



## Fire Fighter Dies After Responding to a Call – New York

### SUMMARY

On February 6, 2005, a 31-year-old male volunteer Fire Fighter (FF) responded to his station during a 911 call for smoke in the basement of a residence. After arriving at his fire station, he waited for a volunteer driver/operator to drive the engine to the scene. In the meantime the First Assistant Chief (FAC) responded directly to the scene and determined that an over-tightened steam valve had caused the problem. He notified Dispatch to hold all equipment in station. The FF, hearing the message over the radio, apparently began to leave the station and walk toward his vehicle when he suffered an unwitnessed collapse. About 36 minutes later, a civilian driving by the fire station noticed the FF lying just inside the station and notified 911. Despite cardiopulmonary resuscitation (CPR) and advanced life support (ALS) performed by ambulance paramedics and hospital emergency department (ED) personnel, the FF died. The death certificate and autopsy, completed by the Medical Examiner, listed “acute intoxication by the combined effects of propoxyphene (Darvon®) and cyclobenzaprine (Flexeril®)” as the cause of death and “hypertension” as another condition. The NIOSH investigator, like the medical examiner, concluded the FF died due to a drug intoxication, but cannot rule out the possibility of a cardiac arrhythmia associated with his hypertensive heart disease and subsequent left ventricular hypertrophy (LVH).

NIOSH investigators offer the following recommendations to prevent similar incidents or to address general safety and health issues:

*Ensure members are knowledgeable of, and comply with, fire department requirements regarding reporting any medical condition that could interfere with their ability to safely perform essential job tasks.*

*Ensure that fire fighters are cleared for duty by a physician knowledgeable about the physical demands of fire fighting, the various components of NFPA 1582, Standard on Comprehensive Occupational Medicine Program for Fire Departments, and the US Department of Transportation (DOT), Physical Qualifications for Drivers.*

*Provide pre-placement and annual medical evaluations to fire fighters in accordance with NFPA 1582 to determine their medical ability to perform duties without presenting a significant risk to the safety and health of themselves or others.*

*Consider conducting exercise stress tests for male fire fighters with two or more risk factors for coronary artery disease.*

The **Fire Fighter Fatality Investigation and Prevention Program** is conducted by the National Institute for Occupational Safety and Health (NIOSH). The purpose of the program is to determine factors that cause or contribute to fire fighter deaths suffered in the line of duty. Identification of causal and contributing factors enable researchers and safety specialists to develop strategies for preventing future similar incidents. The program does not seek to determine fault or place blame on fire departments or individual fire fighters. To request additional copies of this report (specify the case number shown in the shield above), other fatality investigation reports, or further information, visit the Program Website at

[www.cdc.gov/niosh/fire](http://www.cdc.gov/niosh/fire)  
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*Phase in a mandatory wellness/fitness program for fire fighters to reduce risk factors for cardiovascular disease and improve cardiovascular capacity.*

*Perform an annual physical performance (physical ability) evaluation to ensure fire fighters are physically capable of performing the essential job tasks of structural fire fighting.*

### **INTRODUCTION & METHODS**

On February 6, 2005, a 31-year-old male FF experienced sudden death after responding to a call. Despite CPR and ALS performed by ambulance and hospital ED personnel, the FF died. NIOSH was notified of this fatality on February 8, 2005, by the United States Fire Administration. NIOSH contacted the affected fire department (FD) on February 8, 2005, to obtain further information, and on August 5, 2005, to initiate the investigation. On August 15, 2005, a Safety and Occupational Health Specialist from the NIOSH Fire Fighter Fatality Investigation and Prevention Team traveled to New York to conduct an on-site investigation of the incident.

During the investigation NIOSH personnel met and/or interviewed the following people:

- Fire Chief
- Assistant Chief
- School District Superintendent (The FF was a school bus driver.)

During the site visit NIOSH personnel reviewed the following documents:

- FD incident reports
- Primary care physician (PCP) records
- Occupational physical exam records
- Ambulance report

- Hospital ED report
- Death certificate
- Autopsy

### **INVESTIGATIVE RESULTS**

On February 6, 2005, the FF responded to his fire station at about 1000 hours to assist the Fire Chief and another FF in assembling a gear rack. Finding insufficient parts, the crew departed the station and went their separate ways. The FF did not express any heart-related symptoms or any other health problems at that time.

At 1110 hours the FD was dispatched to a 911 call for smoke in the basement of a residence. The FF responded to Station 2 and awaited a FD apparatus driver/operator. While the FF was waiting, the First Assistant Chief (FAC) responded directly to the scene, arriving at 1114 hours. The FAC conferred with the homeowner and found that an over-tightened steam valve had caused the problem. The FAC advised Dispatch to hold all FD equipment (1118 hours). No other fire fighter arrived at Station 2, and the FF apparently began to leave the station when he suddenly collapsed. Due to the location and configuration of the station where the FF collapsed, he went unnoticed for about 36 minutes (1154 hours) until a civilian passing by the station saw the collapsed FF and called 911.

An ambulance and a paramedic unit were dispatched at 1156 hours and arrived on the scene at 1158 hours. Initial assessment revealed the FF was unresponsive, pulseless, and breathing apnally (abnormal pattern of breathing characterized by shallow, slow [3–4 per minute], irregular inspirations followed by irregular pauses). CPR was begun and oxygen was administered via bag-valve mask. Cardiac monitoring revealed asystole



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(no heart beat). The FF was intubated (breathing tube inserted into the trachea) and proper tube placement was confirmed via auscultation of bilateral breath sounds and end-tidal carbon dioxide testing, a secondary technological test consistent with American Heart Association protocols.<sup>1</sup> Three attempts to establish intravenous (IV) access were unsuccessful. Due to the laceration on his head indicating a possible head/spinal injury, ambulance personnel applied a cervical collar to stabilize his head and neck. He was placed onto a stretcher and into the ambulance, which departed the scene at 1209 hours en route to the local hospital's ED. ALS medications were initially administered via endotracheal tube until IV access was obtained on the fourth attempt. Then ALS medications were given via IV, however this did not change the FF's clinical status.

Cardiac pacing via an external pacemaker was unsuccessful.

The ambulance arrived at the hospital ED at 1223 hours. Inside the ED, ALS resuscitation measures were continued. After a total of 45 minutes of CPR and ALS in the ED, there was no improvement in the FF's condition. At 1243 hours, the attending physician pronounced the FF dead, and resuscitation measures were discontinued.

*Medical Findings.* The death certificate and autopsy completed by the Medical Examiner listed "acute intoxication by the combined effects of propoxyphene (Darvon®) and cyclobenzaprine (Flexeril®)" as the cause of death and "hypertension" as an "other" condition.

The autopsy, performed on February 7, 2005, included the following findings:

- Acute intoxication by the combined effects of propoxyphene and cyclobenzaprine CAD:

- Propoxyphene (Darvon®) blood level of 3.3 micrograms per milliliter (mcg/mL) and Norpropoxyphene blood level of 9.0 mcg/mL
- Cyclobenzaprine (Flexeril®) blood level of 90 nanograms per milliliter (ng/mL) and Norcyclobenzaprine with a positive blood level
- Hypertensive cardiovascular disease:
  - Left ventricular hypertrophy (LVH)(left ventricle wall thickness 1.5 centimeters [cm]) [normal 0.6cm–1.1cm]),<sup>2</sup>
  - Cardiomegaly (heart weight 500 grams [normal < 400 grams])<sup>3</sup>
- No evidence of atherosclerotic coronary artery disease (CAD)
- No evidence of pulmonary embolus

Microscopic examination of the heart revealed myocyte hypertrophy (consistent with mild hypertensive cardiomyopathy) but no infarcts or myocarditis. The autopsy did not mention "myocytes in disarray," which is diagnostic of hypertrophic cardiomyopathy.

At autopsy, the FF weighed 270 pounds and was 72 inches tall, giving him a body mass index (BMI) of 36.6 kilograms per square meter (kg/m<sup>2</sup>). A BMI 30 kg/m<sup>2</sup> and over is considered obese.<sup>4</sup> The FF had the following medical conditions:

- Family history of CAD
- Hypertension (diagnosed in 1992) that was poorly controlled by prescription medication
- High blood lipids (diagnosed in 1994) that were moderately controlled with prescription medication

During a 1994 fire department medical evaluation, the FF listed a previous back injury (pulled muscles). In 2000 and 2001 the FF suffered



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additional back injuries and was prescribed medications including narcotics for chronic pain management. Records from medical evaluations for Sheriff's Department corrections officer (2001), Fire Department (2003), and County School District bus driver (2003 and 2004) did not mention the back injuries nor the pain medications. Bus driver medical examinations are based on the requirements of the Department of Transportation's commercial driver's license.<sup>5</sup>

In July 2004, the FF was evaluated at the ED for chest pain. Blood tests for cardiac isoenzymes were negative for a heart attack. Subsequent medical work-up for possible CAD included an exercise stress test (EST). The FF exercised for 6 minutes, 39 seconds using the Bruce protocol,<sup>6</sup> achieving a work level of 7.9 metabolic equivalents (METs) and a maximum heart rate of 112 beats per minute (59% of the maximal age-predicted heart rate). No reason was given on the EST report as to why the EST was stopped, but his heart rate response was probably muted due to his taking a beta blocker for hypertension. His resting blood pressure was 108/78 mmHg, which rose to 160/90 mmHg during exercise. No chest pain and no ischemic changes were found on the EKG, and no arrhythmias were identified. Despite only exercising for 6½ minutes and only reaching 59% of his target heart rate, the EST was deemed negative, and the FF was advised to follow up with his PCP in 1–2 days. His PCP felt the chest pain was most likely muscular in origin.

According to crew members, the FF was active but did not perform regular strenuous exercise. He had no recent complaints of cardiac symptoms, other than the chest pain experienced in 2004.

## **DESCRIPTION OF THE FIRE DEPARTMENT**

At the time of the NIOSH investigation, this volunteer FD consisted of 45 uniformed personnel, served a population of 15,000 in a 54 square mile area, and had two fire stations.

In 2004, the FD responded to 523 calls including the following: 28 structure fires, 22 vehicle fires, one wildland fire, six trash/dumpster fires, 13 other fires, 88 rescue calls, 98 hazardous condition calls, 31 service calls, 40 good intent calls, 194 false alarm calls, and two flood calls.

The FF had responded to two other calls within 24 hours of the call involving this incident, a standby call on February 5, 2005 at 1552 hours and a motor vehicle crash at 2032 hours.

Membership and Training. The FD requires all fire fighter applicants to possess a valid state driver's license; interview with the membership committee; and pass a pre-placement medical evaluation, complete a self-contained breathing apparatus course, and pass a practical test prior to being selected for membership. The member is then placed on 1 year probation. Probationary fire fighters may not conduct interior structural fire fighting unless they possess a voluntary State Fire Fighter 1 certification. There are no State minimum standards for volunteer fire fighters. New York is an Occupational Safety and Health Administration (OSHA) State-plan State, and paid and volunteer fire departments are required to comply with OSHA standards.

The FF was certified as a Fire Fighter 1, Fire Officer 1, and at the awareness level for hazardous materials. He had 16 years of fire fighting experience.



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*Pre-placement Physical Examination.* A pre-placement physical examination is required by this FD for all applicants, including transfers. Components of the examination include the following:

- Complete medical history
- Physical examination
- Vital signs
- Vision screening
- Audiogram
- Urinalysis
- Resting electrocardiogram (EKG)
- Tuberculosis Mantoux test
- Chest x-ray if medically necessary
- Blood work if urinalysis indicates medical necessity
- OSHA respirator clearance for interior structural fire fighters only

The examinations are performed by a City-contracted physician who makes the final determination for fitness for duty.

*Periodic Evaluations.* Periodic medical evaluations are required for all members. The components are the same as the pre-placement physical examination. The frequency of the evaluation is determined by the member's age and position. The evaluations are performed by a City-contracted physician who makes the final determination for fitness for duty. SCBA clearance is performed for interior structural fire fighters only. Return-to-duty medical clearance is required for injuries that prevent fire fighters from performing their duty. The fire fighter's personal physician provides the medical clearance. Illnesses are not covered under the current policy.

*Physical Ability and Wellness/Fitness.* A periodic physical agility/ability test is not required. Voluntary wellness/fitness programs are available at this FD. The FD pays for membership tickets to a local health club but participation and the exercise regimen are voluntary.

## **DISCUSSION**

Propoxyphene (Darvon®) is a narcotic analgesic that has been in clinical use since 1963. It is somewhat less potent than codeine, and bears a close structural relationship to methadone. It is available in oral formulations either as the hydrochloride (Propoxyphene HCl) or the napsylate salt (Propoxyphene N [Darvocet-N®]). Both formulations are often combined with aspirin or acetaminophen. Daily therapeutic oral doses of propoxyphene range from 128 – 390 mg for Propoxyphene HCl and from 200 – 600 mg for Propoxyphene N.<sup>7</sup> The FF had been prescribed both Propoxyphene HCl 65 mg (take 1 capsule every 6 hours as needed) and Propoxyphene-N 100 mg with acetaminophen 650 mg (take 1 tablet every 12–24 hours as needed). The Darvon® prescription was last filled in September 2004 and the Darvocet-N® was last filled in January 2005.

Propoxyphene is metabolized to norpropoxyphene, which is one fourth to one half as active an analgesic as propoxyphene, but accumulates in blood plasma due to a longer half-life. The contribution of norpropoxyphene to the efficacy or toxicity of the parent drug has not been thoroughly established.<sup>7,8</sup> Propoxyphene has the usual respiratory depressant effects common to all beta-agonist narcotics.<sup>8</sup> Overdosage with propoxyphene can result in stupor, coma, convulsions, respiratory depression, cardiac arrhythmias, hypotension, pulmonary edema, and circulatory collapse.



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Following a single 130 mg oral dose of propoxyphene HCl, plasma concentrations reach 0.23 milligrams per liter (mg/L) at 2 hours, while the plasma concentration of its metabolite (norpropoxyphene) reaches 0.27 mg/L at 4 hours. Chronic daily doses of 195 mg of propoxyphene HCl were shown to produce average plasma concentrations of 0.42 mg/L propoxyphene and 1.45 mg/L norpropoxyphene 2 hours after the last administration.<sup>7</sup>

Generally, blood propoxyphene concentrations exceeding 1 mg/L are considered indicative of serious toxicity, and concentrations of 2 mg/L or more are consistent with death. However, fatalities have been reported with blood propoxyphene concentrations < 1 mg/L.<sup>7</sup> Seven acutely intoxicated patients who survived due to hospital treatment were found to have average plasma propoxyphene and norpropoxyphene concentrations of 1.6 mg/L and 2.0 mg/L respectively.<sup>7</sup> In another report of 72 cases in which acute propoxyphene overdose was the sole cause of death, postmortem femoral blood concentrations averaged 2.8 mg/L (range, 1.3 – 8.1). In most specimens norpropoxyphene concentrations exceed those of propoxyphene.<sup>7</sup> This FF had a propoxyphene (Darvon®) blood level of 3.3 mcg/mL (3.3 mg/L) and norpropoxyphene blood level of 9.0 mcg/mL (9.0 mg/L). Both results were well above the therapeutic level, and in the range associated with lethal intoxication.

Cyclobenzaprine, a centrally-acting skeletal muscle relaxant, has been available since 1977. The drug is supplied as the hydrochloride salt (HCL) in 10 mg tablets for oral use; daily doses range from 30 mg to 60 mg, but are not recommended for periods longer than 2–3 weeks.<sup>7</sup> The FF had been prescribed Cyclobenzaprine 10 mg since December 2000.

A single oral 10 mg dose given to healthy adults gave rise to peak plasma cyclobenzaprine levels averaging 0.009 mg/L at 3.8 hours. When this dose was repeated three times daily for 1 week, peak plasma levels averaged 0.026 mg/L at 3.9 hours after the last dose. Nine healthy adults given 20 mg oral doses three times daily for 3 days attained peak and trough plasma levels that averaged 0.034 mg/L and 0.024 mg/L respectively.<sup>7</sup>

Symptoms of cyclobenzaprine toxicity include drowsiness, dry mouth, dizziness, tachycardia, blurred vision, nausea, and paresthesias (abnormal sensations such as tingling, numbness, or pins and needles). Agitation and psychosis have been reported with long-term therapeutic usage. Overdosage may cause confusion, hallucinations, agitation, fever, hypotension, convulsions, coma and cardiac arrhythmias. Cyclobenzaprine blood levels of 0.03 mg/L to 0.35 mg/L were measured in 11 hospitalized victims of drug overdose.<sup>7</sup> The FF had a cyclobenzaprine (Flexeril) blood level of 90 ng/mL (or 0.09 mg/L), well above the therapeutic level and in the toxic range.

The FF had also been prescribed Percocet® (5 mg oxycodone with 325 mg acetaminophen), last filled in October 2004 and Oxycontin® (oxycodone HCl) 10 mg, which was last filled in December 2004.

The drug screen at autopsy, however, failed to detect any oxycodone in the FF's blood. Therefore, this FF's sudden death was probably due to a narcotic overdose, or less likely, a cardiac arrhythmia due to cyclobenzaprine toxicity. The City Police Department determined the death to be accidental.



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*Left Ventricular Hypertrophy.* On autopsy the FF had an enlarged heart and moderate left ventricular hypertrophy. Hypertrophy of the heart's left ventricle (left ventricular hypertrophy) is a relatively common finding among individuals with long standing high blood pressure (hypertension), a heart valve problem, or cardiac ischemia (reduced blood supply to the heart muscle).<sup>3</sup> The FF had no signs of cardiac ischemia, and only a slightly thickened mitral valve on echocardiogram in 2001. Therefore, the most likely reason for his LVH was his long-standing high blood pressure. Although LVH increases the risk for sudden cardiac death, the most likely reason for his sudden death was a narcotic overdose.

*Occupational Medical Standards for Structural Fire Fighters.* The National Fire Protection Association (NFPA) developed NFPA 1582, *Standard on Comprehensive Occupational Medical Program for Fire Departments*<sup>9</sup> to provide guidance and information for physicians and other health care providers for a comprehensive occupational medical program for fire departments. NFPA 1582 considers use of narcotics and beta-blocker agents to be a Category A condition, defined as “a medical condition that would preclude a person from performing as a fire fighter in a training or emergency operational environment by presenting a significant risk to the safety and health of the person or others.”<sup>9</sup> The Department of Transportation (DOT) will not issue a commercial driver's license (CDL) to “a person taking narcotics unless the drug is prescribed by a licensed medical practitioner who is familiar with the driver's medical history and assigned duties; and has advised the driver that the prescribed drug will not adversely affect the driver's ability to safely operate a commercial vehicle.”<sup>5</sup> The FF did not indicate his prescribed medications on his CDL examinations

in 2003 and 2004 nor his FD medical evaluation in 2003. On the 2003 CDL examination, the physician checked that a drug screen had been performed, but there was no test result identified on the report.

NFPA 1582 recommends, for informational purposes only, screening asymptomatic fire fighters with two or more CAD risk factors for obstructive CAD by an EST.<sup>9</sup> Although the FF had three risk factors for CAD, the FD did not require an EST. Rather, he had an EST in 2004 for further evaluation of chest pain. The test was nondiagnostic as his heart rate only reached 59% of the target heart rate, and his exercise tolerance was limited to 6½ minutes at 7.9 METS. As mentioned earlier, the EST was not negative, only nondiagnostic because he did not achieve an adequate heart rate (> 90% of target heart rate) nor did he exercise until symptoms appeared. It is unclear why the test was stopped early.

## **RECOMMENDATIONS**

NIOSH investigators offer the following recommendations to prevent similar incidents or to address general safety and health issues:

***Recommendation #1: Ensure members are knowledgeable of, and comply with, fire department requirements regarding reporting any medical condition that could interfere with their ability to safely perform essential job tasks.***

At the time of this FF's death, the FD required a pre-placement physical examination for new members, but would accept a passing examination conducted within the past year. It further required the FF to disclose medications and medical history. Medical records suggest the FF was not compliant with this policy. The FD



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has since changed the policy to require all prospective members, including transfers, to pass a pre-placement physical examination conducted by a State-approved City-contract physician. Although NIOSH investigators recommend non-punitive solutions, when effective, disciplinary action needs to be considered.

***Recommendation #2: Ensure that fire fighters are cleared for duty by a physician knowledgeable about the physical demands of fire fighting, the various components of NFPA 1582, Standard on Comprehensive Occupational Medicine Program for Fire Departments and the US Department of Transportation (DOT), Physical Qualifications for Drivers.***

Physicians providing input regarding medical clearance for fire fighting duties should be knowledgeable about the physical demands of fire fighting and should recognize that fire fighters frequently respond to incidents in environments that are immediately dangerous to life and health. They should also be familiar with the consensus guidelines published by NFPA 1582, *Standard on Comprehensive Occupational Medicine Program for Fire Departments*.<sup>9</sup> NFPA 1582 precludes “a person taking narcotics and beta-blocker agents from performing as a fire fighter in a training or emergency operational environment by presenting a significant risk to the safety and health of the person or others.” The DOT, under most circumstances, precludes a person from obtaining a CDL if the person is taking narcotics.<sup>5</sup> To ensure physicians are aware of these guidelines, we recommend that the FD, or the FF, provide personal physicians with a copy of NFPA 1582 and 49 CFR 391.41. Additionally, all “return to duty” clearances should be reviewed by the FD-contracted physician.

***Recommendation #3: Provide pre-placement and annual medical evaluations to fire fighters in accordance with NFPA 1582 to determine their medical ability to perform duties without presenting a significant risk to the safety and health of themselves or others.***

Guidance regarding the content and frequency of pre-placement and periodic medical evaluations and examinations for structural fire fighters can be found in NFPA 1582, *Standard on Comprehensive Occupational Medical Program for Fire Departments*,<sup>9</sup> in the report of the International Association of Fire Fighters/International Association of Fire Chiefs (IAFF/IAFC) *Wellness/Fitness Initiative*,<sup>10</sup> and the National Volunteer Fire Council (NVFC) *Health and Wellness Guide*.<sup>11</sup> The FD is not legally required to follow any of these standards.

***Recommendation #4: Consider conducting exercise stress tests for male fire fighters with two or more risk factors for coronary artery disease.***

NFPA 1582 and the IAFF/IAFC *Wellness/Fitness Initiative* recommend EST for fire fighters with two or more CAD risk factors.<sup>9,10</sup> The American Heart Association states EST may be indicated for individuals over 45 years of age who have two or more risk factors for CAD,<sup>12</sup> or for those involved in occupations in which impairment might affect public safety (e.g., fire fighters). The EST could be conducted by the fire fighter’s personal physician or the City/County contract physician. If the fire fighter’s personal physician conducts the test, the results should be communicated to the appropriate FD representative.



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**Recommendation #5: Phase in a mandatory wellness/fitness program for fire fighters to reduce risk factors for cardiovascular disease and improve cardiovascular capacity.**

Physical inactivity is the most prevalent modifiable risk factor for CAD in the United States. Additionally, physical inactivity, or lack of exercise, is associated with other risk factors, namely obesity and diabetes.<sup>13</sup> NFPA 1500, *Standard on Fire Department Occupational Safety and Health Program*, requires a wellness program that provides health promotion activities for preventing health problems and enhancing overall well-being.<sup>14</sup> NFPA 1583, *Standard on Health-Related Fitness Programs for Fire Fighters*, provides the minimum requirements for a health-related fitness program.<sup>15</sup> In addition, the NVFC *Health and Wellness Guide* addresses wellness/fitness programs as they relate to volunteer fire departments.<sup>11</sup>

**Recommendation #6: Perform an annual physical performance (physical ability) evaluation to ensure fire fighters are physically capable of performing the essential job tasks of structural fire fighting.**

NFPA 1500 requires fire department members who engage in emergency operations to be annually evaluated and certified by the fire department as meeting the physical performance requirements identified in paragraph 8-2.1.<sup>14</sup> The MET requirement for a fire fighter has been determined to be  $\geq 10$  METS.

It is difficult for a volunteer fire department to implement wellness/fitness guidelines due to such issues as budget and reduced recruitment/retention. However, the NVFC *Health and Wellness Guide* addresses these issues and provides recommendations for implementation.<sup>11</sup>

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