

LINE OF DUTY DEATH REPORT

F2021-18 • December 2023

1000 FREDERICK LANE, MORGANTOWN, WV 26508 • 304.285.5916

26-Year-Old Firefighter Dies of Complications from Acute Promyelocytic Leukemia

Executive Summary

On August 10, 2021, a 26-year-old volunteer firefighter (VF) collapsed at the scene of a working building fire. The VF was part a mutual aid engine company working a three-alarm fire in a neighboring town. The VF's crew had been assigned RIT (Rapid Intervention Team) upon arrival at the incident and were given a staging position, designated as the RIT staging area. Several physical tasks were completed from this position including forcing doors and moving a large diameter hoseline. The crew had returned to the RIT staging area when the VF collapsed onto a kneeling crew member and was assisted to a supine position on the ground. The initial assessment of the VF by crew members revealed the VF was conscious but disoriented. The crew summoned a nearby staged ambulance medical crew for assistance and transport to the emergency department (ED). The VF's mental status and neurological status deteriorated during transport. Shortly after arrival to the ED, the VF was intubated, and a head CT scan showed a large intracranial bleed. Initial blood tests confirmed the diagnosis of acute promyelocytic leukemia (APL) and associated disseminated intravascular coagulation (DIC), which caused the bleed. The VF underwent an emergency surgery to evacuate the blood and relieve pressure on his brain. Following surgery, the VF was admitted to the intensive care unit (ICU). Despite treatment of the APL and administration of blood products to correct the coagulopathy, he died 2 days later. The cause of death was noted as right heart failure caused by APL and DIC.

Contributing Factors

Gastrointestinal bleeding and prolonged bruising that occurred before the VF's collapse may have been early signs of the leukemia, which caused his subsequent collapse. Early diagnosis of the APL and initiation of treatment has been shown to improve clinical prognosis and long-term survival.

Key Recommendations

NIOSH offers the following recommendations to reduce the risk of heart attacks and sudden cardiac arrest among firefighters at this and other fire departments across the country.

- *Key Recommendation #1: Fire Departments should educate members on the signs and symptoms of leukemia and other cancers with a young adult age of onset.*
- *Key Recommendation #2: Fire Departments should ensure there is a communication protocol regarding abnormal results of a medical screening examination so that timely follow-up can occur.*

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The National Institute for Occupational Safety and Health (NIOSH) initiated the Fire Fighter Fatality Investigation and Prevention Program to examine deaths of fire fighters in the line of duty so that fire departments, fire fighters, fire service organizations, safety experts and researchers could learn from these incidents. The primary goal of these investigations is for NIOSH to make recommendations to prevent similar occurrences. These NIOSH investigations are intended to reduce or prevent future fire fighter deaths and are completely separate from the rulemaking, enforcement and inspection activities of any other federal or state agency. Under its program, NIOSH investigators interview persons with knowledge of the incident and review available records to develop a description of the conditions and circumstances leading to the deaths in order to provide a context for the agency's recommendations. The NIOSH summary of these conditions and circumstances in its reports is not intended as a legal statement of facts. This summary, as well as the conclusions and recommendations made by NIOSH, should not be used for the purpose of litigation or the adjudication of any claim.

For further information, visit the program Web site at www.cdc.gov/niosh/fire or call toll free 1-800-CDC-INFO (1-800-232-4636).

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Introduction

A 26-year-old male volunteer firefighter (VF) passed away in a hospital intensive care unit (ICU) two days after working a 3-alarm building fire. The U.S. Fire Administration notified the National Institute for Occupational Safety and Health (NIOSH) of this fatality on August 13, 2021. On October 6, 2021, a Technical Information Specialist from the NIOSH Fire Fighter Fatality Investigation and Prevention Program contacted the VF's fire department. NIOSH investigators did not travel to the site of the event but conducted a virtual investigation.

During the investigation, the NIOSH investigator interviewed the following people:

- *Chief*
- *VF's mother*
- *Primary Care Provider*
- *Incident Commander*

The NIOSH investigator reviewed the following documents:

- *Fire Department (FD) incident reports*
- *Emergency medical services (EMS) (ambulance) report*
- *Emergency department (ED) and inpatient medical records*
- *Death certificate*
- *Records from the VF's Primary Care Provider*

Fire Department

At the time of the NIOSH investigation, this volunteer fire department consisted of 60–70 firefighters operating out of 4 fire stations. It serves a population of approximately 10,000 in a geographic area of about 30 square miles.

The FD mandates an annual physical evaluation program, which is also part of initial membership to the department. The physical is administered by a third-party vendor and consists of the following:

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- Comprehensive work & medical history
- Health risk appraisal questionnaire
- Physical Exam including but not limited to blood pressure, height, weight, visual acuity and hearing test
- Chest x-ray
- Electrocardiogram
- Laboratory tests including complete blood count (CBC), expanded metabolic panel with liver function tests, hepatitis B surface antibody, thyroid panel, prostate specific antigen for males over 40, CA-125 antigen (ovarian cancer marker) for females, urinalysis, and U.S. Department of Transportation (DOT) urine drug test
- Stool screen
- Calculated body mass index (BMI)
- Firefighter clearance - Respirator /personal protective equipment (PPE)
- Firefighter clearance - Fitness for duty
- DOT/commercial driver's license (CDL) medical evaluation
- Medical clearance statements

The VF was compliant with the physical evaluation program and received his most recent evaluation on April 9, 2021.

Membership and Training

Members must be at least 18 years of age, have a high school diploma or equivalent, possess a valid driver's license, and be a resident of the state. Potential members complete an application and interview with the Chief. Contingent membership offers are made based on a background check and successful completion of a medical evaluation consistent with the annual medical evaluation for incumbent members. The FD has three levels of membership: support, apparatus operator, and interior firefighter. On the fireground, support is most closely associated with facilitating rehabilitation and hydration activities for FD personnel. Apparatus operator can facilitate most fireground activities associated with exterior operations, for example pump operations, defensive and offensive hoseline deployment, and ground ladder placement. Interior firefighters are the only members that may make entry into a working structure fire and mount an offensive attack. Membership and annual training standards are compliant with state requirements for volunteer fire departments.

Preplacement/Periodic/Return to Work Medical Evaluations

The FD requires pre-placement medical evaluations for applicants and annual medical evaluations for incumbents. Components of the medical evaluation are the same for both groups. Though many components of the medical evaluation are consistent with National Fire Protection Association (NFPA) 1582 Standard [NFPA 2018], the evaluation does not contain all components; most notably an aerobic

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capacity evaluation. Firefighters must be medically cleared by the designated fire department physician before returning to work following a serious injury or illness.

Wellness/Fitness Programs

The FD has fitness equipment available to firefighters at its main station. However, the FD does not require that firefighters participate in any type of fitness program. The equipment is for voluntary usage. The FD considers the comprehensive health risk appraisal questionnaire (part of the pre-placement and annual medical evaluation) an integral part of their wellness programming. Their contracted third-party administrator of the evaluations delivers the standardized questionnaire and provides individual feedback as part of every medical evaluation.

Investigation

On August 10, 2021, at 0225 hours, a structure fire was dispatched in a rural community of Connecticut. With radio notification of multiple reports of the roof being on fire, the jurisdiction department's (JD) fire chief struck a second alarm enroute to the incident. This initiated a multi-jurisdictional mutual-aid response. The JD's chief arrived at 0233 and took the role of Incident Commander (IC). Heavy fire was reported on the roof of an approximately 7,000 square foot, 3-story structure. The structure was a combination of ground floor commercial and upper floor residential apartment occupancies. Fire was also reported from the C-side porches of the upper-level apartments. The IC immediately employed a defensive strategy and struck a third alarm.

The second alarm was dispatched at 0232 hours. The 26-year-old VF was part of the mutual-aid department (Fire Department A) that responded to the second alarm. Fire Department A responded two apparatus, a rescue engine and a tanker. The VF was part of a 6-person crew, including the officer, on board the rescue engine. The tanker had 2 people on board. The chief of Fire Department A responded in his own vehicle. The initial assignment of the rescue engine crew was RIT (Rapid Intervention Team). The crew gathered their tools and staged close to the A/D corner of the fire building. The IC confirmed that no firefighters were in the building and the rescue engine crew was assigned to assist with forcing ground floor doors and ensuring evacuation was complete along the A and D sides of the structure. The six-person crew split up into 3 teams of 2, the VF was with the officer. The officer and VF worked along the length of the A side forcing doors and ensuring evacuation of tenant spaces. The team was wearing full PPE, including self-contained breathing apparatus (SCBA). The VF was on air. The team did not proceed to the B-side, as the potential for structural collapse existed. The VF was then asked to assist a company assigned to suppression operations move a 2.5" hoseline on the A-side. The VF operated the hoseline for a short period of time and returned to the officer.

The officer told the VF to go change out his SCBA bottle at their engine and return to the RIT staging area. The 6-person crew was back together in the RIT staging area where they removed their gear and rehydrated. The officer noticed flashlights in the fire building and ordered the crew to don their gear and fully re-engage their RIT assignment. As the VF was donning his PPE, he collapsed onto another crew member who was kneeling next to him. According to documents and interviews, the VF did not display or express any problems prior to the collapse, and the crew suspected nothing considering the VF had been engaged in strenuous work. The crew assisted the VF to the ground. The initial assessment of the VF by crew members revealed the VF was conscious but disoriented. A crew

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member caught the attention of a nearby staged ambulance crew, and they came over to assist. The VF's collapse occurred just before 0500 hours, the patient care report documented arrival at the VF's side at 0500 hours. The ambulance crew consisted of one paramedic and one emergency medical technician.

The paramedic found the VF's skin to be hot and diaphoretic. The VF appeared confused and could not answer questions appropriately. The VF was verbal, but only complained of being "hot". The paramedic noted several contusions on the VF's right arm and leg. No other injuries were noted. The VF remained conscious but confused throughout the transport to the hospital. His pupils were 2 millimeters (mm) in diameter and reactive to light. He was only responsive to painful stimuli on his left side and no response to pain on his right side. Initial examination also noted bruising on his right hand and right leg. On arrival to the ED at 0542, he had an intact gag reflex. The VF's blood oxygenation dropped from 94% to 86% on room air followed by an episode of vomiting. The VF was intubated to protect his airway from aspirating vomitus and to improve oxygenation. The initial head CT done at 0556 showed large lesion centered in the left parietal lobe exhibiting mass effect (i.e., the volume of the lesion was large enough to shift the left side of the brain over to the right side) with properties concerning for a bleed. An initial blood sample showed an extremely high white blood cell (WBC) count with abnormally low red blood cell (RBC) and platelet counts. Tests of other clotting factors performed on blood collected shortly after ED arrival at 0614 were consistent with disseminated intravascular coagulation (DIC), a disorder that occurs when the body's clotting capacity is quickly overwhelmed, using up the existing clotting factors and resulting in bleeding that is difficult to stop. The VF was taken to the operating room to evacuate the mass and relieve the pressure on his brain. A large blood clot was removed, blood products were given to improve oxygenation and restore clotting function, and hematology was consulted to evaluate the abnormal results of his blood sample. A neurosurgery consultation on admission noted "significant bruising" on both arms and on his legs from thighs to ankles. The ICU admission note states hematology was consulted due to concerns for acute leukemia in addition to the coagulopathy. The hematology consultant's note concurred, and they continued treatment for DIC and initiated treatment for "presumed APL" with all-trans retinoic acid (ATRA) and corticosteroids while more advanced blood tests were ordered to characterize the leukemia. These tests confirmed that the VF had acute promyelocytic leukemia (PML), a subtype of acute myeloid leukemia (AML). Shortly after admission to the ICU, the VF began to have kidney failure, which was treated with hemodialysis.

On the morning of August 12, 2021, the VF suddenly developed a fast heart rate, low blood pressure, low oxygenation despite being on a ventilator with added oxygen, and an ultrasound showed dilation of the right ventricle of his heart. All these could be consistent with a pulmonary embolus, a blood clot (or multiple clots) in the vasculature of the lungs. His heart rate began drop until he went into cardiac arrest. The ICU staff continued resuscitation efforts for the next 2 hours including administration of clot dissolving medications without success.

Cause of Death/Autopsy/Medical Findings

The death certificate lists the cause of death was right heart failure due to acute promyelocytic leukemia (APL) and DIC. An autopsy was not performed.

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Discussion

Cancer and Leukemia Terminology

Cancer is an illness produced by a group of cells that grow without “listening” to the natural signals that the body normally uses to limit cell growth. They are named based on the tissue they originate from regardless of where they spread (called metastasis) in the body. Each type of cancer has its own risk factors, diagnostic and screening tests, disease course, survival rates, treatments, etc. Some cancers are associated with chromosomal changes, which are changes in one’s genes that are inherited. Genes are the instructions our bodies use to create all the proteins, enzymes, etc. inside of it. Science has yet to understand all the factors that “trigger” a cancer to start its abnormal growth. For example, prostate cancer has been linked to several changes or mutations in multiple genes, and men with these changes are at higher risk for developing prostate cancer. However, for men with the associated genetic mutations who do develop prostate cancer, there is no way to predict when that will happen, so close monitoring is needed [CDC 2022; Sandhu et al. 2021].

Leukemias are cancers of the blood cells and the bone marrow which produces these cells. There are many different types of cells in the blood, including white blood cells that directly attack invading organisms (lymphocytes), white blood cells that make antibodies to indirectly fight infectious agents (myelocytes), red blood cells that carry oxygen to all parts of the body (erythrocytes), and cells that produce platelets (megakaryocytes) to help stop bleeding. Cancers are termed acute if their development and spread happens quickly or chronic if it develops over a long period of time.

Blood cells generally start from a progenitor stem cell that has the potential to develop into many different types of blood cells. Various factors and chemical signals result in the end product being one of the specific types of blood cells (e.g., lymphocytes, myelocytes, erythrocytes). The prefix of “pro” is added when the source of the cancer is a blood cell further up the chain of development, so promyelocytic leukemia indicates that the abnormality is occurring in cells that have started developing into a myelocyte but have not fully differentiated into one specific type of myelocyte.

Acute Promyelocytic Leukemia

APL is a subtype of AML that appears in approximately 10% of AML cases [Yedla et al. 2020]. This variant is due to a translocation (swap) between segments of chromosomes 15 and 17 that results in a fusion of the PML gene and the gene coding the retinoic acid receptor alpha (RARA) protein. This fusion gene produces an inefficient receptor, resulting in a decreased concentration of retinoic acid, commonly known as vitamin A, getting into the nucleus where it plays a vital role in regulating the transcription and expression of many different genes, including ones that guide the development of white blood cells and regulate cell growth such as various tumor suppressor factors [Napoli 2004]. This subtype was first identified in 1957 and described as the “most malignant form of acute leukemia” due to the clinical picture of an elevated white blood cell (WBC) count dominated by promyelocytes and a tendency for severe bleeding accounting for its “rapid fatal course” [Hillestad 1957; Wang and Chen 2008].

The body produces many different types of white blood cells to fight infections through a process called differentiation, which starts with stem cells that have the potential to become many different types of specialized cells once they finish their development. These stem cells are located in the bone marrow and go through many stages of development to result in different types of mature WBCs used

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by the body as its line of defense. The promyelocyte is the progenitor to the granulocyte subset of WBCs that include neutrophils, basophils, and eosinophils. When APL occurs, the maturation process of WBCs is arrested at the promyelocyte stage while at the same time increasing the rate of cell production. This often results in an abnormally low number of mature, functional WBCs among the large number of promyelocytes instead of mature neutrophils, basophils, and eosinophils. The Sanz risk stratification system for APL is based on total WBC and platelet counts and those patients with total WBC counts of $> 10 \times 10^9/\text{L}$ were considered as high risk for a poor outcome [Abedin and Altman 2016; Yedla et al. 2019].

Age of onset for APL is much younger than other types of AML, with cases increasing in the second decade of life before reaching a plateau in early adulthood and decreasing after age 60 years (UpToDate). In contrast, all subtypes of AML have an age of onset of 60–70 years. In the United States, approximately 600–800 new cases of APL are diagnosed each year [Jurcic et al. 2007; Salhotra and Mei 2021; Yedla et al. 2020].

APL is often diagnosed following a severe bleeding episode due to clotting disorders induced by the condition in approximately 90% of patients [Abedin and Altman 2016]. There is conjecture that the malignant promyelocytes generate and release substances that trigger the clotting cascade. One of the more severe clotting disorders associated with APL is disseminated intravascular coagulation (DIC) where clotting factors are rapidly used up, resulting in bleeding episodes that are difficult to stop. The most common site for the initial bleeding event is intracranial, occurring in 65%–80% of patients [Norsworthy and Altman 2016]. One study reported a fatality rate due to bleeding episodes occurring as the first manifestation of APL as high as 47% [Warrell et al. 1993]. APL should be suspected in the event of a sudden bleeding event with no prior history of bleeding disorder. Although large bleeding events are a hallmark sentinel event, bleeding may also present as slower bleeding from mucosal surfaces such as the mouth, nose, gums, or the lining of the gastrointestinal tract. Fevers may also occur. The peripheral blood smear will show a predominance of promyelocytes in the white blood cell count. The diagnosis is confirmed by analyzing a peripheral blood sample for the PML-RARA fusion gene.

If the patient survives the sentinel bleed event, then mortality decreases significantly with treatment involving replacing the clotting factors, corticosteroids, and all-trans retinoic acid (ATRA). Due to the fact that ATRA can enter the cell nucleus via the fusion PML-RARA receptor when given at pharmacological doses (vs smaller amounts from dietary intake), this is one of the few types of leukemia that has a direct treatment. Complete remission rates of APL have been reported as high as 80% using ATRA alone. Higher treatment success rates for prolonged periods have been achieved with the addition of arsenic trioxide and traditional chemotherapeutic agents such as daunorubicin [Napoli 2004; Salhotra and Mei 2021; Yedla et al. 2020].

It is currently not known what causes the initial translocation leading to the development of APL. The medical literature mentions risk stratification for treatment of APL, but this is directed at using parameters of the patient's condition at the time they manifest symptoms (e.g., promyelocyte counts, levels of clotting factors, etc.) to determine treatment protocols rather than at identifying ways to reduce the risk of developing PML [Sanz et al. 2010]. Since no clear data exist on how to reduce the risk of developing PML, it is important to identify its presence as early as possible, ideally prior to the occurrence of a major bleeding event so that treatment can begin before this potentially fatal event

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develops. Some of the early signs may be easy and frequent bruising, often without a noticeable or recallable recent impact to the bruised area.

Discussions with the VF's mother revealed no prior history of hematological/bleeding disorders in the VF or his 2 other siblings (an older and younger brother). The VF was a regular blood donor without problems. Medical screening questionnaires and examinations were conducted through the FD on March 13, 2020, when he initially applied to be a volunteer FF as this department and April 9, 2021, as part of his incumbent annual medical evaluation. A guaiac stool test conducted on a sample collected on March 13, 2020, as part of his pre-employment medical evaluation was found to be "abnormal". There is no further explanation of this finding in the report specifying if their report of "abnormal" is equivalent to "guaiac positive" which would be indicative of blood present in the stool in microscopic amounts. There was no documentation of follow-up to this result was found in the VF's FD file (i.e., no documentation of referral to GI specialist when the initial abnormal result was reported and the test was not repeated the following year). It is unknown if the VF and/or his primary care physician was informed of the 2020 abnormal result.

The VF was last seen by his primary care physician on March 16, 2021, and his physical examination was normal. No blood tests were done at that time as there were no findings to investigate. The patient encounter note from the March 16, 2021 visit does not mention the abnormal guaiac test reported by the FD medical evaluation from the previous year as part of his past medical history (if a GI referral was obtained to further investigate the 2020 abnormal guaiac test, that consultation report should appear or at least be referenced in this section of the medical record) or active problem list.

Two weeks prior to his collapse at the fire response, the VF, his parents, and his younger brother had gone on vacation, which included bike rides up to approximately 17 miles. During that trip, his younger brother collided with the VF's bicycle causing him to fall off; sustaining a bruise on his right thigh where the handlebar hit and a small scrape on his chin due to chafing from the helmet strap as it was slightly dislodged. Immediately after the fall, the VF reported being tired from the ride but nothing out of the ordinary. Nothing further was noted by the VF until 2 days before his collapse when he showed his mother the bruising on his right thigh and commented that he felt it should have been more healed than it appeared. The VF's mother reported the bruise was still dark purple and about 5–6 inches long on the medial part of his thigh with no lightening to yellow or greenish brown. Bruises, also known as contusions, have a general timeline to their resolution. Bruises are formed when blunt trauma results in extravasation of blood from inside small vessels into the surrounding tissue. It is the iron-containing hemoglobin molecule inside red blood cells which gives blood its red color, so bruises are initially red in color. As the hemoglobin molecule breaks down, its color and that of the skin overlying the bruise changes color over the next 24–48 hours to darker red, purple, or even black. Over the next 5–10 days, the color changes to green and/or yellow before returning to the pre-injury skin color as hemoglobin resorption is completed [Ratini 2021]. Therefore, by nearly 2 weeks after incurring the injury, a bruise should have been nearly resolved or at least significantly lightened. Recognition of delayed healing of the leg bruise 2 days before the intracranial bleed may have been an opportunity for a medical evaluation to diagnose the APL before the occurrence of the catastrophic intracranial bleed on August 10, 2021.

Due to the long duration of time between the guaiac abnormal stool test in March 2020 and the August 2021 intracranial bleed, it is unlikely that the stool finding represented the initial onset of the APL even

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if the abnormal test was indicative of microscopic blood being present. However, if there was blood in the stool, the FD should have arranged a follow-up medical evaluation to determine the source of the gastrointestinal bleeding or with the VF's consent, relayed that information to his primary care physician to pursue additional medical testing.

Follow-up Evaluation of Abnormal Screening Test Results

The 2020 edition of NFPA 1720 Organization and Development of Fire Suppression Operations by Volunteer Fire Departments under its section on Safety and Health Systems does not cite any abridged policies for volunteer departments in its section regarding Safety and Health Systems and refers back to the 2018 version of NFPA standard 1500 Occupational Safety, Health, and Wellness Programs. Chapter 11 "Medical and Physical Requirements" sections 11.1 and 11.2 state FD candidates should meet the medical requirements specified in NFPA 1582 Chapter 6 and FD members had to meet the medical requirements in Chapter 9 and be evaluated annually as per Chapter 7. The NFPA standard 1582 is the Standard on Comprehensive Occupational Medical Program for Fire Departments. Chapter 11 of NFPA 1500 specifies that "a confidential, permanent health file is established and maintained on each individual member" and that this record should include "the results of regular medical evaluations, physical performance tests, occupational illness or injuries, and any events that expose the individual to known or suspected hazardous materials, toxic products, or contagious diseases". This standard contains guidance for fitness for duty evaluations which are centered around the ability of the firefighter to perform essential job functions [NFPA 2021].

In the case of this VF, there does not appear to be a direct reporting mechanism for the guaiac positive stool result to the FD unless it was part of a diagnosis which could inhibit his ability to perform the essential job functions. The 2018 edition of NFPA 1582 in force at the time of this event, mentions conducting a guaiac stool test with respect to colon cancer screening and requires that "Fecal occult blood testing risks and benefits shall be discussed with all members above the age of 40 or earlier if clinically indicated". It is unclear why the guaiac test was performed on a 25-year-old candidate FF with no personal past medical history or family history to indicate high risk for colon cancer or any gastrointestinal symptoms whose evaluation would include this test. Once the abnormal test result was returned to the FD, there was no documentation that this result had been discussed with the VF along with a plan for follow-up evaluation. The FD should review its policies to ensure there is a procedure to inform personnel of any abnormal test results returned from tests the FD orders and provide these individuals with copies of the abnormal test results. If abnormal results are found, the follow-up evaluation could be done by the VF's primary care physician if the FD does not have the resources to do so. In that case, the VF would then assume responsibility of arranging that evaluation with their primary care physician and providing their PCP with copies of the abnormal test results that the FD provided to them.

Although NFPA 1582 recommends fecal occult blood (also known as a guaiac test, checks for microscopic levels of blood in the stool) testing to be "discussed" with "members above the age of 40 or earlier if clinically indicated," this FD included this test as part of their initial medical assessment of all cadet applicants. Although occult blood in the stool may be an initial sign of colon cancer, it can be caused by other disorders such as leukemias, bleeding disorders, inflammatory gut disorders like Crohn disease and ulcerative colitis, and infection. Any positive guaiac test result should have a follow-up evaluation to determine the source of the blood. It is unclear what protocol was in place to

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ensure this occurred. The VF had an abnormal guaiac test in March 2020, but records did not indicate if there was a recommendation for a follow-up evaluation or a protocol in place to relay such findings to the cadet's primary care provider. NFPA 1582 section 9.9 regarding medical conditions concerning the GI tract requires the fire department physician to report to the FD if the member has a condition that would impact their ability to complete essential job tasks such as diarrhea or GI bleeding severe enough to cause symptomatic blood and/or volume loss resulting in arrhythmia, lightheadedness, etc. Section 4.2 discussing Fire Department Physician Responsibilities states "Forward copies of any abnormal results along with patient instructions regarding primary care follow-up to individual who were instructed to see (as appropriate) medical follow-up to address any medical conditions, or lab abnormalities, identified during the medical evaluation" [NFPA 2022].

The National Volunteer Fire Council published guidance jointly with the NFPA, regarding ways to implement the NFPA standards in volunteer fire departments that often have fewer resources than fully funded municipal fire departments. One recommendation is to "require members to receive annual physicals from personal physicians" which could have the added benefit of ensuring the firefighter's personal/primary care physician would receive the results of tests done as part of the annual physical as it is general practice for test results to be reported back to the physician who ordered the test [NVFC/NFPA 2012]. The primary care physician would then be able to arrange appropriate follow-up on any abnormal results.

First responders often de-emphasize their own health to care for others, but this is one area where mentors and senior FD officers can encourage their younger counterparts to seek early medical evaluation for something they may consider a "minor" issue but may be a condition where prompt assessment may be the best chance at confirming a diagnosis and initiation of curative treatment. NFPA 1582 classifies leukemia as a category B meaning that a diagnosis does not itself disqualify one from being medically cleared but it is done on a case-by-case basis if the firefighter can perform essential job tasks following treatment. Due to the high cure rate with ATRA (retinoic acid) of up to 90%, concern over disqualification should not play a role for firefighters who experience signs and symptoms consistent with new onset leukemia [NFPA 2018].

Recommendations

Recommendation #1: Fire departments should consider including information on the signs and symptoms of leukemia and other cancers with a young adult age of onset (20's) to the training materials provided to new recruits in that age range.

Discussion: Cadet training classes generally have younger participants than the overall age of incumbent firefighters so cancer awareness education to this audience should also highlight malignancies that have a younger age of onset such as APL, testicular cancer, etc. Emphasis should be placed on prompt medical evaluations for any abnormal bruising or bleeding as these may be the first presenting symptoms of leukemias or other bleeding disorders such as idiopathic thrombocytopenic purpura that would benefit from early diagnosis and initiation of treatment. Any new lumps/masses or areas of skin discoloration should also be handled by prompt medical evaluation as early diagnosis with prompt initiation of treatment may play a vital role in improving survival rates.

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Recommendation #2: *Fire Departments should ensure there is a communication protocol regarding abnormal results of a medical screening examination so that timely follow-up can occur.*

Discussion: The VF had a stool sample that was abnormal in March 2020, which was obtained as part of his cadet application medical evaluation component. However, there is no notation in those records or in his subsequent August 2021 admission records that he was informed of the abnormal result nor that a follow-up evaluation should be done to ascertain the cause of the abnormal guaiac test. Abnormal screening test results should always be reviewed with the patient and include a plan for a follow-up assessment of the abnormal finding. It is general good practice to include in the testing protocol a clear procedure on how abnormal test results will be handled to ensure timely follow-up.

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Investigator Information

This incident was investigated by the NIOSH Fire Fighter Fatality Investigation and Prevention Program, Medical Team, in Cincinnati, Ohio. Rob Saunders is a Technical Information Specialist with NIOSH who conducted the virtual investigation and co-authored the report. He has been in the fire service for over 31 years retiring from the Pike Township Fire Department, Indianapolis, Indiana. In addition to having served as a firefighter, paramedic, heavy rescue technician, and rescue diver, he has held the positions of company officer, Division Chief of Emergency Medical Services, Deputy Chief of Operations, and Fire Chief. Judith Eisenberg MD, MS (NIOSH) provided medical consultation.

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