Contextual information and cognitive bias in the forensic investigation of fatal fires:

Do these incidents present an increased risk of flawed decision-making?

Author 1: Neil Morling

Author 2: Marika Henneberg

Abstract

In sudden or unexpected deaths, there is a need to identify whether or not the death resulted from a criminal act. Adding evidentiary problems associated with fire and arson to this further complicates the investigation. A multi-agency approach with an open exchange of information is recommended, though the use of unrestrictive contextual information is problematic. Extraneous contextual information may introduce bias into the investigative process, risking flawed decision-making, and fatal fires may be particularly vulnerable to this. The authors examine the effect of cognitive bias on fire investigation and argue that, in fatal fire investigations, the sharing of contextual information should involve the use of strict information management strategies to ensure that forensic experts only receive task-relevant contextual information.

Keywords

Fatal fires; cognitive bias; decision-making; scientific protocols; linear sequential unmasking; case-manager approach.

1. Introduction

Fire investigation is arguably one of the most difficult areas of investigation (Henneberg & Morling, 2018). Fire investigation is a specialised discipline of forensic science that can often be seen as a world unto itself. It is a complex and demanding endeavor that takes place in a hazardous environment, exposing investigators to scientific and professional challenges not found in other fields of forensic science (Lentini, 2006; Stauffer et al., 2008). A fire investigator must have a thorough understanding of many technical and engineering disciplines including fire science, thermodynamics and heat release rates, building construction and electrical supply equipment. In addition to scientific and technical information, a fire investigator also needs to be able to accurately assess more subjective evidence such as conflicting witness testimony or unpredictable human behavior (Henneberg & Morling, 2018).

The difficulties facing fire investigators further intensify when fatalities or serious injuries are involved. These tragic incidents tend to focus attention on the human cost, complicating the investigator's core role of finding the origin and cause of the fire. In addition, fatal fires require investigators to answer specific questions relating to the

victim. These include where the victim was, how their death came about and was the death due to the fire or only associated with it (DeHaan & Icove, 2014).

These additional demands mean that the investigation of fatal fires require the combined expertise of specialist investigators and forensic examiners and a failure to appreciate the value of the joint approach can seriously compromise the success of an entire investigation (DeHaan & Icove, 2014; McAllister et al., 2014; National Fire Protection Association [NFPA], 2017). The multi-disciplinary approach to the investigation of fatal fires has three distinct elements: the fire investigation, the sudden death investigation, and the pathological examination. It is by bringing together the conclusions reached in each of these stages that an overall judgement can be drawn on how and why a fire death occurred. The close interrelation between all three elements, and the fact that each of these aspects can be seen as independent but complementary disciplines, means that information obtained at one stage can have a significant relevance to the analysis and the conclusions drawn at each of the others. Each specialist examiner may therefore tend to rely more on contextual information in order to reach a conclusion than would normally be expected in more straightforward investigations. Moreover, with fatal fires the reliance on contextual information may be increased due to specific evidential challenges that are apparent within each specialised investigative element. These include the lack of physical evidence at fires started by the application of a naked flame; the difficulty of identifying non-fire related injuries at the scene; and the fact that the fire deaths are among the most difficult pathological cases.

In this article, the authors examine the investigation of sudden and unexpected deaths, focusing primarily on fatal fire investigations. These complex cases involve limited and contaminated physical evidence, potentially indistinguishable violent injuries and inconclusive and misleading pathological findings. In order to overcome these problems, investigative protocols recommend a multi-agency approach with an open exchange of information.

However, although the sharing of data within forensic decision-making may be beneficial and sometimes essential, the use of unrestrictive contextual information is problematic and can increase susceptibility to cognitive bias. All forensic examiners are vulnerable to cognitive bias, and the use of extraneous contextual information has the potential to introduce bias into the entire investigative process, leading to flawed decision-making (Dror, 2017; Edmond et al., 2015; Langenburg, 2017). Cognitive bias exists in all forensic decision-making and research has demonstrated how bias can adversely influence investigations in fields such as DNA analysis, fingerprinting or image interpretation (Edmond et al., 2015; Langenburg, 2017; Jeanguenat et al., 2017). Fatal fire investigations are also vulnerable, perhaps particularly so, as investigative conclusions may often be the result of subjective opinions and not forensic proof. The authors conclude that, where it is necessary to share contextual information, this should only be undertaken using scientifically sound protocols. In the case of fatal fire investigations, this should involve the use of strict information management strategies to ensure that forensic experts only receive task-relevant contextual information. The

authors recommend the use of either the case-manager approach or the strategy of the linear sequential unmasking of contextual information.

It is worth noting that fatal fires are not exclusive to one jurisdiction or country, so although legislation, research and cases used to illustrate these problems within this article are mainly from the United Kingdom (UK), the conclusions drawn and suggestions made are of wider interest for the investigation of fatal fires anywhere.

2. The evidential problems in fire and arson investigations

It is known that the problems associated with fire investigations are compounded when the fire is intentionally set (DeHaan & Icove, 2014). Deliberate fire setting is a complex topic but the most important part of any arson investigation can be seen to be the investigation into the origin and cause of the fire (Arson Prevention Forum, 2014; Ottley, 2010). This is because, unlike in many crimes, the fire scene must first be investigated in order to ascertain whether or not a crime has even taken place. It is the conclusion of the fire investigator that the fire was the result of a deliberate act that will result in a criminal investigation into who was responsible (Henneberg & Morling, 2018; NFPA, 2017).

Yet it is a fact that in many cases of incendiary fires there is little physical evidence of their cause (Henneberg & Morling, 2018). Fires that are deliberately started with the application of a naked flame to a combustible item will leave little or no evidence of the act itself (DeHaan & Icove, 2014; Lentini, 2010). Even if there was physical evidence of the source of ignition at the start of the fire, the source may be altered, destroyed, moved

or removed during the fire and any subsequent firefighting operations (NFPA, 2017). Without definitive physical evidence of the ignition source, the fire investigator may have to rely on the analysis and assessment of data such as burn patterns, smoke staining or timing estimates to reach a conclusion on how the fire started (Henneberg & Morling, 2018). This type of evidence is subjective and open to interpretation and therefore a cause based on such evidence is more likely to be inconclusive or open to doubt.

In addition, arson scenes may contain viable accidental sources of ignition, such as portable gas fires or electrical equipment. These need to be examined and eliminated as possible causes of fire before an act of arson can be reliably determined. Extensive fire damage can make the task of discounting these potential accidental causes problematic. Some sources of ignition, such as discarded smoking materials or candles present investigators with particular difficulties in discounting them as potential accidental causes of fire. The presence of these ignition sources in an arson scene can provide investigators with physical evidence of a well-known and often viable accidental cause of the fire which can be extremely hard to completely eliminate.

The challenges of fire scene investigation mean that fire investigators must follow a systematic and analytical approach based on the scientific method in order to reach conclusions that are valid, robust and reliable (Cox, 2011; DeHaan & Icove, 2014; Henneberg & Morling, 2018; NFPA, 2017). However, some fire scenes produce such little reliable data that several possible causes may continue to exist despite attempts by an investigator to reach a definitive conclusion. Fire investigators are therefore expected

to make an assessment of how likely or unlikely each of the identified scenarios was in causing the fire. In such cases, additional contextual information may become a significant factor in the determination of which potential cause is 'more likely' than another. If a fire scene investigator cannot exclude all alternatives then the fire may be recorded as undetermined or with having more than one qualified potential cause (DeHaan & Icove, 2014; NFPA, 2017).

In England and Wales the causes of fire are classified in three ways: accidental, deliberate or not known (Department of Communities and Local Government [DCLG], 2012). Procedural guidance including the Police Act 1964, Home Office Circular 44/2000 and Fire and Rescue Service Circular 1/2006 all charge the police with responsibility for the criminal investigation into fires where the supposed cause is not accidental (Pretious, 2006). In effect this means that the police will commence a criminal investigation when the cause of a fire is deemed suspicious. However, fires where the cause is recorded as not known are treated as accidental fires (Home Office, 2017a; London Fire Brigade, 2017). In addition there is a generally accepted and long held principle among fire investigators that if the cause of a fire cannot be proven to be deliberate then it should be presumed to be accidental (Bennett, 1958; Lentini, 2013). As a result, fires with multiple qualified possible causes, or those deemed to have an unknown cause, would not normally reach the threshold of 'suspicious' where a police investigation would be triggered. In deliberate fires involving fatalities, the lack of

evidence proving an act of arson can result in the police treating the incident as a non-suspicious or unexplained sudden death.

The investigation of homicide presents unique challenges to police investigators, partly because of the fact that the range of circumstances in which homicides occur means that investigating officers face numerous problems in locating and recovering evidence. This is a particular problem where it is not obvious in the initial stages of an incident that a homicide has occurred, as opportunities to gather significant material may be lost. Fatal fires present just such a scenario (Association of Chief Police Officers [ACPO], 2006; Cook & Tattersall, 2014; DeHaan & Icove, 2014). It is therefore vital that any evidence indicating a homicide is identified at the earliest opportunity. The limited physical evidence available at some deliberate fire scenes means that, even if an act of arson can reliably be determined, this may only have happened after a detailed scene excavation. As a result there is the potential for an arson associated homicide scene to be contaminated and forensically compromised before it is recognised as such.

However, although incident scenes are an important source of material, and the recovery of physical evidence a vital part of any investigation (ACPO, 2006; Cox, 2011), they are by no means the only important aspect of a sudden death investigation. One element that provides critical evidence is the detailed examination of the body and the analysis of any injuries sustained. This applies both to the inspection of the body in situ and through a post-mortem examination. Not only do these provide the information relating to the immediate cause of death, but autopsy and injury data can also provide discriminating,

scientific evidence to assist in the origin and cause of the fire (McAllister et al., 2014; NFPA, 2017). In addition, the presence of any non-accidental injuries on a fire victim can provide critical evidence to identify a crime scene prior to the establishing of the origin and cause of the fire. Yet, as with fire scene examination, the physical examination of fire victims is problematic and the information obtained from autopsies may be inconclusive or misleading.

3. Sudden deaths and fire fatalities

In cases of sudden unexplained deaths the police have a general duty to ensure that no criminal offences have been committed, although in England and Wales there are no formal legislative rules governing the role of the police in these investigations (Doyle, 2011). As a result, the investigative resources employed at each incident can vary considerably. The police are also responsible for the overall conduct of any investigation into a fire where a death or serious injury has occurred. Such investigations should be managed by a police senior investigating officer and should involve close liaison with both the fire and rescue service and forensic providers (Pretious, 2006). Standard texts on fire investigation also reflect the importance of a multi-disciplinary approach, recommending that both fire and homicide investigators, together with forensic pathologists, are involved in the investigation (DeHaan & Icove, 2014; NFPA, 2017).

Autopsy and injury data from a fire victim is inherently linked not only to the development and behaviour of the fire, but also to how the victim interacted with it.

Police investigative guidance recognises that fire related deaths present challenges that make it more difficult to judge whether the death is the result of a criminal act and may therefore need to be subjected to a higher level of investigation (ACPO, 2006; Cook & Tattersall, 2014; DeHaan & Icove, 2014; McAllister et al., 2014). A fire is an extremely complex event that can kill in any number of means and people react to fire in a wide variety of ways (DeHaan & Icove, 2014; Icove & DeHaan, 2004; NFPA, 2017). Deaths from fires can occur from mechanisms including burns, inhalation of fire fumes, anoxia, internal edema, trauma or electrocution. In addition, the wide range of homicidal and accidental causes of sudden death may also be present in fatalities recovered from fire scenes. It should not therefore be assumed that the relationship between the fire and the death is directly causal (Byard, 2017; DeHaan & Icove, 2014; NFPA, 2017). Moreover, the prolonged burning of a body causes the destruction of forensically useful material and can in severe cases lead to almost total destruction. All fire fatalities therefore need to be viewed with particular care (Bohnert et al., 2003; DeHaan & Icove, 2014; Yadev et al., 2013).

Sudden death investigators are advised that, where the cause of a death is uncertain, a brief examination of a body should be carried out at the scene to check for obvious wounds (Cook & Tattersall, 2014). However, fire scenes can be dark, dangerous and difficult to work in and it is highly unlikely that anyone conducting a brief examination of either a fire fatality or the wider scene will determine any conclusive evidence. Moreover, experience has shown that there is a temptation to regard a fatal fire as a single

static set of conditions and assess the physiological effects on the body as a result of exposure to that event (DeHaan & Icove, 2014). Fires will always present a valid potential cause of death to a victim and, because the dangers of fire and the risk they pose to human life are so well known, there is a risk that investigators will assume that the death of a fire victim is a direct result of the fire. This can delay or prevent the examination of a victim and lead to critical evidence being missed. It is therefore vital that fire deaths should always be treated as uncertain and a preliminary and careful external examination of the victims in situ for non-fire related injuries carried out by a trained investigator as soon as practicable.

One of the most pressing issues in any fatal fire investigation is the question of whether the victim was alive at the time of the fire (DeHaan & Icove, 2014; Byard, 2017). Clearly, evidence of movement during the fire, such as a victim trying to escape can provide valuable information that a person was alive during the early stages of the fire. Conversely, the absence of any such evidence can provide an early indication that a victim may have been dead prior to the fire. Yet potential signs of movement must be viewed with caution by investigators as such evidence can be misleading and counter-intuitive. When a body is subjected to heat from a fire, the muscles and tendons contract causing joints to flex. This is particularly evident in the limbs and is the cause of the 'boxer's or pugilistic pose' which is commonly found in burned bodies. This can be mistaken for a behavioral response to the fire by the victim or even a last minute defensive posture rather than simply the post-mortem physiological response to heat that

it actually signifies (DeHaan & Icove, 2014; NFPA, 2017; Ćicolić & Ziković, 2015; Saukko & Knight, 2016). In addition, the post-mortem flexing of joints can be severe enough to cause the body to move from its pre-fire position. Experiments conducted in the United States of America (USA) have seen pre-placed cadavers changing position after the rooms in which they had been placed were set alight. In some cases the joint flexing has been strong enough to cause the bodies to move, resulting in the corpses falling off chairs or beds during the fire (DeHaan & Icove, 2014; Pope et al., 2004). This response of the body could potentially be misinterpreted as evidence of the victim being alive during the fire.

It must be borne in mind that the physical appearances of victims who have died in a fire and those who were already dead when a fire started can inevitably look identical (Prahlow, 2010). The physical effects of fires on human bodies can not only mask evidence of violent ante-mortem injuries but also cause injuries that mimic those of an assault (DeHaan & Icove, 2014; NFPA, 2017). Smoke and soot staining on bodies can readily mask the physical signs of soft tissue injuries, such as bruising, making it difficult to identify signs of criminal assault. In addition, soot can enter the nose and mouth of a corpse and stain the tongue and pharynx and even reach the glottis (Prahlow, 2010; Saukko & Knight, 2016). This can give the unwary investigator the false impression that the fatality had been breathing in smoke, an important indicator of vitality, when in fact they had already been dead prior to the fire.

A body exposed to fire will contribute fuel and support combustion as it continues to react with the fire. Although it is rare for a body to be completely consumed by a fire, under certain conditions there can be a substantial incineration of the victim (Cox, 2011; Icove & DeHaan, 2004; NFPA, 2017). In cases with badly burned bodies it can sometimes be difficult to determine that the remains are in fact human, and the burned bodies of pigs, deer and even large dogs have been mistaken for human remains (DeHaan & Icove, 2014). With such destruction making even identification of human remains problematic, severe charring and destruction of body tissue can make it increasingly difficult, and in some cases impossible, for scene investigators to identify non-fire related injuries that were present prior to the fire.

In contrast, the effects of fire on a body can, in itself, cause injuries that may be mistaken for evidence of violent assault. Prolonged exposure to heat destroys the dermal layer and causes desiccation and discoloration. As it desiccates the skin shrinks and can split leaving torn surfaces similar in appearance to incised wounds from sharp objects (Icove & DeHaan, 2004). The destruction of the skin layers and the contraction of powerful flexors can cause bones to fracture, commonly involving the arms and lower legs. In addition, the effects of heat can cause the skull to fracture or become friable and vulnerable to mechanical damage from post fire debris or firefighting activities. These types of fire effects can appear similar in appearance to ante-mortem injuries. This presents a risk both of such thermal effects being mistaken for violent non-fire related

injuries but also of investigators attributing actual evidence of homicide to the exposure of the body to the effects of a fire.

These issues mean that it is sometimes extremely difficult for non-medical professionals, even experienced homicide and fire investigators, to identify physical injuries on the bodies of fire victims or to tell if injuries that are apparent have been caused by the fire or by a violent assault. During a 2015 study, the Forensic Pathology Unit of the Home Office concluded that a lack of, or poor examination of, a body at a scene of sudden death is a significant factor in cases where a homicide is not immediately identified. In some cases officers even ignored visible marks indicating violence when making the decision not to treat the death as suspicious. Fire deaths must therefore present a higher risk than non-fire related sudden deaths as, even with a careful external examination of a victim, it can be impossible for scene investigators to determine what injuries are present, whether or not the person's death was a direct result of the fire and consequently whether or not a homicide has occurred.

Investigators will almost certainly require more information relating to the injuries sustained by the victim than can be obtained from the scene to make valid conclusions on the cause and manner of the death. Fire victims, irrespective of whether the death is immediate or occurs after the fire, should therefore be subjected to a full pathological and toxicological examination (DeHaan & Icove, 2014; NFPA, 2017).

4. Post-mortem and pathological information

In England and Wales, a coroner will investigate if a death was violent or unnatural, the cause of death is unknown, or the deceased died while in state custody. As a result, all fire death investigations will involve a coroner. During this investigation a post-mortem examination should be carried out if the person has died a sudden death or where the cause of death is unknown (Ministry of Justice, 2014; National Confidential Enquiry into Patient Outcome and Death [NCEPOD], 2006). In relation to the investigation of sudden deaths there are fundamentally two types of post-mortem examination; a non-forensic or coronial post-mortem and a forensic post-mortem (Hutton, 2015).

A coronial post-mortem is simply to determine a cause of death. In basic terms, the coronial autopsy exists to identify or exclude unnatural and violent. A coronial post-mortem will be carried out by a suitable medical practitioner, normally a pathologist, and in most cases the level of diagnostic accuracy is expected to be 'probably true' rather than 'accurate beyond reasonable doubt' (Ministry of Justice, 2014; NCEPOD, 2006). In comparison, forensic post-mortems are carried out by Registered Forensic Pathologists in order to assist in cases where there is, or is likely to be, an investigation leading to serious criminal charges and the information derived from the examination used in the investigation or in trial proceedings (Home Office et al., 2012; Ministry of Justice, 2014). In theory there is some degree of overlap between the practice of forensic and non-forensic pathology but in reality there is a clear distinction between both the work and professional position of the relevant pathologists (Hutton, 2015; College of Policing,

2019). While it is true that both types of autopsy are concerned with the identification of the deceased and the cause and circumstances of the death, coronial legislation does not extend to the determination of information necessary for the investigation and prosecution of criminal offences. The identification and recovery of forensic evidence from a body therefore requires police powers under Section 19 of the Police and Criminal Evidence Act 1984 or common law (Forensic Science Regulator, 2014a; Jones, 2014). As a result, forensic pathologists are required to undergo specialist training and accreditation to achieve and maintain a high level of expertise (Hutton, 2015; British Association in Forensic Medicine, 2016). Courts in England and Wales have reflected upon the distinction between the knowledge and experience of the two groups of pathologists, and therefore the value of their expert opinion. For example, in *R v Clarke and Morabir*¹ the Court of Appeal upheld a trial judge's decision that a non-forensic pathologist was not competent to challenge the findings of a forensic pathologist.

Although many non-forensic pathologists conduct autopsies to a high standard, historically concerns have been raised over the standard of coronial post-mortems and the possibility of homicides being missed (Harvard, 1960; Johnson, 1969). In 2006, NCEPOD reviewed coronial autopsies and concluded that many were inadequate with one in four reports judged poor or unacceptable. In a third of autopsies the mortuary technician opened the body and removed organs before the pathologist had examined the body and in a fifth of cases the cause of death was deemed questionable. In addition, the

¹ [2013] EWCA Crim 162.

examination of the body and organs was thought to be generally poor and half of the cases produced findings that were unexpected before death (NCEPOD, 2006). The Royal College of Pathology reviewed the 2006 study nearly a decade later, and found that not only were the findings still valid, but if anything the situation had actually worsened (Forensic Pathology Unit of the Home Office, 2015). These factors mean that, despite a principle purpose of a coronial post mortem examination being to exclude a homicide, reliance on a non-forensic post-mortem is risky and unlikely to identify a complex murder (Forensic Pathology Unit of the Home Office, 2015; NCEPOD, 2006).

In all cases of sudden death a decision has to be made on which type of post-mortem will be carried out. In cases of a homicide, or where a homicide is suspected, there is clear guidance for the requirements of the police investigation. Effective pathology is recognised as being essential to the overall forensic strategy and a registered forensic pathologist will be appointed (Doyle, 2011; College of Policing, 2019). Whether or not this process is undertaken is dependent on the identification of evidence indicating that a sudden death is indeed suspicious. If no evidence of homicide is available at the scene, or if the initial investigators miss such evidence, then it is unlikely that homicide investigation guidelines will be followed. The undertaking of a non-forensic post-mortem in cases where a forensic examination should have been carried out could result in unqualified practitioners failing to identify and recover forensic evidence (Jones, 2014). If the initial investigation leads to flawed decision-making and the death is not treated as

suspicious, then there could be no forensic examination of the body and pathological evidence of a homicide may be completely missed (College of Policing, 2019).

The information that is obtained from the scenes of sudden death is therefore an essential factor in the decision on what type of post-mortem examination will subsequently be carried out. The lack of evidence of arson at some deliberate fire scenes together with the likelihood that first responders will be unable to determine the presence of non-accidental injuries on fire victims mean that fatal fires can present scenes where evidence of a homicide can be limited in quantity and subtle in appearance.

Fire deaths are highly complex pathological cases and among the most difficult for pathologists to investigate (Byard, 2017; Fanton et al., 2006; Ćicolić & Ziković, 2015). The wide range of injuries that fire victims can suffer and the destruction of the body can make the pathological examination of fire fatalities problematic. Irrespective of whether a forensic or a non-forensic post-mortem is performed on a fire victim, a crucial question is whether or not the victim was alive at the time of the fire (e.g. Bernitz et al., 2014; Bohnert et al., 2003; Ćicolić & Ziković, 2015). The issue of vitality and the cause of death are closely linked (Bohnert et al., 2003) and the cause of death can be considered to be a pivotal factor in an allegation of homicide. In England and Wales legal guidance states that a charge of murder should not be made without a statement of unlawful death from a pathologist (Crown Prosecution Service, 2017; College of Policing, 2019). Signs of vitality in fire fatalities do not provide evidence to suggest that the death could be suspicious and could not, therefore, be expected to alert a pathologist to the prospect of a

homicide in the same way as a lack of such evidence would. Yet in the case of fatal fires it is important to consider that a cause of death proving that a victim died from the effects of the fire does not preclude the possibility of a homicide. In such cases the pathological examination cannot determine whether or not a death was unlawful without contextual information regarding the fire scene; the cause of fire would be considered as the determining factor and not the cause of death. Pathological evidence should be scientifically robust but the complex nature of fire fatalities may mean an understanding of both the fire scene information and the injuries to the victim are therefore needed if the cause and manner of death is to be fully understood.

5. Discussion

5.1. Cognitive bias and contextual information

Fatal fires are extremely challenging investigations that require investigators and forensic scientists to work closely together in order to determine the cause and manner of the victim's death. Investigative protocols and guidance states that forensic examiners working in each of the three stages of the investigation (fire investigation, sudden death investigation, and the pathological examination) should exchange information fully and work in close cooperation with each other if the sequence of events is to be accurately reconstructed (DeHaan & Icove, 2017; McAllister et al., 2014). In addition, recent research in the USA has emphasised the beneficial effects of sharing history and context

between pathologists and investigators, improving both consensus and investigator confidence with regard to the medical diagnoses (Oliver, 2017).

Yet improved consensus and increased confidence are not the same thing as accuracy and reliability (Dror et al., 2018a). If forensic experts are working within a variety of contextual influences then this has the potential to significantly affect their evaluation of the evidence (Bernstein, 2008; Charman, 2013; Kassin et al., 2013; Koppl, 2005). In the case of fatal fires, the multi-agency framework and unrestricted information sharing protocols, procedures specifically intended to improve reliability and accuracy, effectively create an investigative environment that can readily introduce bias into the analytical process.

Cognitive bias is a well-established phenomenon in scientific analysis. Psychological research has repeatedly demonstrated that people's perceptions and cognitions are affected by context, motivation, expectation and experience and that this can initiate systematic errors in decision making (MacLean & Dror, 2016). This cognitive vulnerability is an important factor that can result in premature conclusions being reached by investigators (Forensic Science Regulator, 2015a; NFPA, 2017). Such bias has been identified as a leading cause of poor decision making and one that can lead to investigators missing apparent and obvious indicators of criminal behaviour. A 2012 study into decision making at the scene of sudden deaths carried out by the Forensic Pathology Unit of the Home Office found that there is a tendency for the first attending officers to quickly make up their mind whether the incident is suspicious or not, often

believing the first accounts that they are given. In some cases this has resulted in attending officers overlooking apparent and obvious indicators of criminality. This bias subsequently impacts the investigator's assessment of any new evidence which comes to light and also the briefing of senior officers and the coroner (Forensic Pathology Unit of the Home Office, 2015).

The biasing effect of contextual information is not only limited to the evaluation of evidence but can also significantly influence the way that different types of evidence are combined into one coherent investigative narrative (Charman, 2013). Fatal fire investigations, like most major criminal investigations, must take different strands of evidence gathered from multiple sources and integrate them together into a single framework. The handover of information, whether through the briefing of senior officers or further investigators is a fundamental part of a fire investigation. If bias has affected the initial assessments then it can subsequently become fully embedded in the investigative process, with the same flawed information being handed over again and again (Dror et al., 2017). This can effectively prejudice the entire investigation.

The dangers of this can be illustrated by the role of the post-mortem in sudden deaths. Both forensic and non-forensic pathologists are expected to provide a background history in order to give some context to the pathological examination (Forensic Science Regulator, 2014b; Royal College of Pathologists, 2002). Yet in the majority of cases this information will come directly from the investigation team. A 2013 audit of forensic post-mortems following fire deaths, found that the forensic pathologist had visited the

relevant fire scene in only 20% of the cases with the other histories being entirely based on briefing materials provided to the pathologist (Forensic Science Regulator, 2015b). A similar situation exists in relation to non-forensic post-mortems, with the vast majority of case histories essentially being identical to the supporting documentation provided or even simply stated as 'history as provided' (NCEPOD, 2006).

Trained and experienced investigators should be aware of the dangers of cognitive bias and use established and recognised methodologies in order to minimise any effects. However, the initial scene assessments at sudden deaths are often carried out by first attending officers generally outside of the control of senior investigators who will only become involved if it is determined that the incident is suspicious (ACPO, 2006). Responders who are inadequately trained, untested, under-supervised and inexperienced are more likely to reach mistaken conclusions (Haber & Haber, 2013). In the case of fatal fires, responding police officers will liaise with operational firefighters at the scene and the information exchanged between these parties will form an important part of the overall initial assessment. Yet operational fire officers are likely to have received only limited training in fire investigation and firefighters may have received none at all (National Fire Chiefs Council, 2018; Pretious, 2006).

5.2. Lack of exposure causing lack of experience

Fire related fatalities in developed countries have been on a general downward trend for many years with the vast majority of fatal fires caused accidentally (Bryant & Preston,

2017; Federal Emergency Management Agency, 2011; United States Fire Administration, 2017). The use of fire within a crime of homicide also tends to be considered as a rare occurrence (Davies & Mouzos, 2007; Ferguson et al., 2015; Tümer et al., 2012). Research into arson-associated homicide in Chicago between 1965 and 1995 found that it involved only 1.9% of all homicides (Drake & Block, 2003) and a 2015 study in Australia found a similar rate of 2% (Ferguson et al., 2015). In England a study examining homicides in London over a five year period between 2010 and 2015 found that fire was involved in just over 4% of all homicides (Morling, 2016).

Statistics and published research therefore indicate that fire-related homicides form a small percentage of both fatal fires and murders. As a result, individual fire and police officers and investigators may have little or no experience of dealing directly with these problematic crimes. A lack of experience has been found to significantly and adversely affect decision making at the scene of critical incidents. Individuals without complex memories containing a broad repertoire of relevant situations to rely on are more likely to be prone to error (Eyre & Alison, 2007). Both fire and police officers have been shown to be susceptible to reacting to the typicality of the situation facing them and this experiential decision making process tends to result in officers reacting in the same way that they had in previous similar situations (Klein, 2008; Klein & Klinger, 1991; Stelfox, 2007). In effect, limited previous experience, together with the known statistical percentages, can act to bias the decisions made at the scene of a fatal fire.

The exact nature of a fatal fire and how the victim interacted with it may only become apparent after a comprehensive examination by specialist investigators. Yet these specialist investigators may not even be involved in the investigation if the initial attending officers, based on incomplete analysis, determine that there are no suspicious circumstances. This may be more of a significant problem with fatal fires as bias in sudden death assessments has been found to be especially notable in cases where the deceased had been using alcohol or were elderly. These are two profiles that are often found to be present in victims of fatal fires and both are known to be factors that increase the likelihood of a person dying in an accidental fire (Bryant & Preston, 2017; Forensic Pathology Unit of the Home Office, 2015; Home Office, 2017b).

Fatal fires therefore clearly present a risk of bias affecting the way such scenes are viewed by the responding investigators and as a consequence the investigative resources that are subsequently applied to the investigation. These issues can be illustrated by the death of Peter Fasoli in London on 7 January 2013. Firefighters were called to Fasoli's burning home shortly before one o'clock in the morning where they recovered Fasoli from the building but he was pronounced dead a short time afterwards. There were no immediate signs of suspicion and a multi-agency fire investigation determined that the most likely cause of the fire was a faulty light bulb. A coronial post-mortem examination found no evidence of third party involvement and concluded that Fasoli had died from smoke inhalation. The subsequent inquest into the death of Fasoli was held on 16 August

2013 at West London Coroner's Court and the coroner returned a conclusion of accidental death (Grierson, 2017; Metropolitan Police, 2017; Summers, 2017).

During the investigation the police had seized a computer from Fasoli's home but the hard drive was never examined. The computer had been placed in storage and was subsequently handed to Fasoli's nephew in August 2014. On viewing the files on the hard drive the nephew found a number of videos showing his uncle taking part in sexual activities with other men. One of these videos was recorded by the computer's webcam on the night of the fire and showed the torture and murder of Fasoli. The seven hour long footage recorded a prolonged and violent attack on Fasoli, which culminated in him being forcibly injected and suffocated with Clingfilm. Following the assault, the attacker splashed a liquid around the flat and used a cigarette lighter to start a fire. He then left the flat shortly before a smoke alarm operated (Metropolitan Police, 2017; Summers, 2017).

A murder investigation was launched by the Metropolitan Police in November 2014 and the attacker was subsequently identified as Jason Marshall. During the investigation it emerged that, following the attack, Marshall had taken Fasoli's bank cards and used them to withdraw hundreds of pounds and to buy return flights to Rome. Marshall then flew to Italy where, on the night of 26/27 January 2013, he murdered a 67 year old man, again taking and using the victim's bank cards. A third attack in February 2013 failed and Marshall was subsequently caught by the Italian police, convicted and sentenced to sixteen years in prison. He was extradited to the UK in February 2017 and convicted of the Fasoli murder and arson in August of the same year (BBC, 2017; Metropolitan Police,

2017). This incident shows the dangers of contextual information from one stage of the incident influencing the others. As there was no clear evidence of arson from the fire investigation and a potential accidental ignition source was identified, no examination of the recovered computer was carried out by the police and a forensic post-mortem, which should have identified the violent non-fire injuries on Fasoli's body, did not take place.

5.3. Decision-making and contextual information

Whether or not an incident is treated as suspicious often relies on the decisions made by the initial sudden death investigators at the scene. If such errors are a recognised problem for sudden death investigations where there is clear evidence of suspicion available, then scenes of incendiary fires that may contain little or no physical evidence of their cause must present an even greater risk of being overlooked. In addition, the lack of, or poor inspection of, a body at a scene by first attending officers is a significant problem. Even when visible marks indicating possible violence are present on bodies, in many cases decisions are made not to treat the deaths as suspicious (Forensic Pathology Unit of the Home Office, 2015). If investigators are not reacting to clearly visible evidence of violent injuries then it is unlikely that any similar wounds present on fire fatalities would be recognised and acted upon.

The actions and decisions taken by officers at the scene may largely determine what investigative resources the police will allocate to the incident, and whether a forensic or non-forensic post-mortem should be undertaken. However, if initial investigations do not

uncover evidence which indicates grounds for suspicion then a coronial rather than a forensic post-mortem is likely to be carried out. The fact that coronial post-mortems are unlikely to uncover a complex murder, together with acknowledged poor standards of some coronial examinations, increases the risk that an opportunity to identify and recover critical pathological evidence may be missed. Incidents such as the death of Fasoli are not unique to the UK. Similar fire related and initially undetected homicides have recently been recorded in Australia (Roberts, 2009) and the USA (Knight & Raiche, 2017).

The extent of the influence that contextual information can have on forensic examiners is illustrated in the Scottish case of *Earnest D’Arcy v Her Majesty’s Advocate*². In this case a man who was sentenced to four years for an arson attack on a caravan appealed his conviction on the grounds of the expert testimony heard at his trial. The appeal focused on the trial judge’s summing up of evidence heard from a police scene of crime officer (SOCO) and from a fire officer. Both had given expert opinion evidence at the trial that the fire had been started deliberately and that an accelerant had been used. However, under cross-examination the SOCO admitted that he had not carried out an extensive investigation into the fire, as there had been no fatality and no significant financial loss. The SOCO went on to admit that his opinion on the cause of the fire and that an accelerant had been used was based primarily on a witness statement that he read prior to completing his report. Similarly the fire officer admitted that the accounts in the witness statements, that he had also been aware of, had influenced his thinking.

² [2013] ScotHC HCJAC 173.

The fact that there was no proof of the cause of the fire, nor any physical evidence of the use of an accelerant, did not stop the two fire scene examiners from giving expert opinion evidence to the contrary based on contextual information from witness statements. In the trial judge's summing up it was stated that the jury should not be distracted by speculation about what other evidence may have been available if the investigation had been carried out in a more thorough way. Yet this goes to the heart of the problem. It may not have been an issue for the jury at court, according to the judge, but it is an issue for the investigators. In England and Wales, the Criminal Procedures and Investigations Act 1996 contains provisions to ensure that all reasonable steps are taken for the purpose of the investigation and, in particular, all reasonable lines of inquiry are pursued (Ministry of Justice, 2015). *Earnest D'Arcy* illustrates how contextual bias can act to prevent the exploration of alternative hypotheses. Cases such as *Fasoli* and *Earnest D'Arcy* show how contextual bias can significantly affect the decisions made at fire scenes and how this can impact the entire investigative process, potentially leading to serious miscarriages of justice.

6. Potential solutions

6.1. The importance of information management

Fatal fires require a multi-agency approach with trained and experienced investigators and forensic examiners involved throughout the investigation. However, the problematic issues surrounding the actual significance of the physical evidence recovered during each

specific stage of the investigation means that it is difficult and sometimes impossible to draw definitive conclusions without reference to contextual information obtained from the other stages. This inter-disciplinary nature means that it is inevitable that information from different evidence streams is integrated into a cohesive investigative narrative in order for a valid and robust conclusion to be reached. Although it is accepted that some degree of contextual information can be beneficial or even essential to the scientific analysis, having excess knowledge beyond what is required can inadvertently influence objectivity (Kukucka et al., 2017; Skellern, 2015).

Forensic investigators are trained to avoid physical contamination to protect the integrity of evidence and it is crucial that the same emphasis is placed on 'psychological contamination' in order to reduce the effects of cognitive bias (Kassin et al., 2013). If, as with fatal fires, contextual information is necessary then it is vital that the integration of such evidence is carried out using scientifically sound protocols. Such protocols can help to manage contextual influences in ways that minimise the risk of cognitive bias and cross-contamination (Dror et al., 2018b). The protocols that could be successfully applied to information sharing in fatal fire investigations are considered to be the case manager approach and linear sequential unmasking.

6.2 The case manager approach

The case manager approach relies on the concept of a 'context manager' having access to all information but who passes to a forensic examiner only the information that is

necessary for the examiner to complete their task. Contextual information can therefore be classified in two ways: task-relevant or task-irrelevant. The term task-relevant applies to information that is necessary in order for the competent examiner to draw conclusions through the analysis of physical evidence by an accepted methodology (National Commission on Forensic Science [NCFS], 2015a; Osborne & Taylor, 2018). The information required clearly depends on the specific role that the forensic examiner is being asked to undertake and it is not always simple and self-evident what information is relevant and what is irrelevant. In addition, whether information is classified as relevant or not and may change during different phases of the investigation (Dror et al., 2017; NCFS, 2015b). Despite these difficulties, the effectiveness of the case manager approach relies on the appropriate control of information between the different stages of an investigation. This means that someone has to decide what information is provided, when it is provided and to whom (Dror et al., 2017).

This is a role that could only effectively be carried out by an investigator who is not engaged in the actual forensic examination of any physical evidence themselves. The case manager must maintain a detached overview in order to assimilate and analyse the evidence from all aspects of the investigation in order to decide what information to release to a specific forensic examiner. This role requires the ability to organise complex information and maintain close liaison with multiple agencies and would therefore require the person to be a trained and experienced investigator. In the case of fatal fires, the nature of the incident and the corresponding investigative frameworks mean that this

role could only effectively be carried out by the police, and only providing that sufficient investigative resources had been allocated to the incident in the initial stages.

6.3. Linear sequential unmasking

Another technique, which also involves the separation of tasks between a case manager and a forensic examiner in order to control the flow of potentially irrelevant information, is through sequential unmasking and the more recent development of linear sequential unmasking. The critical element of this approach is that the forensic examiner must first examine and document the crime scene before being exposed to the known reference material (Dror 2016; Krane et al., 2008; Mattijssen et al., 2016). A key element of sequential unmasking is that it also allows for the possibility that some degree of contextual information may be beneficial, or even essential, to the examiner's analysis. As a result, sequential unmasking enables examiners to re-evaluate and alter their initial context free judgements in light of additional task relevant information, provided that these revisions are fully documented (Kukucka et al., 2017). Sequential unmasking allows for unlimited and unrestricted changes to the evidence once the examiners are exposed to the contextual information. This feature led to calls to impose limits and restrictions on how often examiners are able to revisit and alter their findings in order to strike a balance between procedures that forbid analysts from changing their opinion and those that allow unlimited changes. The development of linear sequential unmasking therefore not only requires examiners to first examine the evidence in isolation from the

contextual information but then also places restrictions on the changes that can be made after exposure to the reference material (Dror et al., 2015; Krane et al., 2008). Linear sequential unmasking recommends that confidence levels are specified at each stage of the unmasking process, constraining the examiner's ability to continually revise forensic findings. This creates a better balance between forbidding analysts from changing their position and allowing unlimited changes (Dror et al., 2015; Koppl, 2019). In this way, it is argued that

Utilising the strategy of linear sequential unmasking would enable forensic examiners involved at each stage of the fatal fire investigation to carry out their specific examination and reach a preliminary conclusion before being exposed to potentially biasing contextual information. The initial findings could then be reviewed in the light of the additional reference material and shared between the different elements of the investigation. However, fire investigation can be considered unusual in that the fire investigator is a forensic examiner that is expected to determine whether a crime has or has not occurred (Bieber, 2012). The difficulty of obtaining physical evidence from some arson scenes means that the fire scene examination may not provide definitive proof of a crime even if a fire has been started deliberately. Linear sequential unmasking, like the case manager approach, relies on having an experienced investigator managing the investigation and controlling the flow of information to the forensic examiners. This role cannot be carried out by the fire scene examiner without the risk of introducing bias into the whole

investigative process. Once again, this highlights the importance of having the right resources in place from the very beginning of the investigation.

7. Conclusion

The article has highlighted how each stage within an investigation of a fire death, namely the fire investigation itself, the sudden death investigation that follows, and the pathological examination, all come with their specific, but related problems. As such, investigations are multi-agency as well as multidisciplinary, and the uncontrolled sharing of information between disciplines results in a process that has inherent problems and creates conditions with the potential for bias to occur.

All forensic investigations are potentially vulnerable to cognitive bias and contextual information is a common cause for creating such bias. The complementary nature of fatal fire investigations and the difficulties that investigators face in finding conclusive proof of the nature of the victim's death can leave these investigations more susceptible to bias. If the investigative process allows too much contextual information to be provided to forensic practitioners then errors in decision-making may follow. This is something that needs to be addressed for the process of investigating fatal fires to be more accurate, and less prone to flawed decision-making. It is therefore important that forensic examiners rely solely on task-relevant contextual information when carrying out a scientific analysis and they should not be exposed to information which is not necessary for drawing conclusions about the proposition in question.

This can be achieved through the adoption of either the case manager approach or linear sequential unmasking. Both approaches involve managing the flow of contextual information to the forensic examiners and analysts, so that it is filtered through when need be, rather than part of a background pack available from the beginning (where someone else may already have drawn conclusions). It is established within the fire investigation scientific community that multi-agency joint investigations involving close liaison and an information sharing process is essential to reach conclusions on how a fire death occurred. It is then also of paramount importance to ensure that only task-relevant contextual information is provided to forensic experts if cognitive bias and investigative cross-contamination is to be minimised. The use of these scientifically sound protocols will help fatal fire investigators reach conclusions that are valid, robust and forensically reliable.

Whilst the authors have used legislation, cases and research from the UK to illustrate the problems, it must be emphasised that these problems are not bound to a specific jurisdiction, and thus, the conclusions drawn are useful globally.

References

Arson Prevention Forum, 2014. Arson: A call to action- a state of the nation report.

<http://www.stoparsonuk.org/documents/resources/DS2014-1156ArsonReportandappendix.pdf> (accessed 25 July 2019).

Association of Chief Police Officers, 2006. Murder Investigation Manual. ACPO Centrex, Wyboston UK.

BBC, 2017. 'Pc fantasist' guilty of sex game murder and arson.

<https://www.bbc.co.uk/news/uk-england-40880239> (accessed 25 July 2019).

Bennett, G.D., 1958. The arson investigator and technical aids. *J. Crim. Law. Crim.* 49 (2), 172-177.

Bernitz, H., van Staden, P.J., Cronjé, C.M., Sutherland, R., 2014. Tongue protrusion as an indicator of vital burning. *Int. J. Legal Med.* 128 (2), 309-312.

<https://doi.org/10.1007/500414-013-0861-4>.

Bernstein, D.E., 2008. Expert witnesses, adversarial bias and the (partial) failure of the Daubert revolution. *Iowa Law Rev.* 93, 451-489.

Bieber, P., 2012. Measuring the impact of cognitive bias in fire investigation.

https://www.dropbox.com/s/dmq504ulb14jw1q/ISFI2012Proceedings_MeasuringtheImpactofCognitiveBias.pdf?dl=0 (accessed 25 July 2019).

Bohnert, M., Werner, C.R., Pollack, S., 2003. Problems associated with the diagnosis of vitality in burned bodies. *Forensic Sci. Int.* 135, 197-205.

British Association in Forensic Medicine, 2016. A response to the Hutton review of forensic pathology. <https://www.rcpath.org/uploads/assets/12205132-4c4d-4685-b639e5e7466b05b8/british-association-in-forensic-medicine-a-response-to-the-hutton-review-of-forensic-pathology.pdf> (accessed 25 July 2019).

Bryant, S., Preston, I., 2017. Focus and trends in fires and fire-related fatalities. https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/65869/focus-trends-fires-fatalities-oct17.pdf (accessed 2 March 2018).

Byard, R.W., 2017. The autopsy evaluation of “straightforward” fire deaths. *Forensic Sci. Med. Path.* <https://doi.org/10.1007/512024-017-9907-0>.

Charman, S.D., 2013. The forensic confirmation bias: A problem of evidence integration, not just evidence evaluation. *J. Appl. Res. Mem. Cogn.* 2, 56-58.

College of Policing. 2019. Practical advice: The medical investigation of suspected homicide. https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/799310/Medical_investigation_of_suspected_homicide_COP.pdf (accessed 26 July 2019).

Cook, T., Tattershall, A., 2014. Blackstone’s Senior Investigating Officer Handbook, third ed. Oxford University Press, Oxford.

Cox, P.G., 2011. A Guide to Fire Investigation. The Institute of Fire Engineers, Leicester UK.

Crown Prosecution Service, 2017. Prosecution guidance: Homicide- murder and manslaughter. <https://www.cps.gov.uk/legal-guidance/homicide-murder-and-manslaughter> (accessed 26 July 2019).

Davies, M., Mouzos, J., 2007. Fatal fires: Fire associated homicide in Australia 1990-2005. *Trends and Issues in Crime and Criminal Justice*, 340, 1-6.
<https://aic.gov.au/publications/tandi/tandi340> (accessed 26 March 2018).

DeHaan, J.D., Icové, D.J., 2014. *Kirk's Fire Investigation*: Pearson New International Edition. Pearson Education Ltd, Harlow.

Department of Communities and Local Government, 2012. Incident recording system-questions and lists. DCLG, London.

Doyle, M., 2011. Non-suspicious death (or is it?): The duties and responsibilities of the police. *J. Homicide Major Incident Investigation*, 7 (1), 45-56.

Dror, I. E., 2016. A hierarchy of expert performance. *J. Appl. Res. Mem. Cogn.* 5, 121-127.

Dror, I. E., 2017. Human expert performance in forensic decision making: Seven different sources of bias. *Aust J Forensic Sci*, 49 (5), 541-547.

Dror, I.E., Kukucka, J., Kassin, S.H., Zapf, P.A., 2018a. When expert decision making goes wrong: Consensus, bias and the role of experts and accuracy. *J. Appl. Res. Mem. Cogn.* 7, 162-163.

Dror, I.E., Kukucka, J., Kassin, S.H., Zapf, P.A., 2018b. No one is immune to contextual bias- not even forensic pathologists. *J. Appl. Res. Mem. Cogn.* 7, 316-317.

Dror, I., Morgan, R., Randao, C. Nakhaeizadeh, S., 2017. The bias snowball and the bias cascade effects: Two distinct biases that may impact forensic decision making. *J Forensic Sci.* 62 (3), 832-833. <https://doi.org/10.1111/1556-4029.13496>.

Dror, I.E., Thompson, W. C., Meissner, C. A., Kornfield, I., Krnae, D., Saks, M., Risinger, M., 2015. Context management toolbox: A linear sequential unmasking (LSU) approach for minimizing cognitive bias in forensic decision making. *J Forensic Sci.* 60(4), 1111-1112.

Drake, D. S., Block, C. R., 2003. An evaluation of arson-associated homicide in Chicago-1965-1995. Public health and criminal justice approaches to homicide research: Proceedings of the 2003 Homicide Research Working Group annual symposium, 227-241.

Edmond, G., Tangen, J. M., Searston, R. A., Dror, I. E., 2015. Contextual bias and cross-contamination in the forensic sciences: The corrosive implications for investigations, plea bargains, trials and appeals. *Law Probab Risk*, 14, 1-25.

Eyre, M., Alison, L., 2007. To decide or not to decide: Decision making and decision avoidance in critical incidents, in Carson, D., Milne, R., Pakes, F., Shalev, K., Shawyer, A. (Eds.), *Applying Psychology to Criminal Justice*. Wiley Chichester, pp. 211-232.

Fanton, L., Jdeed, K., Tilhet-Coartet, S, Malicier, D., 2006. Criminal burning. *Forensic Sci. Int.* 158, 87-89.

Federal Emergency Management Agency, 2011. Fire death rate trends: An international perspective. Topical Fire Report series. 12 (8).

<https://www.usfa.fema.gov/downloads/pdf/statistics/vl218.pdf> (accessed 27 March 2018).

Ferguson, C., Doley, R., Watt, B., Lynham, M., Payne, J., 2015. Arson-associated homicide in Australia: A five year follow up. Trends and Issues in Crime and Criminal Justice, 484, 1-11. <https://aic.gov.au/publications/tandi/tandi484> (accessed 26 March 2018).

Forensic Pathology Unit of the Home Office, 2015. A study into decision making at the initial scene of unexpected death: A report for the Forensic Science Regulator concerning the 2012 audit of forensic pathology reports.

https://www.gov.uk/government/uploads/system/uploads/attachements_data/file/484298/Report_into_the_2012_FSR_FP_Audit_Publication_copy_pdf.pdf (accessed 2 March 2018).

Forensic Science Regulator, 2014a. Legal issues in forensic pathology and tissue retention: FSR-G-203 (3). The Forensic Science Regulator, Birmingham.

Forensic Science Regulator, 2014b. Guidance: Information to be included in the “history” section of a forensic pathologists report: FSR-G-210. The Forensic Science Regulator, Birmingham.

Forensic Science Regulator, 2015a. Cognitive bias effects relevant to forensic science examinations: FSR-G-217 (1). The Forensic Science Regulator, Birmingham.

Forensic Science Regulator, 2015b. Forensic pathology specialist group: Audit of the work of forensic pathologists based in the United Kingdom 2013- Report of the fourth annual audit.

https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/484306/Audit_report_4.pdf (accessed 5 April 2018).

Grierson, J., 2017. Fantasist jailed for 39 years for murdering man during sex session.

<https://www.theguardian.com/uk-news/2017/sep/26/fantasist-jason-marshall-jailed-murdering-man-peter-fasoli-sex-session> (accessed 26 July 2019).

Haber, R.N., Haber, L., 2013. The culture of science: Bias and forensic evidence. *J. Appl. Res. Mem. Cogn.* 2, 65-67.

Harvard, J.D.J., 1960. *The Detection of Secret Homicide: A Study of the Medico-Legal System of Investigation of Sudden and Unexplained Deaths*. Macmillan, London.

Henneberg, M. L., Morling, N.R., 2018. Unconfirmed accelerants: Controversial evidence in fire investigations. *Int. J. Evidence and Proof.* 22 (1), 45-67.

Home Office, 2017a. Fire statistics definitions.

https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/679114/fire-statistics-definitions-fire-rescue-incidents.sep2017.pdf (accessed 22 February 2018).

Home Office, 2017b. Detailed analysis of fires attended by fire and rescue services, England. April 2016-March 2017. <https://www.gov.uk/government/statistics/detailed-analysis-of-fires-attended-by-fire-and-rescue-services-england-april-2016-to-march-2017> (accessed 26 July 2019).

Home Office, Forensic Science Regulator, Department of Justice, The Royal College of Pathologists, 2012. Code of practice and performance standards for forensic pathology in England, Wales and Northern Ireland.

<https://www.gov.uk/government/publications/standards-for-forensic-pathology-in-england-wales-and-northern-ireland> (accessed 26 July 2019).

Hutton, P., 2015. A review of forensic pathology in England and Wales.

https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/477013/Hutton_Review_2015__2_.pdf (accessed 26 July 2019).

Icove, D.J., DeHaan, J.D., 2004. Forensic Fire Scene Reconstruction. Prentice Hall, Upper Saddle River, NJ.

Jeanguenat, A. M., Budowle, B., Dror, I. E., 2017. Strengthening forensic DNA decision making through a better understanding of the influence of cognitive bias. *Sci Justice*, 57, 415-420.

Johnson, H.R.M., 1969. The incidences of unnatural deaths which have been presumed to be natural in coroner's autopsies. *Med. Sci. Law*. 9 (2), 102-106.

Jones, D.W., 2014. The relationship between homicide rates and forensic post mortem examinations in England and Wales. *J. Homicide Major Incident Investigation*, 9 (2), 58-72.

Kassin, S.M., Dror, I.E., Kukucka, J., 2013. The forensic confirmation bias: Problems, perspectives and proposed solutions. *J. Appl. Res. Mem. Cogn.* 2, 42-52.

Klein, G., 2008. Naturalistic decision making. *Human Factors*, 50 (3), 456-460.

Klein, G., Klinger, D., 1991. Naturalistic decision making. *Human Systems IAC Gateway 2* (1). <http://www.au.af.mil/au/awc/awcgate/decision/nat-dm.pdf> (accessed 26 July 2019).

Knight, K., Raiche, R., 2017. 'Accidental' fire in Winter Haven now considered arson; two teens arrested for murder. <https://www.abcactionnews.com/news/local-new/18-and-16-year-olds-charged-with-first-degree-murder-in-death-of-winter-haven-man> (accessed 3 Oct 2018).

Koppl, R., 2005. How to improve forensic sciences. *Eur J. Law Econ.* 20 (3), 255-286.

Koppl, R., 2019. Strategic choice in linear sequential unmasking. *Sci Justice*, 59, 166-171.

Krane, D. E., Ford, S., Gilder, J. R., Inman, K., Jamieson, A., Koppl, R., Kornfield, I. L., Risinger, D. M., Rudin, N., Taylor, M. S., Thompson, W. C., 2008. Sequential unmasking: A means of minimizing observer effects in forensic DNA interpretation. *J. Forensic Sci.* 53 (4), 1006-1007.

Kukucka, J., Kassin, S. M., Zapf, P. A., Dror, I. E., 2017. Cognitive bias and blindness: A global survey of forensic science examiners. *J. Appl. Res. Mem. Cogn.* 6 452-59.

Langenburg, G., 2017. Addressing potential observer effects in forensic science: A perspective from a forensic scientist who uses linear sequential unmasking techniques. *Aust J Forensic Sci*, 49 (5), 548-563.

Lentini, J.J., 2006. *Scientific Protocols for Fire Investigation*. Taylor and Francis, London.

Lentini, J., 2010. Areas of scientific agreement and disagreement: Field investigation, in: Faigman D.L., Saks, N.L., Sanders, J., (Eds.) *Modern Scientific Evidence: The Law and Science of Expert Testimony* vol 5 (forensics, engineering & economics). West, St Paul MN.

Lentini, J.J., 2013. *Scientific Protocols for Fire Investigation*, second ed. CRC Press, Boca Raton.

London Fire Brigade, 2017. Fire facts: Fires in greater London 1966-2016. <https://www.london-fire.gov.uk/media/2341/fires-in-london-2016-fire-facts-december-2017.pdf> (accessed 26 July 2019).

MacLean, C. L., Dror, I.E., 2016. A primer on the psychology of cognitive bias. In C.T. Robertson and A.S. Kesselheim (Eds.) *Blinding as a Solution to Bias: Strengthening Biomedical Science, Forensic Science and Law*. Academic Press, London, pp. 13-24.

Mattijssen, E. A. J. T., Kerkhoff, W., Berger, C. E. H., Dror, I. E., Stoel, R. D., 2016. Implementing context information management in forensic casework: Minimizing contextual bias in firearms examination. *Science and Justice*. 56, 113-122.

McAllister, J.L., Carpenter, D.J., Roby, R.J., Purser, D., 2014. The importance of autopsy & injury data in the investigation of fires. *Fire Technol.* 50, 1357-1377.

Metropolitan Police, 2017. Man jailed for 39 years for murder of Peter Fasoli.
<http://news.met.police.uk/news/man-jailed-for-39-years-for-murder-of-peter-fasoli-26-september-2017> (accessed 22 December 2017).

Ministry of Justice, 2014. A guide to coroner services.
https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/363879/guide-to-coroner-service.pdf (accessed 26 July 2019).

Ministry of Justice, 2015. Criminal Procedures and Investigations Act 1996 (section 23(11)): Code of Practice. <https://www.legislation.gov.uk/ukpga/1996/25/contents> (accessed 26 July 2019).

Morling, N., 2016. Arson associated stalking: A study of the links between stalking and deliberate fire setting. Unpublished Masters dissertation.

National Commission on Forensic Science, 2015. Ensuring that forensic analysis is based on task-relevant information. <https://www.justice.gov/ncfs/file/818196/download> (accessed 1 October 2018).

National Commission on Forensic Science, 2015. Views of the commission ensuring that forensic analysis is based on task-relevant information.
<https://www.justice.gov/ncfs/file/795201/download> (accessed 1 October 2018).

National Confidential Enquiry into Patient Outcome and Death, 2006. The coroner's autopsy: Do we deserve better?
<https://www.ncepod.org.uk/2006Report/Downloads/Coronial%20Autopsy%20Report%202006.pdf> (accessed 26 July 2019).

National Fire Chiefs Council. 2018. Fire investigation competency framework.
https://www.uk-afi.org/sites/default/files/field/page/nfcc_fsi_competency_guidance_document.pdf (accessed 26 July 2019).

National Fire Protection Association, 2017. NFPA 921: Guide for Fire and Explosion Investigation. NFPA, Quincy.

Ńicolíć, S., Ziković, V., 2015. Protrusion of the tongue in bodies burned after death: Two cases of arson to cover homicide. *Med. Sci. Law*, 55 (4), 300-303.

Oliver, W.R., 2017. Effect of history and context on forensic pathologist interpretation of photographs of patterned injury of the skin. *J. Forensic Sci.* 62 (6), 1500-1505.

Osborne, N. K. P., Taylor, M. C., 2018. Contextual information management: An example of independent-checking in the review of laboratory based bloodstain pattern analysis. *Science & Justice*. 58, 226-231.

Ottley, B. L., 2010. Beyond the crime laboratory: The admissibility of unconfirmed forensic evidence in arson cases. *New Engl. J. Crime Civil Confinement*, 36 (2), 263-288.

Pope, E. J., Smith, O.C., Huff, T.G., 2004. Exploding skulls and other myths about how the human body burns. *Fire Arson Investigator*, April 2004.

<https://www.burnedbone.com/downloads/ExplodingSkulls.pdf> (accessed 26 July 2019).

Prahlw, J., 2010. *Forensic Pathology for Police, Death Investigators, Attorneys and Forensic Scientists*. Humana Press, London.

Pretious, T., 2006. Fire and rescue circular 1-2006: The investigation of fires where the supposed cause is not accidental. Office of the Deputy Prime Minister, London.

Roberts, G., 2009. Vic fire death now treated as murder.

<https://www.smh.com.au/national/vic-fire-death-now-treated-as-murder-20090102-78> (accessed 16 May 2018).

Royal College of Pathologists, 2002. Guidelines on autopsy practice: Report of a working group of the Royal College of Pathologists. <http://www.ihrdni.org/314-008-1.pdf> (accessed 26 July 2019).

Saukko, P., Knight, B., 2016. *Knight's Forensic Pathology*, fourth ed. CRC Press, Boca Raton.

Skellern, C., 2015. Minimising bias in the forensic evaluation of suspicious paediatric injury. *J Forensic Leg. Med.* 34, 11-16.

Stauffer, E., Dolan, J.A., Newman, R., 2008. *Fire Debris Analysis*. Academic Press, London.

Stelfox, P., 2007. Professionalising criminal investigation, in Newburn, T., Williamson, T., Wright, A. (Eds), Handbook of Criminal Investigation. Willan, Abingdon, pp. 628-651.

Summers, H., 2017. Fantasist found guilty of murdering man during sex session. <https://www.theguardian.com/uk-news/2017/aug/09/jason-marshall-fantasist-found-guilty-murdering-man-peter-fasoli-sex-session> (accessed 26 July 2019).

Tümer, A.R., Akçan, R., Karacaoğlu, E., Balseven-Odabaşı, A., Keten, A., Kanburoğlu, C., Ünal, M., Dinç, A.H., 2012. Postmortem burning of the corpses following homicide. J. Forensic Leg. Med. 19, 223-228.

United States Fire Administration, 2017. Fire in the United States 2006-2017, 19th ed. <https://usfa.fema.gov/downloads/pdf/publications/fius19th.pdf> (accessed 27 March 2018).

Yadev, A., Alam, F., Kothan, N.S. Gahlot, R.K., 2013. A rare case of homicidal gagging concealed by fire. Medico-legal Update, 13 (2), 8- 11.