Improving Cardiovascular Health and Fitness

By Shawn Perry
How do we as firefighters define and measure our cardiovascular health and fitness? How do we determine if we are fit and healthy enough to perform the demands of our profession and survive?

Traditional fire service, military, and other public safety entities emphasize performance-based protocols (i.e., timed running events) to evaluate cardiovascular health and fitness. This may be a commonsense and an economical approach for evaluating cardiovascular fitness early in our careers, but risk profiles change with aging. Relying on activity-based cardiovascular assessments becomes problematic at best and dangerous (even deadly) at worst.

Age, injury accumulation, heredity, and lifestyle take their toll, particularly in our profession as we face unpredictable and extraordinary physical demands under very stressful conditions. As our careers progress, however, our effectiveness shifts from relying on peak physical capabilities to more refined skills and efficient operations. It’s called experience, a natural evolution that allows us to survive our profession for two to three decades.

To a certain extent, elite athletes attempt to do the same through advanced training methods, sound nutritional practices, and continued skill refinement. Brett Favre certainly is no longer at his physical peak, but he had one of the best seasons of his career in his late 30s. We may find this exceptional for a professional athlete, but in fire service terms, Brett Favre might only be halfway through his career!

CARDIOVASCULAR HEALTH VS. CARDIOVASCULAR FITNESS

When we discuss heart attacks (the number-one cause of firefighter line-of-duty deaths, at 47 percent annually), we are really talking about a catastrophic failure resulting from a chronic deteriorating condition. Contrary to popular descriptions, heart attacks are generally not a result of overexertion (a fitness issue); they result from poor cardiovascular health that has developed in the individual firefighter over many years. Although the terms “cardiovascular health” and “cardiovascular fitness” are often used interchangeably, they have very different meanings and evaluation criteria.

Cardiovascular fitness is defined by measuring an individual’s work output (sub-maximal) over a period of time through a controlled exercise modality (i.e., running on a treadmill, step test, etc.). Physicians and exercise physiologists measure our performance over time and interpret that information as our ability to use oxygen (O₂). This performance type is very different from a maximal power measurement, such as weight lifting or performing a short sprint. These short-burst activities use the anaerobic (without O₂) energy systems and do not necessarily correlate with cardiovascular health or fitness. A high level of aerobic/cardiovascular fitness, however, will enhance recovery time between anaerobic activities.

The body’s O₂ use is measured in milliliters of O₂ per kilogram of body weight per minute (ml/O₂/kg/min). In other words, no matter what your size, you are assessed according to your ability to produce based on your weight, which is why running is one of the most common methods of measuring O₂ use.

Based on performance studies involving both specific firefighting activities and general activities such as running, the consensus among physicians and exercise physiologists is that firefighters need to be able to use 42 to 44 ml/O₂/kg/min. This performance parameter allows us to perform our duties effectively yet retain a reserve capacity for extended work periods or sudden maximal exertion. In running terms, this equates to jogging at an eight-minute-mile pace for 1½ miles (12 minutes total).

Note: Do not go out and time yourself on a track today unless you are fit and have been running. Running performance...
is not necessarily an accurate or direct predictor of fireground performance capabilities. It may have relevance, but running does not cover all the various activities and associated muscular demands on the human body while firefighting.

The health component of cardiovascular assessment describes the functional condition of all the components of the cardiovascular system (heart, lungs, and vascular network); it's the ABCs (airway, breathing, circulation) of the body. For engineers, it's like an air-intake system, the pump, and the hose. If you have a large air-intake capacity (lungs), a big pump (heart), and large-diameter hose (vascular system), you can produce a lot of work without permanently damaging your body. You may still reach a point of maximum work capacity (physical exhaustion), but ultimately you will recover and survive the event. People who win marathons don't die at the finish line.

Medically based assessments of the cardiovascular system include measuring electrical heart functions (ECG), narrowing and hardening of the vascular walls, and blood lipid levels. Medical screening tools, such as a resting 12-lead electrocardiogram, various blood panels, and more invasive procedures (chest x-rays, heart scans), may reveal medical issues that require a more complex and monitored approach to correcting a dangerous situation.

Poor cardiovascular fitness ultimately leads to poor cardiovascular health. However, good cardiovascular fitness does not guarantee a clean bill of health. A firefighter may be able to run a marathon, but conditions including heredity, lifestyle choices, job exposures, stress, and hidden cancers may take a silent toll that can still lead to poor cardiovascular health. There are no guarantees, but we must subscribe to the proven concept that addressing cardiovascular fitness gives us the best probability of supporting cardiovascular health.

**READY! SET! HOLD ON!**

You may be ready, or at least motivated, to fly out the door and do stadium stairs, and exercise is definitely a part of the “success equation,” but you need to evaluate yourself first. Unless you are 25 years old and fresh out of the academy (where you ran six-minute miles), you must visit with your physician for a basic medical exam that includes the following:
1. A review of your family medical history, including physical and cultural heredity.
2. A basic orthopedic exam (bone, muscle, connective tissue, joints, etc.).
3. Physiological parameters (blood pressure, heart rate, resting 12-lead ECG).
5. Blood lipid profile (cholesterol).
6. If you are over age 40 or if you have existing medical conditions such as hypertension, do a graded exercise sub-maximal treadmill test with a 12-lead ECG. You might need to push for this test with your physician.

If you are older and have issues that preclude you from running, or you simply hate to run, some other options that will bring similar desired results include power walking, biking and spin classes, swimming, aerobics, hiking, elliptical training, and rowing. These standard options and other modalities certainly exist, but the common features are based on a generally accepted definition of cardiovascular exercise among exercise physiologists.

Cardiovascular exercise is generally defined as using the major muscle groups of the body in a continuous motion for at least 20 minutes. This fundamental definition has existed for a few decades and stands as the reference for improving and maintaining cardiovascular fitness. However, there are recent studies that also conclude that shorter bouts of intermittent exercise throughout the day can have a positive effect on the cardiovascular system. The message is that "some is better than none," and our nation needs to seriously address some level of commitment to prevention through exercise and better nutrition, especially for firefighters.

**ESTIMATING APPROPRIATE EFFORT AND INTENSITY**

Cardiovascular exercise intensity is commonly determined by measuring heart rate. Your target heart rate during exercise should be anywhere between 60 and 80 percent of your estimated maximum heart rate. Your maximum theoretical heart rate is calculated by subtracting your age from 220. For example, a 40-year-old person has a theoretical maximum heart rate of 220 minus 40, or 180 beats per minute. Multiply this estimate by 60 to 80 percent, and you have a target heart rate of between 108 and 144 beats per minute during your exercise session. Each person is different, however, and these figures will vary among individuals.

**HOW WE IMPROVE**

No matter what your age, if you make an appropriate effort to improve your condition, your body will respond positively. You may not embrace the initial physical discomfort, but eventually this subsides and gives way to a feeling of empowerment and self-control; you stop being a passive victim of our profession and you take control of your life.

Each cell in your body is under constant reconstruction/replacement. Most of your body's cells today will be gone and replaced in three to six months. In fact, your body produces and replaces approximately two million red blood cells per second! The point is that each replaced cell can be influenced by your activity level and what you eat. The energy-producing component of each cell in your body is the mitochondria. Mitochondria combines $O_2$ and sugar (CHO) to produce energy, carbon dioxide ($CO_2$), and water ($H_2O$).

Each cell contains varying numbers of mitochondria. Muscle cells, including the heart, have extremely high mitochondria concentrations when compared with other cells in the body because of the constantly produced work. A person in poor cardiovascular condition has a lower concentration of mitochondria per cell than a fit person. Exercising sends your brain a message to crank up the number of powerhouses per cell. This is only one example of the many positive physiological changes that occur when you place physical demands on your body.

Some physical benefits include improving your heart's stroke volume (the amount of blood pumped by the right/left ventricle of the heart in one contraction), your vascular system's elastич-
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ity and diameter, and your lung’s capacity for absorbing \( \text{O}_2 \) and releasing \( \text{CO}_2 \). Yes, your heart, hose, and air intake can actually enlarge over time, thus reducing blood pressure and heart rate at any activity level while also increasing work output.

BASIC TRAINING STRATEGIES AND TIPS

Base your exercise prescriptions on the “reverse engineering” principle. Cardiovascular health poses our greatest risk for death and disability and thus must be our first priority. If you buy in to this survival strategy, the following training principles will likely bring success:

1. Perform cardiovascular exercises three to five days per week and for a minimum of 20 minutes per session at a level at which you can have a conversation with some difficulty. If you are gasping for breath, slow down.

2. Choose exercises that match your interest and physical capabilities. Walking and jogging are popular, natural choices but may not necessarily be appropriate based on your orthopedic health.

3. Vary your routine to include inclines and variable speeds/intensities. As an exercise physiologist and personal human experiment, I believe the following weekly routine to be extremely effective at improving and maintaining an appropriate level of firefighter cardiovascular fitness:
   - One session of long, slow distance.
   - One session of interval training (variations in speed from fast to slow to fast, etc.).
   - One session of incline-based training.

   • In addition to your normal routine, you can also do “tempo run.” This entails walking/running a shorter distance (20 to 30 minutes) at a brisk pace.

Avoid competitive sports as part of your exercise program. The probability of injury increases exponentially. A friendly game of basketball among firefighters really isn’t possible after about the first minute; we just aren’t built to be passive.

The fire service recognizes that our greatest threat to survival is not what Hollywood might portray. Our profession has slowly but steadily improved training, equipment, and fireground strategy.

Annual firefighter injury and fatality statistics clearly portray that we continue to make little to no measurable progress regarding cardiovascular issues. The solution isn’t rocket science, and in the end a positive cultural shift and accepting personal responsibility for our health and fitness are key ingredients. If you are committed to a firefighter’s oath, addressing your health and fitness is simply an extension of that commitment you made to the public you swore to serve and your fellow firefighters who depend on you.

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COURSE EXAMINATION

To receive credit and your certificate of completion for participation in this educational activity, you must complete the program post examination and receive a score of 70% or better. You have the following options for completion.

Option One: Online Completion
Use this page to review the questions and mark your answers. Return to www.FireEngineeringUniversity.com and sign in. If you have not previously purchased the program, select it from the “Online Courses” listing and complete the online purchase process. Once purchased, the program will be added to your User History page where a Take Exam link will be provided. Click on the “Take Exam” link, complete all the program questions, and Submit your answers. An immediate grade report will be provided and on receiving a passing grade your “Certificate of Completion” will be provided immediately for viewing and/or printing. Certificates may be viewed and/or printed anytime in the future by returning to the site and signing in.

Option Two: Traditional Completion
You may fax or mail your answers with payment to PennWell (see Traditional Completion Information on following page). All information requested must be provided to process the program for certification and credit. Be sure to complete ALL “Payment,” “Personal Certification Information,” “Answers,” and “Evaluation” forms. Your exam will be graded within 72 hours of receipt. On successful completion of the post test (70% or higher), a “Certificate of Completion” will be mailed to the address provided.

COURSE EXAMINATION

1. A timed running event is considered a:
   a. proportion-based protocol.
   b. stress-protocol.
   c. performance-based protocol.
   d. stress-based program

2. High risk profiles change with:
   a. age.
   b. weight.
   c. diet.
   d. workload.

3. As careers progress, however, our effectiveness shifts from relying on peak physical capabilities to:
   a. knowledge.
   b. more refined skills and efficient operations.
   c. the effectiveness of others.
   d. none of the above

4. According to the course, the number one cause of line of duty deaths among firefighters is:
   a. blunt trauma.
   b. crushing.
   c. burns.
   d. heart attacks.

5. Measuring an individual’s work output over a period of time through a controlled exercise modality is known as:
   a. cardiovascular fitness.
   b. cardiovascular health.
   c. both a. and b.
   d. neither a. or b.

6. Weight lifting is an example of:
   a. cardiovascular fitness.
   b. maximal power measurement.
   c. an increasing factor.
   d. strength dissection.

7. The body’s O₂ use is measured in:
   a. milliliters of O₂ per kilogram of body weight per second.
   b. milliliters of O₂ per kilogram of body weight per minute.
   c. millimeters of O₂ per kilogram of body weight per minute.
   d. millimeters of O₂ per kilogram of body weight per second.

8. The consensus among physicians and exercise physiologists is that firefighters need to be able to use:
   a. 42 to 44 ml/O₂/kg/min.
   b. 44 to 46 ml/O₂/kg/min.
   c. 40 to 42 ml/O₂/kg/min.
   d. 46 to 48 ml/O₂/kg/min.

9. The cardiovascular system is the:
   a. heart.
   b. lungs.
   c. vascular network.
   d. all of the above.

10. Poor cardiovascular health can result from:
    a. heredity.
    b. lifestyle choices.
    c. both a. and b.
    d. neither a. or b.

11. An examination of the bones, muscle, and connecting tissue is an:
    a. endoscopic exam.
    b. anterior exam.
    c. orthopedic exam.
    d. allusion exam.

12. Your target heart rate during exercise should be what percent of your maximum heart rate?
    a. 50% – 60%.
    b. 40% - 50%.
    c. 60% - 70%.
    d. none of the above
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13. Mitochondria combines O2 and sugar (CHO) to produce:
   a. energy.
   b. carbon dioxide.
   c. water.
   d. all of the above

14. The amount of blood pumped by the right/left ventricle of the heart in one contraction is known as the heart:
   a. stroke volume.
   b. lift rate.
   c. performance stroke.
   d. none of the above

15. According to the course, cardiovascular exercises should be conducted:
   a. twice a week.
   b. three to five days per week.
   c. four to five days per week.
   d. every day.

16. Cardiovascular exercise should be a minimum of:
   a. 10 minutes.
   b. 20 minutes.
   c. 30 minutes.
   d. 45 minutes.

17. A “tempo run.” entails walking/running a shorter distance at a brisk pace for:
   a. 20 – 30 minutes.
   b. 25 – 35 minutes.
   c. 30 – 45 minutes.
   d. 10 minutes.

18. You should do a graded exercise sub-maximal treadmill test with a 12-lead ECG if you are over:
   a. 35.
   b. 40.
   c. 45.
   d. 50.

19. Blood lipid profile is known as:
   a. blood pressure.
   b. heart rate.
   c. cholesterol.
   d. blood volume.

20. Most of your body’s cells today will be gone and replaced in:
   a. three to six months.
   b. three to six weeks.
   c. two to four months.
   d. two to four weeks.

Notes
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PROGRAM COMPLETION INFORMATION
If you wish to purchase and complete this activity traditionally (mail or fax) rather than Online, you must provide the information requested below. Please be sure to select your answers carefully and complete the evaluation information. To receive credit, you must answer at least six of the eight questions correctly.

Complete online at: www.FireEngineeringUniversity.com

PERSONAL CERTIFICATION INFORMATION:

Last Name (PLEASE PRINT CLEARLY OR TYPE)

First Name

Profession/Credentials License Number

Street Address

Suite or Apartment Number

City/State Zip Code

Daytime Telephone Number with Area Code

Fax Number with Area Code

E-mail Address

TRADITIONAL COMPLETION INFORMATION:
Mail or fax completed answer sheet to Fire Engineering University, Attn: Carroll Hull, 1421 S. Sheridan Road, Tulsa OK 74112
Fax: (918) 831-9804

PAYMENT & CREDIT INFORMATION
Examination Fee: $25.00      Credit Hours: 4

Should you have additional questions, please contact Pete Prochilo (973) 251-5053 (Mon-Fri 9:00 am-5:00 pm EST).

❑ I have enclosed a check or money order.
❑ I am using a credit card.
❑ American Express   ❑ Visa   ❑ MC   ❑ Discover

Please provide the following (please print clearly):

Please provide the following (please print clearly):

Exact Name on Credit Card

Credit Card # Expiration Date

Signature

ANSWER FORM
Please check the correct box for each question below.

1. ❑ A ❑ B ❑ C ❑ D
2. ❑ A ❑ B ❑ C ❑ D
3. ❑ A ❑ B ❑ C ❑ D
4. ❑ A ❑ B ❑ C ❑ D
5. ❑ A ❑ B ❑ C ❑ D
6. ❑ A ❑ B ❑ C ❑ D
7. ❑ A ❑ B ❑ C ❑ D
8. ❑ A ❑ B ❑ C ❑ D
9. ❑ A ❑ B ❑ C ❑ D
10. ❑ A ❑ B ❑ C ❑ D

COURSE EVALUATION
Please evaluate this course by responding to the following statements, using a scale of Excellent = 5 to Poor = 1.

1. To what extent were the course objectives accomplished overall? S 4 3 2 1
2. Please rate your personal mastery of the course objectives. S 4 3 2 1
3. How would you rate the objectives and educational methods? S 4 3 2 1
4. How do you rate the author's grasp of the topic? S 4 3 2 1
5. Please rate the instructor's effectiveness. S 4 3 2 1
6. Was the overall administration of the course effective? S 4 3 2 1
7. Do you feel that the references were adequate? Yes No
8. Would you participate in a similar program on a different topic? Yes No
9. If any of the continuing education questions were unclear or ambiguous, please list them.

10. Was there any subject matter you found confusing? Please describe.

11. What additional continuing education topics would you like to see?

USE THIS ANSWER SHEET FOR ADDITIONAL PARTICIPANTS.