolic and <90 diastolic	"Group I" normal blood pressure, no restrictions
		>160 systolic or 90–104 diastolic; or diagnosis of hypertension controlled by diet/medications	"Group II" mild hypertension, no restrictions if normal blood pressure response to exercise on stress ECG
		105–114 diastolic >115 diastolic	"Group III" moderate hypertension "Group III" severe hypertension, restricted duty and treatment required
National Heart, Lung, and Blood Institute National High Blood Pressure Education Program (JNC 7), 2003[3]	General population	<120 systolic and <80 diastolic	Normal
		120–139 systolic or 80–89 diastolic	Pre-hypertension/increased education to reduce BP and prevent hypertension
		140–159 systolic or 90–99 diastolic	Stage 1 Hypertension/lifestyle modifications ± single-agent treatment
		≥160 systolic or ≥100 diastolic	Stage 2 Hypertension/lifestyle modifications + Most need 2 – drug combination

ECG, electrocardiogram; JNC 7, seventh report of the Joint National Committee on Prevention, Detection, Evaluation, and Treatment of High Blood Pressure.

would agree that emergency responders, even when counseled directly about uncontrolled risk factors, may misinterpret an unrestricted clearance to work during a fitness for duty examination as having no issues that merit follow-up with their primary care physician. Comparing the mean blood pressures for emergency responders who developed CHD or stroke in **Table 4** to workplace guidelines for blood pressure in **Table 5**, it is obvious that these standards lack sensitivity for identifying individuals at risk.

A more prudent approach based on the evidence summarized in this review and the seventh report of the Joint National Committee on Prevention, Detection, Evaluation, and Treatment of High Blood Pressure is presented in **Table 6**. First of all, population-based wellness strategies that promote healthy habits such as aerobic exercise, maintenance of normal weight, healthy diet, sleep hygiene, and stress management should be made available to the entire workforce.[85] Given that cardiovascular disease risk factors tend to cluster together, BMI assessment and blood pressure measurements are excellent noninvasive screening tools for basic wellness programs. Second, individuals with higher cardiovascular disease risk (those in the prehypertension and hypertension categories) should also receive individualized counseling regarding the nonpharmacologic management of blood pressure, including diet, sodium restriction, physical activity, moderate consumption of alcohol, and maintenance of healthy weight or weight loss for those with BMI in the overweight/

obese categories. Such interventions, along with their rationales, have been reviewed in depth elsewhere.[3,86]

Third, an innovative aspect of our approach is to use time-limited work clearances for emergency responders with stage 1 hypertension. This strategy is consistent with recent changes enacted regarding the medical examination of commercial truck drivers,[87] another group whose basic health maintenance is important for public safety. Recently, this scheme, along with company-sponsored health promotion and disease management, was shown to be successful in decreasing the prevalence of uncontrolled hypertension from 28 to 20% ($P < 0.01$) among drivers.[88]

The major benefit of time-limited clearance is the assurance that hypertensive emergency responders receive appropriate treatment and do not continue to work indefinitely with uncontrolled blood pressure. Thus, although stage 1 hypertension would not lead to an immediate change in the emergency responder's duties, he/she would be presented with a strong incentive to achieve better blood pressure control over the following months. However, when stage 2 hypertension is present, the emergency responder should be restricted from strenuous duties until blood pressure control is significantly improved.

Prospective data are lacking to demonstrate the efficacy of our proposed workplace hypertension management plan, and future research should focus on determining the most effective workplace programs for blood pressure control. However, our

Table 6 | Proposed blood pressure management scheme for emergency responders

Blood pressure	Fitness determination	Recommended intervention(s)	Occupational follow-up
Normal	Unrestricted duty	• Population-based wellness programs	• 12–24 months based on overall CVD risk factor profile[a]
Prehypertension	Unrestricted duty	• Population-based wellness programs • Individual education[b]	• 6–12 months based on overall CVD risk factor profile[a]
Stage 1 hypertension	Time-limited clearance for duty	• Population-based wellness programs • Individual education[b] • Hypertension treatment and evaluation	• Time-limited clearance (6–12 months) based on overall CVD risk factor profile[a] • Expect controlled blood pressure at follow-up • If blood pressure control improves, revert to annual follow-up
Stage 2 hypertension	Restricted to modified duty (excluding physical exertion related duties) until blood pressure reaches stage 1 or lower	• Population-based wellness programs • Individual education[b] • Clinical management of Hypertension	• Time-limited clearance after adequate blood pressure control • Follow steps for stage 1, as above

Assumes absence of comorbid conditions potentially affecting fitness for duty, prognosis, and treatment decisions.
CVD, cardiovascular disease.
[a]Full CVD risk factor assessment, including tobacco use, fasting lipid profile, blood glucose level, etc. [b]e.g., DASH: Dietary Approaches to Stop Hypertension,[3] and other nonpharmacologic measures.

proposal represents a balanced approach based on voluminous scientific evidence. One should also recognize that workplace guidelines are always challenging to develop and even more complicated to implement in practice. Therefore, our proposal should be viewed as providing a broad framework that could be adapted and negotiated as locally appropriate to accommodate different administrative and labor management circumstances. The overarching goal of our proposal is to ensure continuous efforts to improve blood pressure and risk factor control among hypertensive emergency responders. In other words, it is crucial that hypertensive emergency responders with inadequate blood pressure control are not passively encouraged (as they are by the current guidelines) to believe that their blood pressure is "under control."

Complementary considerations along with assessing cardiovascular disease risk factors include appropriate investigations for target organ damage in emergency responders with stage 2 hypertension or long-standing stage 1 hypertension with undocumented control. For example, an echocardiogram should be considered in such cases to rule out left ventricular hypertrophy.

PRESCRIBING CONSIDERATIONS

In general, the initial drug of choice for hypertension in emergency responders should follow the recommendations of the seventh report of the Joint National Committee on Prevention, Detection, Evaluation, and Treatment of High Blood Pressure for individuals with or without compelling indications.[3] However, during emergency responses, these workers may be exposed to extreme temperatures and experience significant physical exertion. For example, experiments have demonstrated decreased stroke volume due to vasodilatation and/or large fluid losses by firefighters entering high-temperature environments wearing nonbreathable full personal protective equipment.[89] Thus, caution should be exercised when diuretics are prescribed for hypertension in these professions, and alternative choices should be considered.[90,91] In addition, given the nature of occupational duties in first responders, clinicians should be especially attentive to potential adverse medication effects such as dizziness that might compromise the operation of vehicles or machinery or the performance of safety-sensitive tasks.

CONCLUSIONS

Approximately three-quarters of emergency responders have elevated blood pressure (prehypertension or hypertension), and their prevalence of hypertension is expected to increase. Currently, elevated blood pressure is inadequately controlled among these professions and strongly linked to on-duty cardiovascular disease morbidity and mortality. Private employers are increasingly recognizing the benefits of health promotion on the well-being, health-care costs, and productivity of diverse groups of workers.[92] Given the important roles of emergency responders to our local communities and society at large, it is of paramount importance that the public and private authorities overseeing our public safety professionals, recognize the potential benefits of prevention and take specific actions to promote cardiovascular disease wellness programs. Efforts to maintain healthy weight and achieve blood pressure control should be emphasized as practical and high-yield starting points.

1. Hall WD, Ferrario CM, Moore MA, Hall JE, Flack JM, Cooper W, Simmons JD, Egan BM, Lackland DT, Perry M Jr, Roccella EJ. Hypertension-related morbidity and mortality in the southeastern United States. *Am J Med Sci* 1997; 313:195–209.
2. Sytkowski PA, D'Agostino RB, Belanger AJ, Kannel WB. Secular trends in long-term sustained hypertension, long-term treatment, and cardiovascular mortality: the Framingham Heart Study 1950 to 1990. *Circulation* 1996; 93:697–703.
3. Chobanian AV, Bakris GL, Black HR, Cushman WC, Green LA, Izzo JL Jr, Jones DW, Materson BJ, Oparil S, Wright JT Jr, Roccella EJ; the National High Blood Pressure Education Program Coordinating Committee. The seventh report of the Joint National Committee on Prevention, Detection, Evaluation, and Treatment of High Blood Pressure. *JAMA* 2003; 289:2560–2571.
4. National Fire Protection Association (NFPA). Fire statistics: the U.S. fire service <http://www.nfpa.org/categoryList.asp?categoryID=955&URL=Research%20&%20Reports/Fire%20statistics/The%20U.S.%20fire%20service> (2007). Accessed 25 October 2007.
5. U.S. Department of Labor—Bureau of Labor Statistics. Occupational outlook handbook: police and detectives. <http://www.bls.gov/oco/ocos160.htm> (2007). Accessed 16 January 2007.
6. U.S. Department of Labor—Bureau of Labor Statistics. Occupational outlook handbook: emergency medical technicians and paramedics. <http://www.bls.gov/oco/ocos101.htm> (2006). Accessed 7 November 2007.
7. Law Enforcement Wellness Association, Inc. Physical fitness. <http://www.cophealth.com/fitness.html>. Accessed 27 May 2008.
8. Barnard RJ, Duncan HW. Heart rate and ECG responses of fire fighters. *J Occup Med* 1975; 17:247–250.
9. Kuorinka I, Korhonen O. Firefighters' reaction to alarm, an ECG and heart rate study. *J Occup Med* 1981; 23:762–766.
10. Mittleman MA, Maclure M, Tofler GH, Sherwood JB, Goldberg RJ, Muller JE. Triggering of acute myocardial infarction by heavy physical exertion. Protection against triggering by regular exertion. Determinants of myocardial infarction onset study investigators. *N Engl J Med* 1993; 329:1677–1683.
11. Franklin BA, Bonzheim K, Gordon S, Timmis GC. Snow shoveling: a trigger for acute myocardial infarction and sudden coronary death. *Am J Cardiol* 1996; 77:855–858.
12. Wilbert-Lampen U, Leistner D, Greven S, Pohl T, Sper S, Volker C, Guthlin D, Plasse A, Knez A, Kuchenhoff H, Steinbeck G. Cardiovascular events during World Cup soccer. *N Engl J Med* 2008; 358:475–483.

13. Kales SN, Soteriades ES, Christouphi CA, Christiani DC. Emergency duties and deaths from heart disease among firefighters in the United States. *N Engl J Med* 2007; 356:1207–1215.

14. Holder JD, Stallings LA, Peeples L, Burress JW, Kales SN. Firefighter heart presumption retirements in Massachusetts 1997–2004. *J Occup Environ Med* 2006; 48:1047–1053.

15. Kales SN, Soteriades ES, Christoudias SG, Christiani DC. Firefighters and on-duty deaths from coronary heart disease: a case control study. *Environ Health* 2003; 2:14.

16. Firefighter fatality retrospective study, April 2002. (Prepared for the Federal Emergency Management Agency, United States Fire Service, National Fire Data Center.) Arlington, VA: TriData Corp., 2002.

17. Maguire BJ, Hunting KL, Smith GS, Levick NR. Occupational fatalities in emergency medical services: a hidden crisis. *Ann Emerg Med* 2002; 40:625–632.

18. Rosenstock L, Olsen J. Firefighting and death from cardiovascular causes. *N Engl J Med* 2007; 356:1261–1263.

19. Franke WD, Ramey SL, Shelley MC 2nd. Relationship between cardiovascular disease morbidity, risk factors, and stress in a law enforcement cohort. *J Occup Environ Med* 2002; 44:1182–1189.

20. International Association of Fire Fighters (IAFF). US and Canadian presumptive laws. <http://www.iaff.org/HS/PSOB/infselect.asp> (2007). Accessed 8 November 2007.

21. U.S. Department of Justice—Bureau of Justice Assistance (BJA). Public Safety Officers' Benefits (PSOB) Program: Hometown Heroes Survivors Benefits Act of 2003. <http://www.ojp.usdoj.gov/BJA/grant/psob/psob_heroes.html>. Accessed 8 November 2007.

22. Briley ME, Montgomery DH, Blewett J. Dietary intakes of police department employees in a wellness program. *J Am Diet Assoc* 1990; 90:65–68.

23. Paley MJ, Tepas DI. Fatigue and the shiftworker: firefighters working on a rotating shift schedule. *Hum Factors* 1994; 36:269–284.

24. International Association of Fire Chiefs (IAFC). Effects of sleep deprivation on fire fighters and EMS responders: final report. <http://www.iafc.org/associations/4685/files/progsSleep_SleepDeprivationReport.pdf> (2007). Accessed 7 November 2007.

25. Sterud T, Hem E, Ekeberg O, Lau B. Health problems and help-seeking in a nationwide sample of operational Norwegian ambulance personnel. *BMC Public Health* 2008; 8:3.

26. Tubbs RL. Noise and hearing loss in firefighting. *Occup Med* 1995; 10:843–856.

27. Bryant R, Harvey A. Posttraumatic stress reaction in volunteer fire fighters. *J Trauma Stress* 1996; 9:51–52.

28. Jonsson A, Segesten K, Mattsson B. Post-traumatic stress among Swedish ambulance personnel. *Emerg Med J* 2003; 20:79–84.

29. Wolk R, Somers VK. Sleep and the metabolic syndrome. *Exp Physiol* 2007; 92:67–78.

30. Getz GS, Reardon CA. Nutrition and cardiovascular disease. *Arterioscler Thromb Vasc Biol* 2007; 27:2499–2506.

31. Vilke GM, Tornabene SV, Stepanski B, Shipp HE, Ray LU, Metz MA, Vroman D, Anderson M, Murrin PA, Davis DP, Harley J. Paramedic self-reported medication errors. *Prehosp Emerg Care* 2007; 11:80–84.

32. Gallagher S, McGilloway S. Living in critical times: the impact of critical incidents on frontline ambulance personnel—a qualitative perspective. *Int J Ment Health* 2007; 9:215–223.

33. Wolk R, Gami AS, Garcia-Touchard A, Somers VK. Sleep and cardiovascular disease. *Curr Probl Cardiol* 2005; 30:625–662.

34. Jennings JR, Muldoon MF, Hall M, Buysse DJ, Manuck SB. Self-reported sleep quality is associated with the metabolic syndrome. *Sleep* 2007; 30:219–223.

35. Vioque J, Torres A, Quiles J. Time spent watching television, sleep duration and obesity in adults living in Valencia, Spain. *Int J Obes Relat Metab Disord* 2000; 24:1683–1688.

36. Di Lorenzo L, De Pergola G, Zocchetti C, L'Abbate N, Basso A, Pannacciulli N, Cignarelli M, Giorgino R, Soleo L. Effect of shift work on body mass index: results of a study performed in 319 glucose-tolerant men working in a Southern Italian industry. *Int J Obes Relat Metab Disord* 2003; 27:1353–1358.

37. Kitamura T, Onishi K, Dohi K, Okinaka T, Ito M, Isaka N, Nakano T. Circadian rhythm of blood pressure is transformed from a dipper to a non-dipper pattern in shift workers with hypertension. *J Hum Hypertens* 2002; 16:193–197.

38. Matthews KA, Kamarck TW, H Hall M, Strollo PJ, Owens JF, Buysse DJ, Lee L, Reis SE. Blood pressure dipping and sleep disturbance in African-American and Caucasian men and women. *Am J Hypertens* 2008; 21:826–831.

39. Fialho G, Cavichio L, Povoa R, Pimenta J. Effects of 24-h shift work in the emergency room on ambulatory blood pressure monitoring values of medical residents. *Am J Hypertens* 2006; 19:1005–1009.

40. Boggild H, Knutsson A. Shift work, risk factors and cardiovascular disease. *Scand J Work Environ Health* 1999; 25:85–99.

41. van Kempen EE, Kruize H, Boshuizen HC, Ameling CB, Staatsen BA, de Hollander AE. The association between noise exposure and blood pressure and ischemic heart disease: a meta-analysis. *Environ Health Perspect* 2002; 110:307–317.

42. Price TG, Goldsmith LJ. Changes in hearing acuity in ambulance personnel. *Prehosp Emerg Care* 1998; 2:308–311.

43. Sawada Y. Hemodynamic effects of short-term noise exposure—comparison of steady state and intermittent noise at several sound pressure levels. *Jpn Circ J* 1993; 57:862–872.

44. Chang TY, Su TC, Lin SY, Jain RM, Chan CC. Effects of occupational noise exposure on vascular properties in male workers. *Environ Health Perspect* 2007; 115:1660–1664.

45. Fogari R, Zoppi A, Corradi L, Marasi G, Vanasia A, Zanchetti A. Transient but not sustained blood pressure increments by occupational noise. An ambulatory blood pressure measurement study. *J Hypertens* 2001; 19:1021–1027.

46. Keane TM, Marshall AD, Taft CT. Posttraumatic stress disorder: etiology, epidemiology, and treatment outcome. *Annu Rev Clin Psychol* 2006; 2:161–197.

47. Guthrie RM, Bryant RA. Auditory startle response in firefighters before and after trauma exposure. *Am J Psychiatry* 2005; 162:283–290.

48. Bedi US, Arora R. Cardiovascular manifestations of posttraumatic stress disorder. *J Natl Med Assoc* 2007; 99:642–649.

49. Violanti JM, Fekedulegn D, Hartley TA, Andrew ME, Charles LE, Mnatsakanova A, Burchfiel CM. Police trauma and cardiovascular disease: association between PTSD symptoms and metabolic syndrome. *Int J Emerg Ment Health* 2006; 8:227–237.

50. Karasek RA. Job demands, job decision latitude, and mental strain: implications for job redesign. *Adm Sci Q* 1979; 24:285–308.

51. Bishop GD, Enkelmann HC, Tong EM, Why YP, Diong SM, Ang J, Khader M. Job demands, decisional control, and cardiovascular responses. *J Occup Health Psychol* 2003; 8:146–156.

52. Goldstein IB, Jamner LD, Shapiro D. Ambulatory blood pressure and heart rate in healthy male paramedics during a workday and a nonworkday. *Health Psychol* 1992; 11:48–54.

53. Soteriades ES, Kales SN, Liarokapis D, Christiani DC. Prospective surveillance of hypertension in firefighters. *J Clin Hypertens (Greenwich)* 2003; 5:315–320.

54. National Volunteer Fire Council (NVFC). 2004 and 2005 summary of screening results. <http://www.healthy-firefighter.org/files/documents/2006nvfcsummarycharts.pdf>. Accessed 8 November 2007.

55. Ramey SL, Franke WD, Shelley MC 2nd. Relationship among risk factors for nephrolithiasis, cardiovascular disease, and ethnicity: focus on a law enforcement cohort. *AAOHN J* 2004; 52:116–121.

56. Ramey SL, Downing NR, Knoblauch A. Developing strategic interventions to reduce cardiovascular disease risk among law enforcement officers: the art and science of data triangulation. *AAOHN J* 2008; 56:54–62.

57. Pyorala M, Miettinen H, Laakso M, Pyorala K. Hyperinsulinemia predicts coronary heart disease risk in healthy middle-aged men: the 22-year follow-up results of the Helsinki Policemen Study. *Circulation* 1998; 98:398–404.

58. Volpino P, Tomei F, La Valle C, Tomao E, Rosati MV, Ciarrocca M, De Sio S, Cangemi B, Vigliarolo R, Fedele F. Respiratory and cardiovascular function at rest and during exercise testing in a healthy working population: effects of outdoor traffic air pollution. *Occup Med (Lond)* 2004; 54:475–482.

59. Davis SC, Jankovitz KZ, Rein S. Physical fitness and cardiac risk factors of professional firefighters across the career span. *Res Q Exerc Sport* 2002; 73:363–370.

60. Franke WD, Cox DF, Schultz DP, Anderson DF. Coronary heart disease risk factors in employees of Iowa's Department of Public Safety compared to a cohort of the general population. *Am J Ind Med* 1997; 31:733–737.

61. Kales SN, Polyhronopoulos GN, Aldrich JM, Leitao EO, Christiani DC. Correlates of body mass index in hazardous materials firefighters. *J Occup Environ Med* 1999; 41:589–595.

62. Glueck CJ, Kelley W, Wang P, Gartside PS, Black D, Tracy T. Risk factors for coronary heart disease among firefighters in Cincinatti. *Am J Ind Med* 1996; 30:331–340.

63. Sparrow D, Thomas HE Jr, Weiss ST. Coronary heart disease in police officers participating in the normative aging study. *Am J Epidemiol* 1983; 118:508–513.

64. Soteriades ES, Hauser R, Kawachi I, Liarokapis D, Christiani DC, Kales SN. Obesity and cardiovascular disease risk factors in firefighters: a prospective cohort study. *Obes Res* 2005; 13:1756–1763.

65. Kales SN, Soteriades ES, Christoudias SG, Tucker SA, Nicolaou M, Christiani DC. Firefighters' blood pressure and employment status on hazardous materials teams in Massachusetts: a prospective study. *J Occup Environ Med* 2002; 44:669–676.

66. Ogden CL, Carroll MD, Curtin LR, McDowell MA, Tabak CJ, Flegal KM. Prevalence of overweight and obesity in the United States, 1999–2004. *JAMA* 2006; 295:1549–1555.

67. Pi-Sunyer FX. The obesity epidemic: pathophysiology and consequences of obesity. *Obes Res* 2002; 10(Suppl 2):97S–104S.

68. Gledhill N, Jamnik VK. Development and validation of a fitness screening protocol for firefighter applicants. *Can J Sport Sci* 1992; 17:199–206.

69. Clark S, Rene A, Theurer WM, Marshall M. Association of body mass index and health status in firefighters. *J Occup Environ Med* 2002; 44:940–946.

70. Vgontzas AN, Tan T-L, Bixler EO, Martin LF, Shubert D, Kales A. Sleep apnea and sleep disruption in obese patients. *Arch Intern Med* 1994; 154:1705–1711.

71. Lavie P, Herer P, Hoffstein V. Obstructive sleep apnoea syndrome as a risk factor for hypertension: population study. *BMJ* 2000; 320:479–482.

72. Nieto FJ, Young TB, Lind BK, Shahar E, Samet JM, Redline S, D'Agostino RB, Newman AB, Lebowitz MD, Pickering TG. Association of sleep-disordered breathing, sleep apnea, and hypertension in a large community-based study. Sleep Heart Health Study. *JAMA* 2000; 283:1829–1836.

73. Peppard PE, Young T, Palta M. Prospective study of the association between sleep-disordered breathing and hypertension. *N Engl J Med* 2000; 342:1378–1384.

74. Vasan RS, Larson MG, Leip EP, Kannel WB, Levy D. Assessment of frequency of progression to hypertension in non-hypertensive participants in the Framingham Heart Study: a cohort study. *Lancet* 2001; 358:1682–1686.

75. Hajjar I, Kotchen TA. Trends in prevalence, awareness, treatment, and control of hypertension in the United States, 1988–2000. *JAMA* 2003; 290:199–206.

76. Kotchen TA. Why the slow diffusion of treatment guidelines into clinical practice?. *Arch Intern Med* 2007; 167:2394–2395.

77. Fang J, Alderman MH, Keenan NL, Ayala C, Croft JB. Hypertension control at physicians' offices in the United States. *Am J Hypertens* 2008; 21:134–135.

78. Pyorala M, Miettinen H, Laakso M, Pyorala K. Plasma insulin and all-cause, cardiovascular, and noncardiovascular mortality: the 22-year follow-up results of the Helsinki Policemen Study. *Diabetes Care* 2000; 23:1097–1102.

79. Pyorala M, Miettinen H, Halonen P, Laakso M, Pyorala K. Insulin resistance syndrome predicts the risk of coronary heart disease and stroke in healthy middle-aged men: the 22-year follow-up results of the Helsinki Policemen Study. *Arterioscler Thromb Vasc Biol* 2000; 20:538–544.

80. Geibe JR, Holder J, Peeples L, Kinney AM, Burress JW, Kales SN. Predictors of on-duty coronary events in U.S. male firefighters. *Am J Cardiol* 2008; 101:585–589.

81. Lawes CM, Vander Hoorn S, Rodgers A; International Society of Hypertension. Global burden of blood-pressure-related disease, 2001. *Lancet* 2008; 371:1513–1518.

82. National Fire Protection Association (NFPA). *NFPA 1582: Standard on Comprehensive Occupational Medical Program for Fire Departments*. National Fire Protection Association: Quincy, MA, 2007.

83. Commonwealth of Massachusetts *Human Resources Division. Police Officer and Fire Fighter Medical Standards Conference*. Commonwealth of Massachusetts: Boston, 1998.

84. Weyers SG. California Commission on Peace Officer Standards and Training (POST) Medical Screening Manual for California Law Enforcement. <http://www.post.ca.gov/selection/pdf/Cardio.pdf> (2007). Accessed 24 October 2007.

85. International Association of Fire Fighters (IAFF), International Association of Fire Chiefs (IAFC). *The Fire Service Joint Labor Management Wellness/Fitness Initiative*. International Association of Fire Fighters, International Association of Fire Chiefs: Washington, DC, 2000.

86. Svetkey LP. Management of prehypertension. *Hypertension* 2005; 45:1056–1061.

87. U.S. Department of Transportation—Federal Motor Carrier Safety Administration. Cardiovascular Advisory Panel Guidelines for the Medical Examination of Commercial Motor Vehicle Drivers. <http://www.fmcsa.dot.gov/documents/cardio.pdf> (2002). Accessed 8 November 2007.

88. Harshman RS, Richerson GT, Hadker N, Greene BL, Brown TM, Foster TS, Turner BH, Skrepnek SH, Doyle JJ. Impact of a hypertension management/health promotion program on commercial driver's license employees of a self-insured utility company. *J Occup Environ Med* 2008; 50:359–365.

89. Smith DL, Manning TS, Petruzzello SJ. Effect of strenuous live-fire drills on cardiovascular and psychological responses of recruit firefighters. *Ergonomics* 2001; 44:244–254.

90. McInnes GT, Macdonald EB. Therapeutics of hypertension in the work environment. *J Soc Occup Med* 1981; 31:31–37.

91. Wexler RK. Evaluation and treatment of heat-related illnesses. *Am Fam Physician* 2002; 65:2307–2314.

92. Okie S. The employer as health coach. *N Engl J Med* 2007; 357:1465–1469.

93. North Carolina Justice. Academy. Officer Safety Tip—Heart Disease. <http://www.jus.state.nc.us/NCJA/w-08–99tip.htm>. Accessed 4 June 2008.