

Pets and smoke inhalation: improving immediate and prehospital management

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Introduction

Household pets, such as dogs and cats, are part of many people's lives. According to Animal Medicines Australia (2021), pet ownership in Australia has increased to 69% of homes in 2021, up from 61% in 2019 (Animal Medicines Australia 2019). In comparison, in the United States, pet ownership rates are 49% to 68% (Bruilliard & Clement 2019). Given the high rates of pet ownership in the United States, it is not surprising that between 40,000 to 150,000 animals there are estimated to die each year in residential fires, mostly due to smoke inhalation (Kahler 2018, Invisible Fence Brand 2022). To reduce the risk of animals suffering injury due to residential fires, pet oxygen masks have been distributed for use by firefighting and emergency medical service authorities in North America (Wag'N O2 Fur Life LLC 2021, Invisible Fence Brand 2022) and in the United Kingdom (British Animal and Rescue Trauma Care Association 2021, Smokey Paws Ltd 2022). The Scottish Fire and Rescue Service has also indicated its intention to equip fire stations in Scotland with pet oxygen masks (Milligan 2019). This capability development in prehospital care of pets suffering smoke inhalation does not exist in Australia.

Through the review and synthesis of existing literature, this paper supports improvements in evidenced-based practice for the prehospital management of pets suffering from smoke inhalation due to residential fires in the Australian context. This paper identifies patient-focused improvements in research and practice pertaining to the prehospital management of smoke inhalation in pets.

Methodology

This study was initially intended as a scoping review and an interrogation of existing research and publicly available reports pertaining to smoke inhalation in pets was undertaken. A search of international veterinary journals¹ was conducted for literature related to smoke inhalation in cats and dogs. This yielded limited results. Literature was excluded from the review where it involved animal experimentation, was not available in the English language, or where the full-

1. See: www.ebsco.com/products/research-databases/veterinary-source

Abstract

Around the world, pets and companion animals coexist with people to help them live their lives through work, social support and companionship. Commentary by Kahler (2018) and the Invisible Fence Brand (2022) report that significant numbers of these animals are estimated globally each year to die from smoke inhalation during residential fires. International efforts have improved the prehospital management of pets suffering from smoke inhalation, however, this trend has not been experienced in Australia. To support improvements in the prehospital management of pets suffering smoke inhalation, a narrative review of existing research and publicly available reports was undertaken. This review considered aspects of the unknown number of pets suffering smoke inhalation due to residential fire, the potential for under-reporting and the potential value of improved veterinary integration at the small-scale incident level. Several conclusions are drawn that can inform further research and contribute to existing practice by Australian fire service agencies in the prehospital treatment of pets suffering smoke inhalation.

text article was not available. Due to the limited nature of the results, grey sources of literature such as websites, veterinary educational materials and media reports were included within the original literature review.

As a result of the limited search results, a narrative review was undertaken in place of a scoping review. Opportunities for further research and improvements in current practice within Australia have been identified as part of this review. As the intention was to focus on the patient-based approach to smoke inhalation by pets, specific and detailed recommendations for firefighter safety and training were not included. Furthermore, additional injuries that pets may be exposed to in a residential fire event, such as thermal injuries or other trauma, are not included in this review.

Frequency of pet smoke inhalation

While the significance of pets in people's lives is well documented (Animal Medicines Australia 2021, Human Animal Bond Research Institute 2022), the frequency of pets suffering smoke inhalation during residential fires is not. No mechanism appears to exist within Australia to readily and effectively report the death or injury of pets due to smoke inhalation, either by fire services or other agencies.

In the United States, it is acknowledged that no official statistics on the number of animals dying due to fire exists (Invisible Fence Brand 2022). Veterinary literature supports the view that the limited number of pets being presented for veterinary care reflects a high pre-hospital admission mortality rate (Jasani 2015). However, the outcome for animals suffering smoke inhalation alone (i.e. when not complicated by severe burns) has a reported high survivability (Vaughn *et al.* 2012). That said, despite the absence of readily available and publicly reported data relating to pets suffering smoke inhalation in Australia, these occurrences are not uncommon in news reports (Marshall 2015, Naughtin 2017, Paynter 2020) and fire services media releases (Fire and Rescue New South Wales 2007, 2017, 2021; Pakenham 2014).

Reporting mechanism challenges

While animal deaths and injuries due to residential fires remain as estimations, human fatalities and injury associated with residential fire are commonly reported. In Sweden, an investigation of fire-related human fatalities indicated under-reporting in the vicinity of 20–25% (Jonsson *et al.* 2015). In Australia, a study based in New South Wales revealed only 15% of fire-related injuries to humans were recorded by or attended to by fire services agencies (Ghassempour *et al.* 2021). Jonsson *et al.* (2015) and Ghassempour *et al.* (2021) interrogated records such as coronial reports, hospital admission data and fire services reporting to identify reporting accuracy and both point to the likelihood that multiple sources of data are required.

Despite the reported under representation that may occur in the identification of human fire-related fatalities and injuries, the situation is even more complex when identifying the frequency of pets dying or sustaining injury due to residential fires. In the United States, fire services agencies are not required to report fire-related animal deaths and injuries (Animal Welfare Institute 2022) and implications for the purpose and intent of reporting mechanisms appear to further influence the absence of data. This

is recognised in the differing nature of fire services reporting when compared with health services reporting (Ghassempour *et al.* 2021).

Complicating the insufficiency of current fire services reporting mechanisms further, Fitzgerald and Flood (2006) state that dogs and cats that did not have worsening signs by the second day had an improved prognosis. However, it is unlikely that these outcomes could be effectively captured by fire-specific reporting mechanisms. The absence of suitable reporting and follow-up in Australia does not address the knowledge gap in short- and long-term outcomes for smoke inhalation. This is particularly concerning when delayed complications of smoke inhalation are well reported and understood within the veterinary literature (Vaughn *et al.* 2012, Cope 2021). Put succinctly, unless fire services reporting mechanisms are designed to intentionally capture data relating to animals, it is unlikely that meaningful data will be collected for animals suffering smoke inhalation.

Animal outcomes in the broader incident context

For many people, the loss of their pet can be emotionally devastating. Hunt *et al.* (2008) reported on pet loss following Hurricane Katrina, identifying the significance of the psychological harm associated with the loss of a pet during the disaster. Zottarelli (2010) identified that people who lost pets during Hurricane Katrina were also more likely to have experienced other traumatic events, such as family separation or an increased likelihood of being injured. These findings may appear unsurprising, given the role of animals in people's lives, however, the effects of smoke inhalation by pets may extend beyond the psychological harm of pet loss and grief alone.

In a reported case from the United States, a dog suffering smoke inhalation-related medical complications required hospitalisation for 16 days and cost over US\$15,000 (Guillaumin & Hopper 2013). This is a significant financial cost and potentially outside the financial capabilities of many pet owners. It is difficult to envisage suffering a residential fire let alone making decisions for a loved pet based on financial circumstances. The death of a pet from smoke inhalation does not stop at the fire scene. The absence of follow-up mechanisms can mask the full outcomes for animals and humans alike. This paucity of evidence pertaining to psychosocial harm also extends to first responders. Reported anecdotal evidence of psychological harm exists for firefighters during bushfires in association with animal welfare needs (Klinberg, cited in Westcott *et al.* 2017; Walsh, cited in Westcott *et al.* 2017). Further research is required and a focus on improving animal-patient outcomes may offer improvements to outcomes that extend beyond the animal alone.

Forensic and fire investigations

Research by Stern *et al.* (2014) reports on the post-mortem investigation of 4 dogs; 2 were identified as having died as a direct result of fire. That research showed that the 2 dogs died from carbon monoxide poisoning due to smoke inhalation. The research also identified that although one of the deceased dogs had sustained burns, the burns occurred after the dog had died.

These findings, although adding to literature relating to smoke inhalation in animals, relates specifically to forensic investigation and concluded with the importance of veterinary forensics in arson investigation. Such views are supported by Sobhakumari *et al.* (2018) who reported on the investigation of 2 cats that were found deceased with their owners following exposure to carbon monoxide (due to a non-fire-related event). In exploring their investigative methodology, Sobhakumari *et al.* (2018) commented on the shared environment of pets and people, positing the value of a collaborative approach between veterinary and human forensic investigations in simultaneous pet and human fatalities. It appears that an approach involving veterinary forensics may prove beneficial in the investigation of fires that do not involve human fatalities or injury, particularly with respect to better understanding of fire development and behaviour (as potentially indicated by carbon monoxide and hydrogen cyanide exposure in pets). Further investigation is required to confirm the potential value of veterinary forensics in fire investigation for fires not involving human fatalities or injury.

Smoke toxicology in animals and communication of smoke exposure history

Although literature and research about animal smoke inhalation due to residential fires may be limited, the understanding of smoke toxicology within veterinary medicine is not. The significance of carbon monoxide and/or hydrogen cyanide is clearly identified as are the mechanisms in which these compounds (and other compounds, particulates and thermal injury) cause harm to animals (Vaughn *et al.* 2012, Jasani 2015, Hanel *et al.* 2016). The circumstances of smoke exposure, such as exposure time, fire environment and combustible materials present, are all identified as important factors in diagnosis and treatment (Fitzgerald & Flood 2006, Jasani 2015, de Laforcade 2017). However, it is recognised that these details may typically not be provided to treating veterinary staff (Cope 2021). This is a circumstance likely to remain unchanged in the absence of timely and effective information sharing between fire services agencies and veterinary staff within Australia.

Contributing to the lack of reporting of pets suffering smoke inhalation at residential fires is the anecdotal evidence of pets being returned to owners to seek veterinary attention (Pakenham 2014, Marshall 2015). While these actions align with the responsibilities of owners to their pets during emergencies (Gurtner & Parison 2021), any communication breakdown between first responders and veterinary staff may deprive veterinarians of important clinical history from the fire scene that can guide treatment. There is a need to address the lack of reporting and communication, both within fire services agencies and outward to pet owners and veterinarians.

Smoke inhalation management

Smoke is a mixture of heterogeneous gases and particles with specific toxicity attributed to carbon monoxide and hydrogen cyanide (Jasani 2015, Cope 2021). The American College of Veterinary Emergency and Critical Care Committee on Trauma has developed guidelines for the prehospital care of dogs and cats (Hanel *et al.* 2016) that includes smoke inhalation. These guidelines, specifically those for smoke inhalation, highlight the

significance of oxygen administration to animals exposed to smoke (where possible), the transportation of injured animals to veterinary care and the need to inform veterinary staff about the fire environment, including the burnt materials. Where possible, according to the British Animal Rescue and Trauma Care Association (2021), the administration of oxygen should continue for at least 20 minutes, with the likelihood of veterinary staff needing to continue this beyond that time.

The decontamination of animals following exposure to smoke and/or fire should also be addressed as part of prehospital care, however, current guidance remains limited. Fitzgerald and Flood (2006) note that decontamination, such as irrigation of the eyes and skin, can be instigated at the fire scene. In contrast to animal decontamination, the health-protective benefits of decontaminating firefighters and their personal protective clothing is well described. For example, Baker (2019) indicated the need to routinely decontaminate firefighters exposed to smoke. In a limited study, Davidson *et al.* (2020) identified weaknesses in the decontamination of human burns patients outside of mass casualty events, pointing to the need for further investigation of burns patient decontamination practices and also highlighting that inadequate decontamination may hinder the provision of care within the clinical setting. The need for adequate decontamination following exposure of pets to residential fires is explained by Jim Green (personal communication, 13 December 2022) who said that conscious pets may, and do, ingest contaminants from their skin and coat following exposure to a residential fire. The decontamination of animals suffering smoke inhalation warrants further investigation. However, it appears reasonable that evidence-based decontamination protocols may minimise risks to pets suffering smoke inhalation while enhancing the safety of first responders and veterinary staff.

The British Animal Rescue and Trauma Care Association provides guidance for the management of smoke inhalation by first responders (Oxygen Therapy for Companion Animals³) in addition to the National Fire Chiefs Council National Operational Guidance.⁴

Conclusion

Pets exert a considerable influence on human behaviour and, according to Green (2018), emergency response resourcing and actions, regardless of the incident type, should consider animals as part of routine emergency planning and response. Australian emergency management organisations have made considerable advancements in the management of animal-specific incidents, such as large animal rescue, with the introduction of techniques and equipment to safely manage these events (e.g. State Emergency Service of South Australia 2021). Smoke inhalation by pets due to residential fire differs from these events as the management of smoke-affected animals exists as one of the many time-critical considerations, such as human prehospital care, fire suppression and other activities. The identification of smoke as a complex mixture of toxins and particulates in

3. Oxygen Therapy for Companion Animals, at www.bartacic.org/wp-content/uploads/2021/03/Smokey-Paws-Guidance-1-1.pdf.

4. Incidents involving animals, at www.ukfrs.com/guidance/incidents-involving-animals?bundle=control_measure&id=20973&parent=20974.

veterinary literature (Fitzgerald & Flood 2006, Jasani 2015) holds parallels to the complex and diverse needs of pets and their owners during fires. Mechanisms that support animal welfare in larger-scale events may not prove sufficient nor appropriate for managing the immediate welfare needs of animals harmed during emergency incidents such as residential fires.

The need for prompt treatment and transportation poses challenges for fire services agencies, first responders and pet owners. Improving the immediate prehospital care of pets, including improvements in inter-disciplinary cooperation, has potential to improve outcomes for animals and people alike. The absence of representative research and data relating to pets and residential fires internationally has not hindered the development of capabilities within some emergency services organisations with improvements developed to support guidelines and animal outcomes. Further research into the frequency, current prehospital management and outcomes for pets suffering smoke inhalation due to residential fire is warranted.

The anecdotal evidence suggests prehospital treatment of pets for smoke inhalation does not mirror that given to human smoke inhalation patients, nor mirror best practice international veterinary guidelines. Investments in training and equipment appear to offer considerable improvements in animal welfare. Such efforts may help drive improvements in reporting mechanisms, and these in turn may likely demonstrate if the hypothesised benefits are realised.

Existing literature related to smoke inhalation in pets involved in residential fire, although limited, reveals a complex and broad number of considerations. These considerations often involve under-reporting, an unknown frequency of pets suffering smoke inhalation, the identification of broader psychosocial effects of smoke inhalation in pets and the value of enhanced veterinary integration at the small-scale incident involving animals. Further research is imperative to fully understand these matters in an Australian context, and to drive evidence-based practice in the future.

To address the matters raised in existing literature, Australian fire services should consider if investment in pet oxygen masks and animal first aid training may prove beneficial. Fire services may also consider improving reporting methodology to enhance data collection related to animals affected by residential fire, such as animal species, state of consciousness, treatment provided and the provider of definitive care. Such data may be captured within current fire reporting systems or through novel reporting mechanisms explicitly for this purpose. Actions to develop relationships and improve mechanisms to share time-critical and pertinent information with veterinary staff about animals affected by residential fire should be implemented.

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