

FIRES AND BURNS INVOLVING HOME MEDICAL OXYGEN

**Marty Ahrens
Fire Analysis and Research Division
National Fire Protection Association**

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**National Fire Protection Association, 1 Batterymarch Park, Quincy, MA 02169-7471
www.nfpa.org**

Abstract

According to 2003-2006 data from the Consumer Product Safety Commission's National Electronic Injury Surveillance System, home medical oxygen was involved in an average of 1,190 thermal burns seen annually at U.S. emergency rooms. Data from Version 5.0 of the U.S. Fire Administration's National Fire Incident Reporting System indicate that, in 2002-2005, U.S. fire departments responded to an estimated average of 182 home fires per year in which oxygen administration equipment was involved in ignition. Forty-six people per year died in these fires. Smoking is by far the leading factor in these incidents. Several studies suggest that the number of burn injuries associated with home use of medical oxygen has been increasing over time. Fires burn hotter and faster in oxygen-enriched atmospheres. Things also ignite at lower temperatures. Strict requirements regulate the use and storage of medical oxygen in health care facilities, yet few regulations apply in the home environment. Finding the balance between preserving the patient's privacy and protecting safety is a multi-disciplinary challenge.

Keywords: fire statistics, medical oxygen, home fires, home care

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One-Stop Data Shop

1 Batterymarch Park

Quincy, MA 02169-7471

www.nfpa.org

e-mail: osds@nfpa.org

phone: 617-984-7443

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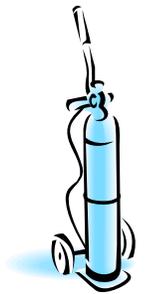
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Fires and Burns Involving Home Medical Oxygen

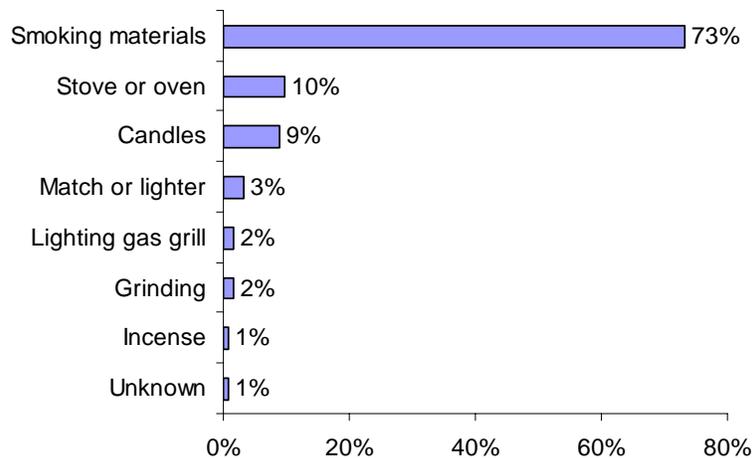
The air is normally 21% oxygen. Oxygen is not flammable, but fire needs it to burn.

- When more oxygen is present, any fire that starts will burn hotter and faster than usual.
- More oxygen in the air means that things such as hair, plastic, skin oils, clothing, and furniture can catch fire at lower temperatures.

In 2003-2006, hospital emergency rooms saw an estimated average of 1,190 thermal burns per year caused by ignitions associated with home medical oxygen.

- Eighty-nine percent of the victims suffered facial burns.
- In most cases, the fire department was not involved.

Heat Source in 2003-2006 Medical Oxygen-Related Burns Seen at Hospital Emergency Rooms



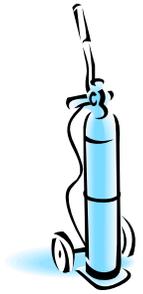
Source: CPSC's National Electronic Injury Surveillance System

During 2002-2005, oxygen administration equipment was involved in an estimated average of 182 home fires reported to local fire departments per year.

- These fires caused an average of 46 civilian deaths and 60 civilian injuries per year.
- One of every four such fires resulted in death.

Smoking is by far the leading cause of burns, reported fires, deaths, and injuries involving home medical oxygen.

- Cooking and candles were other common factors.



Fire Safety Tips for Home Medical Oxygen Users

The use of home oxygen systems has increased over the past decade. It's important for people to practice fire safe behaviors when oxygen is in use. Oxygen itself does not burn but a fire needs oxygen to start and to keep burning. When more oxygen is in the air, the fire will burn hotter and faster. Smoking should not be allowed in a home where oxygen is used. Even if oxygen is not being used, it may have saturated the home including clothing, curtains, furniture, bedding, hair, and anything in the area.

Safety Tips

- Never smoke in a home where oxygen is used.
- Post “no smoking” signs in and outside of the home to remind residents and guests not to smoke.
- If oxygen is used in the home, the amount of oxygen in the air, furniture, clothing, hair, and bedding goes up, making it easier for a fire to start and spread. This means that there is a higher risk of both fires and burns.
- Never use an open flame, such as candles, matches, wood stoves, and sparking toys, when oxygen is in use.
- People who may have difficulty escaping a fire should have a phone near their bed or chair.
- Make sure that the home has smoke alarms. Test them at least monthly.
- Have a home fire escape plan with two ways out of every room and an outside meeting place.
- Practice the plan at least twice a year.

Fires and Burns Involving Home Medical Oxygen

Introduction

The exact number of people receiving home oxygen therapy is unknown. In a 2006 study done for the American Association for Homecare, Morrison Informatics, Inc. noted that more than 1 million Medicare recipients use this therapy.¹ Bowles reported that in the 30 Oklahoma cases of burns due to smoking while on medical oxygen with known insurance information, only 53% were on Medicare.² Combining the two studies gives a very rough estimate of 2 million households using oxygen. When medical oxygen is not used according to directions, the patient and others are at risk of fire and burns as well as property damage.

Technically, fire is defined as “a rapid oxidation process, which is a chemical reaction resulting in the evolution of light and heat in varying intensities.”³ Oxygen is one of three parts of the fire triangle.⁴ A heat source and fuel (something that can burn) are also required. Oxygen itself is not flammable. The heat triggers a chemical reaction between the oxygen and fuel molecules. Normally, air is 21% oxygen. Increased oxygen makes more oxygen available for the chemical reaction, meaning that any fire that occurs will burn faster and hotter. Increased oxygen also lowers the temperature at which things will ignite, including hair, clothing, plastic, skin oils, furniture, etc. Because oxygen is colorless and odorless, elevated levels are not detectable by human senses. In many ignitions associated with home medical oxygen, only the area around the patient’s face was enriched. However, melted tubing, leaks, and other equipment breaches can result in a much larger enriched area.

Most of the medical literature on incidents involving home medical oxygen has focused on patients treated at burn centers or included in burn registries. In most cases, only the patient was hurt, although some involved death to other household members or building occupants. The fire service and fire protection literature also includes reports about the dangers of smoking on oxygen, but it also addresses issues of oxygen storage, fire protection, and the dangers of firefighting in an oxygen-enriched atmosphere. A related topic, injuries incurred by emergency responders due to problems with regulators in portable oxygen systems, is also relevant. The literature from both disciplines is summarized here.

¹ Morrison Informatics, Inc. *A Comprehensive Cost Analysis of Medicare Home Oxygen Therapy: A Study for the American Association for Homecare*, June 27, 2006. p.2.

² Angie Bowles. “Burn Injuries Due to Smoking while Using Oxygen Therapy, Oklahoma, 2001-2005, *Injury Update, A Report to Oklahoma Injury Surveillance Participants*, September 28, 2007.

³ National Fire Protection Association. *Illustrated Dictionary of Fire Service Terms*, Sudbury, MA: Jones and Bartlett Publishers, 2006, p. 52.

⁴ Safety Advisory Group, European Industrial Gases Association. *Fire Hazards of Oxygen and Oxygen Enriched Atmospheres*, Brussels: 2000.

In addition, original analyses were done on the U.S. Consumer Product Safety Commission's (CPSC's) National Electronic Injury Surveillance System (NEISS) 2002-2006 case files of thermal burns and on 2002-2005 Version 5.0 data from the U.S. Fire Administration's National Fire Incident Reporting System (NFIRS 5.0) data in combination with the results from NFPA's annual fire department experience survey. These fire databases are used together to develop estimates of the frequency of such incidents per year.

Medical and Health Care Literature

Most of the incidents described in the literature involved smoking while on medical oxygen. Bowles reported that from 2001 to 2005, smoking while on medical oxygen killed 15 Oklahomans and injured 24 others.⁵ The victims (both fatalities and injuries) ranged in age from 50 to 86, with a mean of 64. In 62% of the incidents, the fire did not spread beyond the smoker. In 12%, flames spread to the immediate surroundings. One-quarter of the cases resulted in a "full-blown house fire." In all of the full-blown house fires, the smoker died. An average of 6 such cases was reported in 2001-2004, but the number doubled to 14 in 2005.

Twenty-three patients, ranging in age from 50 to 84, were admitted to Mercy Hospital Burn Center in Pittsburgh, PA in 1994-1998 with burns related to the use of home oxygen.⁶ Thirteen (57%) percent also suffered inhalation injuries. The average burn covered 3.9% of total body surface area. Twelve (52%) of the 23 were admitted in 1997-1998, a possible indication that these incidents are increasing. Twenty (87%) of the patients were being treated for chronic obstructive pulmonary disease (COPD) prior to their injuries. All were living independently at home prior to their injuries. Sixteen (70%) were discharged to their homes. Two patients died during hospitalization. Smoking caused 16, or 70%, of the incidents; cooking caused six, or 23%, and one, or 4%, suffered hand injuries while delivering liquid oxygen. Their pulmonologists found that 30% of their patients who smoked before starting medical oxygen continued to do so afterward. The authors recommend that smokers who need medical oxygen be encouraged to participate in smoking cessation programs.

The Joint Commission on Accreditation of Healthcare Organizations reviewed 11 events in which home health care patients using supplemental oxygen were injured or killed by fire.⁷ Common risk factors in these events included: living alone, the absence of working smoke alarms, cognitive impairment, a history of smoking while oxygen was in use, and flammable clothing. Recommendations included better staff training, particularly in smoker identification and management; procedures to notify the doctor and improve

⁵ Angie Bowles. "Burn Injuries Due to Smoking while Using Oxygen Therapy, Oklahoma, 2001-2005, *Injury Update, A report to Oklahoma Injury Surveillance Participants*, September 28, 2007

⁶ T. Tommy Chang, Christopher A. Lipinski, and Harold F. Sherman. "A Hazard of Home Oxygen Therapy," *Journal of Burn Care and Rehabilitation*, Volume 22, Number 1, pp. 71-74, 2001.

⁷ Joint Commission on Accreditation of Healthcare Organizations. "Lessons Learned: Fires in the Home Care Setting," *Sentinel Event Alert* 17, (March 2001).

communication among providers; involving Ethics Committees in decisions to end services to non-compliant patients; and increasing fire safety with smoke alarms and other practices.

In 2007, the Joint Commission added a 15th goal, the identification of safety risks in the patient population to its list of home care patient safety goals.⁸ Requirement 15B requires organizations to identify risks associated with long-term oxygen therapy such as home fires. Implementation expectations include:

- 1) home fire safety risk assessments about the presence and functionality of smoke alarms, fire extinguishers, and fire safety plans;
- 2) fire prevention education to the patient and family; and
- 3) assessment of patient's understanding and compliance with concerns reported to the patient's doctor.

Smoking is a powerful addiction. Martin Jarvis reports that less than 3% of attempts to quit result in 12 months of non-smoking.⁹ Smokers report that when they feel stressed, smoking helps to calm them down. Nicotine withdrawal mood changes and performance decrements begin within hours after a cigarette and disappear after smoking one.

In a 1998-1999 home visit survey of 249 long-term oxygen therapy patients done in Ioannina, Greece, Katsenos et al found that 26% were current smokers, 35% were ex-smokers, and 39% had never smoked.¹⁰ The authors noted: "The benefits of LTOT (long-term oxygen therapy) in active smokers are questionable, while possible risks are in the front line." The Position Statement of the Thoracic Society of Australia and New Zealand on the subject states: "Oxygen therapy is not indicated for patients... who continue to smoke cigarettes (owing to the increased fire risk and the probability that the poorer prognosis conferred by smoking will offset treatment benefit)... and who are not sufficiently motivated to undertake the discipline required for oxygen therapy."¹¹

In his research on home oxygen therapy, Ringbaek noted that international studies of home oxygen users reported that 5-29% continued to smoke. He also assessed follow-up care.¹² One of the measures of "sufficient follow-up" addressed non-smoking status. Only 5% of a subgroup of 890 patients had "sufficient follow-up to assess oxygen flow and compliance with non-smoking and treatment protocols. Records of central Copenhagen COPD patients receiving long term oxygen therapy in 2000 showed that 77.4% were asked about smoking, and 15.5% admitted smoking. Blood tests to measure

⁸ Joint Commission on Accreditation of Health Organizations (JCAHO). *2007 Home Care National Patient Safety Goals*.

⁹ Martin J. Jarvis. "Why People Smoke," *BMJ* 2004;328:277-279

¹⁰ Stamatis Katsenos, Marios E Froudarakis, Alexandros Charisis, Miltiadis P. Vassiliou and Stavros H Constantopoulos. "Long-term oxygen therapy in Ioannina," *Respiration* 2004 Nov-Dec; 71(6):619-24.

¹¹ Christine F. McDonald, Alan J. Crockett and Ivan Young. "Adult Domiciliary Oxygen Therapy. Position Statement of the Thoracic Society of Australia and New Zealand. *Medical Journal of Australia* 2005; 182 (12): 621-626.

¹² Thomas Joergen Ringbaek. "Home Oxygen Therapy in COPD Patients: Results from the Danish Oxygen Register," *Danish Medical Bulletin* 2006; 53 (3): 310-325.

carbon monoxide were done on 50.5%; 15.8% showed abnormal values of CO. Overall, 79.6% were either asked about smoking or had blood gases checked for carbon monoxide. Indications of smoking by either method were noted for 21.2% of the patients checked.

Writing in Denmark, Ringbaek, Lange, and Viskum point out that national guidelines state current smokers are not candidates for long term oxygen therapy but provide no guidance on ensuring this. The authors propose adding recommendations for testing for carboxyhemoglobin in expired air or blood gases to the guidelines.¹³

Fire Literature or Sources

In their review of 2007, the Las Vegas Fire and Rescue Department noted two fires in which smoking with medical oxygen was believed to be the cause. A two-alarm fire in an apartment building on November 22 caused one smoke inhalation injury. On November 30, the body of an elderly man was found in motel room at a fatal fire.¹⁴

In Massachusetts, fires involving smoking and home oxygen systems claimed 18 lives and caused severe burn or smoke inhalation to 30 others since 1997.¹⁵ An eight-year-old girl died in a fire that started when her 56-year-old father dropped his cigarette while using home oxygen. The fire was intensified when an oxygen tank ruptured. Even though he had turned off his oxygen system, a 71-year-old man died from a flash fire that occurred when he lit a cigarette in the still oxygen-enriched room. His wife and daughter were burned on their hands when they tried to put out the fire.

From March 3, 1999 to November 30, 2000, the Philadelphia Fire Department responded to 12 fires involving home medical oxygen. These fires caused three deaths, seven burn injuries and the displacement of 12 people. In six of these fires, the cause was listed as smoking. The other six were started by open flames such as matches or lighters, but all the open flames were used to light smoking materials.¹⁶

These fires can progress so quickly that even the best fire protection may not be enough to prevent fatal injury, particularly to someone who is already in poor health. The National Fire Protection Association (NFPA) has received reports about a number of other such fires. Sprinklers were present in at least two home fires and one assisted living

¹³ Thomas J. Ringbaek, Peter Lange, and Kaj Viskum. "Geographic Variation in Long-Term Therapy in Denmark: Factors Related to Guideline for Long-Term Oxygen Therapy," *Chest* 2001: 119; 1711-1716, DOI 10.1378/chest.119.6.1711.

¹⁴ Tom Szymanski. "Las Vegas Fire & Rescue – The Year 2007 in Review," Media Release, January 1, 2008.

¹⁵ Office of the State Fire Marshal, Massachusetts Department of Fire Services, "Smoking and Home Oxygen Systems: Some People Don't Know When to Quit," FireFACTORS Series, March 2007, accessed online at http://www.mass.gov/Eeops/docs/dfs/osfm/pubed/flyers/smoking_and_home_oxygen.pdf.

¹⁶ Garrity, Thomas J. *A Public Education Program to Prevent Oxygen-Therapy Fires: Strategic Analysis of Community Risk Reduction*, National Fire Academy applied research project as part of the Executive Fire Officer Program, 2000.

facility fire involving medical oxygen. Assisted living facilities are more tightly regulated than the home environment, but even their typically greater level of fire protection may not be enough to prevent serious injury in a fire involving medical oxygen.

- In 2005, a 73-year-old woman was smoking in bed while on oxygen in a 12-story Delaware apartment building for seniors when her cigarette ignited her pajamas. One sprinkler operated and extinguished the fire, but the unit remained smoky. The victim was able to get in her wheel chair and go to the stair tower where the firefighters found her. She died of her burns.¹⁷
- Discarded smoking materials ignited paper in a wastebasket in an Arizona single-family home. When the occupant, on oxygen, carried the wastebasket to the sink, fire burned through the plastic tubing and spread to an upholstered stool and the oxygen generator in the living room. Two sprinklers extinguished the flames. Firefighters found the woman in the bathroom, dead of smoke inhalation.¹⁸
- When a 49-year-old Florida assisted living resident tried to light a cigarette while using medical oxygen, he ignited his facial hair and the oxygen tubing. While the oxygen was still on, he went into the bathroom to try to put out the fire. The tubing started to melt and fell to the carpet. The smoke detection system operated. Staff found the victim on the floor inside his room. One used an extinguisher while the other pulled the man to the hallway. Firefighters put out the remaining fire with a portable extinguisher. The victim died of smoke inhalation. The fire was not large enough to activate the sprinklers. Property damage from the fire was estimated at only \$500.¹⁹

Medical oxygen also increases the risk for firefighters and others. In 2004, two firefighters and a woman smoking while using medical oxygen were fatally injured in a fire in the woman's single family, metal-tract type Nebraska home. Her cigarette ignited the couch upholstery, and the fire quickly grew in the oxygen-enriched environment. The rapid fire, ice build-up on the roof, and rusted fasteners connecting an addition to the original structure led the building to collapse, trapping the firefighters underneath.²⁰

In 2006, a couple died and a firefighter was injured in a fire that started in the bedroom of the couple's single-family home in Tennessee. Medical oxygen was in use and both members of the couple were disabled. The fire started when cigarette ignited bedding.²¹

¹⁷ NFPA's Fire Incident Database Organization (FIDO) files.

¹⁸ Kenneth J. Tremblay, 2004, "Sprinklers Extinguish Fire in Home Oxygen Unit: Arizona," *NFPA Journal* 2004; 98(6):17.

¹⁹ Kenneth J. Tremblay. Man dies trying to smoke while using oxygen. *NFPA Journal* 2004, January/February special on-line edition, accessed at <http://www.nfpa.org/itemDetail.asp?categoryID=706&itemID=20821&URL=Publications/NFPA%20Journal@/January%20/%20February%202004/Online%20Exclusives> on April 17, 2008.

²⁰ NFPA's Fire Incident Database Organization (FIDO) files.

²¹ NFPA's Fire Incident Database Organization (FIDO) files.

Greg Hitchcock, then Captain and now Deputy Chief of the Lake Mishnock Fire/Rescue Company in Rhode Island, described a 2004 house fire with medical oxygen present.²² Responding firefighters found heavy fire showing and a severely burned victim in the backyard. As they entered the structure, an M size oxygen cylinder ruptured. Hitchcock wrote that the force “lifted the attack team off the porch back to the street. Had this cylinder and shrapnel from both the tank and cast metal base stand gone right instead of left, I probably would not be writing this today.” Luckily, no firefighters were injured at the fire. Pictures of the cylinder are shown in Figure 1.



Figure 1. Ruptured Oxygen Cylinder from 2004 Lake Mishnock, RI Fire

Source: Photos by Curt Varone

The U.S. Fire Administration’s (USFA’s) Fire Investigation Programs investigated two high-rise apartment building fires in which medical oxygen played a role: an August 9, 1998 apartment fire in North Bergen, New Jersey and an October 12, 1998 fire in St. Louis, Missouri.²³ Both properties were made with fire-resistive construction; neither had sprinklers in the apartments. Four people died and fifty-four were injured in the New Jersey fire. A small steel cylinder in the area of origin ruptured and relief devices actuated on a large steel cylinder and small aluminum cylinder in another room. The fire-resistive construction was successful in confining the fire to the room of origin and adjacent hallway, although smoke filled the stairwells.

²² Gregory C. Hitchcock. “Lake Mishnock Fire Rescue Responded Dwelling Fire,” *1st Responder Newspaper*, Story Number 120904109, accessed at <http://www.1rbn.com/webpages/news/displayNews.aspx?PT=news&ID=cf608296-02e4-45c6-8a0d-f203e54d27c8> on July 8, 2008.

²³ John Lee Cook, Jr. *A Comparison of Two Fires: The Westview Towers, North Bergen, New Jersey and the Council Towers Apartments, St. Louis, Missouri*, Miami, FL: Varley-Campbell and Associates, Inc./TriData Corp. September 2001 under contract EME-97-CO-0506 to U.S. Fire Administration, National Fire Data Center, Technical Report Series USFA-TR-119.

Sixty-eight people were injured in the Missouri fire, including a firefighter who would not be able to return to work. Most of the remaining injuries were minor. Three aluminum cylinders ruptured, damaging a separating wall between the unit of origin and an adjacent unit. This allowed heat and toxic gases into the next unit. The fire broke through the glass in the apartment of origin and spread to the unit above through the outside windows. The fire resistive construction was effective in containing both fires, but trapped the heat and smoke making it more difficult to extinguish them. The author writes:

“Firefighters should always assume, until proven otherwise, that any dwelling that houses an elderly or ill resident contains oxygen cylinders. Most of these cylinders will be constructed of aluminum due to their light weight. Aluminum cylinders are susceptible to failure in a fire. At a minimum, cylinder venting will increase the rate of combustion and generate more heat.”

Oxygen Use for Unintended Purposes

Although addressing industrial use rather than medical use of oxygen, the European Industrial Gases Association (EIGA) notes that serious incidents have resulted from the use of oxygen for unintended purposes such as inflation or cooling.²⁴ A July 1997 fire in NFPA’s files illustrates the point. A 59-year-old male Massachusetts oxygen user was killed in a fire that began when unattended incense ignited bedding in a teenager’s adjacent room in a 12-unit apartment building. A window fan that pulled the flames across the bed helped spread the fire. At the same time, the deceased tried to cool himself by releasing oxygen from a 30-liter cylinder, a process he had used in the past. The oxygen enriched atmosphere intensified the fire and prevented the man’s escape. The bedroom and living room windows and casings in the apartment of origin blew out 20-25 feet. Investigators found the top of an oxygen tank in the living room burned away and the tank showing implosion damage and a hole at the liquid fill line. The top of a tank in the master bedroom was also burned away. This tank had a smaller hole at the liquid fill line. A “D” cylinder was found in a hall closet, and a pony tank was also found in the master bedroom.

More about Oxygen Enriched Environments

EIGA also notes that the atmosphere can become oxygen enriched when pipe connections or flanges leak, particularly in areas with poor ventilation. Spilled liquid oxygen results in a dense oxygen enriched cloud. Cold gaseous oxygen is three times as heavy as air. They also advise that people who have been exposed to an oxygen enriched environment should avoid smoking or heat sources until their clothes have been ventilated in normal

²⁴ Safety Advisory Group, European Industrial Gases Association. *Fire Hazards of Oxygen and Oxygen Enriched Atmospheres*, Brussels: 2000, p. 2.

atmosphere for at least 15 minutes. In normal medical oxygen use, the enriched atmosphere is near the person's face. If a larger area becomes enriched, perhaps by cylinder breach, anyone entering the space for rescue is in serious danger of also catching fire. They recommend deluging the victim with water and bringing the victim into fresh air as soon as possible. They also caution that replacement parts must be specifically approved for use with oxygen and that oil and grease should not be used as lubricants.

Medical Oxygen and Regulatory Requirements

Strict codes regulate the use and storage of medical oxygen in health care facilities. Areas where it is used and stored are prominently labeled. This is not necessarily true in the home environment. Francis Manfredo of the Utica, New York Fire Department described several medical oxygen fires in his community.²⁵ Three Utica firefighters were injured in an October 30, 2005 fire in which two oxygen cylinders ruptured. Thirty-six more cylinders were present in the home. A second fire involving medical oxygen was reported on November 24, 2005 and a third occurred two days later. A fourth medical oxygen fire on May 9, 2006 killed the 77-year-old resident. The fire service had no information about the presence of medical oxygen prior to these incidents. Manfredo sent 70 surveys to New York fire departments asking about their experiences with and programs tracking usage and storage of home oxygen. Based on the 46 surveys returned, one-third of the departments had at least one incident involving home oxygen in the previous 24 months, with a total of 152 incidents. Only 18% of the respondents had any kind of program to track usage and storage of home oxygen. None of these programs were mandatory.

Jesus J. Alba, Jr. discussed home oxygen safety programs after two fires involving home medical oxygen in Waukesha, Wisconsin.²⁶ In an October 2004 fire, they discovered that a flash fire had occurred in the fourth floor of a Housing Authority high-rise building. The resident, who used home oxygen, had facial burns. Smoking materials were found in several places, and a trail of melted oxygen tubing was found on the kitchen floor. Damage was limited to the apartment of origin. In a December 2004 incident, a flash fire ignited at the oxygen tubing connector on the floor approximately 15 feet from the oxygen bottle and 10 feet from the occupant. The resident had been smoking with her cannula around her neck as she walked around her home. Investigators determined that a cigarette ash ignited the tubing or carpeting. Although they were not a factor in the incident, 15 full cylinders and 32 full bottles were found in the home.

The Waukesha Fire Department Fire Marshal reported that there were no regulations on the number of oxygen bottles or how they may be stored in the home environment. He spoke with a respiratory therapist for a home oxygen supply company who reported that

²⁵ Manfredo, Francis A. *Improving Firefighter Safety by Identifying Oxygen Storage and Use for Home Health Care: Leading Community Risk Reduction*, National Fire Academy applied research project as part of the Executive Fire Officer Program, 2006.

²⁶ Alba, Jesus J., Jr., *An Assessment of Home Oxygen Safety Programs in the City of Waukesha: Leading Community Risk Reduction*, National Fire Academy applied research project as part of the Executive Fire Officer Program, 2005.

new users of home oxygen receive a two-hour in-home training session on the safe use and operation of the equipment with follow-up evaluations at two-weeks, one-month, two months and six months. She noted that cost leads some companies to deliver two-week supplies, and that bottle accumulation was an area of undefined responsibility. Mr. Alba believes that regulating the use of oxygen in the home could violate the fourth amendment of the U.S. Constitution prohibiting unreasonable search and seizure. Instead, he advocates a voluntary identification program and public housing policies that would allow housing administrators and residents to monitor the use of the systems.

In 2004, a Massachusetts task force on the subject proposed a regulation that would prohibit the delivery of medical oxygen to homes and other non-health care properties that did not display an oxygen identification decal from the oxygen provider on the front door or door frame of the home or unit. This proposal did not pass.²⁷ Such identification in private homes may pose a security risk as it implies that someone medically vulnerable lives there.

In 2002, New Jersey enacted a law requiring fire department notification of medical oxygen or oxygen delivery systems in residential settings. If the patient consents, the pharmacist or supplier is required to make the notification. If the patient does not provide informed consent, then the patient must notify the fire department. Persons who knowingly fail to comply are considered disorderly. In addition, the Division of Fire Safety in the Department of Community Affairs was tasked to develop regulations about the placement of warning signs for residences with oxygen or oxygen delivery systems or residents who are disabled.²⁸

A voluntary emblem program was developed.²⁹ Emblems are used on the front door and individual's sleeping area. Emergency responders are trained to recognize the emblems, but the general appearance is not publicized for security reasons. This program supersedes other emblem programs developed by local communities or medical supply companies. The Division of Fire Safety mails emblems to the applicant and maintains the database. Applicants submit a simple, one-page, confidential form with the individual's name, address, date of birth, device for assistance, and nature of disability to the Division of Fire Safety.³⁰ The form must be signed by a doctor.

²⁷ Jennifer L. Meith, Public Information Officer for the Office of the State Fire Marshal of Massachusetts, personal communication, 3/21/2008.

²⁸ New Jersey State Legislature. "Chapter 118: An act concerning medical oxygen and oxygen delivery system use in a residential setting and supplementing P.L. 1971, c. 134, (C.52:17B-118 et seq.). Approved December 12, 2002. Accessed online at http://www.njleg.state.nj.us/2002/Bills/PL02/118_.HTM.

²⁹ New Jersey Division of Fire Safety Emblems Program, Contractors Certification and Emblems Unit, *Questions and Answers*, accessed on line at <http://www.state.nj.us/dca/dfs/emblemsqa.pdf> on April 9, 2008.

³⁰ New Jersey Division of Fire Safety Emblems Program, Contractors Certification and Emblems Unit, *Disability and Oxygen Emblem Application*, accessed on line at <http://www.state.nj.us/dca/dfs/disabilityemblem.pdf> on April 9, 2008.

Fire and Life Safety Code Consultant Robert J. Davidson identified several problems with the law.³¹ First, his visual and word search of New Jersey's administrative regulations revealed nothing more on the subject of mandatory notification. As written, if the patient does not provide consent to notify, the pharmacist has no further responsibility. If the patient does sign, the pharmacist then must determine which fire department protects the patient's home and make the notification. Fire department coverage does not necessarily correspond to municipal borders, so determining the proper fire department may not be straightforward. The pharmacist would have little incentive to encourage informed consent to something that would simply add more work. Even if notification is made, the local fire department may lack the administrative capacity to use the information. This could be a particular issue in volunteer departments that have not been provided any administrative resources. In addition, the required notification addresses only the first location of the equipment. No additional notification is required for temporary or permanent moves. The fire service is the party most interested in this notification. Barring a more restrictive local ordinance, the only oversight of owner-occupied one-and two-family dwellings allowed by New Jersey's Uniform Fire Code is smoke alarm inspections at resale.

It is also unclear how local fire departments could enforce emblem removal requirements. Even if the regulations did allow local enforcement, such a requirement would be considered an unfunded state mandate/state pay program. Privacy issues also pose challenges. Mr. Davidson believes that tracking the locations of home medical oxygen is unworkable. He believes that the default assumption should be that medical oxygen is present. In his opinion, residential sprinklers would provide the best protection against these fires.

As already discussed, when safety requirements for medical oxygen are not met, the lives of others in the building are also threatened. In 2005, a seven-month-old Michigan baby girl died in an apartment building fire started by a 56-year-old intoxicated smoker's cigarette near some of his medical oxygen tanks. The infant's family lived in the apartment above the smoker. While escaping down the smoky stairwell, the mother dropped the child and was unable to find her in the smoke. Authorities charged the smoker with second-degree murder, involuntary manslaughter, and arson of a dwelling.³² At the trial, an investigator reported that at least one of the oxygen tanks exploded, making the fire burn more intensely. Respiratory therapists for the medical oxygen company testified that the smoker had been informed of the danger of smoking and signed a contract stating that he understood. They also reported seeing burn marks on the carpet and sofa, suggesting that he had continued to smoke in spite of the warning. The smoker was convicted of involuntary manslaughter and sentenced to four to 15 years.³³

³¹ Robert J. Davidson, Fire and Life Safety Code Consultant, Davidson Code Concepts. E-mail correspondence, April 10, 2008.

³² Chad Halcom. "Smoker Charged in Fatal Fire," *Macomb Daily*, March 18, 2006.

³³ Heidi Roman. "Smoker to Serve 4 Years for Causing Fatal Apartment Fire," *C and G News*, November 8, 2006, online at <http://www.candgnews.com/Homepage-Articles/11-08-06/CC-renwicksentence.asp>

Property managers may find themselves in a difficult position when tenants continue to smoke while on medical oxygen. In a 2006 retaliatory discharge case, the Nashville, Tennessee Court of Appeals upheld the right of a medical supply company to fire an employee who had violated company procedure by reminding a property manager that smoking in units with medical oxygen should not be allowed. He initiated this conversation after the customer came to the door holding a cigarette. Although he did not name the individual, the manager knew which unit he had visited and started eviction proceedings. The customer complained to the medical supply company that her privacy had been violated. The employee was terminated for violating company policy of reporting safety violations immediately to company management rather than directly addressing the issue. The court granted the company's motion for a directed verdict due to the "at-will" employment requiring no cause for termination. The court also ruled that regulations on smoking while medical oxygen is in use apply to facility management, *not* the smoker. Consequently, the report to facility management would be communication to the offender (the facility), not the reporting of illegal activities to official authorities. In a footnote, the court noted that 45 C.F.R. § 164.512(j) of the Privacy Rule in HIPAA permits disclosure of patient information to prevent a threat to public safety. The resident was allowed to stay after she agreed to attend a training program on using medical oxygen.³⁴

A North Dakota court ruled that services could be denied when smoking was allowed in a home in which medical oxygen was used. In 2005, the Supreme Court of North Dakota ruled in *Martin v. Stutsman v. Social Services* that the Department of Human Services was justified in refusing services based on "contraindicated practices" it had defined.³⁵ The plaintiff, Judith Martin, received Medicaid benefits. Following her discharge from a nursing home where she recuperated from a broken leg, she sought home-based services. Her husband was a medical oxygen user. Mrs. Martin smoked in the home and also gave a caregiver permission to smoke. The initial request was denied because the anticipated cost would exceed the benefit allowance and because of the presence of smokers in a home with medical oxygen. The district court ruled that "the act of smoking near an oxygen tank is a contraindicated practice" as defined in the North Dakota Administrative Code. Mrs. Martin appealed, noting that her husband was not a smoker, and that "there was no evidence presented as to the amount of oxygen that would be present in the apartment nor was evidence produced regarding the likelihood of a fire or an explosion occurring if she smoked in her bedroom while her husband used oxygen in a separate room. The Court agreed that her smoking was a contraindicated practice under the Administrative Code, and affirmed the earlier decisions.

A May 2006 Department of Veteran Affairs Directive requires that incidents in which patients on home oxygen do not comply with the guidelines or could endanger

³⁴ Thomas W. Brothers. "Thomas E. Bright, Jr. v. MMS Knoxville, Inc. Appeal from the Circuit Court for Davidson County." No. 03C-1642 August 15, 2006 session, online at www.tsc.state.tn.us/OPINIONS/TCA/PDF/073/BrightTEOPN.pdf.

³⁵ Dale V. Sandstrom, Justice. *Martin v. Stutsman Co. Social Services*, No. 20050019, North Dakota Supreme Court Opinions, 2005 ND 117, 698 N.W. 2d 278.

themselves or others be documented and reported.³⁶ The patient or surrogate must be counseled about the risks and possible consequences. A multidisciplinary review process or Ethics Consultation is used when there is a conflict between an oxygen patient's continued smoking and safety. These groups decide if and how oxygen therapy will continue in these situations.

In a 1997 Massachusetts case, the parents of a 5-year-old boy with developmental disabilities were awarded \$16,000 plus interest (for a total verdict of \$20,000) in a case brought against an elderly woman who started a fire in the six-unit condominium complex when she smoked while using oxygen.³⁷ The boy and his family were physically unharmed but had to pass within feet of the flames. The child had to live with another relative for 15 months while the family's unit was repaired. They sought redress on the child's behalf for emotional distress, post traumatic stress disorder and separation anxiety that required medication.

Flash Fires and First Responder Use of Medical Oxygen Equipment

USFA's technical report on medical oxygen fires³⁸ detailed 10 flash fires in 1993-1999 that involved portable oxygen cylinders and combination pressure flow regulators used by the fire service or emergency medical service personnel. The use of brass or nickel-plated brass regulators was recommended instead of aluminum as the former are less of a flash fire hazard. Opening a cylinder valve quickly increases pressure at a corresponding rate and produces more heat of compression. This heat can ignite contaminants such as skin or hair oil, lubricants, and soap residue. The area within three feet of the point where oxygen is released should be considered oxygen enriched. Some organizations are having oxygen regulators cleaned and inspected annually to remove any contaminants, such as metal flakes or other debris. Cylinder, valve, and regulator maintenance should be done only by trained technicians at special facilities to prevent damage that could result in a fire. The author also notes the National Institute for Occupational Safety and Health (NIOSH) recommends that oxygen cylinders be stored upright to prevent particles from getting into the regulator.

³⁶ Department of Veterans Affairs. "Reducing the Fire Hazard of Smoking when Oxygen Treatment is Expected," Washington, DC: Veterans Health Administration, VHA Directive 2006-021, accessed at http://www1.va.gov/vhapublications/ViewPublication.asp?pub_ID=1407 on August 6, 2008.

³⁷ Brett & Gale Schlossberg on behalf of Aaron Schlossberg v. Edith Allanbrook, Superior Court of Massachusetts, 1997, Westlaw, JAS MA Ref No. 94438WL (Mass.Super.). 1997, WL 33103190.

³⁸ Miller, Thomas H. *Fires Involving Medical Oxygen Equipment*, Miami, FL: Varley-Campbell and Associates, Inc./TriData Corp. under contract EME-97-CO-0506 to U.S. Fire Administration, National Fire Data Center, March 1999.

National Statistics

None of the literature reviewed provided estimates of the number of U.S. fires or burns associated with the home use of medical oxygen. The next portion of the paper discusses national estimates of

- 1) Thermal burns caused by ignitions associated with home medical oxygen seen in hospital emergency rooms, and
- 2) The number of fires and associated casualties incurred at fires reported to local fire departments in which medical oxygen equipment was said to be the equipment involved in ignition.

Oxygen-related burns seen at hospital emergency rooms

The CPSC administers NEISS, a probability sample of hospital emergency rooms.³⁹ Roughly 100 hospitals from five strata are included in the sample. Four of the strata are based on the number of emergency room visits. Emergency rooms in children's hospitals are included in the fifth stratum. Weights are assigned to the hospitals based on their strata and are used to calculate estimates of the total number of U.S. emergency room visits. Weights are adjusted when necessary due to changes at the hospital such as mergers, closings, etc. The CPSC maintains an interactive website⁴⁰ where NEISS data may be queried and downloadable files generated of relevant cases.

In this analysis, queries were done on thermal burns reported in the four calendar years of 2003-2006. Thermal burns include both burns from fire and burns from contact with hot (or very cold) objects such as stoves, heaters, and irons. The narrative fields were searched for the terms "oxygen" and "O2." Only burns involving medical oxygen and a heat source at homes, manufactured homes, or in unrecorded locales (codes 1, 6, and 0) were included.⁴¹ A burn that occurred when an oxygen hose used with a torch broke was omitted, as was a burn that occurred when the patient's hand got stuck to her mother's oxygen tank. Heat sources for medical oxygen burns were identified by using detail from the narratives and the product codes. When the narrative and product codes disagreed, the narrative information was used. Total thermal burns from smoking (cigarettes, cigars, pipes, or tobacco) were identified by product code 1909 without further adjustments based on narratives. No adjustments were made for inconsistencies between narratives and the fire department attendance/fire involvement field. Anoxia injuries were not considered in this analysis.

A total of 123 reported burns at the sample hospitals met the criteria, resulting in an estimated average of 1,190 burns related to medical oxygen per year. These incidents

³⁹ Tom Schroeder and Kimberly Ault. *The NEISS Sample (Design and Implementation) 1997 to Present*, Division of Hazard and Injury Data Systems, U.S. Consumer Product Safety Commission, June 2001.

⁴⁰ <https://xapps.cpsc.gov/NEISSQuery/home.do>

⁴¹ U.S. Consumer Product Safety Commission. *NEISS Coding Manual: January 2008*.

accounted for 1% of all thermal burns seen at hospital emergency departments. The percentages that follow are based on the unweighted 123 incidents.

Eighty-nine percent of the victims suffered facial burns. Forty-three percent were either admitted or transferred to another hospital, 2% were held for observation, and 55% were either treated and released or released without treatment.

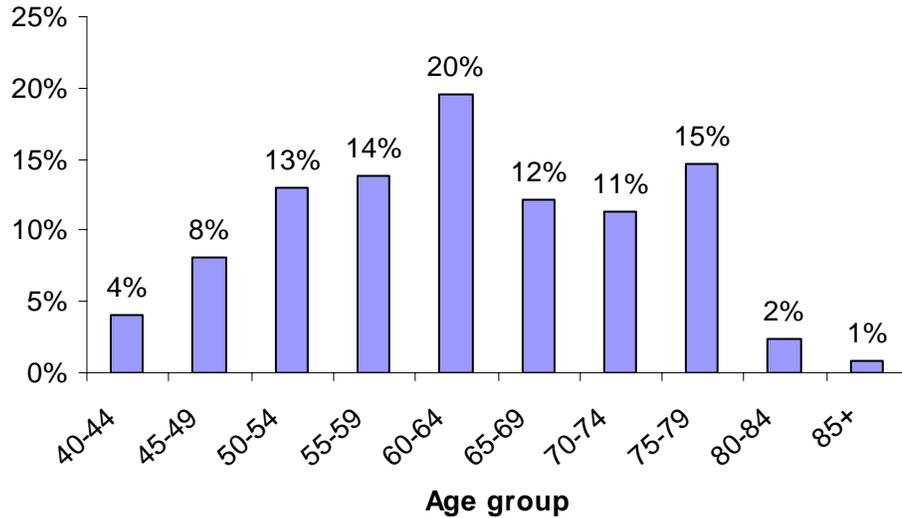


Figure 2. Medical Oxygen-Related Burns Seen at Hospital Emergency Rooms by Age Group: 2003-2006

Sixty-six percent of the victims were male. The victims' ages ranged from 40 to 86, with a mean age of 62. The age distribution is shown in Figure 2.

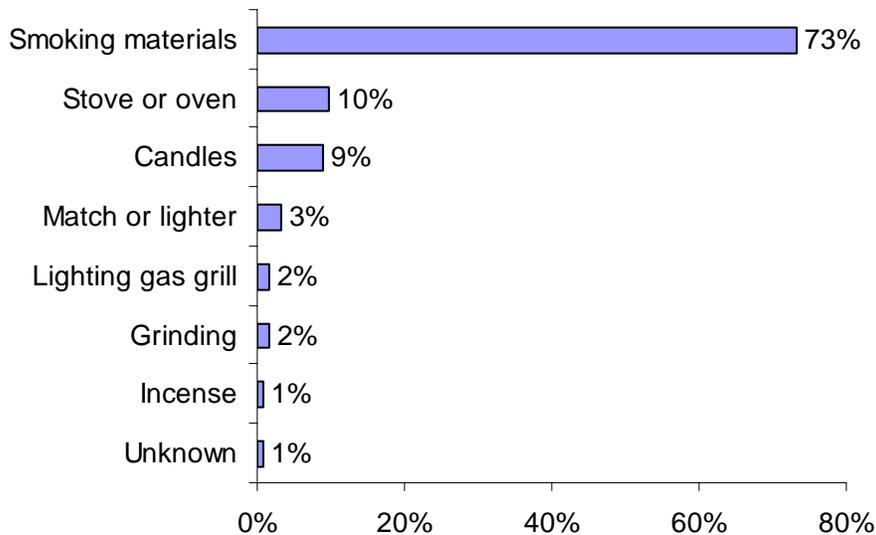


Figure 3. Medical Oxygen-Related Burns Seen at Hospital Emergency Rooms, by Heat Source: 2003-2006

Figure 3 shows that smoking materials were involved in 73% of the medical oxygen-related burns. Burns related to medical oxygen accounted for 16% of all burns involving smoking materials. Stoves or ovens were involved in 10% and candles in 9%. Two percent were burned while lighting gas grills. Another two percent of the burns occurred when the victims were using grinding equipment.

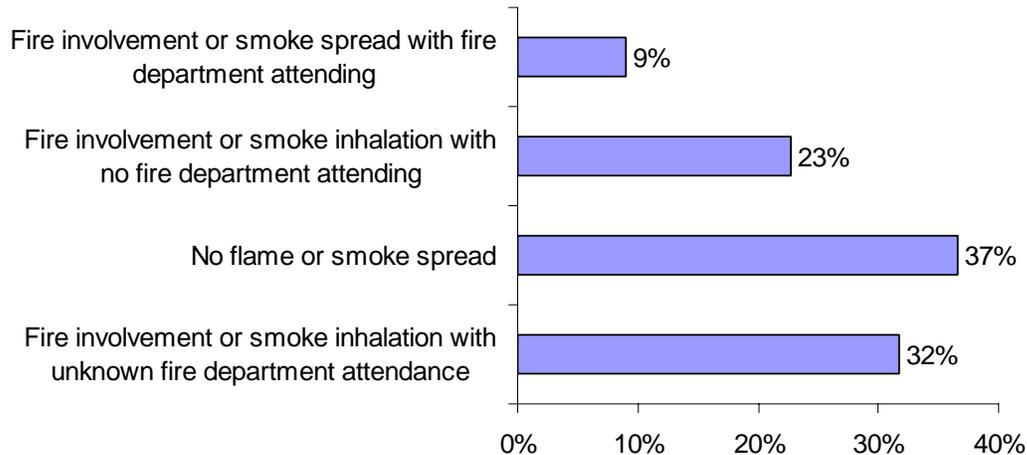


Figure 4. Medical Oxygen-Related Burns Seen at Hospital Emergency Rooms, by Fire Department Attendance: 2003-2006

Figure 4 shows that fire departments were known to have been present at only 9% of the incidents where these burns were incurred. When burns with unknown fire department attendance are excluded, this rises to only 13%. The fire department is never called to the vast majority of such ignitions.

Fire statistics

The national fire experience statistics that follow are estimates derived from the USFA’s NFIRS 5.0 and NFPA’s annual survey of U.S. fire departments. NFIRS is a voluntary system by which participating fire departments report information on fire causes and circumstances, and victim characteristics. It was not designed as a statistical sample. Reporting requirements vary by state. Roughly two-thirds of U.S. fire departments participate, although not all of these departments provide data every year. Using NFIRS data alone would underestimate the extent of any fire problem. Equipment involved in ignition code 416 captures “oxygen administration equipment.”

National estimates of specific fire problems are obtained by using the results from NFIRS 5.0 with the results of NFPA’s annual sample-based fire department experience survey. This survey collects summary data only and lacks detail. NFPA’s survey is sent to all local fire departments protecting population of 50,000 or more and a random sample, stratified by population, of the smaller departments. In most years, the sample size is sufficient to result in

completed surveys returned from roughly 10% of the nation's fire departments. Survey results are used to estimate the total number of reported U.S. fires and associated losses by broad occupancy class and general incident type. Percentages of specific fire circumstances and causes from NFIRS 5.0 are applied to the projected totals from the NFPA survey. This approach is based on the national estimates methodology described by Hall and Harwood⁴² with modifications to account for the fact that NFIRS data not collected originally according to NFIRS 5.0 rules and definitions have been omitted from the analysis. In 2002-2005, U.S. fire departments responded to an estimated average of 377,100 home structure fires annually, resulting in an average of 2,870 civilian deaths and 13,360 reported civilian injuries per year. The term "home" encompasses one- and two-family dwellings, including manufactured homes, and apartments, regardless of ownership. The term "civilian" is used to describe anyone who is not a firefighter.

NFIRS 5.0 does not require causal information such as equipment involved in ignition for six types of minor structure fires, including cooking fires confined to the vessel of origin, confined chimney or flue fires, confined fuel burner or boiler fires, and confined compactor, incinerator, and trash fires that did not spread to the contents or structure. Analyses of the circumstances of fires in which oxygen administration equipment was involved excluded those six incident types.

NFIRS coding rules state the equipment involved in ignition is "the piece of equipment that provided the principal heat source to cause ignition."⁴³ Theoretically, oxygen administration equipment should be listed as the equipment involved in ignition only when it was the heat source. However, it appears that some fire departments are using equipment involved in ignition code 416 to document incidents in which home medical oxygen played any role. This deviation from the rules makes it possible to get a preliminary estimate of the number of fire department responses to these incidents.

The raw NFIRS 5.0 dataset for 2002-2005 contained 71 home fires with home medical oxygen coded involved in ignition. Twelve civilian deaths and 27 civilian injuries were also reported. Fires and casualties with unknown or missing equipment involved, and equipment involved coded as none when the heat source code did not indicate a non-equipment source were allocated proportionally among fires with known equipment involved. The percentage of fires and casualties in which medical oxygen equipment was involved was applied to the estimated home totals from NFPA survey to develop estimates of the size of the problem. The estimates also include a proportional share of fires in which unclassified commercial and medical equipment was involved. Only one entry is allowed for equipment involved in ignition. By definition, then, no other types of equipment, such as stoves or heaters, may be specifically identified.

During 2002-2005, oxygen administration equipment was involved in an estimated average of 182 home fires reported to local fire departments per year, resulting in an average of 46

⁴² J. Hall, Jr. and B. Harwood, Beatrice. "The National Estimates Approach to U.S. Fire Statistics", *Fire Technology* 1989; 25 (2): 99-113.

⁴³ U.S. Fire Administration National Fire Data Center, *National Fire Incident Reporting System 5.0 Complete Reference Guide*, p. 4—29.

civilian deaths and 60 civilian injuries per year.⁴⁴ These fires accounted for 0.1 % of reported home fires, 1.6% of home fire deaths, and 0.5% of reported home fire injuries. Given that oxygen administration equipment is listed under commercial equipment in the code choices, the deviation from standard NFIRS coding practices, and Manfredo’s report of 152 home oxygen incidents encountered by 46 New York fire departments in 24 months, these statistics are likely underestimates. Even so, they provide a starting point to help understand these fires.

On average, based on the projected data, a civilian is killed at one of every four fires reported to NFIRS in which oxygen administration equipment was involved. A civilian is injured at one of every three such incidents. Forty-five percent of the injuries were categorized as minor, 36% moderate, and 15% life-threatening.

For both deaths and injuries, males outnumbered females 3:2. For deaths, the victims’ ages ranged from 48 to 82. Non-fatally injured victims were between 28 and 82 years of age, inclusive. The statistics for age and other causal elements are based on incidents with known data for their respective elements.

Figure 5 shows that, when the heat source was known, smoking materials provided the heat of ignition in roughly three-fifths of these fires and injuries and three-quarters of the deaths. Matches and lighters may have been used for smoking-related activities or for other purposes. Hot embers or ashes provided the heat in 9% of the fires and injuries. Arcing was the heat source in 5% of these fires, 18% of the deaths, and 4% of the injuries.

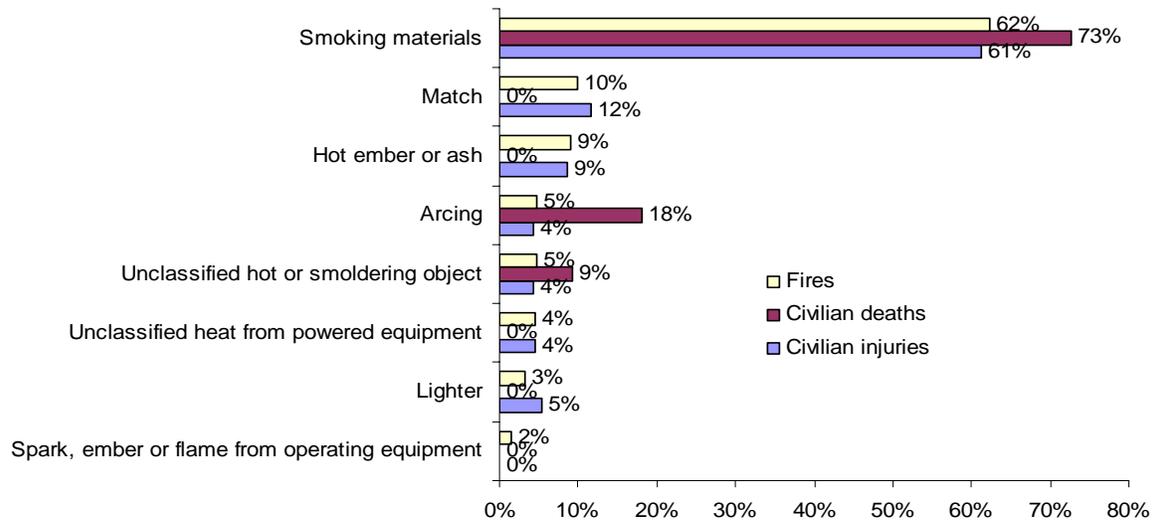


Figure 5. Home Fires in Which Oxygen Administration Equipment Was Involved in Ignition, by Heat Source: 2002-2005

Fires beginning in two areas of the home: a) the bedroom, and b) the living room, family room, or den, accounted for the majority of these incidents and casualties. Figure 6 shows

⁴⁴ John Hall. “Home Structure Fires Involving Equipment.” Quincy, MA: National Fire Protection Association, 2008 (revised).

that the bedroom was the leading area of origin in these fires and civilian deaths and second in injuries, while the living room, family room, or den, ranked first in civilian injuries and second in fires and civilian deaths. The kitchen ranked third in fires and injuries. In home fires overall, kitchens were the leading area of origin in home structure fires and home structure fire injuries, even when confined cooking fires were excluded.⁴⁵

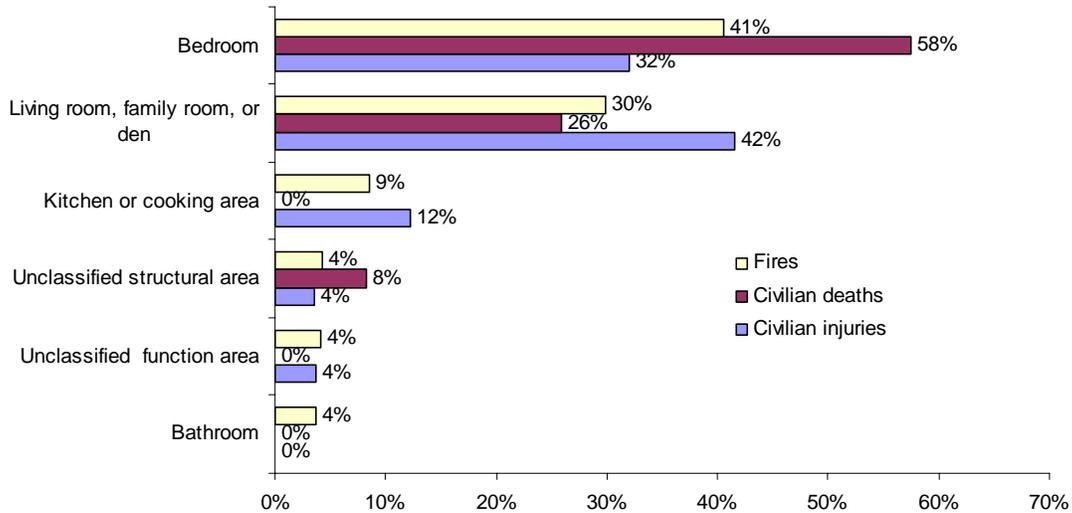
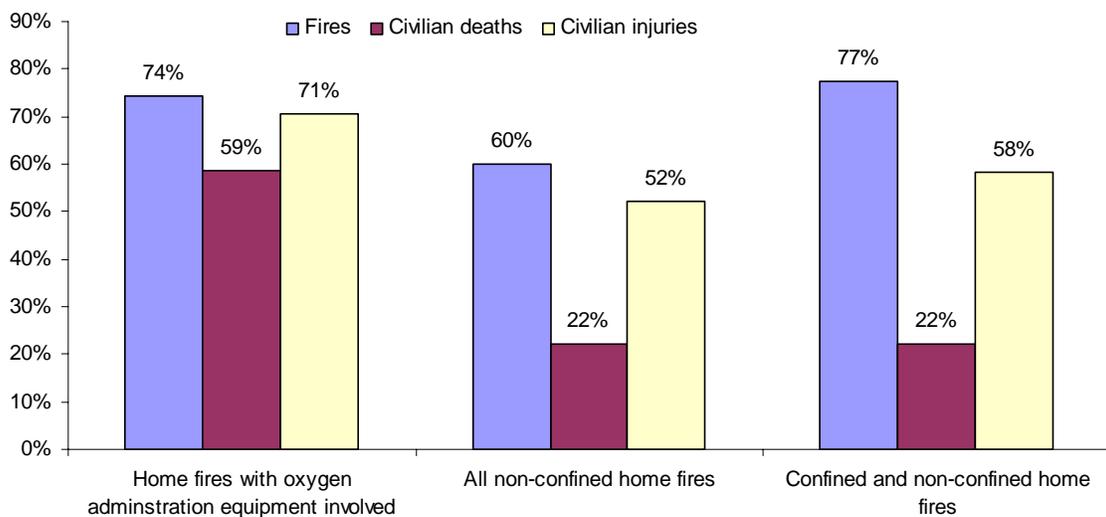


Figure 6. Home Fires in Which Oxygen Administration Equipment Was Involved in Ignition, by Area of Origin: 2002-2005

Figure 7 shows the percent of fire, civilian deaths, and civilian injuries in home fires in which flame damage was confined to the object or room of origin. As mentioned earlier, fires in which oxygen administration equipment was involved were estimated from the set of non-confined home fires. These fires are compared with all non-confined fires and all home fires, including the confined incident types mentioned earlier and the non-confined fires.



⁴⁵ Marty Ahrens. *Home Structure Fires*, Quincy, MA: National Fire Protection Association, September 2007, p. 30.

**Figure 7. Home Fires in which Flame Damage Was Limited to the Room of Origin
2002-2005**

The area of oxygen enrichment may be quite small, but any fire in that area will burn hotter and faster. Only 22% of all home fire deaths resulted from fires in which flame damage was limited to the room of origin, but 59% of the deaths from fires involving home oxygen equipment resulted from fires with this limited damage.

Figure 8 shows that three-quarters of home fire deaths in which oxygen administration equipment was involved resulted from fires reported between 9:00 a.m. and 9:00 p.m. In contrast, only one-third of all home fire deaths resulted from fires reported during this 12-hour period.

In 2005, attached or detached single-family dwellings or manufactured homes accounted for 81% of the households with one or more members of at least 65 years of age.⁴⁶ Figure 9 shows that 70% of these fires occurred in one- and two-family dwellings, including manufactured homes. All of the home fire deaths associated with this equipment that were reported to NFIRS 5.0 during this period also occurred in these properties. It is important to remember that these percentages are calculated from a very small number of incidents and NFPA is aware of oxygen-related deaths in apartment fires. However, the data does suggest that the majority of home oxygen use is occurring in one- and two-family homes, the least regulated properties. Property managers in rental housing can try to enforce safety requirements in their properties, but no other external authority will be exerting such influence in private homes.

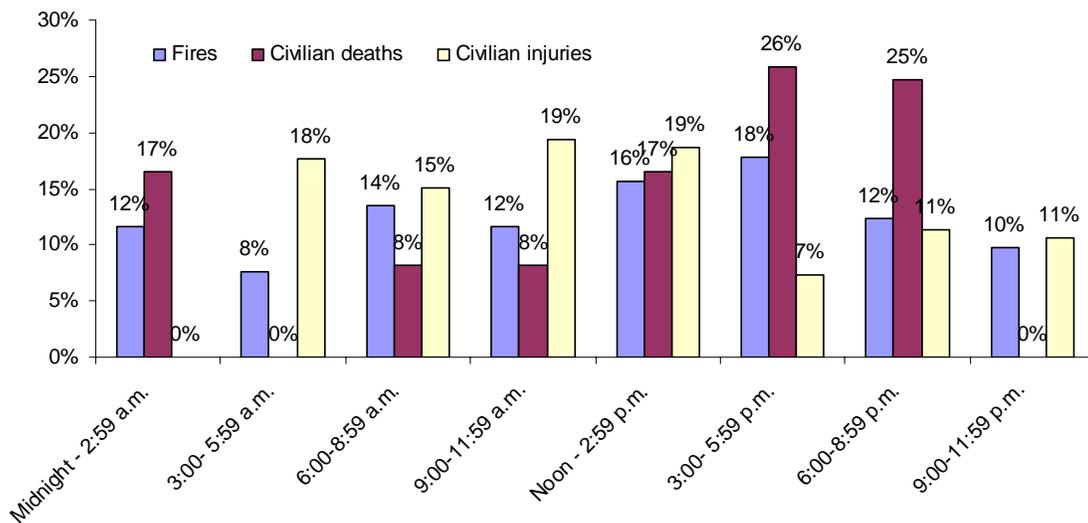


Figure 8. Home Fires in Which Oxygen Administration Equipment Was Involved in Ignition, by Time of Alarm: 2002-2005

⁴⁶ U.S. Census Bureau, Current Housing Reports, Series H150/05. American Housing Survey for the United States: 2005. Table 2-25. Units in Structure by Selected characteristics – Occupied Units. U.S. Government Printing Office, Washington, DC, 2006.

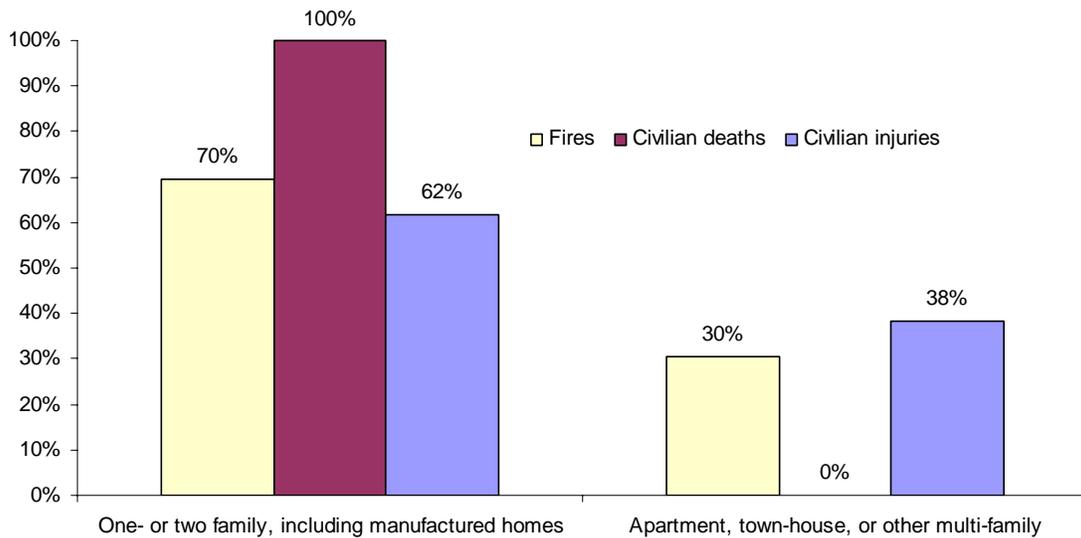


Figure 9. Home Fires in Which Oxygen Administration Equipment Was Involved in Ignition by Occupancy: 2002-2005

Because of oxygen’s role in fire, many people believe that oxygen itself can catch fire. Figure 10 shows that the leading item first ignited on all three measures was a flammable liquid or gas. The second leading item first ignited in terms of fires and injuries was a pipe, duct, conduit, hose, or covering of these materials. The tubing and cannula would most likely fit into this category. Common household items, such as mattresses and bedding, upholstered furniture, rugs and floor covering, and wall coverings, were also frequently mentioned.

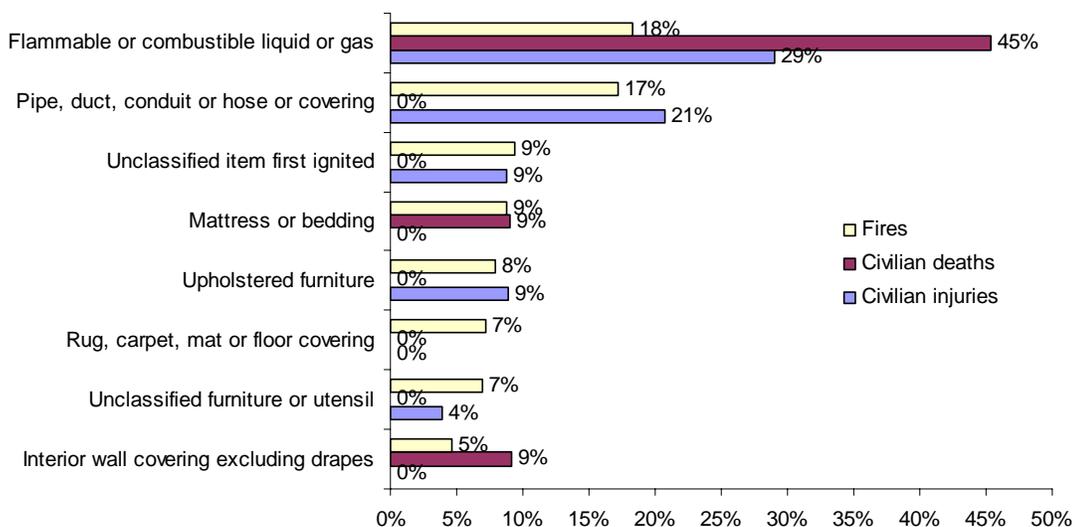


Figure 10. Home Fires in Which Oxygen Administration Equipment Was Involved in Ignition, by Item First Ignited: 2002-2005

Figure 11 shows that smoke alarms were present and operated in 48% of the fire and 57% of the deaths in which home oxygen equipment was involved. No smoke alarms were present in 22% of the fires and 43% of the deaths. The fire was too small to activate the smoke alarm in 16% of the fires. These small fires resulted in 31% of the associated injuries.

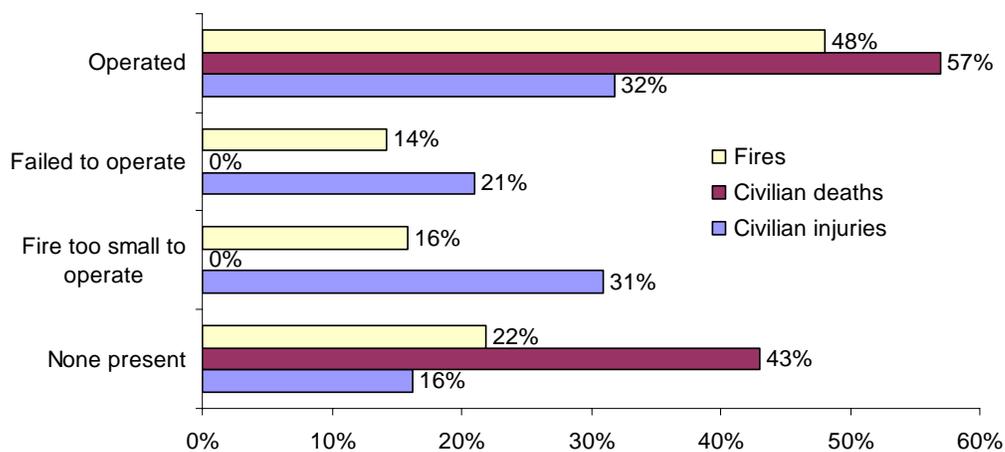


Figure 11. Home Fires in Which Oxygen Administration Equipment Was Involved in Ignition, by Smoke Alarm Status: 2002-2005

Discussion

In 2003-2006, an estimated average of 1,190 emergency room visits annually were due to burns from associated with medical oxygen. The oxygen-related burns in the NEISS data were identified by a narrative field. Medical oxygen is not itself a coded product. If it was not mentioned in the brief narrative, it could not be identified. When an emergency room patient was not directly involved in causing a fire, the cause of the fire in this dataset is likely to be unknown. The majority of these burns were not attended by local fire departments.

The fire statistics are likely underestimates. No data element specifically identifies incidents in which medical oxygen plays a role. Instead, oxygen administration equipment is one of the choices of commercial or medical equipment involved in ignition. In most of the cases reported, the oxygen was a factor, but the equipment was not the heat source. Consequently, the estimate of 182 reported fires and 46 civilian deaths involving medical oxygen equipment is likely an underestimate. Even so, one of every four home fires involving medical oxygen that was reported to local fire departments resulted in death. Fifty-nine percent of these deaths resulted from fires that

were confined to the room of origin. Only 22% of all home fire deaths resulted from fires that limited.

Sprinklers can play an important role in preventing these fires from growing. However, these fires can progress so quickly that even the best fire protection may not be enough to prevent fatal injury, particularly to someone who is already in poor health. In two of the incidents discussed, sprinklers extinguished home fires involving medical oxygen, but the oxygen user died anyway. An oxygen-related fatal fire in an assisted living facility was not large enough to activate the sprinklers and was put out with fire extinguishers. Staff responded to the incident as soon as smoke detectors sounded. Smoke alarms or detection equipment play an important role in alerting others to the fire, but these fires will start more intensely than most. Preventing the ignitions will often be the only effective strategy.

Smoking materials were involved in three-fifths of the fires and civilian injuries involving medical oxygen reported to local fire departments as well as three-quarters of the associated deaths and the emergency room burns associated with medical oxygen. Heat sources such as cooking equipment, candles, and grinding equipment suggest that the patient was engaging in activities that would have been benign prior to the use of medical oxygen but became dangerous with its use. Arcing was cited as the heat source in 5% of the reported fires and 18% of the associated deaths. Individuals may have less ability to limit sources of arcing than open flames.

Only 28% of the medical oxygen costs for Medicare recipients were for the oxygen equipment alone. Other costs include equipment preparation; delivery of equipment and supplies; equipment maintenance; assessing, training and education patients; documentation, customer service, and standard operating and overhead.⁴⁷ The proposed 2009 Medicare budget would require Medicare patients to own and manage home oxygen equipment after 13 months of its rental.⁴⁸ This has implications on the maintenance of this equipment. Miller noted that some first responder organizations are having oxygen regulators cleaned and inspected annually to remove contaminants. He also noted that cylinder, valve, and regulator maintenance should be done only by trained technicians at special facilities. Maintenance of privately owned home oxygen equipment could become an issue.

Smoking is a tough addiction to break, particularly when combined with the stress of poor health. Patients may need considerable assistance. Some may not be motivated to quit at all. The Thoracic Society of Australia and New Zealand maintains that medical oxygen is contraindicated for active smokers. It is difficult to imagine walking into the home of someone using such treatment unsafely and removing the equipment as they gasp for breath. In some homes, it could be quite dangerous to do so. Some home oxygen users may themselves not smoke, but have family members that do. Ethical questions

⁴⁷ Morrison Informatics, Inc.

⁴⁸ Michael Reinemner and Walt Gorski. "President's Proposed 2009 Medicare Budget Would Weaken Seniors' Access to Durable Medical Equipment and Therapies Required in the Home," *News Release*, Arlington, VA: American Association for Home Care, February 4, 2008.

abound. The Veterans Administration utilizes a multidisciplinary clinical committee or Ethical Consultation Service to determine if and how oxygen therapy should be provided when if a patient's smoking threatens the safety of the patient or others.

In 2007, the Massachusetts Supreme Judicial Court heard a case brought against a physician for prescribing medications that could impair driving to a patient without warning against driving. A car driven by the patient struck and killed a child. In a 4-2 decision, the Court ruled to reverse the dismissal of the summary judgment granted the defendant. Justice Ireland, writing for himself and two other justices, concluded that "...a physician owes a duty of reasonable care to everyone foreseeably put at risk by his failure to warn of the side effects of his treatment of a patient."⁴⁹ It is not inconceivable that future courts could consider the provision of medical oxygen to someone who is known to smoke a foreseeable harm.

In the retaliatory discharge case, the Nashville Tennessee Court of Appeals noted that regulations on smoking while medical oxygen is in use apply to facility management, *not* the smoker. Two other court cases suggest that health care institutions may be considered negligent when fatal injuries were incurred by in-patients or residents smoking while using medical oxygen. While these did not occur in the home environment, there are parallels in terms of professional awareness of unsafe behavior.

Although health care institutions are expected to ensure a higher level of safety than would be expected at home, at least two decisions held institutions accountable when patients continued to smoke while receiving medical oxygen.

On July 14, 1977, the Court of Civil Appeals of Waco, Texas reversed an instructed verdict in the hospital's favor in the case of Luther Fleming v. Baylor University Medical Center.⁵⁰ The case was remanded back to the 191st District Court in Dallas County. Mr. Fleming, a 68-year-old "compulsive smoker" was admitted to Baylor University Medical Center in 1973 with pneumonia and other conditions. His mental status was described as confused, he needed assistance to move from bed or chair, and he received medical oxygen while in bed.

Staff continually removed cigarettes and matches from him and warned him of the fire risk. He regularly asked passersby for smoking materials. While he sat in the chair, the oxygen was turned off. At his request, a nurse brought him a cigarette and matches and lit his cigarette while he was in the chair. She left the room, returning soon after at the patient's request to help him back into bed so he could nap. She reported that she extinguished the cigarette in the over-bed table's ashtray, and turned the oxygen back on, but did not check the bedside drawer when she left or at

⁴⁹ Lynn-Ann Coombes vs. Roland J. Florio, SJC-09869. December 10, 2007. Social Law Library, SLIPS Appeals Court

⁵⁰ Fleming v. Baylor University Medical Center. Court of Civil Appeals of Texas, Waco., 1977, Westlaw 554 S.W. 2d 263.

all that day. Shortly after the nurse left the room, a fire occurred in Mr. Fleming's bed and clothing, and he was badly burned.

After the fire, cigarettes were found on the floor and in the bedside cabinet. Mr. Fleming's family had not been not informed of the issues with his smoking and stated that around the clock nursing could have been hired had they known. The Court noted that if the nurse had checked the bedside table, the smoking materials would have been discovered. If Mr. Fleming had not lit another cigarette, then the nurse had not completely extinguished the cigarette he smoked when the oxygen was disconnected and he was in the chair. The failure to notify the family of his smoking and resulting dangers was also cited. The Court noted that any one of the failures did not meet ordinary care standards. "...The fire in question was a foreseeable consequence that could and probably would result from the failure of defendant's employees to keep smoking materials from Mr. Fleming, and remove lighted cigarettes from his room, while oxygen was in use.

On April 3, 2007, a \$125,000 settlement was approved in *Page v. Daybreak Venture*.⁵¹ The plaintiffs' mother, a 62-year-old, wheelchair bound smoker receiving medical oxygen for chronic obstructive pulmonary disease had wheeled herself to the nursing home's smoking area and lit a cigarette. In the resulting fire, she was burned over 19% of her body. She refused intubation at the hospital and died the following day. Her children sued, arguing that the facility had failed to comply with their policies to secure the cigarettes and smoking room and to prevent unsupervised resident smoking. The defendants had argued that the patient's injuries were a result of her own actions and pre-existing conditions.

Rental property managers are between a rock and a hard place when it comes to preventing smoking while on medical oxygen. Other tenants have a right to expect a safe building, but their options for preventing unsafe practices are severely limited. As the Tennessee court noted, it is not illegal to smoke while using medical oxygen. However, facilities may not permit such smoking. In practice, such strictures are hard to enforce outside of a building's common areas. The threat of eviction may be the only leverage property managers have, but eviction proceedings take time. While not all Hospice patients are in the home environment, half of the Hospice discharges had been receiving medical oxygen.⁵² The threat of future eviction may not be meaningful to someone who is terminally ill.

⁵¹ *Page v. Daybreak Venture*, District Court of Texas, 162nd Judicial District, Dallas County, 2007, 2007 Westlaw WL1839824 (Tex. Dist.)

⁵² Haupt BJ. *Characteristics of Hospice Care Discharges and their Length of Service, United States*, 2000, National Center for Health Statistics, Vital Health Stat 2003; Series 13, no. 154, Table 6.

Beginning home oxygen users, like beginning drivers, must learn how to operate the equipment safely and to anticipate hazards in their environment. A medical oxygen user who normally does not use candles should also avoid birthday candles. Some may be careful themselves but live with others or have visitors who refuse to respect the precautions.

Medical oxygen in the home is largely unregulated. Can standards for safe storage and use in the home environment be developed and enforced? If so, by whom? What rights or recourse do other tenants have if a fellow tenant is smoking where medical oxygen is used? Policies for eviction under these circumstances may exist, but these procedures take time. If an individual on oxygen agrees to quit smoking, is a landlord then obligated to stop eviction proceedings? Jarvis noted that less than 3% of attempts to quit smoking resulted in 12 months of non-smoking. What should concerned family members do? Is there a way to honor the patient's right to privacy while at the same time alerting emergency responders to the presence of medical oxygen and preventing its unsafe use?

Given the fiscal situations of both the health care system and local government, approaches that require more staff time and/or money may be unrealistic. Informal mentoring from experienced oxygen users may help oxygen users anticipate unsafe situations. However, today's smokers have ignored years of warnings about the dangers of smoking. Too many also seem able to ignore the added warning about the danger of smoking on oxygen. The Joint Commission expects home care organizations to assess medical oxygen patients' understanding and compliance and report concerns to the patient's doctor. The question remains for all parties: What happens when concerns are raised? The VA developed an interdisciplinary procedure to address these concerns. This may be a model for the rest of the country. Unfortunately, there are no easy answers. More interdisciplinary dialogue is needed to develop coherent policies that can be used by housing officials, tenants groups, home oxygen users and providers, the medical profession, and first responders.

Appendix A. How National Estimates Statistics Are Calculated

The statistics in this analysis are estimates derived from the U.S. Fire Administration's (USFA's) National Fire Incident Reporting System (NFIRS) and the National Fire Protection Association's (NFPA's) annual survey of U.S. fire departments. NFIRS is a voluntary system by which participating fire departments report detailed factors about the fires to which they respond. Roughly two-thirds of U.S. fire departments participate, although not all of these departments provide data every year.

NFIRS provides the most detailed incident information of any national database not limited to large fires. NFIRS is the only database capable of addressing national patterns for fires of all sizes by specific property use and specific fire cause. NFIRS also captures information on the extent of flame spread, and automatic detection and suppression equipment. For more information about NFIRS visit <http://www.nfirs.fema.gov/>. Copies of the paper forms may be downloaded from <http://www.nfirs.fema.gov/download/nfirpaperforms2007.pdf>.

Each year, NFPA conducts an annual survey of fire departments which enables us to capture a summary of fire department experience on a larger scale. Surveys are sent to all municipal departments protecting populations of 50,000 or more and a random sample, stratified by **community size**, of the smaller departments. Typically, a total of roughly 3,000 surveys are returned, representing about one of every ten U.S. municipal fire departments and about one third of the U.S. population.

The survey is stratified by size of population protected to reduce the uncertainty of the final estimate. Small rural communities have fewer people protected per department and are less likely to respond to the survey. A larger number must be surveyed to obtain an adequate sample of those departments. (NFPA also makes follow-up calls to a sample of the smaller fire departments that do not respond, to confirm that those that did respond are truly representative of fire departments their size.) On the other hand, large city departments are so few in number and protect such a large proportion of the total U.S. population that it makes sense to survey all of them. Most respond, resulting in excellent precision for their part of the final estimate.

The survey includes the following information: (1) the total number of fire incidents, civilian deaths, and civilian injuries, and the total estimated property damage (in dollars), for each of the major property use classes defined in NFIRS; (2) the number of on-duty firefighter injuries, by type of duty and nature of illness; and (3) information on the type of community protected (e.g., county versus township versus city) and the size of the population protected, which is used in the statistical formula for projecting national totals from sample results. The results of the survey are published in the annual report *Fire Loss in the United States*. To download a free copy of the report, visit <http://www.nfpa.org/assets/files/PDF/OS.fireloss.pdf>.

Projecting NFIRS to National Estimates

As noted, NFIRS is a voluntary system. Different states and jurisdictions have different reporting requirements and practices. Participation rates in NFIRS are not necessarily uniform across regions and community sizes, both factors correlated with frequency and severity of fires. This means NFIRS may be susceptible to systematic biases. No one at present can quantify the size of these deviations from the ideal, representative sample, so no one can say with confidence that they are or are not serious problems. But there is enough reason for concern so that a second database - the NFPA survey - is needed to project NFIRS to national estimates and to project different parts of NFIRS separately. This multiple calibration approach makes use of the annual NFPA survey where its statistical design advantages are strongest.

Scaling ratios are obtained by comparing NFPA's projected totals of residential structure fires, non-residential structure fires, vehicle fires, and outside and other fires, and associated civilian deaths, civilian injuries, and direct property damage with comparable totals in NFIRS. Estimates of specific fire problems and circumstances are obtained by multiplying the NFIRS data by the scaling ratios.

Analysts at the NFPA, the USFA, and the Consumer Product Safety Commission have developed the specific analytical rules used for this procedure. "The National Estimates Approach to U.S. Fire Statistics," by John R. Hall, Jr. and Beatrice Harwood, provides a more detailed explanation of national estimates. A copy of the article is available online at <http://www.nfpa.org/osds> or through NFPA's One-Stop Data Shop.

Version 5.0 of NFIRS, first introduced in 1999, used a different coding structure for many data elements, added some property use codes, and dropped others.

Figure 1.

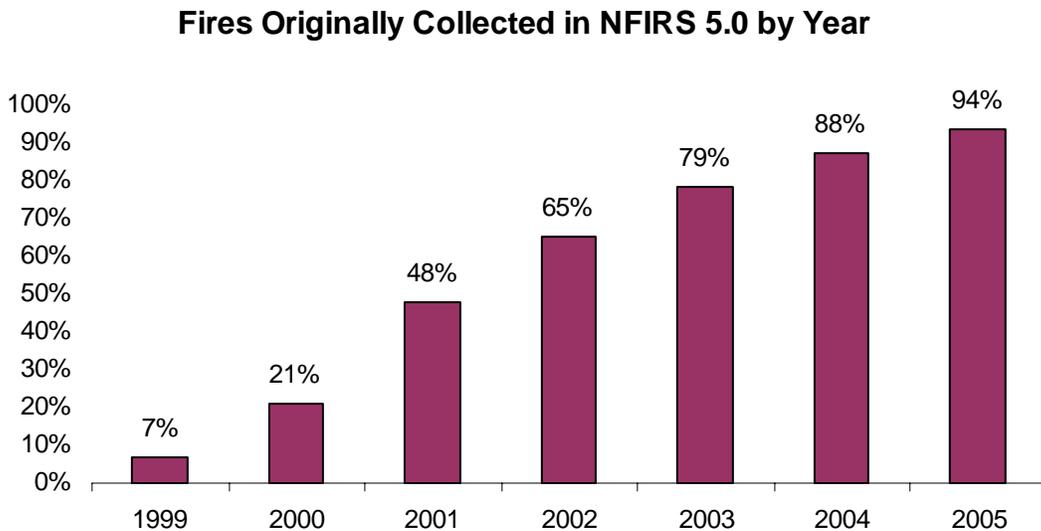


Figure 1 shows the percentage of fires originally collected in the NFIRS 5.0 system. Each year's release version of NFIRS data also includes data collected in older versions of NFIRS that were converted to NFIRS 5.0 codes.

For 2002 data on, analyses are based on scaling ratios using only data originally collected in NFIRS 5.0:

$$\frac{\text{NFPA survey projections}}{\text{NFIRS totals (Version 5.0)}}$$

For 1999 to 2001, the same rules may be applied, but estimates for these years in this form will be less reliable due to the smaller amount of data originally collected in NFIRS 5.0; they should be viewed with extreme caution.

A second option is to omit year estimates for 1999-2001 from year tables.

NFIRS 5.0 has six categories of confined structure fires, including:

- cooking fires confined to the cooking vessel,
- confined chimney or flue fires,
- confined incinerator fire,
- confined fuel burner or boiler fire or delayed ignition,
- confined commercial compactor fire, and
- trash or rubbish fires in a structure with no flame damage to the structure or its contents.

Although causal and other detailed information is typically not required for these incidents, it is provided in some cases. In order for that limited detail to be used to characterize the confined fires, they must be analyzed separately from non-confined fires. Otherwise, the patterns in a factor for the more numerous non-confined fires with factor known will dominate the allocation of the unknown factor fires for both non-confined and confined fires. If the pattern is different for confined fires, which is often the case, that fact will be lost unless analysis is done separately.

For most fields other than Property Use, NFPA allocates unknown data proportionally among known data. This approach assumes that if the missing data were known, it would be distributed in the same manner as the known data. NFPA makes additional adjustments to several fields.

For Factor Contributing to Ignition, the code "none" is treated as an unknown and allocated proportionally. For Human Factor Contributing to Ignition, NFPA enters a code for "not reported" when no factors are recorded. "Not reported" is treated as an unknown, but the code "none" is treated as a known code and not allocated. Multiple entries are allowed in both of these fields. Percentages are calculated on the total number of fires, not entries, resulting in sums greater than 100%. Groupings for this field show all category headings and specific factors if they account for a rounded value of at least 1%.

Type of Material First Ignited (TMI). This field is required only if the Item First Ignited falls within the code range of 00-69. NFPA has created a new code “not required” for this field that is applied when Item First Ignited is in code 70-99 (organic materials, including cooking materials and vegetation, and general materials, such as electrical wire, cable insulation, transformers, tires, books, newspaper, dust, rubbish, etc..) and TMI is blank. The ratio for allocation of unknown data is:

$$\frac{\text{(All fires – TMI Not required)}}{\text{(All fires – TMI Not Required – Undetermined – Blank)}}$$

Heat Source. In NFIRS 5.0, one grouping of codes encompasses various types of open flames and smoking materials. In the past, these had been two separate groupings. A new code was added to NFIRS 5.0, which is code 60: “Heat from open flame or smoking material, other.” NFPA treats this code as a partial unknown and allocates it proportionally across the codes in the 61-69 range, shown below.

61. Cigarette,
62. Pipe or cigar,
63. Heat from undetermined smoking material,
64. Match,
65. Lighter: cigarette lighter, cigar lighter,
66. Candle,
- 67 Warning or road flare, fusee,
68. Backfire from internal combustion engine. Excludes flames and sparks from an exhaust system, (11)
69. Flame/torch used for lighting. Includes gas light and gas-/liquid-fueled lantern.

In addition to the conventional allocation of missing and undetermined fires, NFPA multiplies fires with codes in the 61-69 range by

$$\frac{\text{All fires in range 60-69}}{\text{All fires in range 61-69}}$$

The downside of this approach is that heat sources that are truly a different type of open flame or smoking material are erroneously assigned to other categories. The grouping “smoking materials” includes codes 61-63 (cigarettes, pipes or cigars, and heat from undetermined smoking material, with a proportional share of the code 60s and true unknown data.

Equipment Involved in Ignition (EII). NFIRS 5.0 originally defined EII as the piece of equipment that provided the principal heat source to cause ignition if the equipment malfunctioned or was used improperly. In 2006, the definition was modified to “the piece of equipment that provided the principal heat source to cause ignition.” However, the 2006 data is not yet available and a large portion of the fires coded as no equipment involved (NNN) have heat sources in the operating equipment category. To compensate,

NFPA treats fires in which EII = NNN and heat source is not in the range of 40-99 as an additional unknown.

To allocate unknown data for EII, the known data is multiplied by

All fires

(All fires – blank – undetermined – [fires in which EII =NNN and heat source <>40-99])

Additional allocations may be used in specific analyses. For example, NFPA’s report about home heating fires treats Equipment Involved in Ignition Code 120, fireplace, chimney, other” as a partial unknown (like Heat Source 60) and allocates it over its related decade of 121-127, which includes codes for fireplaces (121-122) and chimneys (126-127) but also includes codes for fireplace insert or stove, heating stove, and chimney or vent connector. More general analyses of specific occupancies may not perform as many allocations of partial allocations. Notes at the end of each table describe what was allocated.

Rounding and percentages. The data shown are estimates and generally rounded. An entry of zero may be a true zero or it may mean that the value rounds to zero. Percentages are calculated from unrounded values. It is quite possible to have a percentage entry of up to 100%, even if the rounded number entry is zero. Values that appear identical may be associated with different percentages, and identical percentages may be associated with slightly different values.