Smoke Alarms in the Home: What Every Physician Should Know

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Primary care physicians interested in health education and accident prevention should be knowledgeable about smoke alarms (smoke detectors with built-in alarms). Either ionization or photoelectric smoke alarms can help save lives if they are properly installed and maintained. The number, site and maintenance of smoke alarms in the home and the steps a person should take in the event of a fire are discussed. Considering the rates of death, disability and disfigurement associated with residential fires, early warning devices such as smoke alarms make sense.

Most primary care physicians are interested in educating their patients on accident prevention. Authoritative information given to compliant patients may encourage them to take action that could avoid potential disasters for them and their families.

Loss of life because of fire is a significant problem throughout the world. It is estimated that 40% to 50% of the people killed in fires each year could be saved if adequate early-warning detection devices were installed. Because of this we feel it is important for physicians to be as knowledgeable as possible about an inexpensive and potentially life-saving device — the smoke alarm.

Despite some apparent improvement during the last few years, the United States and Canada still share the highest rate of death resulting from fire per million people among the nations compared in Fig. 1. In the United States the largest number of annual fatalities resulting from fire are due to accidents in residential buildings, such as one- and two-family dwellings, mobile homes, apartments, boarding facilities and hotels. In 1983 the estimated number of deaths from residential fire was 4820 in the United States and 488 in Canada; these deaths represented 86% and 90% respectively of the total deaths resulting from fire.

About 21% of residential fires occur from 8 am to 8 pm and 79% from 8 pm to 8 am, with 40% occurring between 12 am and 4 am. Since a high percentage of fires occur while people are sleeping, an early-warning device should be installed in residences to alert the occupants to fires.

Operating mechanism of smoke alarm

The smoke alarm has two main components: a smoke sensor to determine the existence of fire and an alarm device to alert the building’s occupants. A breakdown in either component will prevent a fire warning. Fire alarms may be powered by battery or connected to the main power supply in the building.

There are two basic types of residential smoke alarms: ionization and photoelectric. Ionization smoke alarms respond more quickly to smoke...
originating from flaming fires, and photoelectric smoke alarms generally respond faster to smoke originating from smoldering fires. Bukowski, however, has reported that residential smoke alarms, either ionization or photoelectric, that have been properly installed and well maintained will provide adequate warning for most residential fires.

**Ionization alarms**

The sensor in this type of smoke alarm is an ionization chamber bounded by two electrodes and containing a very weak radiation source (Fig. 2). Between the electrodes the air is made electrically conductive (ionized) by bombardment of nitrogen and oxygen molecules with α-particles emitted from a radioactive source. A voltage applied across the ionization chamber causes a small electric current to flow as the ions travel to the electrode of opposite polarity. When smoke particles enter the ionization chamber they attach themselves to the ions and cause a reduction in the flow of electric current between the electrodes. The reduced current increases the voltage at the electrodes. When sufficient smoke is present that a predetermined electrode voltage is reached an alarm sounds.

**Photoelectric alarms**

Photoelectric alarms sense smoke by the principle of light obscuration. Inside the smoke alarm chamber is the smoke sensor, which comprises a light source and a special photosensitive cell (Fig. 3). Under normal operation, when a beam of light falls on the photocell a small current is established through an electric circuit. When sufficient smoke has entered the chamber the light beam is interrupted and the electric current reduced. When a predetermined current level is reached an alarm sounds.

**How many smoke alarms are needed?**

The number of smoke alarms needed depends not only on the size and layout of the residential building but also on where the residents sleep. At least one alarm should be installed in the corridor outside the bedrooms. If, for instance, a building has two areas of bedrooms separated by a considerable distance two alarms would be needed, and they should be in the corridors outside the bedrooms.

In buildings with more than one storey there should be at least one alarm on each level, including the basement. A field study by Bukowski on response time, defined as the time between the start of the fire and the first response of the smoke alarm, suggested that the response time of a smoke alarm on the second floor of a two-storey building to a fire on the first floor was inadequate.

For extra protection a user may also consider putting a smoke alarm in each bedroom, in addition to the corridor alarm, especially if the resident prefers to sleep with the bedroom door closed, and particularly if he or she intends to smoke in bed — a habit that, of course, should be discouraged.

**Where to install smoke alarms**

A fire could start anywhere in a residential building. In one study the areas of origin of multiple-death fires in such buildings were as follows: living room, 43.1%; bedroom, 22.2%; and kitchen/dining room, 17.6%. Hence, these areas should have a high priority for the installation of smoke alarms.

Smoke alarms may be installed on either the
ceiling or the upper portion of a wall but should never be within a "dead-air" space such as that shown in Fig. 4. Bukowski found no significant difference in response times between ceiling-mounted and wall-mounted alarms.

If only one smoke alarm is installed it should be in the bedroom corridor, as close as possible to the bedrooms, and the bedroom doors should be kept open. If a fire were to start inside a bedroom with a closed door the smoke's movement toward an alarm in the corridor would be impeded. Lethal conditions would likely occur within the room before the alarm could sense the smoke and respond. Similarly, when one alarm is installed on each level of a residence whose only sleeping area is on the upper level, the smoke alarm on the upper level should be in the corridor, as close as possible to the bedrooms, and the bedroom doors should be kept open. The smoke alarm on the main level should be in the hallway close to the living room and dining room. The smoke alarm in the basement should be on the ceiling near the basement steps.

A smoke alarm should not be too close to the bathroom, because water droplets may set off the alarm; similarly, the alarm on the main floor should not be too close to the kitchen, because fumes from cooking may also set the alarm off.

**Maintenance of smoke alarms**

A smoke alarm is simple to install and will provide continuing protection if the manufacturer's maintenance procedures are implemented.

The alarm should be cleaned periodically as recommended by the manufacturer. This can usually be done by lifting the cover and gently vacuuming the interior. The cover may be wiped clean with a damp cloth.

The operation of the alarm must be checked periodically. This can be done by activating the alarm with smoke. Some older alarms are equipped with test buttons; using real smoke is considered more dependable. Some newer alarms have more refined functional test systems that simulate the presence of smoke in the alarm chamber. These do not need to be tested with real smoke; however, the manufacturer's recommendations should be followed precisely. If the alarm is battery-operated the battery must be replaced as soon as the alarm...
starts to emit a repeated low-power warning.

Additional safety measures

Frequent false alarms may indicate a poor location of the alarm. The unit should never be disconnected or covered up during cooking. It is better to move the unit.

The smoke alarm’s sound is designed to wake a person of average hearing. One occupant may simulate an alarm by operating the buzzer while the other occupants are sleeping to make sure everyone will awaken in a real emergency. If some do not awaken, additional units may need to be installed.

Everyone in the residence should become familiar with the alarm’s sound and plan what to do when they hear it. They should all know not to telephone the fire department from a burning building but to get out and then call from a neighbour’s telephone. They should also know that if they must go through a smoke-filled area they should do so on their hands and knees to avoid breathing the smoke. Individuals should be designated to assist children or handicapped people in escaping.

The occupants should agree on a place to meet outside the home, so that they can all be accounted for.

References

1. Bright RG: Recent advances in residential smoke detection. Fire J 1974; 68 (6): 69-77


