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Home injuries: Potential for prevention.

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STATE OF THE ART
REVIEWSKarin A. Mack, PhD, and
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Home Injuries: Potential for Prevention

Abstract: *There are approximately 18 000 injury-related deaths at home each year. Some of the leading causes of home injury deaths are falls, fire/burns, poisonings, choking/suffocations, and drownings. Many more home injuries are treated at emergency departments, in doctors' offices, or with self-care at home. Children and older adults are especially at risk for home injuries, and environmental factors can contribute to population disparities in home injuries. The causes and circumstances of home injuries are complex and multifaceted. This article provides an overview of the epidemiology and burden of home injuries and reviews the evidence for prevention by life stage. Reducing the risk of injuries at home is challenging, but fortunately there many ways that practitioners can help promote safer behaviors and help change home environments for patients and their families.*

Keywords: home; residential injury; fires; falls; poisonings; drowning

Epidemiology and Burden of Home Injuries

The burden and cost of home injuries are substantial. There are approximately 18 000 injury-related deaths at home each year,¹ and there are an average of

21 million medical visits made each year due to home injuries.² The home is the second most common location for fatal injuries in the United States, following motor vehicle injuries.¹ Leading causes of home injury deaths include falls, poisonings, fire/burns, choking/suffocations, and drownings. Together these comprise 90% of all unintentional home injury deaths.² Children younger than 15 years and adults older than age 70 years are at high risk for injuries in the home. Among children ages 0 to 14 years, the leading causes of home injury deaths are fire/burns, choking/suffocations, drownings, firearms, and poisonings. Among older adults, the leading causes of home injury deaths are falls, fire/burns, poisonings, natural/environmental exposures (primarily exposures to excessive heat or cold), and choking/suffocations.²

Home injuries are not equally distributed across population groups—for example, males experience many more unintentional home injury deaths than females.¹ Individuals with disabilities are also at higher risk for home injuries. There are also regional differences. In the United States, death rates for unintentional home injuries are greatest in New Mexico, followed by Mississippi and Arizona.² Southeastern states have high death rates due to residential fires, whereas drownings are highest in Florida, Arizona, Nevada, and California.

Unintentional injuries are very costly to society. These injuries cost at least \$217 billion in 1998. The cost of fatal unintentional injuries alone was \$34 billion, with nonfatal injuries accounting for the remaining \$183 billion. Medical costs totaled \$22 billion.³

Leading Causes of Home Injury

Fire/Burns/Carbon Monoxide Poisoning

In 2007, house fires were responsible for approximately 2865 deaths and injuries to approximately another 140 000 persons (not including firefighters).⁴ Most fire victims do not die from burns but from smoke or toxic gases.⁵ Those at high risk of death because of fire or heightened difficulty in benefiting from smoke alarms include children 4 years and younger; older adults; those living in poverty; people with hearing, vision, or other physical or mental limitations or disabilities; and smokers.⁶⁻⁹ Households with income below the poverty level, with lower levels of education attainment, or with older or no children were less likely to have a smoke alarm.¹⁰ Additional groups at high risk for dying in a house fire include African Americans and people who live in substandard homes where emergency egress is often compromised.¹¹

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A primary risk factor for death and injury in residential fires is absent or nonworking smoke alarms.^{7,12} Studies show that even though 90% of homes in the United States have smoke alarms, only about three quarters of the alarms are functioning.^{12,13} When a fire occurs in a home with a functioning smoke alarm, the risk for death is decreased by 40% to 50%.¹²

Scalds and thermal and electrical burns also contribute to home injuries. Between 1997 and 2002, 78 000 infants and toddlers were treated annually in ambulatory care settings for injuries due to contact with a hot object or substance.¹⁴ Exposure in an adult for 2 seconds to water at a temperature of 150°F can result in a third-degree burn, and for children, it can happen even more quickly.^{15,16}

Carbon monoxide (CO) is found in combustion fumes, such as those produced by stoves, lanterns, burning charcoal and wood, gas ranges, and heating systems. Each year, more than 400 Americans die from unintentional CO poisoning, more than 20 000 visit the emergency room, and more than 4000 are hospitalized.^{17,18} Fatality is highest among older Americans.

Falls

Falls alone account for 53.7% of all unintentional home injury deaths,¹ 36% to 45% of all nonfatal home injuries, and almost 4 million emergency department visits annually.¹⁹ Falls are the most common cause of injury death among older Americans.^{20,21} More than one third of all adults 65 years of age and older fall each year—with women 67% more likely to have a nonfatal fall than men.²⁰⁻²² As a result of falls, many older adults experience devastating consequences such as fractures and head trauma.^{23,24} Important fall-related hazards for older adults in the home include poor lighting on stairs, lack of handrails on stairs, lack of grab bars in bathroom areas, use of throw rugs, and individual conditions such as impaired balance and vision.

Falls also are a major cause of nonfatal injury in children and resulted in an estimated 2.5 million emergency room visits in 2007 for children ages 0 to 18 years.²²

Fall rates among children younger than age 5 years are second only to those observed in the elderly population.²⁵ Young age (children 0-6 years), male gender, and low socioeconomic status have been shown to be risk factors for fall injuries.²⁶ Important fall-related hazards for children in the home include baby walkers, stairs, windows above ground level, bathrooms, and furniture.^{27,28} Beds have been identified as the leading product involved in injuries in infants and as the leading product in the percentage of nonfatal home injury costs for children younger than 5 years of age.^{3,29} In particular, an estimated 23 000 children ages 0 to 9 years are treated in emergency departments annually for bunk bed-related injuries.³⁰ Outside play equipment, including play sets and trampolines, can also be dangerous for children. Most injuries occur when a child falls from the equipment onto the ground.³¹

Poisonings

Most poisoning deaths in the United States are unintentional, and rates have been rising steadily since 1992.³² More than two thirds of all home poisoning deaths occur among adults aged 30 to 49 years, and males have higher rates of poisoning death than females across all age groups.¹ The American Association of Poison Control Centers reports that there were more than 2.4 million poisoning exposures in 2007.³³ Almost all exposures (92%) occurred in the home. The most common exposures for children younger than age 5 years included ingestion of household products such as cosmetics and personal care products, cleaning substances, analgesics, foreign bodies, and topical preparations.³³ In addition, unintentional poisonings led to 703 702 emergency department (ED) visits, and approximately 25% of the ED visits resulted in hospitalization or transfer.³² In 2000, poisonings led to \$26 billion in medical expenses and made up 6% of the economic costs of all injuries in the United States.³²

Drowning

Approximately 820 deaths occur in homes each year due to drowning.¹

Drowning is the second leading cause of home injury death among children aged 1 to 9 years.¹ Among infants, 71% of drownings occur in bathtubs and 16% in buckets.³⁴ Males are more likely than females to die from unintentional drownings, and African Americans are more likely to die from unintentional drownings than whites.³⁵ Among children ages 1 to 4 years, 56% of drownings are in pools, and among children ages 5 to 9 years, 31% are in pools.³⁴ The majority of residential pool drownings (61%) occur at the victims' home; however, 22% take place at the homes of neighbors, friends, and relatives.³⁶ In the summer, between May and August, drowning deaths among children increase 89% over the rest of the year.³⁷

Choking/Suffocation

More than 1000 suffocation/choking deaths occur in the home each year.¹ Young children and older adults have the highest rates of fatal choking and suffocation. More than half (60%) of infant suffocation occurs in the sleeping environment.²⁸ Cribs and playpens are responsible for half of all nursery product-related deaths among children ages 5 years and younger.²⁸ Strangulation deaths from window cords happen in places such as in a crib or a bedroom. From 1991 to 2000, the US Consumer Product Safety Commission received reports of 160 strangulations involving cords on window blinds.³⁸ For older adults, asphyxia of food has a number of predisposing factors that include poor dentition, insufficiently chewing food, semisolid diet, alcohol use, sedative drug use, reduced motor coordination, dementia, and various neurological or other diseases.³⁹ Positional asphyxia is also a cause of suffocation-related death in older adults. Body position in these cases causes airway obstruction or impaired respiration. People who live alone may be at higher risk for choking because they may be less likely to enlist help when they are choking.

Excessive Heat-Cold Exposure

Environmental extremes are a leading cause of home injury death among

older adults.² These include illnesses, as well as injuries and conditions related to excessive heat (eg, heat cramps, heat exhaustion, heat syncope, heat-stroke, or hyperthermia) and excessive cold (eg, central nervous system depression, arrhythmias, and renal failure). Approximately 420 deaths occur in homes each year due to natural/environmental exposures.¹ Among all heat exposure deaths (inside and outside the home), males accounted for 66% of deaths.⁴⁰ Seven percent of the deaths were among those aged <15 years, 53% were aged 15 to 64 years, and 40% were aged >65 years. The states with the highest average annual hyperthermia-related death rate were Arizona, Nevada, and Missouri.⁴⁰ Among all cold exposure deaths (inside and outside the home), males accounted for 67% of deaths.⁴¹ Among those who died from hypothermia, 49% were aged >65 years. States with the highest average annual rates were Alaska, Montana, Wyoming, and New Mexico.⁴¹

Animal/Insect Bites

Although not a leading cause of injury death, bites and stings are the third leading cause of ED visits for young children, and many of these events occur at home. Dogs bite more than 4.7 million people per year in the United States, with more than 800 000 Americans seeking medical attention.⁴² The rate of dog bite-related injury is highest for children ages 5 to 9, decreasing as children age. Noncanine bites and stings (eg, cats, bees, snakes) result in more than 900 000 ED visits annually, with nearly 90% of the injuries occurring in and around the home.⁴³ These numbers do not include deaths from bites or stings or the multitude of bite and sting injuries that are treated outside the ED by other health care providers or treated at home. Risk is typically greatest in the summer months, and injuries mostly occur to extremities of the body. According to the American Veterinary Medical Association, there were nearly 71 million pet cats, 10 million pet birds, 5 million pet rabbits, 1 million pet hamsters, and 700 000 pet snakes in US households in 2001.⁴⁴ As

the practice of exotic pet trade activity increases, practitioners are more likely to be treating injuries from these species.

Mammalian bites are of particular concern for public health because they can lead to rabies exposure, rat-bite fever, and other zoonotic infectious diseases. The US animal species that carry rabies include raccoons, skunks, bats, foxes, cats, dogs, and cattle. Distribution of hamsters and other pet rodents from centralized breeding facilities to pet stores located in various states and the distribution of imported, exotic pets have resulted in the diffusion of potential infectious exposures that may be infrequently seen by local physicians.

Prevention of Home Injuries: Practice Considerations

Health care professionals should be aware that home safety education in a clinical setting can be effective in increasing a range of safety practices, especially when partnered with the provision of safety equipment.^{45,46} Patient counseling is a promising injury prevention strategy, if based on behavioral and communication theories.⁴⁷ The following are practice recommendations for children, adults, and older adults.

Children

Preparing and practicing a fire escape plan, especially teaching fire escape skills to children, can minimize injuries and death from fires.^{28,48} Scald injuries can be prevented as well. Home safety education can be effective in increasing the proportion of families that have a safe hot tap water temperature.^{45,49} Successful strategies to decrease scalds include reducing the temperature in water heaters to 120°F, installing hot water temperature limiters at the faucet, using roll-up cords for electric coffee pots, and using pots, pans, and kettles designed to be less likely to tip and spill hot liquids.⁵⁰ Five years after a 1983 Washington state law required new water heaters to be preset at 120°F at the factory, 77% of homes tested had safe tap water temperatures accompanied by a reduction in the

frequency, morbidity, and mortality of tap water burn injuries in children.⁵¹

Parents and caregivers should be given advice on the types of objects that pose a strangulation or suffocation risk for children and become familiar with methods to reduce this risk. For example, children younger than 4 years should not be fed round, firm foods (eg, hot dogs, nuts and seeds, grapes, hard candy, raw vegetables) unless they are chopped completely. Dangerous household items include balloons, coins, magnets, marbles, and toys with small parts. Parents should be advised to learn and practice cardiopulmonary resuscitation (CPR) and basic first aid in case of emergencies at home.

Infants should be placed on their back on a firm sleep surface, such as a safety-approved crib mattress, and soft objects or loose bedding should not be placed in a crib. Loop window blind and drapery cords should be tied up out of reach, or the ends should be cut and retrofitted with safety tassels. The inner cords of blinds should be fitted with cord stops.³⁸

Recent research suggests that formal swim lessons can reduce the risk of drowning in 1- to 4-year-old children.⁵² To help prevent drowning, parents might consider enrolling children in formal swim lessons, but they also need to be within arm's length of children who are bathing or playing around water.⁵³ Children should never swim alone or without adult supervision.⁵⁴ When combined with self-closing and self-latching gates, 4-sided fencing provides a passive intervention that prevents unintended access to pools by residents and visitors.⁵⁵

To protect children from poisonings, it is recommended that the poison control number, 1-800-222-1222, be kept on or near each home phone and saved on cell phones. Drugs and medicine should be kept in locked cabinets, and patients should be advised to follow all label instructions. Child-resistant packaging significantly reduces the morbidity and mortality of childhood poisonings. Studies show clear declines in poisonings after passage of the Poison Prevention Packaging Act (PPPA) in 1970.^{56,57} One study revealed that a substantial

number of the post-PPPA poisonings (as high as 40%) were due to either improperly secured safety caps or products that were not required to be packaged in a child-resistant container.⁵⁸ Clinicians should urge patients to keep medicines in original bottles and containers and to turn on a light at night when using medications. Adults should never leave children alone around medicines. Homes with pools should store pool chemicals away from children and animals, as well as store them as recommended by the manufacturer.⁵⁹ Chemicals should be protected from mixing or getting wet.

Residential hazards associated with falls among children include a lack of safety devices such as properly installed and used safety gates or window guards, use of bicycle helmets, and structural defects (eg, uneven floors; insufficient surfacing under play equipment). Although few child fall prevention interventions have been rigorously evaluated, individual studies have suggested positive results. Interventions to increase stair gate use and reduce baby walker use have been shown to be effective.⁶⁰ Other interventions that may help to prevent childhood fall injuries include window guards,⁶¹ balcony railings less than 4 inches apart, and window locks for windows above ground level.²⁸ The evidence that window guards reduce childhood morbidity and mortality from falls comes primarily from dramatic results following a community-wide program to provide window guards in high-risk apartments, where falls declined 50% in the 2 years after the program's inception.⁶² Building codes that require window guards, safe stair and balcony design, and other modifications are likely to be effective for fall prevention because they remove the need for home dwellers to modify their home for safety.

Playground equipment should be properly sited within the yard, have appropriate surfacing beneath the equipment, and be age appropriate, well maintained, and adequately supervised when children are playing.⁶³ Children should use bike helmets when riding bicycles; indeed, many states and localities have laws requiring their use.⁶⁴

Injuries to children from common household equipment can be extremely damaging. Recent reviews of injuries from equipment such as lawn mowers⁶⁵ and treadmills⁶⁶ demonstrate the potential harm. Although equipment redesigns to enhance passive safety measures might be the most effective way to prevent these injuries, clinicians can advise parents to keep children away from this equipment, especially when adult supervision is not present. Other measures, such as keeping keys for these devices out of reach of children, is also prudent.

The American Academy of Pediatrics has anticipatory guidance available in the TIPP (The Injury Prevention Program) education program. It is designed to provide a systematic method for clinicians to counsel parents and children about adopting behaviors during various child development stages to prevent injuries.⁶⁷ It targets children newborn through 12 years of age to help prevent common injuries from motor vehicles, firearms, bicycle crashes,

standard times. In addition, residential sprinklers are a promising strategy to prevent deaths and injuries due to fires and are gaining greater acceptance as a feature of new home construction.^{68,69} Only 23% of homes in the United States have a fire escape plan and practice it, and yet residents should be prepared to exit a home when a smoke alarm sounds.¹⁰ The fire escape plan should include at least 2 different ways of escape for each household resident (and that egress routes are not blocked), and a safe place should be designated outside of the home to meet after escaping the fire.

Cooking is the leading cause of home fires and home fire injuries.⁷⁰ Food that is cooking should not be left unattended, and caution should be used when frying foods. While cooking, it is prudent practice to roll up sleeves and use oven mitts. Grilling outdoors can cause house fires as well.⁷¹ Grills should be placed well away from the house. Propane and charcoal grills should only be used outdoors to avoid fire and

Home injuries are related to many factors that span individual, interpersonal, organizational, community, and societal determinants.

drowning, poisoning, choking, burns, falls, and pedestrian hazards.

Adults

To prevent residential fire and burn deaths, smokers should be advised to quit as smoking is the leading cause of residential fire deaths. In addition, families should be counseled about fire and burn prevention. Home safety education has been effective in increasing the proportion of families with a functional smoke alarm.⁴⁵ Existing homes should have properly placed smoke alarms, and the batteries should be checked and replaced regularly—for example, patient reminders for new batteries can be timed to coincide with when clocks are reset to daylight or

carbon monoxide hazards. Before using gas grills, propane tanks and the fuel lines should be examined to be sure they are working properly and not leaking.⁷²

Falls from ladders can result in serious injuries.^{73,74} Prevention strategies for ladder safety include ensuring the ladder is on secure and level ground before climbing, spacing the base of the ladder 1 foot away from the wall for every 4 feet it extends up, and staying centered between the rails of the ladder.⁷⁵ Advise patients not to overreach or stand on the top 2 rungs of the ladder. To reach a roof, the ladder should be extended at least 3 feet beyond the edge of the roof. A folding step ladder should never be used when it is closed.

Older Adults

Older adult falls in the home can be prevented by taking note of home hazards and safety features. Structural residential hazards associated with falls among older adults include lack of handrails on stairs, lack of grab bars and nonslip surfaces in the bathroom, tripping or slipping hazards (eg, throw rugs, waxed flooring), outdoor steps, inadequate lighting, and the presence of electrical or telephone cords in the walkway.⁷⁶ Individual behaviors and physical ability levels also are important factors contributing to falls in older adults.^{77,78} Homes can be designed and constructed to protect elderly occupants from fall-related injuries through installation of grab bars in bathtubs and showers and adding handrails and good lighting in stairwells. Many homes currently do not have these simple safety features. The evidence that structural modifications, such as installation of handrails, grab bars, and improved lighting, are promising interventions for reducing risk of falls among older adults comes from 2 systematic reviews.^{79,80}

Similar to recommendations for children, preparing and practicing a fire escape plan can be beneficial for older adults. Increased risk for death in fires for older adults may arise in part from decreased mobility, hearing loss, and confusion. Smoke alarms may be less effective at waking older adults who suffer hearing loss.⁶ Older adults may want to consider alarms with flashing lights or vibration alerts. Clinicians should recommend that older adults stay in the kitchen when food is cooking on the stove and not wear loose clothing while cooking.

Periods of extreme heat or cold are potentially dangerous for older adults. During periods of extreme heat or cold, having a system in place for checking in with relatives or neighbors can be helpful. Air-conditioning is a key protective factor against heat-related illness and death.⁴⁰ If a home is not air-conditioned, older adults might consider spending time in public facilities that are air-conditioned. Clinicians can recommend the following during hot weather: staying cool indoors, drinking plenty of fluids, replacing salt and minerals, wearing appropriate clothing and sunscreen, and

using a buddy system. The ability to feel a change in temperature decreases with age.⁴¹ Also, older people are more susceptible to health problems caused by cold. Recommending that older adults place an easy-to-read thermometer in an indoor location where they can see it frequently, and checking the temperature of the home often during the winter months are prudent measures.

Conclusions

Clinicians can help patients and families take actions to change lifestyle behaviors and create safer home environments. Examples of the more important “best practices” to be encouraged by health professionals include the following:

- Recommend installation, maintenance, and consistent use of safety devices:
 - Smoke alarms
 - Stair gates in homes where young children live or visit
 - Grab bars in bathrooms
 - Adequate outside lighting
 - Proper storage areas for medicines, cleaning solutions, automotive supplies, pool chemicals, and pesticides
 - Four-sided isolation fencing with self-closing, self-latching doors around pools
 - Carbon monoxide detectors
- Recommend parents dispose of baby walkers—they are inherently dangerous
- Have patients in homes where older adults live or visit complete a home fall prevention checklist (see <http://www.cdc.gov/HomeandRecreationalSafety/Falls/fallsmaterial.html>)
- Encourage patients to prepare and practice an emergency fire escape plan (see <http://www.firesafety.gov/citizens/escape/index.shtml>)
- Encourage homeowners and renters to set their water heater temperature at (or below) 120°F to prevent scalding

- To reduce residential fires, encourage patients to not smoke and provide active support for quitting (<http://www.smokefree.gov>)
- Have patients complete a playground safety checklist, if they have playground equipment in their yard (see <http://www.cpsc.gov/cpscpub/pubs/pg1.pdf>)
- Have patients choose poison prevention packaging for all toxic products in the home
- Provide advice to patients regarding basic first aid and recommend CPR and first aid classes to parents
- Recommend that infants sleep on their backs on firm sleeping surfaces

Homes injuries are not accidents. Most are predictable and, more important, preventable. Clinicians can help patients choose lifestyles that prevent home injuries by promoting safe behaviors and changing hazardous home environments.⁸¹ Clinicians, however, cannot do this alone. It is important for home injury prevention messages to be embraced and advocated by teachers, schools, media, local health departments, advocacy groups, business, law enforcement, and policy makers.⁸² Home injuries are related to many factors that span individual, interpersonal, organizational, community, and societal determinants. The costs and consequences of home injuries can be significant, both on families and society. Home injury prevention should be considered right alongside disease prevention as both predictable and preventable through changes in behavior, public policy, enforcement, environment, and product/engineering.^{82,83} Although injury statistics guide our practice and research, a more powerful force are the people behind the statistics whose lives can be spared and disabilities prevented through the application of effective injury prevention strategies at home. **AJLM**

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