AT and telecare to manage fire risks in the homes of older and vulnerable people

Kevin Doughty and Mike Orton

Dr Kevin Doughty is the Co-Director, based at Centre for Usable Home Technologies, University of York and Newcastle University, York and Newcastle, UK. Mike Orton is an AT Consultant, based at Telecare Consulting, Truro, UK.

Abstract

Purpose – *The purpose of this paper is to identify opportunities where technology interventions could help manage the risks associated with fire and explosions in homes of people who are older or who are vulnerable through other causes such as mental health problems or a history of substance abuse.*

Design/methodology/approach – *The approach focused on reviewing the latest available statistics in order to identify the major causes and rooms in which fire accidents occurred.*

Findings – *The authors found that the number of incidents and fatalities continues to decrease as a result of preventive measures such as a greater use of smoke detectors, but that there remained issues with cooking safety. New products for limiting damage and managing risks are available which could have a positive impact.*

Research limitations/implications – *The paper concludes that the challenges are making both professionals and the public aware of the available technologies and of introducing them following appropriate assessment of needs and risks.*

Practical implications – *Greater resources need to be offered for training of the public and of health and safety professionals. Further funding may be needed to implement the introduction of new technology.*

Originality/value – *This is the most up-to-date review of fire control measures employing assistive technology and telecare for domestic properties and will be of value to community health teams, adults care organisations, housing associations and other public bodies.*

Keywords *Safety, Telecare, Risk assessment, Assistive technology, Cognitive impairment, Fire*

Paper type *Case study*

Introduction

An ageing population is likely to put significant strain on the health and social care systems of developed countries. This is mainly because of the additional resources needed to treat older people, who are more likely to have multiple chronic diseases, such as diabetes and arthritis, and to suffer long-term conditions such as cancer, Parkinson's disease and dementia. However, there are secondary costs associated with the management of older people and their health care needs; they involve supporting the well-being and quality of life of individuals, and dealing with additional sensory impairments (such as vision and hearing impairments) and an increased likelihood of accidents, especially falls and environmental issues such as fire, flood and gas discharges.

This paper considers the potential for using connected assistive technologies (i.e. telecare) to support a more comprehensive management plan for the prevention of fires and explosions within the home environment.

The authors are grateful to the UK Department for Communities and Local Government for access to their publication "Fire Statistics – Great Britain 2011 to 2012" as a trusted source of information for use in preparing this paper.

Community fire statistics

There are comprehensive records available covering several years that define the causes of fires and their impact. Fortunately, UK Fire and Rescue Services has succeeded in shifting the focus

of their actions from reaction to prevention over the past two decades. This, together with improved safety standards, advice and lifestyle changes, has resulted in a significant, and continuing reduction in both house and chimney fires over a decade as shown in Figure 1.

The reduction of chimney fires by almost a half is not surprising as increasing numbers of homes have abandoned open coal fires in favour of gas- and oil-fired central heating, but a reduction of a third in the number of house fires must be attributable to an adoption of safer practices and campaigns for people to take more care when dealing with naked flames within the home. Nevertheless, there are over 800 house fires in the UK every week. This leads to about four fatalities, with over 40 per cent caused by smokers' materials such as discarded cigarette butts as shown in Figure 2. The number of fatalities from all causes has decreased by a third in a decade despite people being unable to smoke in public places since bans were imposed in Wales, Scotland and England during this time, which might have contributed to an increase in the amount of smoking performed in the home.

About two-thirds of all fatalities from house fires occur in either the bedroom or in a living room (see Figure 3). These are the rooms that are most likely to contain soft furnishing such as bedspreads, settees, curtains and carpets which might most easily be ignited by a carelessly deposited cigarette end. These furnishings are also likely to emit the toxic fumes and smoke that

Figure 1 Number of recorded house fires and chimney fires in Great Britain between 2000 and 2012

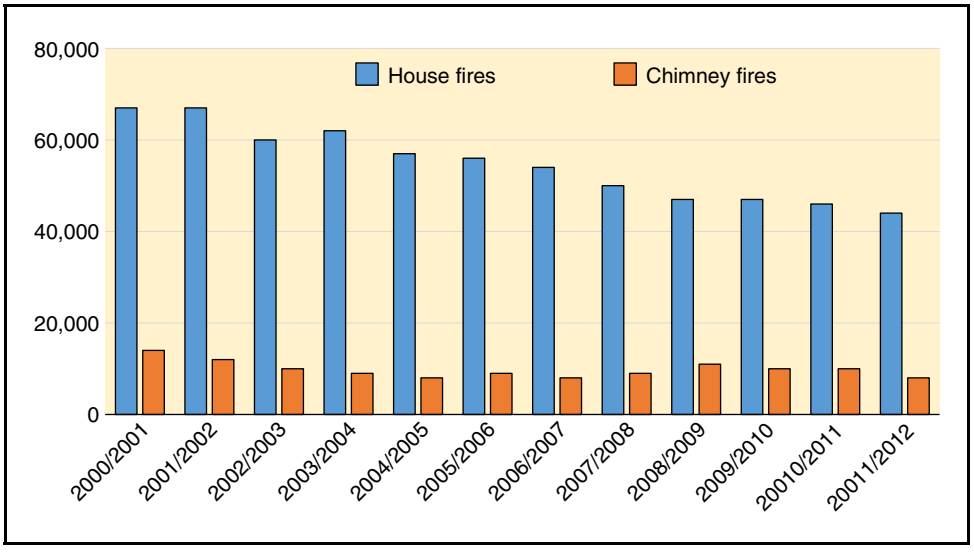


Figure 2 Causes of house fire fatalities in British homes during 2011-2012

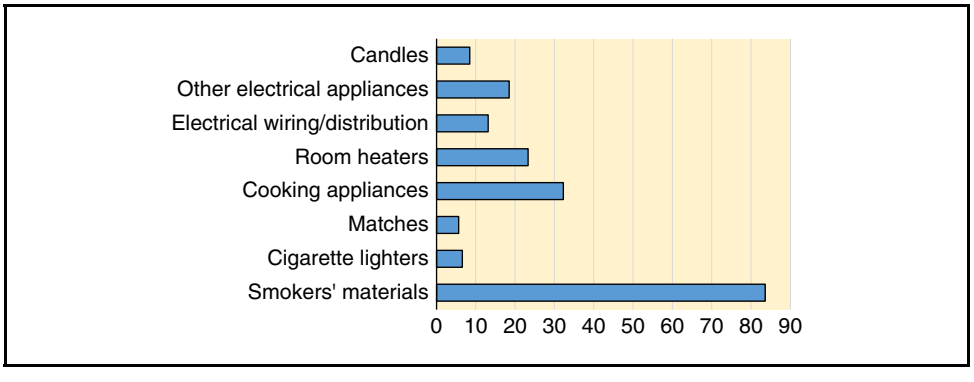
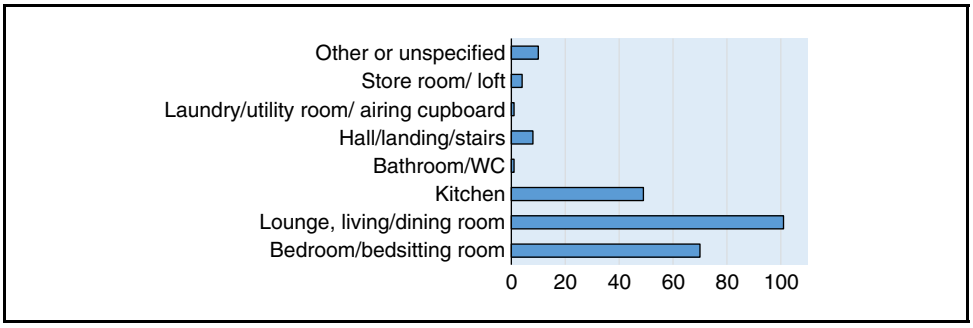


Figure 3 The rooms in which fatal house fires occurred in 2011/2012



can suffocate or poison an individual. The introduction of legislation that prohibits the use of flammable materials in modern furniture will reduce the incidence of some of these fires. However, they are still found in many bedsits and in rented properties that are often inhabited by vulnerable people.

Reducing fatalities in house fires

Soft furnishing materials can be treated with sprays (such as MSL Fire Check and Flame Guard) that can protect them from igniting. Such treatments are often used by mental health teams to support smokers who lack insight and who might be most at risk of a house fire. However, it is likely that the appropriate use of smoke detectors will have a more direct impact on the number of fatalities because they provide an early warning of an emergency enabling the inhabitants to make their escape before the smoke and the heat become excessive. Figure 4 compares the presence and actions of smoke detectors in fatal house fires in 2006/2007 with 2011/2012 by which time over 80 per cent of properties had been fitted with a smoke detector device. It shows a reduction of over 30 per cent in the number of cases where a smoke detector was absent. Unfortunately, there were still over a hundred fatal cases where a smoke detector operated correctly but did not succeed in saving lives. Reasons for this are discussed below.

While sheltered housing and retirement housing schemes have advanced fire detection panels and mains powered smoke alarms, most dispersed housing situations have battery operated devices, often provided free of charge by local authorities or by fire services. Unfortunately, this battery can be accessed and removed so that it can be used in some other domestic device or toy; it may be observed in Figure 5 that this was the most likely reason for failure in 2006/2007 but such incidents had declined by over a half in 2011/2012 partly due to information campaigns and partly due to the introduction of longer life (five years) batteries which makes replacement unnecessary and allows manufacturers to make it difficult for batteries to be removed.

Figure 4 Analysis of fatal house fires according to availability of a smoke detector

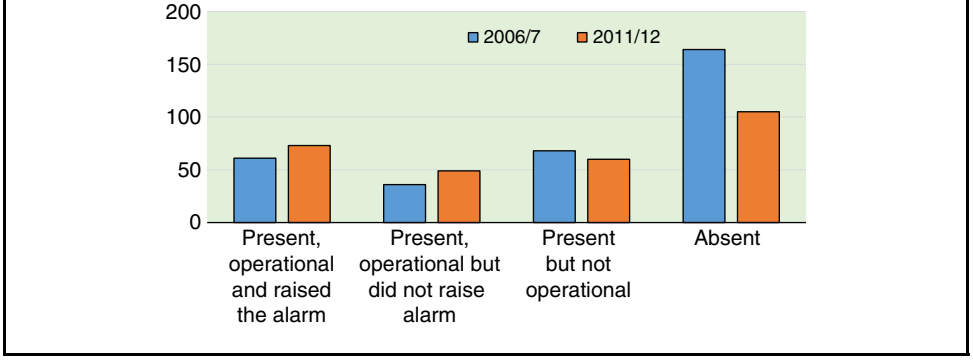
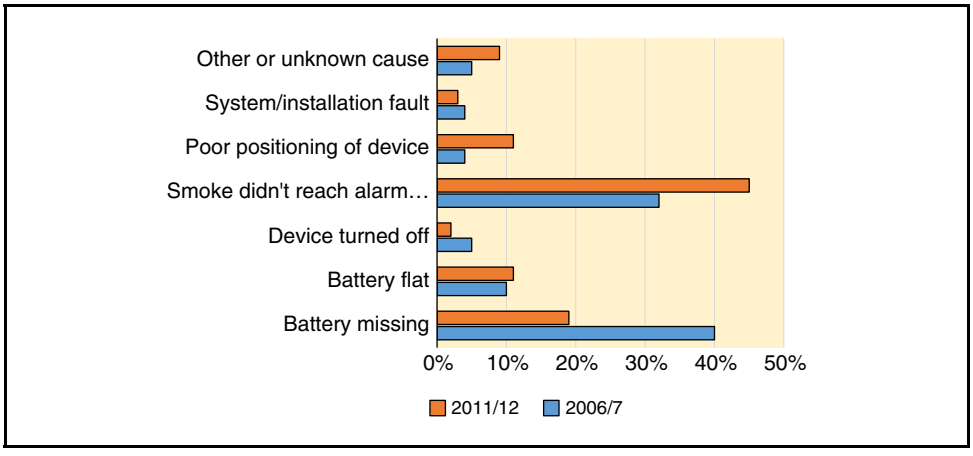
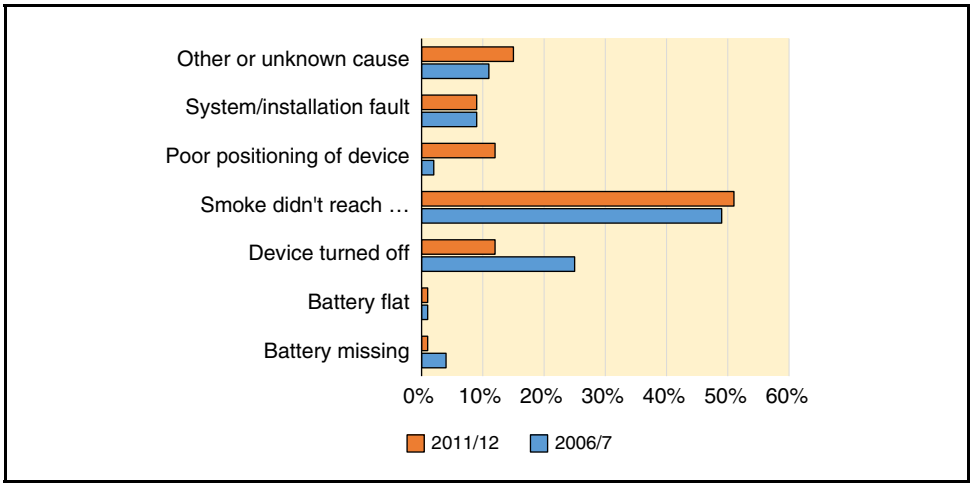


Figure 5 Reasons for battery alarms failing to save life



The most significant reason for both battery and mains operated smoke detectors failing to save lives in 2011/2012 was that the smoke from the fire did not reach the device or did not do so soon enough to allow the inhabitants to escape; the percentages for various failures are shown in Figure 6. This implies that detectors are either placed in the wrong location with respect to the greatest risk, or there are insufficient devices to cover all relevant rooms in the properties that they are monitoring. Increasing the number of smoke detectors in a property, and ensuring that their placement is appropriate, will undoubtedly further reduce fatalities. However, a more rapid response to smoke alarm activations could also ensure that vulnerable people have the best possible opportunity to escape the effects of fire and smoke. This can be achieved by using linked smoke detectors that communicate wirelessly to a telecare dispersed alarm unit which is programmed to contact a monitoring centre immediately; call handlers can pass on details to the Fire and Rescue Service and, by following robust protocols, avoid many of the false alarm issues. Such systems can also be enhanced by flashing lights and vibration devices that can be placed under the pillow so that people with hearing difficulties can also benefit. An alternative approach involves smoke detectors being equipped with a mobile phone transmitter (SIM card) capable of sending a short-text message when activated. This should further simplify both placement and the issuing of alerts both to the householder and to responders without having to formally register with a monitoring centre or telecare service (though such services will provide the most complete and robust solutions).

Figure 6 Reasons for mains alarms failing to save life



Fires in kitchens – electric cookers

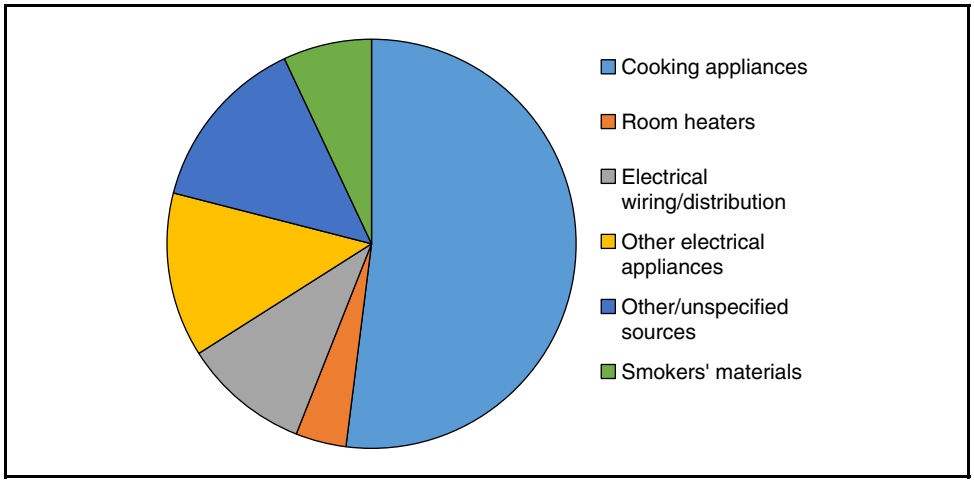
Whilst most house fire fatalities occur in rooms in which people relax or sleep, the kitchen is the by far the most dangerous room in terms of fire incidence. Indeed, more than half of all recorded house fires are caused by cooking appliances as shown in Figure 7. It is likely that a number of these incidents are in the homes of older people and those who may have some form of cognitive impairment such as Alzheimer's disease which can have a significant impact on both short-term memory and on the level of insight. Yet, cooking is an important daily living activity to support independent living within one's own home (and is discussed below). Other groups at risk in this way are drug and alcohol users who may turn on the cooker and forget that they have done so, and people with conditions such as narcolepsy who may fall asleep while cooking.

It follows that some fire incidents may be caused by individuals draping a tea towel or other inflammable items over hotplates, being distracted and allowing saucepans to boil dry or contents to burn, or wrongly estimating cooking times. In the case of electric cookers, burns can be caused when someone fails to appreciate that a hotplate can retain its heat for many minutes after being switched off. There have also been many incidents of a plastic jug kettle being placed directly onto a hotplate, causing the kettle to melt and, unless full of water, to catch fire. Chip pan fires and others involving hot fat (from a wok, for example) are a particular cause of concern both because of the potential for fat to spread quickly around the kitchen and because of the toxic fumes that cooking oils can give off when heated to high temperature before ignition.

Many authorities tackle the problem of kitchen fires by removing the appliances that are considered to be responsible for causing fires – and this includes the cooker, which is generally the most important device used for food preparation. It may be replaced by a microwave oven; this allows prepared or frozen meals to be reheated but, if the individual has not previously used this type of appliance, it would involve a need to teach new skills which may be difficult if they have a cognitive deficit. More importantly, this approach effectively takes away the individual's freedom to manage their own meal planning and management which involves a number of separate tasks including:

- making a list of grocery, vegetables and meat requirements;
- going out to shop for them;
- putting the shopping away and storing them in the kitchen, larder, fridge or freezer;
- preparing vegetables by washing, peeling, dicing and slicing them;
- putting food items in appropriate saucepans or trays;
- timing the cooking of each item;

Figure 7 Piechart showing the causes of kitchen fires in the home



- stirring the food and providing seasoning or herbs during the cooking;
- plating the meal with added sauces or gravy;
- cutting up meat and eating the meal; and
- clearing away and washing up.

The above are all life skills that are important in preserving an individual's quality of life and well-being. They are supported by many devices that are assistive in nature including electronic meal planners and cook books, tin openers, peeling machines and table top dish washers, so it would be perverse to remove and make all these devices and skills redundant through removal of the cooker as a working appliance. Instead, the focus should be on making the cooking experience safer, and to take measures to manage the risks of fire in the kitchen.

Fortunately, assistive technologies and telecare are ideally suited to help manage these risks by either reducing the likelihood of an accident and/or by reducing the harmful consequences. Timers and reminder devices can be employed to warn the person of the need for vigilance, while temperature extreme detectors or devices that respond to a sudden increase in temperature above the hob can give an early warning of, for example, a saucepan that has boiled dry or a hotplate that has been left on after being used for frying or boiling food. Such temperature extreme detectors are readily available from major telecare equipment providers (such as Chubb, Tunstall and Tynetec); they can either communicate directly and wirelessly with a telecare dispersed alarm unit which then sends an alarm to a monitoring centre or to the mobile phone of a relative or neighbour. They also produce an audible alert which warns the user that the temperature has increased to an abnormal level and requires immediate attention. In general, the user can respond quickly to such an alert, but if they have left the kitchen or have poor hearing, then this can become ineffective.

Fortunately, smart hob temperature monitoring systems are now available from some suppliers (e.g. Innohome and STT Condigi) which are capable of automatically switching off the cooker electricity supply within a minute if a potential fire situation is detected and no action has been taken. These systems provide radio and/or audio communication between the intelligent temperature sensor and a cooker control unit which can switch off the cooker directly or through industry standard home automation systems such as X10 or Insteon which are suited to switching off separate electrical hobs which are powered through a standard 13 A socket, for example. Home automation units can be used to provide additional alerting channels (such as flashing beacons, vibrating pads and sirens) for people who have sensory impairments.

Some of these systems have the intelligence to learn their usual cooking environment and to respond accordingly depending on cooking time, for example, but can also be individually programmed to meet local needs. Others employ movement or activity detectors (passive infra-red detectors) to detect the presence or absence of a person in the kitchen or at the stove so that reminders can be issued or power withdrawn until the user returns. Such systems are popular in North America but are not yet certified for the UK market. Figure 8 shows a composite arrangement of such systems while Table I shows a comparison of three popular systems and their respective modes of operation.

When used in conjunction with other safety devices such as fire blankets and appropriate fire extinguishers, the harmful consequences of a kitchen fire are greatly reduced. Unfortunately, few of the properties lived in by older people have such equipment; in many cases, it remains more appropriate for the Fire and Rescue Service to be called immediately as this can reduce the possibility of an older person being harmed trying to fight a fire.

However, an extended use of water sprinkler systems, especially in new homes, is advocated by many authorities because they are known to be associated with improved outcomes, but these benefits are mainly restricted to fire in the living area or bedrooms rather than in the kitchen. Water is not necessarily the best way of tacking a kitchen fire because of the effect of water on electrical supplies and appliances, as well as the potential for causing burning fat or oil to overflow their vessels and to spread the fire quickly along other surfaces. Therefore, wet chemical extinguishers are the most appropriate but few are found outside commercial catering establishments even though small domestic versions are available.

Figure 8 Schematic cooker safety arrangement using smart controller

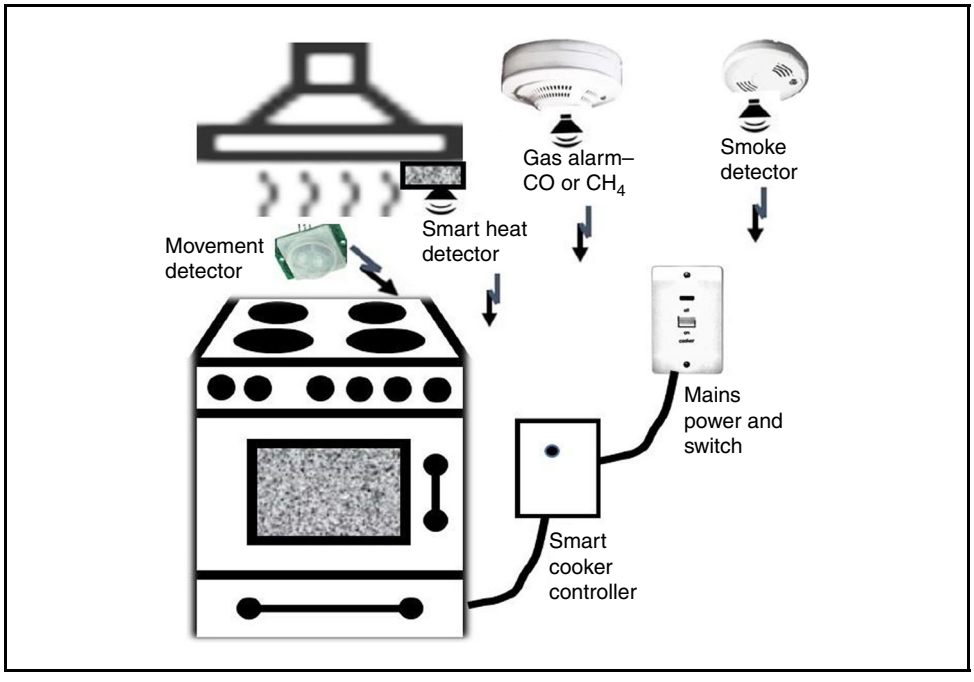


Table I Automatic cooker control systems comparison chart

	Temperature above hob	*Oven cooking time*	*Presence of person*	*Voltage (v)*
Innohome stove guard	✓	X	X	230
STT Condigi cooker guard	✓	✓	X	230
Stove guard international	X	X	✓	110

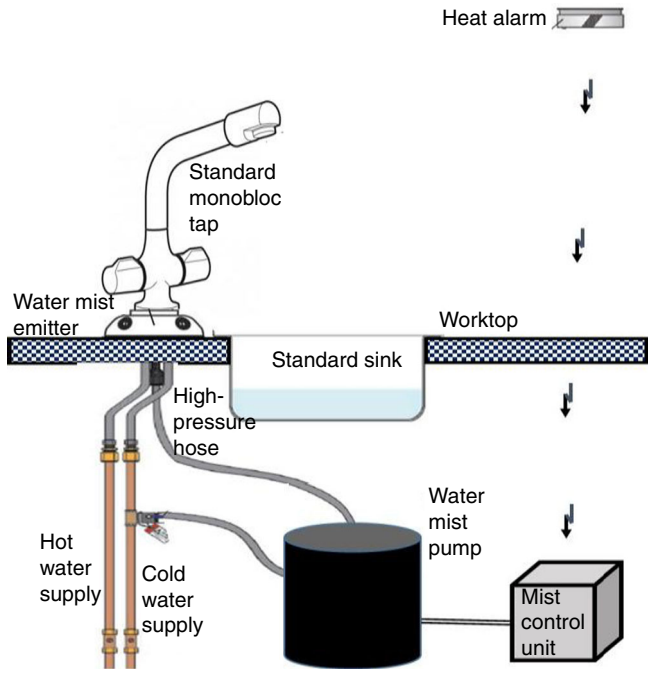
Notes: ✓ indicates that the device has a feature; X indicates that the device does not a feature

Water mist systems

A recent innovation in the fight to tackle house fires is the use of water mist which has previously been used only at sea and in premises where industrial plant is used. Water mist systems rely on specially designed nozzles and the delivery of water through a high-pressure cylinder to create microscopic water droplets. These droplets form a fine mist which not only provides a cooling blanket but also reduces the oxygen content in the air surrounding the fire, effectively suffocating it. The volume of water needed for effective action is considerably less than is used in sprinkler systems (where it is generally unlimited) which means that it causes less water damage to absorbent material such as soft furnishings, and to surfaces that can become treacherous when wet.

Water mist is therefore an ideal way to tackle kitchen fires because the amount of water required does not pose an immediate electrical shorting hazard, and also because the high-pressure action can quickly fill a room irrespective of the source of fire. Some systems are mobile and are designed to be moved between rooms where an at-risk individual spends most of their time, e.g., nursing home bedrooms where patients continue to smoke despite being in an oxygen-rich environment. Others (e.g. Aquamist and Ultramist) are designed for use in a kitchen or in other dangerous areas; integration is possible with the water mist emitter being fabricated for direct insertion into the tap base as shown in Figure 9. In this case, the high-pressure system is activated automatically when the temperature reaches a high temperature (57°C), the wireless alarm unit transmitting a radio signal to the mist control unit.

Figure 9 A high-pressure water mist system installed under the kitchen sink



Issues with gas cookers

Gas explosions are relatively rare in UK homes, but when they do occur they can be devastating. The consequences can be death and destruction, not only of the property in which the gas leaked into the environment, but also of neighbouring properties. North Sea gas is almost pure methane and therefore has little or no smell; additives are used to make it easier to detect. It is, however, highly combustible and explosive. It is little surprise that it is not used in many housing schemes designed for older people even though the cost of heating and cooking with gas is considerably lower than with electricity.

In practice, there is little evidence to suggest that gas explosions are more likely to be caused by the reduced cognitive abilities of older gas customers than by accidental gas leaks from pipes or faulty appliances or, indeed, by poor installation by illegal amateur fitters. However, such is the fear of explosion or suffocation that it has become common practice to respond rapidly and, perhaps, inappropriately:

1. *replace the gas cooker with an electric cooker* – an option which is rarely popular because of the considerable differences in operation;
2. *use a microwave oven to reheat prepared or frozen meals* – an approach which removes the need to perform many of the life skills that are associated with independence;
3. *install a methane alarm to provide an alert if gas is present in high concentration* – but with no guarantee that the user will hear or respond to the alert (when connected through a telecare system this leaves the call handler having to take rapid and decisive action);
4. *control the gas supply using a manual valve operated by a carer* – this prevents the individual from cooking when alone but imposes significant responsibilities on people coming into the home every day;
5. *use an electronic valve to control the gas supply* – this could be operated by a timer device or by a linked electronic gas detector; or
6. *provide a new gas cooker with safety features* – often not considered because of a perception that older people cannot become familiar with a new and expensive appliance.

The risk of gas release posed by older gas cookers has been recognised by the industry for a number of years and has resulted in the use of flame safety detection devices (FSDs) in all current models. Indeed, it is illegal to install a gas cooker (new or previously owned) without such devices in a block of flats even if the cooker itself has been tested and confirmed to be safe. FSDs effectively switch off the gas supply to individual burners if a probe located at the burner does not exceed ambient temperature. This prevents the release of dangerous volumes of gas irrespective of the position of the gas control knobs. Thus, no gas is emitted if a hob burner fails to ignite nor if a lit hob burner is extinguished by water boiling over from a saucepan, for example.

In practice, people with cognitive impairments are capable of learning new skills with appropriate training and can be taught to operate many new household appliances, such as TVs, radios, fridges, freezers, vacuum cleaners and cookers, especially if the functionality is similar, and there are not too many additional features that they do not need. A number of new cookers are available economically priced in the range £200-£300, with a standard layout of four burners controlled by knobs arranged horizontally at the front of the appliance, and similar in design to cookers that were on the market during the 1960s. It means that replacing the cooker becomes a viable option in some cases.

If it is clear that the individual will not be able to cope with a new cooker, then an intelligent arrangement of gas detector and electronic valve can be retrofitted to ensure that the system is safe. These systems have appropriate bayonet fittings that allow them to be quickly installed in-line on the gas supply to the cooker. Some control systems can also switch off the gas supply on detecting alerts from other safety devices such as smoke detectors and carbon monoxide sensors similar to the approach shown in Figure 8 for an electric cooker.

Concluding remarks

House fires are acknowledged as one of the greatest risks to the safety and independence of older people. Fire safety in the kitchen is of particular importance, given the nature of the fire risk and the role cooking activities play in supporting independence. There are a number of assistive technologies, telecare and other measures that can be taken to manage these risks in acceptable ways. When used appropriately, the incidence of fatal fires and the cost of accidents can be greatly reduced. It is therefore necessary for assessors to perform a survey of the home and to carefully profile individuals in order to identify which one, or more, of a growing number of interventions is most appropriate.

Corresponding author

Dr Kevin Doughty can be contacted at: kevin.doughty3@btinternet.com