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Death Scene Investigation from the Viewpoint of Forensic Medicine Expert

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1. Introduction

Medical expertise is crucial in death investigations. It begins with body examination and evidence collection at the scene and proceeds through history, physical examination, laboratory tests, and diagnosis – in short, the broad ingredients of a doctor's treatment of a living patient. The key goal is to provide objective evidence of cause, timing, and manner of death for adjudication by the criminal justice system. Death investigation has been performed for centuries in all societies, although not always by medical professionals (Committee, 2003). The association of law and medicine dates back to the Egyptian culture as early as 3000 B.C. The English coroner system was mentioned in documentations around the 12th century B.C. (Spitz, 2006).

Although the primary goal of a death investigation is to establish the cause and manner of death, the role of the death investigation extends much further than simply answering these two questions. A common question asked is, "Why does it matter? The person is dead." While it is true that the dead cannot benefit, the value in death investigation is to benefit the living and future generations. In a culture that values life, explaining the death in a public forum (the meaning of "forensic") is crucial for many reasons. And this interest goes beyond simple curiosity (Wagner, 2009).

In homicide, suspected homicide, and other suspicious or obscure cases, the forensic medicine expert should visit the scene of the death before the body is removed. Local practice varies but any doctor claiming to be a forensic medicine expert should always make himself available to accompany the police to the locus of the death. This duty is often formalized and made part of a contract of service for those forensic medicine experts who are either full-time or substantially involved in assisting the police, in England and Wales, the 'Home Office Pathologists' are permanently on call for such visits and in many other jurisdictions, such as the medical examiner systems in the USA, and the European State and University Institutes of Forensic Medicine, there is usually a prearranged duty roster for attendance at scenes of death (Saukko & Knight, 2004). In many cases, the scene investigation is more important than the autopsy. A thorough and complete investigation commonly leads to the proper diagnosis of the cause and manner of death prior to an autopsy (Avis, 1993; Dix & Ernst, 1999).

Why go to the scene? The purpose of having the forensic medicine expert attend the death scene is severalfold. By viewing the body in the context of its surroundings, the forensic medicine expert is better able to interpret certain findings at the autopsy such as a patterned imprint across the neck from collapsing onto an open vegetable drawer in a refrigerator. The

forensic medicine expert is also able to advise the investigative agency about the nature of the death, whether to confirm a homicide by a specific means, evaluate the circumstances to be consistent with an apparent natural death, or interpret the blood loss from a deceased person as being more likely due to natural disease than to injury. This preliminary information helps the investigative agency to define its perimeter, structure its approach, organize its manpower, secure potentially important evidence, and streamline its efforts. Nonattendance at death scenes has been regarded as one of the classical mistakes in forensic pathology. Hospital pathologists performing forensic autopsies who are not trained to, or able to, attend death scenes should be provided with information on how, when, and where the body was found, by whom, and under what circumstances. In some deaths, the immediate environment does not contribute to death, such as in cases of metastatic breast carcinoma. In other cases, the environment plays a role although it does not cause the death; for example, consider a case in which a person with marked coronary atherosclerosis collapses with a dysrhythmia while shoveling snow. On the other hand, the scene description and scene photographs are critical in documenting that the physical circumstances and body posture are indicative of death due to positional asphyxia because the autopsy in these cases may yield very few findings. The most meticulous autopsy in all academia will provide only a speculative cause and manner of death in a 30-year-old man with a negative history, negative toxicology, and autopsy findings of visceral congestion. Yet at the scene, a screwdriver is next to an uncovered electrical outlet on a rain-soaked patio at the decedent's house, which is undergoing renovation. The cause and manner of death are provided by the scene (Lew & Matshes, 2005).

The examination of a death scene and subsequent collection of potential evidential material requires special skill, knowledge, aptitude, and attitude. The manner in which a death scene investigation is conducted may be a critical factor in determining the success of an investigation. The thorough examination of a death scene requires a disciplined and systematic approach to recording the various observations made and collection of potential evidential material. This must be combined with the analysis of various observations and the interrelationship of potential evidentiary material (Horswell, 2005a).

If resources are sufficient and the circumstances of death so dictate, it is ideal for a forensic medicine expert to perform a scene investigation. This is particularly relevant if the body remains at the scene of death, and has not been transported to the hospital during attempts at resuscitation; however, a scene investigation can be vitally important and provide valuable information even if the body has been transported to the hospital. If a body is pronounced dead at the scene (as opposed to after transport to the hospital), many death investigation systems require a scene investigation. Others have various protocols as to which case types absolutely require a scene investigation (whether or not the body is present at the scene). Case types that should always have a scene investigation include all confirmed or suspected homicides, suicides, accidents, child deaths, traffic-related deaths, in-custody deaths, and workplace-related deaths (Prahlow, 2010).

Death scene investigation may include a combination of the following types of incidents and examinations:

- Accidental deaths, which include a multitude of circumstances, including misadventure
- Suicidal deaths, which include a multitude of circumstances
- Homicidal deaths, which include a multitude of circumstances
- Sudden deaths, with or without suspicious circumstances
- Difficult victim identification, which includes mummification and putrefaction
- Disaster victim identification dealing with multiple casualties (Horswell, 2005a)

This chapter will focus on the steps of death scene investigation and some real cases will be analyzed.

2. Crime scene & death scene

In some "incidents," it may be readily apparent that a crime has indeed been committed and it is a "crime scene."

The *primary crime scene* is an area, place, or thing where the incident occurred or where the majority or a high concentration of physical evidence will be found, for example, where there has been a sudden suspicious death.

Secondary crime scene(s) are areas, places, or things where physical evidence relating to the incident may be found. The potential physical evidence will usually be transported away from the primary crime scene.

Some examples include: The deceased, the get-away vehicle in crimes of armed robbery, the suspect, the suspect's environment, the suspect's vehicle, the weapon used in the crime (Horswell, 2005a). This classification does not infer any priority or importance to the scene, but is simply a designation of sequence of locations (Miller, 2003).

If a deceased person is at the scene we call it the *death scene*. One of the initial and primary tasks is to determine whether a crime has been committed at the death scene.

Every death scene is a potential crime scene. It is important to carefully examine the scene for evidence or unusual circumstances that may indicate the death of the person is other than by natural causes (Moldovan, 2008).

3. Investigative tools and equipment

The forensic medicine expert should always have appropriate equipment ready to take to a scene investigation at a moment's notice. Further equipment may be carried if autopsies have to be carried out in places where good mortuary facilities are not available. Most forensic medicine experts carry a 'murder bag' in their car and though every expert has his own choice of equipment, the following is a reasonable inventory:

- Waterproof apron and rubber gloves.
- Writing implements (pens, pencils, markers).
- Disposable (paper) jumpsuits, hair covers, face shield, etc.
- Thermometer, syringes and needles, sterile swabs.
- Autopsy dissection set, including hand-saw.
- Cutting needles and twine for body closure.
- Swabs and containers for blood and body fluids.
- Formalin jars for histological samples.
- Plastic bags, envelopes, paper, spare pen and pencil.
- Printed body charts for recording external injuries.
- Hand lens, electric torch, mini-tape recorder.
- Foul-weather gear (raincoat, umbrella, etc.).
- Personal comfort supplies (insect spray, sun screen, hat, etc.).
- Camera, usually 35 mm single-lens reflex with electronic flash (with extra battery). The recent advent of compact digital cameras or digital video cameras with the facility to take still pictures has made instant reviewing possible.

The thermometer can be either a long chemical mercury type, reading from 0 to 50°C, or the more modern electronic digital variety with a probe carrying a thermocouple. The amount

of equipment varies with the facilities likely to be available. In developed countries there are likely to be good mortuary facilities available in a hospital or municipal mortuary and the police forces will have extensive scenes-of-crime expertise with photography, specimen containers and so on. In developing countries and the more remote areas of other states, the forensic medicine expert may have to be virtually self-sufficient in respect of both crime investigation and the subsequent autopsy.

In addition to medical kit, the experienced forensic medicine expert will always have appropriate clothing such as rubber boots and rain or snow-wear ready to hand for any call (Clark, 1999; Saukko & Knight, 2004).

4. Steps of death scene investigation

The deceased is the most valuable piece of potential evidence at any death scene. Hence, a systematic and thorough examination of the deceased should be undertaken at every death scene. Blood spillage or spatter should be noted and will remain after the removal of the body. Weather conditions, location, and poor lighting may mask some faint injuries and trace evidence on the body, therefore the death-scene investigator should document in writing, by sketch, and by photography all information about the body that can be gathered at the scene (Horswell, 2005b). The forensic medicine expert should focus on the physical condition of a body at a scene. Without a scene investigation, much initial, valuable body information can be lost. The following points will serve as a guide.

4.1 Pre-planning the death scene investigation

When initially notified, a forensic medicine expert should determine as much information as possible from the caller. Approximate age and gender places a subject in a certain "medical category." An attempt should be made to ascertain if there is any evidence of foul play or if any instruments are available that might have played a role in the subject's death. By gathering these data, a forensic medicine expert is able to anticipate additional information that may be needed upon arrival at a scene (Dix et al., 1999). The first rule in performing a death scene investigation is to make certain that the scene is safe and secure. Usually, this requires police involvement but in some instances, it will require other professionals, such as fire department personnel or utility workers. The second rule is to not contaminate or disturb the scene. At the very least, death investigators should wear disposable examination gloves and it is also advisable to wear shoe covers and hair nets. Occasionally, full body covering is desirable. When touching items at a scene, examination gloves should always be worn and care should be taken not to sit on furniture or lean against or brush against walls or furniture (Prahlow, 2010). The death-scene investigator must seek answers to the following questions: is trace evidence at the scene consistent with the death having occurred at this location? Does the body contain any trace evidence that is unusual for this location, for example, mud on soles of shoes, grass, or seed material embedded in or found on the clothing when the deceased was located inside a building? Is the death one that can be attributed to natural causes? Are there any external signs of violence? Is there anything amiss or out of the ordinary regarding the scene? (Horswell, 2005b).

4.2 Cooperation among investigators

A successful death investigation, involving more than one individual, requires cooperation and coordination. Any potential conflicts should be worked out (Dix et al., 1999). The opportunity to meet at the scene initiates the collegial working relationship between the

forensic medicine expert and the detective/investigator, and promotes interagency rapport as both professionals strive to solve the medical mystery of why that particular person died at that particular time, under those particular circumstances. This is not melodrama, just intellectual satisfaction for exploring an extremely important, educational, and fascinating aspect of death investigation. After all, a gunshot wound is a gunshot wound: it is the circumstances behind that gunshot wound that are frequently so compelling and always so instructive about human nature (Lew & Matshes, 2005).

4.3 Documentation of the scene

All death scenes should be secured and recorded photographically and diagrammatically. If the information to hand, backed by the postmortem, suggests that the death was due to natural causes then the scene should not be processed any further. However, if there are signs at the scene, and other information suggests that the deceased died in suspicious circumstances, and this is reinforced by signs of a struggle or anything unusual, further processing for latent impressions and trace evidence should take place (Horswell, 2005b).

The four major tasks of documentation are note taking, videography, photography, and sketching. All four are necessary and none is an adequate substitute for another. For example, notes are not substitutes for photography.

Documentation, in all its various forms, begins with the initial involvement of the investigator. The documentation never stops; it may slow down, but the need for documentation remains constant. Death scene documentation will be discussed below in the sequence it should follow at a death scene. The systematic process presented will maintain the organized nature of scientific death scene investigation.

4.3.1 Taking notes at the death scene

Effective notes as part of an investigation provide a written record of all of the crime scene activities. The notes are taken as the activities are completed to prevent possible memory loss if notes are made at a later time. Accurate crime scene note taking is crucial at side the who, what, when, why, and how, and specifically include:

- *Notification information.* Date and time, method of notification, and information received.
- *Arrival information.* Means of transportation, date and time, personnel present at the scene, and any notifications to be made.
- *Scene description.* Weather, location type and condition, major structures, identification of transient and conditional evidence (especially points of entry), containers holding evidence of recent activities (ashtrays, trash cans, etc.), clothing, furniture, and weapons present.
- *Victim description.* Position, lividity, wounds, clothing, jewelry, and identification (presence or absence).
- *Crime scene team.* Assignments to team members, walk-through information, the beginning and ending times, and the evidence-handling results (Miller, 2003).

The forensic medicine expert should observe a great deal, but do very little. He or she should note the position of the body in relation to nearby objects and establish the plan of the premises if indoors. A sketch or his own photograph is sometimes useful, and some forensic medicine experts use a Polaroid, digital or video camera for instant recording of the death scene.

Any obvious cause of death should be observed, and any blood pools or splashes noted in relation to the position of the corpse. The shape of such splashes should be observed, as

blood striking perpendicularly to a surface leaves a circular mark, whilst that landing obliquely is pear-shaped, with the sharper end towards the direction of flight. If the scene is one of apparent violence then the blood flow patterns may indicate the type of weapon and how it was used (Horswell, 2005b; Saukko & Knight, 2004). Both natural and unnatural deaths can produce abundant blood at a scene. Traumatic deaths that involve arterial or venous bleeding, such as stabbing, can produce abundant blood at the scene with spattering. Gunshot wounds can cause extensive external bleeding, but some wounds can cause minimal external bleeding and massive internal bleeding. In short, the amount of blood perceived at a scene does not indicate the severity of the trauma (Wagner, 2009).

4.3.2 Videotaping the death scene

Videotaping a death scene has become a routine documentation procedure. Its acceptance is widespread, due to the three-dimensional portrayal of the scene and increased availability of affordable equipment with user friendly features like zoom lens and compact size. Jury acceptability and expectation have also added to the recognized use of videography in death scene investigations.

Videography of the crime scene should follow the scene survey. The videotaping of death scenes is an orientation format. The operator should remain objective in recording the death scene. Videotaping of death scenes is a valuable tool that allows clear perception that is often not possible with the other documentation tasks. It is not an adequate substitute for any of the other tasks (Miller, 2003).

4.3.3 Photographing the death scene

The purpose of still photography documentation of the death scene is to provide a true and accurate pictorial record of the death scene and physical evidence present. Still photography records the initial condition of the scene. It provides investigators and others with a record that can be analyzed or examined subsequent to the scene investigation, and serves as a permanent record for legal concerns. Photography of a death scene is normally done immediately following the videography of the scene or after the preliminary scene survey. A systematic, organized method for recording the death scene and pertinent physical evidence is best achieved by proceeding from the general to specific guideline. Adherence to this guideline allows orientation of the entire death scene, orientation of the evidence within the scene, and provide; examination quality photographs of specific items of evidence that may be used for analysis away from the scene. The number of photographs that should be taken at a death scene cannot be predetermined or limited (Miller, 2003). Information such as body location and unique circumstances at the death scene may help a forensic medicine expert. It is important to keep in mind the legal implications of the photographs. Will the photographs be subpoenaed? (Dix et al., 1999). The scene and body are photographed before anything is moved or removed. Treat the body with respect. Never remove the clothing in full view of onlookers. If it is not feasible to move the body to a secure area of the scene, police officers may hold up sheets around the body, mobile panels may be used, or police vehicles may be used to block visibility from the public (Lew & Matshes, 2005).

4.3.4 Sketching the death scene

The final task in documentation of a death scene is sketching. All of the previous tasks for documentation record the death scene without regard to the size or measurement of the scene and its physical evidence. Sketching the death scene is the assignment of units of

measurement or correct perspective to the overall scene and the relevant physical evidence identified within the scene (Miller, 2003). The deceased's location relative to other objects and structures within the scene is very important. The position of the deceased is plotted: the head and groin of the deceased are good points on the body to use for plotting its position. Accurate measurements should be noted to place the items within the scene in the sketch in the same locations as they appear in the scene (Horswell, 2005b).

4.4 Identification of the deceased

Positive identification of the decedent is crucial in all death inquiries. The family should be notified. Information such as medical history, work, and social history can only be obtained after an identification is established. Care must be taken to insure that the identification is absolutely correct (Dix et al., 1999).

4.5 Examination of the body

A systematic, thorough inspection and evaluation of the decedent should be performed by a forensic medicine expert. If he/she always begins at the top of a subject's body and moves toward the feet, the possibility of missing important injuries or evidence is lessened (Dix et al., 1999). The body should be prone (face up) during the examination, if possible. Photos of the original position of the body must be taken before the body is moved. One begins with a general assessment and progresses from head to toe, pushing clothing aside but not removing it. Some find it easier to assess rigor, livor, and algor mortis initially. The purpose of the assessment of the body at the scene is to provide some insight into the nature of the case and a working cause of death (Wagner, 2009).

One of the most important questions that needs answering is: did death occur at this location? The position in which the deceased was discovered is of particular importance as it will provide an indication as to whether the deceased was moved or not before being discovered. The presence or absence of rigor mortis or stiffness of the body, whether absent, minimal, moderate, advanced or complete, will help the death-scene investigator determine if the person died at that locus in the position as found. Some death-scene investigators with relevant training and experience may feel they are in a position to evaluate rigor mortis and hypostasis. A pink-purple discoloration is usually present at the lowest point of the body. This is due to the settling of the blood by gravitation and the location and state of fixation should be noted and photographed. For example, unfixed livor blanches white when moderate pressure is applied, as opposed to fixed livor mortis, which remains the same color when pressure is applied. If livor mortis is noted on the deceased in areas not consistent with forming in the lowest parts of the body then the death-scene investigator should consider the possibility that the deceased was moved after death (Horswell, 2005b).

Victims may be found in contorted or apparently uncomfortable positions on the floor, commonly the bedroom or bathroom. Generally, the more contorted the body, the more sudden the death. The person appears to have "fallen in his tracks." However, this does not mean the decedent lying apparently comfortably in bed did not also die suddenly. Bodies found in awkward positions that compromise breathing can die of positional asphyxia. The chest wall must be able to rise and fall for respiration to occur. If one is wedged too tightly in a position, the chest wall cannot rise and fall (Wagner, 2009) (Fig. 1).

Many inexperienced investigators focus on a major injury and neglect to evaluate the rest of the individual. This can lead to important oversights such as fingernail marks, bruises, and



Fig. 1. Seventy two-year-old man had lost the key of the door of his house in his vineyard and he tried to go in from a small hole which he made on the roof. He was stuck and found dead in the hole due to positional asphyxia.

abrasions. Documentation of this inspection should be made noting the presence and absence of unusual markings or abnormalities. Descriptions of the state of rigor and livor mortis as well as the body temperature of a subject helps a forensic medicine expert to estimate the time interval since death. Environmental assessment, including temperature, heating or cooling systems, moisture, and wind conditions must be made at a death scene so that the environmental influence on a decedent can be determined. The assessment should also include the types of clothing and jewelry. This information may be needed to assist in determining the time a subject was last seen alive. Clothing should be appropriate for the weather and location found. If not, it needs to be explained. One should also determine if the clothing fits an individual. If a subject is decomposing, then clothing may appear too small due to body swelling. If the clothing is the incorrect size, one must determine why. Was the person wearing someone else's when death occurred? Or, was the decedent redressed by another person after death? Note the cleanliness of the clothing. A variance in the clothing or body cleanliness may indicate that he was handled by another individual after death (Dix et al., 1999). General uncleanness such as lack of bathing, very dirty clothes, urine -or feces- stained clothes, long and dirty nails, and poor oral hygiene may be due to alcoholism, drug abuse, or a mental disorder (Wagner, 2009). Is the clothing worn properly? Are buttons fastened and zippers closed? It is common to find opened zippers in intoxicated males or some elderly persons living alone. If the clothing is inconsistent with normal dressing techniques, consider whether a subject had a disability contributing to this behavior. Jewelry should be carefully noted and reported as to its type, style, color and body location. All jewelry must be listed, regardless of its apparent value. Obvious "missing" jewelry should also be noted, such as only one pierced earring, or no wedding ring on a married individual. Currency and credit cards should be handled as valuable items. Currency should be counted in the presence of another and credit card details noted. If an investigator decides that these items may be given to the next-of-kin at the death scene, he must be certain that the relative has the legal right to such items. No analyses should be

performed on a decedent's body at a scene, such as gunshot residue or fingerprinting, without the expressed consent of the forensic medicine expert responsible for the postmortem examination. Clothing should not be removed, a body should not be cleansed, and liquids or powders should not be placed on the deceased as these might interfere with radiographs or chemical testing. If more than one hour has elapsed since the initial body assessment and the decedent is still at the scene, a second assessment should be recorded. A thorough body visualization by a forensic medicine expert gives him/her the capability to differentiate between injuries noted at a scene and any bodily injuries sustained during conveyance to the morgue (Dix et al., 1999).

A common misconception among laypeople is that a "painful" expression on the face or a contorted position means the person suffered during the process of dying. Generally, there is no correlation between facial expressions, body positions, and suffering. Pain and suffering can be assessed before and during the dying process, but it is done carefully and generally by the forensic medicine expert after evaluating the autopsy and investigative information. This information can be useful to the family, and can become arguable in civil court cases (Wagner, 2009).

4.6 Other scene information collection

An investigator must also gather information that relates to cause and manner of death. Each type of death requires specific scene information. For instance, questions to be asked in a motor vehicle fatality would not be the same as those asked in an autoerotic asphyxia death. Since different questions need to be asked, an investigational guide for each specific type of death can be very useful. For example, it is critical in suicides resulting from a handgun that investigators determine the handedness of a subject (Dix et al., 1999). The scene should be searched for a medical history in nearly all death investigations. This search may be as simple as finding an inhaler for asthma nearby a gunshot wound victim or as complicated as going through cabinets full of medication at a residence. The deceased's physician can always be called and the hospital records will be available tomorrow, but one has only a single chance to explore the scene to find out what is really going on with the person's diseases and treatment. Many people do not take the treatments the doctor ordered and reject advice given at the hospital. Only interviewing witnesses and searching the scene will reveal this information (Wagner, 2009).

4.7 Determining what information has already been developed

Prior to a forensic medicine expert's arrival, law enforcement officers, paramedics, and other support personnel probably have communicated with individuals or witnesses at the scene. A forensic medicine expert needs to know this initial information so that he can compare it with the decedent's body data and determine if there are any discrepancies. It is better to ask the question twice and get the same answer, than to accept as fact information that has been checked by one source. A forensic medicine expert needs to determine, for instance, if the body data (rigor, livor, temperature, clothing, injuries, etc.) are different from the witness information (Dix et al., 1999).

4.8 Collecting evidences which may be found at the death scene

Forensic medicine experts and law enforcement agents work cooperatively in a team effort. Although the medical expert has jurisdiction over the body, law enforcement has jurisdiction over the entire scene. The forensic medicine expert is invited to the scene and, as

a guest, must comply with house rules. In Britain, for example, several teams converge on a scene of crime, including photographers and video operators, and Scene of Crime Officers (SOCOs) whose function is to collect trace evidence. Scientists from the nearest forensic laboratory often attend with their police liaison officers, as well as fingerprint officers and, of course, the investigating officers from the Criminal Investigation Department. The lead detective will walk the forensic medicine expert through the scene, relaying information and pointing out salient features. The forensic medicine expert should realize that the area within the perimeter of the scene is one giant piece of evidence, and restrict his or her physical contact to the body and items immediately touching the body (Lew & Matshes, 2005; Saukko & Knight, 2004).

Where no such backup is available, the forensic medicine expert must try to collect trace evidence himself, but he should remain within the limits of his own expertise. The forensic medicine expert should accept the instructions of police officers in relation to the approach to the body so as to preserve the immediate environment as much as possible. Out-of-doors access is often limited to a single pathway marked by tapes, and in a building a track to the corpse is usually pointed out by the detective in charge. The doctor should not touch anything unnecessarily and certainly not smoke or leave any object or debris of his or her own. Increasingly, those visiting the scene of a crime are given disposable overalls and overshoes to wear, so that fibers, hairs and so on from the visitor are not spuriously transferred to the scene (Saukko & Knight, 2004). The Locard Exchange Principle states that whenever two objects come into contact, a mutual exchange of matter will take place between them. Linking suspects to victims is the most important and common type of linkage accomplished by physical evidence in criminal investigations. Linking victims and suspects to objects and scenes can also be accomplished by use of the physical evidence (Miller, 2003) (Fig. 2).



Fig. 2. The 18-year-old murderer killed his employer in his workplace as he did not pay his salary. On the death scene investigation, a horror mask (on the top) and footprints of sports shoes of the murderer (on the bottom) were found. These evidences were used to determine the murderer.

After surveying the overall death scene, it should be easy to recognize the sequence in which evidence is to be collected and areas to be searched and in what order. The collection and search should be systematic, ensuring absolutely nothing is overlooked.

Priority in collection should be given to:

- any items that are in danger of being removed or destroyed by wind, rain, vehicles, animals, tides, and the movement of individuals at the scene
- the collection of any evidence which will enable access to the deceased or any critical area of the death scene, such as along entry and exit paths
- those critical areas of the crime scene which may render the most evidence, or once processed, enable the removal of a body, or the remainder of the examination to be carried out
- areas which may give a quick indication as to the identity of any suspect(s)
- areas which when processed will permit the release of scene guards and other resources
- the general examination of the remainder of the death scene for potential evidence.

In establishing the manner and sequence of collecting potential evidence by death scene investigators, consideration must be given to the possible destruction of evidence and which approach will yield the best result in terms of useful information (Horswell, 2005b).

Clues about the cause and manner of a death and who committed a crime may be found at a scene. The following list includes different types of evidence and how they are usually collected and preserved.

Blood - Dried particles should be scraped into a dry container. Some dried areas may be sampled with a wet swab. A specimen should be dried before sealing it in a container. Articles of clothing or other objects containing blood may be submitted to a laboratory for sample removal by a technician.

Semen - An article of clothing containing semen should be collected or the specimen on the clothing can be lifted with water or saline.

Fingerprints - Soft objects that leave an impression may be collected in their entirety. Prints on hard objects like glass or furniture should be lifted at the scene.

Firearms and other weapons - These should be submitted to a lab without special treatment at a scene. A technician must ensure proper handling so that fingerprints are not smudged or ruined.

Bullets and cartridges - These should not be grasped with metal forceps because points of comparison may be damaged.

Hairs and fibers - These should be placed in separate containers and should not be crushed with hard objects such as metal tweezers.

Suspicious foods and pills - Each item should be placed in separate containers or bags to prevent contamination.

Footprints and tire marks - At the scene, casts should be made and close-up photographs should be taken.

Tool marks - There should be close-up photographs of the marks made by tools and, if possible, the damaged material should be removed for analysis by a lab technician.

Blood spatters - These should be photographed and described for analysis as to distance and angle of spatter. Samples may be removed for testing and preservation.

Other - Glass, soil, documents, cigarette butts, tobacco, and all items thought to be involved in arson should be collected and submitted to a lab.

Each item submitted to a lab should be referenced by either a photograph or written description as to its location in the scene. All containers with items submitted to the lab

must be labeled on the lid and side of the container, with a case number, date, time, type of specimen, and name of the person who collected the specimen. A "chain of custody" begins at this point and continues until a disposition of the specimen is completed (Dix et al., 1999). Methods of searching critical areas include grids that are larger in less critical areas and smaller in critical areas, or searching in a clockwise or counterclockwise direction from a fixed point, or conducting a line strip search. All these form part of conducting a professional systematic search of a death scene. A systematic approach to the searching of death scenes reduces stress and fatigue and ensures a more comprehensive search and recovery operation, minimizing the chance of losing potentially valuable evidentiary material (Horswell, 2005b). Any weapon or other item possibly related to the death and found at a scene should be brought to the morgue for analysis by a forensic medicine expert. Often, substances are the causative agent in the death. All medication and alcoholic beverage containers should be confiscated as these will be invaluable to the toxicologists. Note the location where each item was found. Studies have shown that a fatal intoxicant is likely to be found in the same location as a decedent. Any drug paraphernalia, notes, or any unusual item that might have been used by the subject should be confiscated (Dix et al., 1999).

4.9 Interviewing persons regarding the death

Interviews should include basic information such as the subject's identification, clothing, time, date, state of health, date and time the body was discovered, and medical, employment, and social history. Any recent events that may have a bearing on the death are also important. A death investigator should always ask if a decedent had recently been involved in any potential harmful situations. This information may be extremely helpful if later attempts are made to make a prior incident a contributing factor in the death. If suicide is suspected, it is preferable to interview family members and close friends as soon as possible after the death is discovered. This may preclude guilt-related, subconscious, erroneous statements made by loved ones several days later (Dix et al., 1999).

4.10 Estimating the post-mortem interval at the scene

The general warmth or coolness of the hands and face can be assessed by touch, and the degree of rigor mortis felt by gently testing the limbs. The ambient (environmental) temperature must be taken as soon as possible after the discovery of the body, preferably by police scene of crime officers who usually arrive at the locus before the forensic medicine expert. The ambient temperature should be taken as near to the body as possible, as microenvironments can exist, even inside buildings or rooms. Information should be sought as to how much disturbance of the ambient temperature might have occurred, such as opening doors and windows, or turning fires or central heating on or off, so that some idea of post-discovery distortions of temperature can be estimated later. The insertion of a thermometer into the rectum at this stage in the investigation, as advocated by some textbooks, is controversial.

At a scene of death, this usually means either pulling down trousers or pants, and otherwise disturbing clothing, often in cramped and ill-lit places, frequently out in the open. It also risks contaminating the rectum and perineum, by introducing seminal fluid from the anal margin into the rectum, making subsequent examination of that area (and taking swabs for semen) of reduced value. As so many violent crimes now have sexual or homosexual overtones, the practice of taking rectal temperatures at the scene should be performed only

if the forensic scientists or police scene of crime officers are satisfied that trace evidence from the clothing, swabs from the vulva, vagina and anus, etc., can be obtained satisfactorily before rectal thermometry is performed.

In other words, a cost-benefit analysis must be made at the scene, to decide if the difficulties of taking a rectal temperature are worth the small potential advantage of an earlier measurement. In many cases, where the body has obviously been there long enough for the core temperature to have reached ambient - or where other circumstantial evidence has indicated that the time of death is known to a greater degree of accuracy that can be hoped for by thermometry - then nothing is lost by postponing the procedure until the body arrives at the mortuary for autopsy, which, in British practice, is usually directly after the body is moved from the scene.

If the autopsy is to be delayed for many hours owing to difficulties with transport or lack of facilities, then much more must be done at the scene and temperature measurements are justified.

An alternative is to use a place other than the rectum. The axilla and mouth give low readings, which cannot reliably be correlated with the deep temperature because of variable exposure to the air temperature. More useful is the auditory meatus or nostril, the thermometer or thermocouple probe being inserted as deeply as possible. Reliable, reproducible readings can be obtained from these sites, which have the great advantage of being easily accessible without moving clothing, as well as not being required for swabbing to investigate possible sexual assaults (Saukko & Knight, 2004).

Using scene markers to determine when an individual died, though unscientific, is often more accurate than determinations made by scientific means. This is especially true in badly decomposed bodies. Scene markers include:

- Uncollected mail or newspapers.
- Whether the lights are on or off.
- A TV schedule opened to a time and date.
- How the individual is dressed.
- Any food that is out or dirty dishes in the sink.
- Sales receipts or dated slips of paper in the deceased's pockets.
- When the neighbors last saw the individual or observed a change in his habits. Thus, if he typically went for a walk every evening and suddenly is no longer seen, then one might conclude that death occurred on or about the day he failed to take his walk (DiMaio & DiMaio, 2001). Different clues from a scene also must not be overlooked: Was food being prepared? Was a major appliance on? Were there indicators as to a decedent's activities just prior to or at the time of death? A forensic medicine expert may use the answers to such questions to arrive at an estimation of the time of death (Dix et al., 1999).

4.11 Ending the death scene investigation

When the forensic medicine expert has made the best examination possible in the circumstances, his next function is to ensure that the corpse is removed to the mortuary for autopsy with the least disturbance and loss of evidence. He should supervise the removal himself or at least delegate the duty to another person whom he knows is careful and competent. Each hand should be enclosed in a bag, secured at the wrist by adhesive tape or string. A similar bag should be placed over the head. The packaging medium may vary, but generally paper bags are recommended.

The body should be placed gently in a 'body-bag', which has a zip closure, or moved on to a large, new plastic sheet, at least 2 metres square. If a sheet is used, the edges should be wrapped over the body and secured with adhesive tape. The object of the exercise is to retain any loose objects, hairs and fibres that may be adhering to the body or the clothing. The sheet or bag is taken by the forensic laboratory after the body is removed in the mortuary so that they may screen it for trace evidence. The transport of the body is the responsibility of the police or other agency such as the coroner or his officer. The body in its plastic wrapping should be placed in a rigid fibreglass 'shell' or ordinary coffin, and taken by hearse, van or police transport to the chosen mortuary.

Physical damage during the removal should be avoided as much as possible, though in difficult or inaccessible sites this is easier said than done. In fires, the body may be seriously damaged before or during recovery, sometimes because its presence is not suspected in the smoke-filled, often waterlogged, debris of a conflagration. Handling brittle, charred, bodies can easily cause the splits at joints that may mimic ante-mortem injuries.

In summary, the function of a forensic medicine expert at any scene of suspicious death is to observe the situation, to conserve any fragile evidence, to supervise the removal of the body and offer an opinion, based on experience, about the nature of death where this can reasonably be done. He is not there to act as a latter-day Sherlock Holmes, voicing unsubstantiated theories on non-medical matters, nor attempting to overinterpret the situation from the flimsiest of facts. The forensic medicine expert is part of a team of specialists, all experts in their own field, and it is as a member of such a cooperative, coordinated group that his best contributions can be made (Saukko & Knight, 2004).

5. Homicide

In the community, the most serious crime is that of the intentional killing of one person by another and it is therefore necessary that each of these events be thoroughly investigated by a team of specialists (Horswell, 2005b).

Death scenes may be indoors or outdoors. The death may have occurred at the scene or the body may have been "dumped." The death scene may be untouched since the crime was committed or it may have been contaminated by the untrained or the unwary. The murderer may have intentionally altered the scene in an effort to mislead investigators or make a statement, usually a defiant one. A crime scene altered in this manner is said to have been staged.

The forensic medicine expert's focus is mainly on the body. What is the position of the body? What clothes are on the body and are they intact, dirty, torn, or rearranged? If there is blood, is it spattered or pooled? Detailed photographs of the body and the surroundings are critical. What is the temperature of the body? What is the ambient temperature? What injuries are visible? What is the state of rigor mortis? Are there any signs of a struggle? Does anyone know the identity, or presumptive identity, of this person? If there are bullet wounds, the forensic medicine expert determines where the entrance wound or wounds are. If there are exit wounds, the forensic medicine expert notes the presence of bullet holes in the walls or other objects to help determine the position of the victim when the shots were fired. Here, the expertise of the ballistics or firearm expert is crucial (Adelman, 2007).

Homicide victims need to be examined front and back to determine the nature and extent of injuries. For example, once the nature of the injuries is confirmed (gunshot wounds with no casings on the scene), the police will be able to focus their efforts on finding a shooter with a

revolver, as opposed to searching for an assailant with another type of weapon such as an ice pick. Once the extent of injuries is seen, the forensic medicine expert will know how many radiographs are required. A beating death will alert the team that a struggle may have ensued, and scalp hair and fingernail scrapings/clippings are required, in addition to a blood standard obtained during the autopsy. Whenever sexual assault/battery is a possibility, specimens for a sexual battery kit must be obtained from the deceased victim prior to cleaning the body. Bodies with patterned injuries from an object or weapon still at the scene should be photographed with the object close to, but not touching, the injured part of the body. The patterned injury and the object should be photographed separately with a scale. A weapon may be brought to the autopsy for comparison with the wounds only after the weapon has been processed for trace evidence, DNA, and fingerprints to prevent allegations of contamination at the autopsy (Rogers, 2004; Lew & Matshes, 2005).

It is always advantageous for the forensic medicine expert to visit the death scene of a possible homicide. By visiting the scene and actually seeing the position of the body and the pattern of injuries to the deceased and the arrangement of objects in the surrounding areas, the forensic medicine expert can put the pieces of the puzzle together and attempt to reconstruct the circumstances that led to the event (Fig. 3). The autopsy becomes a major item in the solution of this puzzle (Adelman, 2007).



Fig. 3. The murderer sometimes binds the victim's hands and mouth before killing the victim. 65-year-old man was found dead in his bed, his hands and mouth were bound. The cause of death was strangulation and blunt head trauma.

Always be professional—remember that onlookers, including the decedent's family, and news media may be at the perimeter of the scene, so do not say or do anything that would reflect poorly on yourself and the organization you represent. Trash (discarded gloves, etc.) should be placed in bags designated for investigators' refuse, and not in the garbage cans that are part of the scene because in actuality, they are evidence. Never remove items from a scene for souvenirs (Rogers, 2004; Lew & Matshes, 2005).

In any given case of suspected homicide, it is self-evident that the forensic medicine expert who performs the autopsy should visit the death scene because all injuries must be examined within the context of the event. There are still far too many cases where this does not occur, thus making it impossible to carry out an exact reconstruction of the sequence of events in later stages of the criminal investigation. In numerous cases, however, the initial

situation is inadvertently changed by police forces or rescue teams that first arrive at the crime scene. As a result, the initial scene is often not sufficiently documented, and changes may lead to misinterpretation in the future analyzing process (Schröer & Püschel, 2006). Don't forget: The victim himself or herself is the most important crime scene (Trestrail, 2007) (Fig. 4) .



Fig. 4. The murderer killed his 36-year-old brother by strangulation and blunt head trauma. The victim was found on the floor in prone position near his bed. The belt buckle of the killer was found inside the hand of the victim (arrows) and this belt buckle helped in identifying the killer. Strangulations should be presumed to be homicidal unless proved otherwise. In order to determine the origin of ligature strangulation, it is necessary to perform a detailed investigation of death scene and examine the type of ligature on the neck of the victim carefully (McMaster et al., 2001; Verma & Lal, 2006).

In some murders, after killing the victim, the murderer uses a very sharp cutting weapon (a saw, axe, etc.) to sever the limbs and cut the body into small pieces. The operation is generally carried out immediately after the crime, although more rarely a long time may pass between the two events. Dismemberment of the corpse allows the murderer to clear the scene of the crime to delay investigations until the body is found. It also makes it easier to transport the body even for long distances, during times of day when possible witnesses could be about, without raising suspicion (Di Nunno et al., 2006). In a case which authors visited the death scene, a 57-year-old woman's corpse was found between the bed and wardrobe in her house in a prone position. The victim's severed head, right arm and both hands were found in a cardboard box near the bed. After death scene investigation and autopsy the murderer was determined as her 33-year-old schizophrenic daughter (Dogan et al., 2010a) (Fig. 5) .



Fig. 5. The 57-year-old woman was found between bed and wardrobe. Her severed head, right arm and both hands were in a cardboard box. On the right, bloody sports suits of the assailant in the washing machine.



Fig. 6. A homicide victim found in a well (on the left) and a victim who was burned (on the right, note the unburned parts of the clothes which are useful for identification).

Sometimes the assailants, after killing the victims, try to hide their crimes by disposing the corpses by burying, by burning, by throwing them into water or wells, or concealing them in distant places (Figs. 6-8). Corpses found in wells or lime pits must be identified, and the cause and manner of death must be determined. There are several circumstances that may lead to the presence of corpses in wells. People may accidentally fall in wells where safety

measures have not been taken. Other people may use wells for the purpose of committing suicide. Also, the victims of a homicide may be thrown into a well for concealment. A murdered victim may be thrown into a well to prevent the body from being found. In the cases of homicide, the wells chosen to dispose of the body are often distant from the victim's district and close to the killer's district. Wells can provide a means for concealing a corpse and that the corpse can sometimes only be found upon a confession by the killer (Dogan et al., 2010c).



Fig. 7. A buried homicide victim in a desolate land.



Fig. 8. The victim was killed by blunt head trauma first, then 20 kg iron (arrows) was bound to his legs and thrown into a lake.

Homicide-suicide (HS) events are defined by a perpetrator killing one or more victims before killing him or herself. The term “dyadic death” has also been used for these incidents, because deaths often involve a pair of persons (Milroy et al., 1997). In most of the HS cases, the perpetrator knows the victim (Dogan et al., 2010e) (Fig. 9).



Fig. 9. Death scene of a homicide-suicide. Twenty two-year-old man killed his 16-year-old lover (illegitimate relationship), then killed himself with his handgun. The man was married with another woman. Note the handgun between victims.

5.1 Homicide by poisoning

Our ability to detect poisons has greatly improved over the last 100 years, but our ability to suspect poisoning in the first place has not improved, and may have actually gotten worse. Some things that might come up in an investigation that should send up a red flag are as follows:

- The death occurred in a normally healthy individual. Certainly a person can die without warning, but when this type of death occurs, a deeper look into the cause is called for, including an autopsy.
- An individual interfered with the victim receiving proper medical attention. This may lead one to wonder if that person does not want educated eyes and minds delving into the possible cause of the condition in question.
- There is no sign of violence to the body. This is always an indication that the death could have been the result of a poisoning misadventure.
- The affliction appeared as a natural disease yet failed to respond to normal treatment methods.

- An illness reoccurred in cycles; that is, the victim became ill at home, went to a medical facility and seemed to recover, then went home and became ill again, and so on. This would indicate that there is something in the home environment that is proving unhealthy for the individual. Could it be the chronic administration of heavy metals (e.g., arsenic) in the person's meals? There certainly have been recorded criminal cases in which this has happened, and the poisoner is often not caught in the initial stages of the homicide attempt.
- There are common mysterious symptoms in a common group of people. This could indicate that there has been a mass tampering, or that the supposed specific target was a off the mark of the poisoner.
- There is an individual who is anxious to dispose of food, drink, or medicine of which the victim partook. In this case, it is clear that the person is attempting to foil the investigation by destroying critical evidence.
- An individual prevented friends or relations from being sent for during the victim's illness. The criminal investigator should question what that person did not want others to witness.
- There is an insistence on no autopsy. The criminal investigator should clearly state that one will take place. Once again, the desire not to have educated minds look at the problem comes to the forefront.
- There is an insistence on a rapid cremation. This could be construed as an attempt to burn the primary evidence of the crime and foil the investigation. The criminal investigator should clearly state that an investigation must take place before cremation can proceed.
- While grieving over the loss of a close family member or friend, a certain individual does not freely begin to offer an explanation for the cause of death. Neither will the person attempt to guide the investigation in any way. If the person does, it could very well be an attempt to divert investigators' attention from his or her crime, and investigators must be aware of this.
- An individual shows a familiarity with poisons and possesses literature about poisons. In this case, not just a red flag should go up, but a whole sky full of mental fireworks (Trestrail, 2007).

It has been stated that poisoning is the least used method of homicide, accounting for only 3–6% of known homicide cases (Adelson, 1974, as cited in Trestrail, 2007). Because of the complexity of poisoning homicide, it is one of the most difficult homicides to prove.

Regarding the death scene, with poisoning multiple locations may have come into play during the planning and execution of the murder. Each location can yield important clues that must be included in the complete case investigation. Some of the locations and the items to look for to yield clues are as follows:

- Where the victim was *found* (vomited material, clothes containing poison residue).
- Where the poison was *administered* (medicine bottles, food/beverage containers).
- Where the poison was *disposed* of (storage areas, trash containers, sink traps, vacuum cleaner bags).
- Where the poison was *prepared* (tools with poison residues, utensils, clothes, containers).
- Where the poison was *procured* (stolen items, receipts of purchase, signature on a poison register, computer files) (Trestrail, 2007).

6. Suicide

The finding of suicide as a manner of death may impact families differently. Suicide carries a stigma on the family name in many cultures. Consequently, objections are often raised by survivors when suicide is documented on the death certificate. Additionally, the finding of suicide can influence the payment of life insurance policies, as most exclude suicide within the first two years after issuance of the policy in order to prevent profit from an individual's death (Moldovan, 2008).



Fig. 10. Thirty seven-year-old woman hanged herself in her house. There was a farewell letter on the floor.



Fig. 11. Two items found at a suicide death scene. The packing of a rodenticide and the last SMS message in the victim's phone which was sent to his friend containing a suicide note.

An experienced death investigator would recognize several ingredients in the scene. A plastic bag, a large rubber band used to hold the bag in place, and drugs or alcohol are often present in suicide scenes. In his book *Final Exit*, Derek Humphry described in detail how a person can take their own life using the equipment and procedure described here (Humphry, 1991, as cited in Moldovan, 2008). Moldovan (2008) had observed this death scene frequently in the many suicide scenes he investigated. He often found the book *Final*

Exit near the body, indicating that the decedent used it as a reference for the final act of self destruction.



Fig. 12. Seventy eight-year-old woman hanged (partial) herself in the garden of her house.



Fig. 13. The father hanged himself to the same place where his daughter hanged herself (as he loved his daughter so much, he couldn't stand up to the pain). There were farewell letters in both of their clothes' pockets.

Hanging is one of the most preferred methods for suicide, but homicidal hangings were also reported (Vieira et al., 1988; Sauvageau, 2009). So it is important to visit a death scene in

hanging deaths. To determine the cause of death in hanging cases, while the corpse is still at the death scene and in the suspended position, a detailed investigation should be performed by a team including a forensic medicine expert. Further evidence from the death scene investigation, statements from witnesses, the presence of a suicide note, and autopsy findings can all help to determine whether the victim was responsible for his or her own death (Figs. 10-16).



Fig. 14. The hand of the suicide victim is still gripping the handgun (cadaveric spasm).



Fig. 15. The death scene of a 13-year-old boy's suicide. The shotgun is in front of the victim, and the entry wound is under the chin. According to the witnesses, after he argued with his father in the garden of his father's office, he had ran into the office of his father and took his father's shotgun and killed himself.

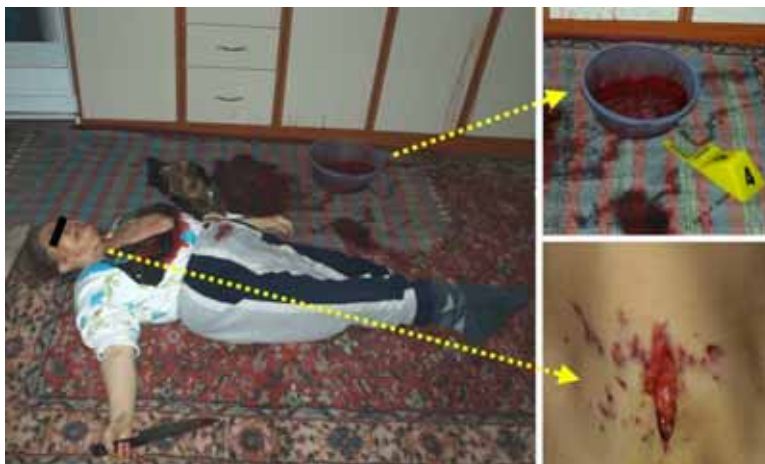


Fig. 16. The death scene of a 75-year-old woman who stabbed herself in the neck. There is a basin which she collected her blood (right top) and there are hesitation wounds on the neck (right bottom). She had psychiatric problems.

The tying together of the wrists in hanging cases is rare, but may not indicate a homicide, so long as the hanging ligature could not have been self-applied. At first glance, a hanging body found with their hands tied together would give the impression of a homicide but some suicidal people try to avoid being rescued by others or themselves. The closing of the mouth with a plastic bag or a scarf was thought to have removed the possibility of calling out for help during the hanging. Both the tying together of the hands and closing of the mouth were regarded as precautions taken by the victims to prevent any change in mind and an indication of their resolve to go through with the suicide (Fig. 17). In addition, placing soft material against the ligature loop was thought to be an attempt to lessen the feeling of pain (Demirci et al., 2009a) (Fig. 18).



Fig. 17. Fifty two-year-old man who hanged himself. Both hands were tied limply behind his back with clothesline and a plastic bag was tied around the mouth.



Fig. 18. A soft piece of cloth against the ligature.

In some cultures, religious books and findings indicating praying before suicide may be found at death scene. Demirci et al. (2008a) reported that in investigating medicolegal death cases believed to be of suicidal origin, evidence showing that this action was committed by the victim, the presence of a suicide note at the death scene, and a history of a previous suicidal attempt, the presence of daily axillary and pubic shaving on the external examination of the victim's body, when of the Muslim faith, may also be considered a feature of suicide (Fig. 19).



Fig. 19. A death scene of a 42-year-old woman's suicide. There was a razor and cut axillary hair in the sink of the bathroom (arrows on right up). Also a prayer rug, pictures of herself, her husband and two daughters, and her ring were on the carpet of the room (right down).



Fig. 20. Forty one-year-old man went to the woodland with his motorcycle (arrow) and hanged himself on a tree. A suicide note about his familial problems was found in his pocket.



Fig. 21. The corpse of a 70-year-old woman who threw herself into the well in the garden of her house. A farewell letter was found in her house.

Suicidal acts carried out in places open to public can be highly traumatic for witnesses (Owens et al., 2009; Reisch & Michel, 2005; Tranah & Farmer, 1994). Moreover, they are considered more newsworthy than those occurring at home, and media reporting may encourage further

suicides (Michel et al., 1995; Pirkis et al., 2007). It was suggested that nearly a third of all suicides occur in public places (Owens et al., 2009). The association of bridges and high buildings with suicide by jumping is well-known, but many other public places offer means or opportunity for suicide. Hanging, car exhaust poisoning and burning involve elaborate preparations and require seclusion. For these deaths, woods and isolated rural car parks provide the perfect opportunity (King & Frost, 2005) (Fig. 20). Wells are a preferred locality for suicides, which is the one reason why individuals may jump into a well, regardless of whether there is water or not. A suicide by drowning, although seen in all age groups, seems to be a preferred method for the elderly individuals (Dogan et al., 2010c) (Fig. 21).

7. Accident

An accidental death scene investigation launches after someone is dead in an automobile or other such accident. The investigation evaluates evidence, usually immediately, as to how the accident occurred. These are some types of accident scenes:

Auto Accident - An auto accident scene investigation may include an accident reconstruction if liability is in dispute. An investigator diagrams and photographs the auto accident scene and evaluates several factors, including points of impact to the vehicles, skid marks, roadway conditions and witness statements.

Fire - The investigator photographs, diagrams and examines the scene. The person who first discovered the fire and the participating fire personnel are interviewed. Physical evidence may be collected for further examination. A report may be drafted about the investigator's conclusions.

Slip and Fall - If a patron slips and falls, the slip and fall accident scene investigation usually begins with one of the employees of the establishment. What kind of fall occurred? Was there a defect in the ground or flooring? Was there a hazardous condition? How long were these conditions exposed? Photographs of the scene may be taken, and available witnesses, including the store employee or manager, are interviewed.

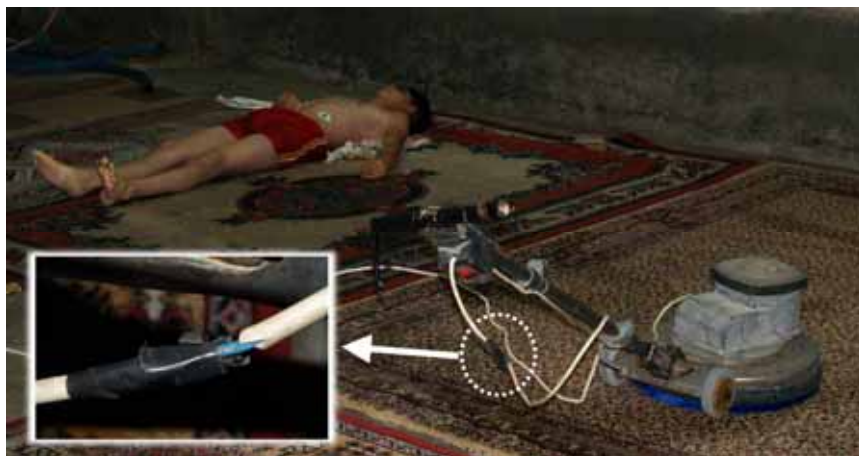


Fig. 22. A 17-year-old worker was dead due to electric shock in his workplace. The scene investigation revealed electrical leakage from the defect of the plastic sheath of the cable of carpet washing machine.

It is sometimes difficult to determine the manner and cause of death, if a detailed death scene investigation is not performed. In a case reported by Demirci et al. (2008b), a 30-year-old man's death was due to throat-cutting. They reported that although the cut in the neck initially suggested homicide, it was found to have occurred as a result of an accident in his workplace after the death scene investigation and autopsy. This case emphasizes the importance of the examination of incident scene and autopsy in determining the origin. Similar cases are deaths due to electric shock. The forensic medicine expert should visit the death scene before the autopsy if it is possible (Fig. 22).

Carbon monoxide (CO) is a colorless and odorless gas, and is lighter than air. It is an incomplete combustion product of hydrocarbons. About 600 accidental deaths due to CO poisoning are reported every year in the United States. CO usually causes accidental deaths, because it is pure and odorless (Thom & Keim, 1989; Cobb & Etzel, 1991; Saukko & Knight, 2004) (Figs. 23,24).



Fig. 23. A family (father, mother and child) was found dead in their bed due to carbon monoxide poisoning. There was a coal stove in the room and soot traces (arrows) were observed at the entry point of the stovepipe on the wall which indicating leakage of smoke of the stove.

Carbon monoxide can affect drivers of a moving vehicle, usually owing to a defective exhaust system that allows gas to percolate through the floor or engine bulkhead into the interior. Rarely, a strong following wind can blow the external exhaust-gas through the open doors of a van or truck. Another cause is a leak in the heat exchanger in vehicles that use a direct air supply from around the exhaust manifold to provide passenger heating (Saukko & Knight, 2004). In motor vehicles in which persons must remain for a long period of time while the vehicle is parked, for example, trucks with sleeping cabs, road service vehicles and mail trucks, a separate heater (working independently of the engine of the vehicle) may be used to heat the vehicle. The engine of the apparatus works with diesel fuel

or gasoline. Combustion products burning in the pre-combustion chamber heat the fins of the engine. The air passing through the fins is heated and is transferred into the cabin. Malfunction of such an apparatus may be the cause of CO poisoning or fire. So the supplementary heater in the truck might be the cause of fatal CO poisoning and of the fires in the cabins of the trucks (Demirci et al., 2009c) (Fig. 25).



Fig. 24. A 42-year-old man was found dead due to carbon monoxide poisoning in his bathroom. There was an LPG water heater which had not a smoke pipe in the bathroom.



Fig. 25. A 48-year old male truck driver (ellipse) was found dead due to a fire in a truck parked in an open area of the truck garage. Scene investigation revealed that the cause of fire was broken supplementary heater (arrows) in the truck.

Decapitation may be suicidal, homicidal, and accidental. Accidental decapitations can result from traffic accidents, or occupational accidents. Decapitation by industrial trauma can occur at any age, and is often associated with heavy machinery in workshops or farm equipment being towed behind a tractor (Sharma et al., 1995). The helix elevator is an appliance connected to a tractor. It is used for loading grains from a field to any vehicle, such as a trailer, for transportation. In a case Demirci et al. (2009b) reported, the victim was a 41-year-old male farmer. In the stackyard, a helix elevator machine was loading a trailer with barley while the victim was distributing the loaded barley with a shovel in the trailer. He had tied a scarf loosely over his face and neck because he was allergic to the barley dust. When the victim's head and neck were level with the turning helix elevator shaft, the scarf

was pulled up and wrapped around the shaft. The scarf then slid around the victim's neck and tightened, causing the head to separate from the body (Fig. 26).



Fig. 26. A 41-year-old male farmer was found decapitated in the stackyard. He was working with a helix elevator machine. He had scarf tied loosely over his face and neck but the scarf was pulled up and wrapped around the shaft of the machine. The scarf then slid around the victim's neck and tightened, causing the head to separate from the body.

Possession of firearms is limited because of the technological requirements in production and strict laws. However, anyone can manufacture a handmade firearm by following some simple instructions and these actions do not carry any legal liability. A mole gun is an unusual weapon used to kill moles in agricultural areas. Mole guns are primitive weapons produced for the purpose of trapping and are capable of firing a standard shotgun cartridge. Injuries and deaths caused by mole guns are generally a result of an accident while the victim is setting or controlling the gun (Demirci et al., 2008c) (Fig. 27).



Fig. 27. A 42-year-old man was injured on the right thigh region while he was setting a mole gun to kill moles which were damaging the vegetables in his field, and died shortly after at the incident scene. The mole gun was found at the scene.

In some cases, it is important to distinguish accidental manner from suicidal or homicidal ones. For example, if a ligature mark is present on the neck, this is usually suicide or homicide. But sometimes the death may be accidental origin. In a case reported by Dogan et al. (2010d), a 53-year-old woman who had been working in the laundry of a hospital sat on the counter of the ironing machine to heat her back and leaned her back closer to the machine in a cold winter day. At that point, her coworkers left the room. When they re-entered the room 15 min later, they found her dead and observed that her scarf was caught in the roller cylinder of the ironing machine (Fig. 28).



Fig. 28. The chief physician of the hospital showing the victim who was found strangulated with her scarf by the roller cylinder of the ironing machine in the laundry of the hospital. On the right side the ligature mark is seen on the neck.

Children have an increased risk for injury or death from accidents for a variety of reasons compared to adults. Perhaps the greatest reason is their natural curiosity, which leads them to explore their environment and investigate situations where they often do not recognize potential hazards (Byard, 1996). Accidental asphyxia can occur in childhood as a result of a variety situations (Dogan et al., 2010b) (Fig. 29).



Fig. 29. The one-year-old child's neck was entangled in a tight cable of the electric heater while he was crawling on the floor of the living room.

Farm accidents are a frequent occurrence in many countries; for example, in the United States, farming is rated second only to mining in terms of occupational danger (Rivara,

1985). Unguarded agricultural power take-off (PTO) drivelines and the related components, including secondary drivelines powered by the PTO, have been historically recognized as serious farm-related hazards that can cause severe, permanently disabling injuries and death when entanglement occurs (Beer & Field, 2005). PTOs are rapidly rotating shafts that transfer power from the tractor attached at one end to a piece of farm machinery at the other end. Clothing or body parts can become entangled, resulting in amputation or avulsion of body parts, strangulation, and massive crushing injuries (Karlson & Noren, 1979) (Fig. 30). Dogan et al. (2010f) reported that 5.8% of the farm tractor-related fatalities involved deaths resulting from PTO entanglement. In these cases, there were extensive crush injuries to the chest, abdomen, and extremities. None of the turning shafts in these cases had safety shields.



Fig. 30. Fatality involving power take-off (water pump) entanglement.

8. Natural deaths

An important portion of the deaths investigated by forensic medicine experts involve natural diseases, the most common being cardiovascular disease. Natural diseases processes alter the way the body reacts to and repairs from injuries. The older the person, the more likely that natural disease has a role in the death (Figs. 31,32). This concept can work in reverse. One can erroneously assume that because the person is young, natural disease is not a factor in the death. Many people have unknown or undiagnosed natural diseases that manifest in sudden, unexpected death. A common history in these cases is that “he hadn’t seen a doctor in years” or “he didn’t believe in doctors.” The result is that the first doctor he sees is the forensic medicine expert, who diagnoses what was a treatable natural disease such as a cardiovascular disease. “Sudden death” is a term used frequently in death investigation but its meaning can be ambiguous. In some situations, death can literally be *instantaneous*, such as with a massive pulmonary embolus. In others, such as a myocardial infarction, the death can be instantaneous, or take minutes to hours or longer. Sudden cardiac death is a sudden, unexpected death from cardiac causes within one hour of onset of symptoms (Wagner, 2009). Investigating natural deaths might not be very exciting to some but can be interesting and rewarding. For example, Wagner (2009) reported that he found an aortic aneurysm in a 14-year-old girl who died suddenly while running. Knowing this condition to be genetic, a study of 12 family members showed the same abnormality in three, thus saving those individuals the same fate as their relative.



Fig. 31. Seventy six-year-old woman who had been living alone was found dead in her home in sitting position and holding a glass in her hand. Note the livor mortis on face, hands and left foot due to the position of the deceased.

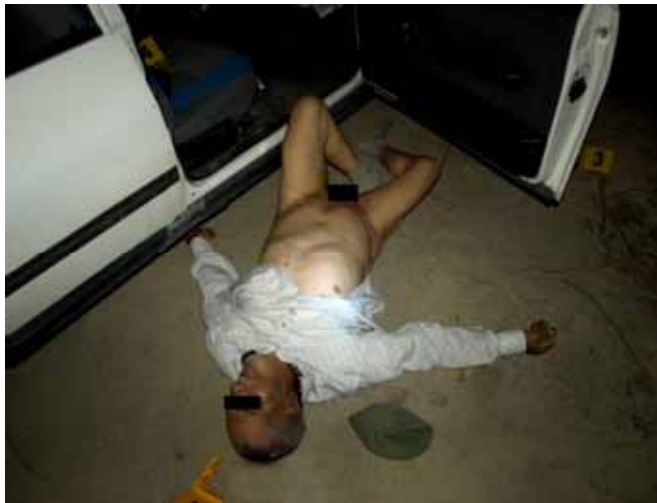


Fig. 32. A 74-year-old man was found dead in half-naked position lying alongside his car. The investigation revealed that when the man and a young woman were having sex, the man suddenly deteriorated and died. The cause of death was determined as myocardial infarction at the autopsy.

9. Sudden and unexplained infant death

Sudden unexplained infant death (SUID) is the sudden and unexpected death of an infant due to natural or unnatural causes. SUID applies to the death of an infant less than 1 year of

age, in which investigation, autopsy, medical history review, and appropriate laboratory testing fails to identify a specific cause of death. Sudden infant death syndrome (SIDS) is one of several causes of SUID. However, SIDS, unlike the other SUID causes, is a diagnosis of exclusion. Even with a thorough death scene investigation, review of the clinical history, and autopsy, SIDS is difficult to distinguish from other SUIDs, such as accidental suffocation and asphyxia. In the world of death investigation, infant death investigation is unique. From scene through certification, these investigations require skill and knowledge drawn from disciplines outside those typically considered a part of medicolegal education (Corey et al., 2007; Hanzlick, 2001; Shapiro-Mendoza, 2006). The post mortem examination, ideally should include a history of the gestation, delivery and postnatal development, a death scene investigation, a family psycho-social history, a complete autopsy, and a confidential case conference (Bajanowski et al., 2007).

Having knowledge about the many causes of SUID, in addition to SIDS, is of utmost importance for the death scene investigator. At the scene, the investigator will gather evidence as well as information from the parents or caregivers who were with the infant and who may be in a great deal of distress. All of this information is crucial for distinguishing between a natural death, an accidental death, or a homicide.

The following is a brief overview of known causes of infant death that are oftentimes overlooked during investigation, resulting in the cause of death being listed as SIDS on the death certificate.

Asphyxia or suffocation is caused by the inability to breathe. This condition leads to a lack of oxygen in the body, which can lead to loss of consciousness and death. Asphyxia can be caused by choking, constriction of the chest or abdomen, strangulation, narrowing of airway passages (severe allergic reaction or reactive airway disorders), or the inhalation of toxic gases. Common objects that are involved with asphyxia or suffocation include plastic bags, soft pillows, and soft materials such as bedding or stuffed animals. These objects can occlude the mouth and nostrils, causing suffocation. The most commonly reported cause of asphyxia in infants is accidental suffocation and strangulation in bed.

If the investigator is very observant, knows what to look for, and is particularly careful in talking with the caregiver, he/she may pick up some clues that will help determine the specific cause of asphyxia or suffocation and determine whether the manner of death was accidental or intentionally inflicted. A thorough death scene investigation can help answer questions about environmental factors that may have interfered with breathing (e.g., covering of the nose and mouth) or hazards related to aspiration, choking, electrocution, excessive heat or cold, and other external factors.

There are a number of risk factors associated with asphyxia and suffocation. The following is a list of the typical causes of infant asphyxia and/or suffocation.

- Overlaying or accidental suffocation on a shared sleep surface.
- Accidental strangulation from unsafe surroundings.
- Wedging or entrapment.
- Immersion in water or drowning.
- Choking.
- Neck compression (Shapiro-Mendoza, 2006).

Accidental asphyxia can occur in younger children and infants, who may move into positions in which their airways become occluded, their bodies become wedged so that they are unable to breathe, or they become suspended from their clothing or restraining

harnesses (Gilbert-Barness et al., 1991; Nixon et al., 1995; Byard, 1996). Many houses in Turkey (especially those situated in the villages and slums) are built with metal rings mounted in the ceilings, so that the occupants can set up swing-like cradles, which are hammock-like in nature. The cradles are constructed by tying two ropes between the two metal rings and connecting them with cloth. Infants are placed in these cradles on top of cushions, and ligatures (e.g., scarf, rope, or sash) are tied around the cradles to prevent them from falling out. However, the ligature can wrap around the neck and asphyxiate the infant if it leans out of the cradle (Dogan et al., 2010b) (Fig. 33).



Fig. 33. The position of dead infant in the swing-like cradle. As the victim leaned out of the cradle, the ligature that was tied around the swing-like cradle wrapped around the child's neck, resulting in asphyxia.

There are a number of risk factors associated with the infant's environment that may be connected with the death. The following is a list of causes typically associated with the environment or death scene.

- Poisoning or intoxication.
- Electrocution.
- Hypothermia.
- Hyperthermia.

Inborn errors of metabolism are rare genetic disorders that stop or prevent the body from turning food into energy. These disorders are usually caused by defects in the enzymes that help break down foods in the body. When the body cannot process these foods, a buildup of toxic substances or a deficiency of substances needed for normal body function can occur. This buildup can be fatal if not controlled with diet or medication. Some metabolic diseases are inherited.

Injuries can be fatal or nonfatal, and they can occur unintentionally or intentionally (because of purposeful acts of harm). It is often difficult to determine whether an infant's injury was a result of an unintentional or intentional act. Examples of unintentional injuries include the infant choking on a small toy or rolling over in bed onto the infant.

Shaken baby syndrome (SBS) is one form of abusive head trauma that occurs when an infant or young child is violently shaken or struck against a hard or soft surface. Shaking may cause bleeding over a large portion of the brain. SBS can cause severe brain damage as well

as death. In cases where a child receives a head injury from a fall or other impact, there may be external signs of injury, such as bruising or abrasions on the scalp. In SBS, there may be no signs of injury on the infant (Shapiro-Mendoza, 2006).

9.1 SUID scene investigation

The physical environment of the death scene may play an important role in the cause and manner of the infant's death. Some research has indicated that the change of seasons, which requires turning on or off heating or cooling devices (furnace, fireplace, air conditioner, ceiling fan), might precipitate an apneic event. Therefore, it is important to determine, describe, and document the specific environmental conditions of the scene such as room temperature and other factors that may affect the microenvironment of the infant at the time of death (e.g., air current from ceiling fan, humidity levels in a spa, water temperature in a hot tub).

The forensic medicine expert should personally inspect the death scene to gain a thorough understanding of the possible environmental hazards to which the infant might have been exposed. He or she should observe and document the furnishings in the room/area where the infant was found dead or unresponsive. In addition, the investigator should describe the general state of the room/area; if there is evidence of rodent, insect, or animal activity or a generally unkempt situation, this should be documented as accurately and objectively as possible. The scene should be documented with photographs, diagrams, and descriptions.

Fumes that are noticed at the scene might have contributed to or been the cause of the infant's death and should be noted in the investigative report. A description of the fumes might provide forensic scientists with clues that will assist them in ordering laboratory tests. The investigator should describe the fumes and their intensity and attempt to ascertain the source of the fumes. If necessary, local fire department personnel should be contacted to ensure that the scene's air is clear of harmful substances.

The smell of smoke may indicate a live-fire situation or tobacco use at the scene. Smoke might have contributed to or been the cause of the infant's death. A description of the smoke smell may provide forensic scientists with clues that will assist them in ordering laboratory tests. The investigator should describe the smoke smell, its intensity, and its possible sources.

Mold growth at the scene may have exposed the infant to dangerous airborne pathogens. A description and location of mold growth may provide forensic scientists with clues that will assist them in ordering laboratory tests. The investigator should describe the mold growth and its location in relation to the infant's sleeping/activity area. Photographs of any suspicious material should be taken at this time.

The observance and documentation of peeling paint at the scene may indicate an infant's exposure to dangerous lead-based materials. A description of the room and the location and size of the peeling paint area can provide forensic scientists with clues that will assist them in ordering appropriate laboratory tests. The location and size of the peeling paint and its location in relation to the infant's sleeping/activity area should be described as accurately as possible. The investigator should contact the local health department if the problem presents safety concerns to persons in the vicinity (Ernst et al., 2006).

10. Conclusion

The forensic medicine expert should visit the death scene before the autopsy if it is possible. Although, investigation and legal systems differs from country to country, there is always a

crime scene investigation team. If the forensic medicine expert does not have the opportunity to visit the death scene him/herself, he/she would check the documents (notes, sketches, photographs, etc) which crime scene investigation team prepared. Many medicolegal deaths may be resolved by death scene investigation. A forensic medicine expert should never forget: If the death scene investigation is not performed before the autopsy, that autopsy will be an imperfect autopsy.

11. References

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