Typhoid Fever — Continued

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Exertional Rhabdomyolysis and Acute Renal Impairment — New York City and Massachusetts, 1988

During the summer and fall of 1988, outbreaks of exertional rhabdomyolysis (the breakdown of muscle fiber) with renal impairment occurred in New York and Massachusetts among candidates or trainees for public safety positions. In each of the outbreaks, risk for illness was lower in persons who were accustomed to vigorous exercise; however, incidence rates, the relation to dehydration, and settings differed.

New York

On June 14, 1988, the New York City (NYC) Department of Health was notified of one death and three hospitalizations among candidates for the NYC Fire Department (NYCFD) who had taken the NYCFD competitive physical fitness test within the previous 2 weeks. The fatality occurred in a young man with sickle cell trait who died because of uncontrollable hyperkalemia secondary to rhabdomyolysis within 6 hours of taking the fitness test; the three other hospitalized candidates had rhabdomyolysis and renal insufficiency.

The firefighter physical fitness test is usually administered during a 2- to 3-month period every 4 years to approximately 25,000–30,000 men and women who are aged 19–29 years and who have passed the NYCFD written employment examination. The test, which was given indoors in a temperature-controlled environment, required the

Exertional Rhabdomyolysis — Continued

candidates to wear a 20-lb vest and a 20-lb oxygen tank while consecutively performing 11 activities that simulate typical firefighter tasks. Completion of the test in ≤7 minutes earned a passing score, and completion in ≤4 minutes earned a 100% score.

Following the hospitalizations, the test was suspended on June 15 and resumed on June 27 with modified pre- and post-testing procedures. However, additional hospitalizations occurred, and on July 13, the test was again suspended. In late July, an epidemiologic investigation was initiated; the investigation included an environmental evaluation for carbon monoxide, which did not reveal elevated levels inside the building. Testing was temporarily suspended four times during the 19 months (May 31, 1988–December 21, 1989) after it was initiated. Each suspension was followed by an evaluation of the test by medical experts and exercise physiologists.

On June 27, a series of interventions was implemented to prevent exertional rhabdomyolysis by minimizing the effect of the ambient temperature, screening out candidates with current or prior medical problems, and assuring adequate hydration. Specific interventions included cancelling the test during the summer, requiring medical clearance from a physician, instructing candidates to reschedule the test if they were ill, urging candidates to avoid all medication and alcohol for 24 hours before and after the test, and providing fluids before the test. Despite these interventions, cases of rhabdomyolysis and/or renal impairment requiring hospitalization occurred during each of the five testing periods (Table 1).

During the 19-month period, 32 (0.2%) of 16,506 candidates were hospitalized for rhabdomyolysis and/or acute renal impairment after taking the fitness test; 41 other candidates were treated in emergency rooms but not admitted to hospitals. Of those hospitalized, four had rhabdomyolysis (defined as a serum creatinine phosphokinase [CPK] ≥600 U/L [normal: 60–200 U/L]), and 16 had renal impairment (defined as serum creatinine ≥3.0 mg/dL [normal: 0.6–1.3 mg/dL]); 12 had both rhabdomyolysis and renal impairment.

Thirty (94%) of the 32 hospitalized candidates presented with back pain, 26 (81%) with nausea and vomiting, 20 (63%) with abdominal pain, 18 (56%) with muscle pain, and 18 (56%) with decreased urine output; four required hemodialysis. The mean hospital stay was 6 days (range: 1–20 days). All hospitalized candidates were men. None of the 84 women candidates reported illness. The mean age of the patients was 25 years; 29 were white, two were black, and one was Hispanic.

TABLE 1. Hospitalizations for rhabdomyolysis and/or acute renal impairment among firefighter candidates — New York City, 1988–89

Period	Candidates tested	Hospitalizations	Hospitalization rate*
May 31–Jun 15, 1988	5,818	7	1.2
Jun 27–Jul 13, 1988	6,690	9	1.3
Oct 17–27, 1988	1,859	6	3.2
May 31–Jun 2, 1989	754	4	5.3
Dec 5–7 and Dec 21, 1989	1,385	6	4.3
Total	**16,506**	**32**	**1.9**

*Per 1000 candidates tested.

Exertional Rhabdomyolysis — Continued

After the second testing period, the NYC Department of Health and CDC conducted a case-control study using patients from the first two testing periods to assess potential risk factors. Thirteen of the 18 patients whose illnesses occurred in the first two periods agreed to be interviewed. Of the candidates who took the test during the same period and were not affected, 161 were selected randomly to serve as controls; 108 (67%) agreed to a telephone interview.

The risk for rhabdomyolysis and/or acute renal impairment after taking the test was increased in candidates with an underlying medical condition (e.g., pneumonia or renal vein thrombosis) (odds ratio [OR] = 10.3; 95% confidence interval [CI] = 2.5–43.6). The risk was lower for men who engaged in physical activity (work plus leisure activity ≥50 hours per week; OR = 0.2; 95% CI = 0.1–0.9). Risk for illness was not associated with the test score.

Based on the epidemiologic and clinical data and the failure of the implemented interventions, the NYC Department of Health recommended that the test be modified before it is given again and a comprehensive survey be done of alternative methods of selecting firefighter candidates in other cities.

Massachusetts

On September 19, 1988, 50 police trainees from local police departments began a 14-week "mental stress" and physical training program at a state-sponsored academy in western Massachusetts. On the evening of September 21, the Massachusetts Department of Public Health was notified that five trainees had been hospitalized. The program was suspended, and an epidemiologic investigation initiated September 22 determined that some trainees had experienced severe dehydration, rhabdomyolysis, and/or acute renal insufficiency. An environmental investigation did not identify any biological agents in the air or water.

All trainees were white; most were young adults (mean age: 25 years) and male (94%). The first 3 days of the training program were physically strenuous and included push-ups, squat-thrusts, and running. Daytime temperatures were 75–80 F (24–27 C), with a relative humidity of 50% (apparent temperature [heat index]: 75–80 F [24–27 C]). During the training program, drinking water was available only during three or four short breaks each day; trainees obtained water from a 19-L (5-gal) water cooler using 90-mL (3-oz) fold-out cups and from faucets in the restrooms by hand scooping. The amount of water drunk by each trainee could not be quantified; however, based on the known limited availability of water, as well as reports of severe thirst and the large volumes of fluids drunk at the end of each day (compensatory hydration), water intake was considered to be grossly inadequate.

All 50 trainees had evidence of rhabdomyolysis (serum CPK ≥10 times normal) and 33 (66%) had severe rhabdomyolysis (serum CPK ≥200 times normal). Thirteen (26%) of the trainees were hospitalized with complaints of nausea, back and abdominal pain, and dark urine; each of those hospitalized had serum CPK levels ≥32,000 U/L (normal: 10–300 U/L) and an abnormal urinalysis. Nine (69%) of those hospitalized had evidence of renal insufficiency (serum creatinine ≥2.0 mg/dL); six (46%) required hemodialysis. One trainee died 44 days after onset from complications of heat stroke, rhabdomyolysis, and renal and hepatic failure.

One month before the program, 49 of the trainees were tested for cardiovascular fitness (2.4-km [1.5-mile] run) and muscular strength (sit-ups). Compared with trainees who passed both tests, those who failed either test were at increased risk for

Exertional Rhabdomyolysis — Continued

severe rhabdomyolysis (relative risk [RR] = 2.5; 95% CI = 1.3–4.9) or renal insufficiency (RR = 2.0; 95% CI = 0.5–8.8).

As a result of this investigation, the Massachusetts Criminal Justice Training Council extensively revised its police training program. "Mental stress" training, including the use of physical exercise as a punishment for infractions, was immediately abolished. An exercise physiologist who was appointed to develop a physical fitness regimen recommended requirements for 1) meeting specific physical fitness and medical standards before and during the training program; 2) adequate hydration during activity, based on the intensity and duration of the activity and prevailing environmental conditions; and 3) a clear administrative chain of responsibility and protocol for responding to injury or illness.

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Editorial Note: Rhabdomyolysis is a natural consequence of vigorous physical activity. In persons unaccustomed to regular physical activity, rhabdomyolysis may be extensive, and renal impairment may occur, especially when dehydration or acidosis are also present (*1*). Dehydration alone can also cause impaired renal function by decreasing renal perfusion. These problems have been recognized among military personnel, long-distance runners, and other athletes (*2–6*). However, exercise-related rhabdomyolysis and renal impairment have not been previously described in the groups involved in this report.

The circumstances in Massachusetts resemble those in military recruit training programs (i.e., young men of varying levels of physical fitness who begin sustained strenuous exercise in moderately warm outdoor conditions). In contrast, the outbreak in the NYC firefighter candidates was associated with an indoor temperature-controlled environment, and the exercise was brief (≤7 minutes) in duration. Only one other outbreak of exertional rhabdomyolysis has been reported following a short exercise period (<10 minutes) in an indoor setting (*4*).

In Massachusetts, neither the ambient temperature nor humidity were markedly elevated (apparent temperature: 75–80 F [24–27 C]). Thus, the outbreak underscores the need to assure adequate hydration during exercise regardless of the temperature. Exercise physiologists recommend that, in addition to normal water replacement, an additional 250 mL of fluids is needed for every 15–20 minutes of exercise (*7*). Based on ambient dry bulb temperatures and relative humidity (Figure 1), nomograms have been developed to aid participants and persons responsible for groups involved in exercise during warm weather. Special efforts to assure hydration may be necessary when the apparent temperature approaches 80 F (27 C).

The substantial difference in the hospitalization rates in NYC (0.2%) and Massachusetts (26%) probably reflects a variety of factors, including environmental conditions and types of exercise. In both outbreaks, however, level of physical fitness appeared to influence the risk for illness. High levels of physical fitness may be protective through increased muscle conditioning, accelerated heat acclimatization, and reduction of postexertional myoglobinemia (*2,8–10*). Thus, findings from both outbreaks support the general recommendation that persons who plan to engage in

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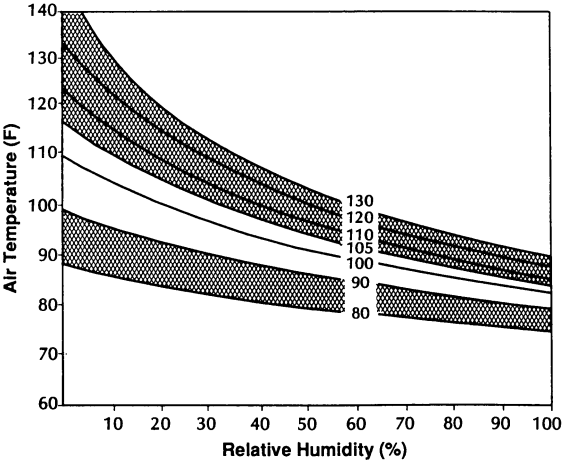
extreme muscle exertion should first participate in a preconditioning program to improve their physical fitness.

Although the NYC investigation suggested that having an acute and/or chronic medical condition placed candidates at a higher risk for rhabdomyolysis and/or renal impairment, these findings should be interpreted with caution because case-patients may have been more likely than controls to report illness; consequently, their underlying conditions were more likely to be detected through medical record review. Certain conditions (e.g., viral illnesses, cocaine and aspirin abuse, and prior history of heat exhaustion) increase the risk for rhabdomyolysis and/or renal impairment (*1,11*). Sickle cell trait has been associated with an increased risk for sudden death during exertion (*12*). However, the absolute risk for sudden death is low, and persons with sickle cell trait should not be excluded, on that basis alone, from employment requiring maximal physical exertion (*13*). Based on this investigation and others (*1,11*), persons with infectious diseases should be advised to postpone testing until their illness has resolved; those with metabolic abnormalities should participate only with medical supervision; those with substance-abuse problems should be referred for appropriate treatment.

In NYC, the increasing risk for illness despite successive implementation of preventive measures suggests that the effectiveness of case-finding improved and that severe rhabdomyolysis and renal impairment among participants in similar programs might occur more frequently than previously suspected. The increasing risk also suggests that the preventive measures could have been inadequate. Prior studies suggested that the measures were appropriate; however, those studies (*1–7*) were of

FIGURE 1. Apparent temperature (F) (heat index)* as a function of ambient air temperature and relative humidity



Source: National Weather Service Bureau, New York, New York.

*With prolonged exposure and physical activity, heat syndromes for each apparent temperature range may occur as follows: 80–89 F (27–32 C)—fatigue possible; 90–104 F (32–40 C)—sunstroke, heat cramps, and heat exhaustion possible; 105–129 F (41–54 C)—heat cramps or heat exhaustion likely, heatstroke possible; ≥130 F (>54 C)—heatstroke or sunstroke imminent.

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persons engaged in exertion of much longer duration than the NYCFD candidates. The effect of measures to reduce or prevent exertional phenomena after short-duration activities needs to be clarified.

In the United States, there are an estimated 800,000 police officers (*14*) and 203,000 paid and 500,000 volunteer firefighters (Federal Emergency Management Agency, National Fire Academy, unpublished data, 1989). Among these workers, fitness testing is used increasingly as a criterion for job entry and for job retention (International Association of Fire-Fighters, personal communication, 1989). The need for physical performance testing must be balanced carefully with the safety of persons participating in the testing; the National Fire Protection Association (NFPA) is developing new standards for fitness testing of firefighters. Physicians and other providers who monitor the health of these persons or who serve as occupational health consultants to fire and police departments, their unions, training academies, or advisory groups (e.g., the NFPA) should be aware of these potential problems.

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Current Trends

Update: St. Louis Encephalitis — Florida and Texas, 1990

In July 1990, active surveillance of national arboviral transmission patterns indicated that outbreaks of St. Louis encephalitis (SLE) might occur in Florida and in Houston and Harris County, Texas (*1*). Subsequently, a cluster of cases was reported

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MORBIDITY AND MORTALITY WEEKLY REPORT

Epidemiologic Notes and Reports

Typhoid Fever – Skagit County, Washington

In June and July 1990, an outbreak of typhoid fever occurred in Skagit County, Washington, following a family gathering of 293 people from five states. This report provides a preliminary summary of the investigation of this outbreak by the Skagit County and Washington State departments of health.

Based on interviews of 257 attendees, 17 (6.6%) of these persons developed an illness that met the case definition for probable or confirmed typhoid fever*. Blood cultures were obtained from seven case-patients and from three other symptomatic persons; four of these yielded *Salmonella typhi*. Stool specimens from nine case-patients and six asymptomatic persons yielded *S. typhi*. The 17 case-patients ranged in age from 1 to 50 years; eight were male. Fourteen were from Washington, and three, from California. The mean incubation period was 16.1 days (range: 7–27 days); mean duration of illness was 19.7 days (range: 7–35 days). Two case-patients were hospitalized and treated with systemic antibiotics.

The investigation indicated that consumption of three food items served during the gathering was associated with risk for illness. A foodhandler who prepared one of the implicated food items had an *S. typhi*-positive stool culture and an elevated antibody titer (1:80) to the Vi antigen, suggesting chronic carriage of *S. typhi*. No other suspected carriers were identified.

To prevent secondary transmission of *S. typhi* associated with this outbreak, the county and state health departments implemented several measures from July 30 to August 17, including 1) widely disseminating information about typhoid fever and its prevention; 2) recruiting local family members to assist with case finding and disease-control efforts by asking them to contact family members and friends who had attended the gathering; 3) culturing stool samples from household contacts of infected persons, foodhandlers who had worked at the gathering, and other attendees who had jobs as foodhandlers; 4) excluding selected persons (foodhandlers who worked at the gathering, attended the gathering, or cultured positive for *S. typhi*) from foodhandling until three consecutive negative stool cultures were obtained; and

*Probable case: illness of ≥7 days in a person present at the family gathering who had subjective or objective fever, beginning 1–4 weeks after June 23, 1990, with three other symptoms characteristic of typhoid fever. Confirmed case: illness in a person that met the above definition and a culture of blood or stool positive for *Salmonella typhi*.