The Methodological Issues of the C.S.I Effect and it's Controversial Impact on Criminal Investigation

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Abstract:

With the rising success of crime-scene related television shows in recent years, and forensic science as a new hot topic in multiple settings, the world of criminal justice faces new complications as this phenomenon continues to grow. This is popularly known as "The *C.S.I Effect*." Contrary to belief, much of what the public perceives, or think they know about the operations of law enforcement and the legal system, comes from television. Consequently, as these television programs appeal to greater audiences around the world, increasingly unreasonable expectations are established in the forensic world, both inside and out of the courtroom.

In light of this issue, research has discussed the many television shows that have greatly influenced the public perception such as *C.S.I, Dexter* and *Sherlock*, and provides a myriad of examples, describing the inconsistencies and flaws that these shows are able to portray in the span of a 40-minute program time slot. With each example, the correct methods, linguistics and techniques that are used in real-world investigations will be explained and the efficiency they provide to criminal cases. Throughout this research, the extension of the C.S.I Effect will be discussed, as well as its impact on a student's decision in choosing a major in Forensic Science- are they truly satisfied with their choice or disappointed by the reality? Comparative analysis of the C.S.I Effect in the courtroom will be presented, as well as the controversy behind such a theory, will also be discussed at length. The goal of this research is to determine any empirical evidence behind the commonly-held belief that juror expectations for forensic evidence are linked to watching law-related television shows and if there can or cannot be anything to fix this detrimental issue.

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I. *Introduction:*

It is no secret that almost every American has watched at least one heinously-fictional, yet intensely intriguing, crime-scene television show in their lifetime. In each 60-minute episode, a skilled team of investigators solve criminal cases by scouring crime scenes, collecting and matching DNA samples they find with those available in their extensive databases. The term, "*The C.S.I Effect,*" also known as "C.S.I Syndrome," has been coined in reference to the existing phenomenon surrounding these shows, and is regularly used as an umbrella term for several hypotheses concerning its rising popularity with television shows about criminal investigations and its impact on the public perception of forensic science (Chin & Workewych, 2016). Most notably, this hypothetical theory has affected the court systems with a plethora of misconceptions, skewing jurors' sense of familiarity with forensic evidence from the impossibly high standards that these shows perpetuate.

In a recent Baltimore homicide trial, jurors acquitted the defendant due to a lack of forensic DNA evidence, despite the testimony of two eyewitnesses (Houck, 2006). According to DNA specialist, Dan Krane, said about shows such as CSI, "viewers never see a case where the sample is degraded, or the lab work is faulty, or the test results don't solve the crime. These things happen in the real world all the time" (Willing, 2004*).* Many cases have faced this obstacle and have joined the long list of others impinged by the C.S.I Effect, courtesy of crime-saturated television.

Because of these shows, the public's perception has been affected, both positively and negatively. On the positive side, an increasing quantity of individuals have entered the field, supplying more attention to the world of forensic science. On the contrary, important aspects of forensic investigation are shown as absolutes. Although crime-related programs are based solely on entertainment purposes, the timeline of analysis is not consistently true, and both technique and technology are not scientifically valid.

II. What is the C.S.I Effect?

A magazine article in *Times (*2002) wrote in reference to the wildly popular show *C.S.I: Crime Scene Investigation* explaining a "cultural phenomenon" that has almost certainly had a diverse impact, affecting "the expectations placed on practitioners and inspiring youths to consider a career in crime scene investigation," (Chin & Workewych, 2016). The term "*C.S.I Effect*" has been used to describe such a phenomenon, in which familiarity with fictional television programs has altered the way jurors view forensic evidence in criminal trials. It is often widely known for its significant impact that has weighed upon public perception and its unrealistic expectation of forensic testing, causing issues for the entirety of the criminal justice system.

Studies have shown both counsel and other actors in the criminal justice system have committed to extra hours on the job, as well as having completed unnecessary tasks of collecting evidence in order to support this phenomenon and overcome any bias surrounding it. When such bias exists in the courtroom – as many cases have shown – decisions are made based on incorrect preconceptions created from these television shows, rather reliant solely on the facts of the case. With the influence of outside information and an impartial jury, the probability of convicting an innocent person and releasing a guilty offender, increases.

Posited in the early 2000s, the "C.S.I Effect" became a recognized theory once *"C.S.I: Crime Scene Investigation*" and shows alike became popular. The C.S.I Effect was first suggested in Maricopa County, Arizona by District Attorney Andrew Thomas (Podlas, 2017). Thomas believed that the current "epidemic of wrongful acquittals" was the result of the newly-introduced television program, *CSI*, which had grown quite popular as of recent (Podlas, 2017). He stated that since forensic testing was publicized on *CSI*, it had created an unreasonable expectation in jurors that the discovery of physical forensic evidence outweighs any circumstantial, interrogative evidence (Podlas, 2017). Consequently, if the prosecution does not introduce such evidence—even if it is irrelevant or unavailable, —jurors will refuse to convict, warranting a wrongful acquittal.

Convinced that the crime show was the main cause to this "thwart of justice," Thomas complained to *CBS*, asking it to run a disclaimer after every episode to inform the public that their perceptions were not to be influenced by viewing (Podlas, 2017). Soon, the media took an interest in the newly founded theory, producing more than fifty newspaper and magazine articles by 2005, and almost 80 by 2006 (Podlas, 2017). Together, the "perfect storm" of *CSI* and the prolific surge of media coverage, introduced the C.S.I Effect into today's reality (Podlas, 2017).

While enjoyable to watch, such shows that depict a glorified crime-scene experience provide unrealistic expectations to be met by forensic testing, and therefore, perpetuate numerous myths that have unjustifiably affected acquittals and convictions. For instance, DNA can be deemed as infallible evidence and is often highly emphasized on television. In reference to television, it is often easily found at a scene and analyzed within a few hours, rather than the actual receiving time of a few weeks (Alldredge, 2015). For many jurors who have been heavily influenced by the C.S.I Effect, DNA is considered the gold standard of evidence, and when it is not present, questions arise (Bell, 2014). While witness statements and suspect interviews may have been presented, jurors are persuaded by television's misconception that forensic evidence disproves the non-scientific, interactive evidence.

During the high-profiled case of Casey Anthony, prosecutors tried to persuade the jury by establishing Anthony's motive and opportunity (Call et al., 2013). However, with the lack of forensic evidence presented, and the defendant's DNA not present on the duct tape which was presumably used to suffocate her two-year-old daughter, the prosecution could not obtain sufficient evidence to convince jurors that Anthony was guilty (Call et al., 2013). Therefore, this case was built on circumstantial evidence in which there was no forensic proof directly linking Casey Anthony to her daughter's death, resulting in her ultimate acquittal (Call et al., 2013). It is difficult to understand what led jurors to the decision to acquit, although there is a strong speculation that the C.S.I Effect was a factor.

It has been supposed that the C.S.I Effect shares a close resemblance to the *Cultivation Theory,* which "argues that heavy television viewing influences peoples' perceptions…," in that "a television viewer gleans conceptions about the world from television viewing and applies these to their social reality," (Hayes-Smith & Levett, 2011). George Gerbner and Larry Gross conducted an experiment to understand the theory, surveying adults in the late 1970's. The survey suggested that adults who were heavily influenced by television - in comparison to a lighter influence - were more likely to give television's portrayal of the answer, rather than the factual answer (Hayes-Smith & Levett, 2011).

From a cultivation perspective, the C.S.I Effect has been heavily researched with a specific focus on the issues that lie in the field of criminal justice. In a 1985 study, a survey of adolescents found a correlation with heavy crime show viewers and a lower level of understanding in legal matters (Hayes-Smith & Levett, 2011). However, even with the many years of research and analysis for the Cultivation Theory, a limited amount of published research support is yet to exist for the C.S.I Effect - leading to a difficult understanding in studying the implications this phenomenon may have.

Television and Film Depictions:

Whether you favor the cerebral forensic experience of *C.S.I* and *N.C.I.S,* contemporary sleuthing depicted in *Sherlock*, or the lovable serial killer and sinister Robin-Hood thematic styled show that is *Dexter*, it is evident that forensic science lies at the very core of these dominating entertainment programs. The show opens with a single task and a team of detectives - dressed to the highest degree – evaluating the crime scene. Returning from a commercial break, the team has processed the lifted fingerprints and blood stains, and are able to locate the correct suspect to elicit a definitive confession - all within the span of a 60 minute time slot. While the public is captivated with the fantasy of television, experts can agree that it is unlike anything to expect with the true reality of the job.

III. *Proper Protective Equipment/Cross Contamination*

N.C.I.S, Season 12, Episode 4, "Choke Hold;" the crime scene unit team gathers outside at a scene located inside an EMS vehicle. A technician inside of the truck is seen taking photographs of the deceased body. He wipes his brow and proceeds to pick up evidence found in the vehicle, possibly a wire garrote, and examines it in his hands. The photography technician continues to handle the evidence, dangling it near his face and begins to converse with the other members of his team. All personnel present on the scene, both outside and inside the vehicle, are wearing basic work attire – baseball-type hats and blazers. A private discussion ensues between two members who stand outside of the vehicle, conversing about the importance of wearing gloves and "rain gear" type equipment to a scene with so much blood (Wired, 2018).

Background

"One of the most important aspects of securing the crime scene is to preserve the scene with minimal contamination and disturbance of physical evidence. The initial response to an incident shall be expeditious and methodical," (Baldwin & Puskarich May, 2017). As small as a computer, or as large as a plane crash, a crime scene can contain valuable information for later investigation. Forensic specialists work together to ensure that "nothing of importance escapes scrutiny," (Baldwin & Puskarich May, 2017). Without methodically protecting, searching and documenting the scene, investigations can be fatally compromised before they have even really begun (Baldwin & Puskarich May, 2017). In general, the greater the number of personnel inside a scene, the more likely it is that the scene and/or evidence will be at risk for contamination (Baldwin & Puskarich May, 2017). Scene personnel can deposit hairs, fibers or trace material from their clothing or destroy latent footwear or fingerprints (Baldwin & Puskarich May, 2017). Footwear patterns can also be deposited by crime scene personnel or anybody entering the scene, therefore it is extremely important that all unnecessary personnel remain outside and away from the scene.

Required personal protective equipment, commonly referred to as PPE, consists of a mask or face shield, a jumpsuit, gloves, booties and a head cover (Baldwin & Puskarich May, 2017). Adequate protection starts with a full-body disposable protective apparel: beginning at the head/face – covering both ears – and extends to the ankles (Baldwin & Puskarich May, 2017). It is vital for all of these items to be disposable (Baldwin & Puskarich May, 2017). Then comes a pair of gloves; these should be taped at the wrist for extra safety (Baldwin & Puskarich May, 2017). The gloves should then be followed by multiple layers of gloves to ensure even more protection (Baldwin & Puskarich May, 2017). For face masks and/or goggles; these need to cover the eyes, nose and mouth, with filters to keep the air clean and odor free (Baldwin & Puskarich May, 2017). Also, protective shoe covers, or booties, should be worn over shoes to keep them clean and free contaminants (Baldwin & Puskarich May, 2017). This required protective gear is usually worn as a biohazard exposure precaution as well as for the purpose of reducing contamination risk (Baldwin & Puskarich May, 2017). However, the use of PPE is also effective in reducing contamination potential and subsequently, increasing the investigative value of biological evidence which may be subjected to forensic analysis (Bell, 2014). As the interpretation and validity of forensic DNA analysis has expanded over time, the reduction of possible contamination at crime scenes has become ever more significant (Baldwin & Puskarich May, 2017). In current years, analysis of fluids and bodily cells can now include or exclude potential suspects using a very small or highly degraded amount, with relatively high confidence (Bell, 2014). Because of the rising furor that surrounds an investigation today in the public eye, the scene of the crime itself often tends to be forgotten (Baldwin & Puskarich May, 2017). Crime scenes are a major source of infections, thus choosing the correct personal protective equipment is vital (Baldwin & Puskarich May, 2017). When a person expires, any and all infections they may have had are retained in their remains (Baldwin & Puskarich May, 2017). As a result, crime scenes are often permeated with biohazards including diseases such as HIV and Hepatitis (Baldwin & Puskarich May, 2017).

Ultimately, the issue that evidence can be easily contaminated remains at large, regardless of the precautions taken. The tiniest smudge on a window pane can be proven useful to an investigation, and if cross-contamination occurs, the result of analysis could be inconclusive at best (Baldwin & Puskarich May, 2017). Evidence that can be overlooked or soiled by investigators may be irretrievably lost or inadmissible in court (Baldwin & Puskarich May, 2017).

Even environmental conditions can be a cause of evidence contamination (Baldwin & Puskarich May, 2017). The interpretation behind contamination perceives a clouded idea regarding the risks to both the forensic evidence and the analyst himself (Baldwin & Puskarich May, 2017). Little is known about these risks and television shows such as *N.C.I.S* illustrate this concept poorly for the point of entertainment and enthrallment. Often depicted in a televised portrayal of a crime scene, a technician may handle a piece of crucial evidence without even wearing a pair of gloves. This evidence is then shown to be easily admissible in court and convicts a suspect in the matter of a sixty minute segment.

Forensic Errors

While the members of the investigation team in *N.C.I.S* discuss the importance of wearing gloves at a scene, especially in the presence of blood, not one of them can be seen dressed in the proper protective gear. The photography technician wipes his forehead and proceeds to handle evidence in the truck, while he continues to talk to the other members about the case at hand (Wired, 2018). In addition, he holds a garrote after touching his brow, without changing his gloves (Wired, 2018). Any time a person or persons enter a crime scene, not only is there potential to leave trace evidence behind, but also to take evidence away from the scene that could be crucial to the case.

In the clip of this episode, the technician has taken his DNA from his camera, and his brow and placed it onto evidence found at the scene. He then proceeds to have an entire conversation with his fellow team members while holding the wire directly adjacent to his face, allowing any of his DNA to further contaminate this piece of evidence that could potentially convict their suspect (Wired, 2018). Everyone who has entered the scene, especially the technician, should be wearing the proper protection gear to avoid the potential risk of contamination in order to secure its use in a court of law.

IV. Collection/Retrieval of Evidence at a Crime Scene

Luther, Season 1, Episode 3, Detective Chief Inspector Luther discovers the whereabouts of a satanic occult killer and is able to track him down. As Luther narrows in and follows the killer down an alleyway, he puts a pair of latex gloves on. Once in close proximity, Luther abruptly punches him in the face, knocking him to the ground. Luther wipes the blood dripping from the killer's nose, removes the glove and wraps the glove up in his hand and flees the scene, with the idea that he now has confidently retrieved a DNA sample that can be matched (Wired, 2019).

Background

The term "forensic evidence" compasses two distinct ideas and processes. The *forensic* aspect of the term refers to the scientific processes through which facts are generated (Bell, 2014). The area of forensic science encompasses a discrete number of well-known disciplines and their methodologies that are inclusive of, but not limited to: hairs, fibers, fingerprints and bloodstain examination. The *evidence* part of the term refers to a distinct set of procedures that are unique to the litigation process and legal measures that serve as the basis for the decision to admit or exclude evidence (Bell, 2014). Given that forensic and other types of evidence are used to reconstruct events of a prosecuted crime, the importance of admissibility is held in high regard in a court of criminal law (Bell, 2014).

Forensic scientists are responsible for generating data, reports and opinions based on fact that can all be used as evidence, yet only if the court allows such evidence to be admitted. A central conception regarding the admissibility of trial information lies in the prerequisite of a solid supporting foundation for any offer of evidence, especially in instances involving scientifically-generated data (Bell, 2014). This information must be presented to a judge and deemed acceptable, with the potential to be seen by a jury as valid and true. Evidence that meets this criteria is considered admissible, and can be presented in court with the notion that it is reliable and relevant to the case at hand (Bell, 2014). Bell (2014) suggests, the intent of admissible proceedings is to prevent the introduction of results obtained using "poor science," or the admission of evidence that has no bearing on the presented case. The standards that courts use to determine admissibility varies amongst jurisdictions, however, such standards all rely on a similar approach for reliability and relevance. The general premise of *Frye v. United States* (1923) states that an expert opinion or testing method is admissible if it is "generally accepted" as reliable in the scientific community (Bell, 2014).

However, in an era of incredible scientific advancement, the Frye standard held little to no weight with such limitations, and was seen as strict with a lack of flexibility. The year 1993 brought about the legal case of *Daubert* v. *Merrell Dow Pharmaceuticals,* which served as a landmark case regarding admissibility following the skepticism surrounding the Frye standard (Bell, 2014). Essentially under Daubert, the trial judge is responsible for determining if scientific evidence is useful and relevant and that the testing method rests on a reasonable scientific foundation (Bell, 2014).

Unlike Frye, Daubert is a flexible standard. Because the judge plays the role of "gatekeeper" under the Daubert standard, the court can revisit admissibility, rather than a single finding and admittance by the scientific community (Bell, 2014). Today, the Frye Standard has been sifted out of most jurisdictions nationwide, however, it is still being used in certain places across the country (Bell, 2014). The Daubert standard remains advantageous as it is still commonly used in the federal court system, superior to its former with its flexibility and broadened approach.

When evidence is obtained illegally, it is unable to be used in court. This is due to the Exclusionary Rule, which mandates that evidence seized in violation of the United States Constitution – or a product of unlawful police activity - is not admissible in court (Wex Definitions Team, 2017). Evidence subject to suppression as a result of the Fourth (search and seizure), Fifth (self-incrimination), or Sixth (right to assistance of counsel) Amendment violations include not only what was seized or discovered in the course of the unlawful conduct, but anything that was subsequently obtained as a product of the illegal action (Wex Definitions Team, 2017). The case of *Mapp v. Ohio (1961)* established the landmark decision of the Exclusionary Rule, in which the Supreme Court ruled that evidence gained from an unreasonable search or seizure was in violation of the Fourth Amendment (Wex Definitions Team, 2017). In addition, the decision in *Miranda v. Arizona (1966)* established that the Exclusionary Rule also applies to improperly elicited self-incriminatory statements gathered, violating the Fifth and Sixth Amendment (Wex Definitions Team, 2017).

The purpose of the Exclusionary Rule is to deter law enforcement from conducting unlawful searches or seizures and to provide a solution to defendants whose rights have been infringed (Wex Definitions Team, 2017). Over time, the courts have expanded upon this rule to incorporate evidence that has been illegally obtained and derived from evidence that has been found inadmissible. The doctrine of the "Fruit of the Poisonous Tree" suggests the metaphorical idea, if the evidential "tree" is tainted, so is its "fruit," (Wex Definitions Team, 2020). Like the Exclusionary Rule, this doctrine is subject to exceptions, including; if evidence was discovered from a source independent of illegal activity, its discovery was inevitable, or if there is attenuation between the illegal activity and the discovery of the evidence (Wex Definitions Team, 2020).

Further, the most prominent exception to both the Exclusionary Rule and the Fruit of the Poisonous Tree Doctrine is the Good-Faith Exception (Wex Definitions Team, 2017). If officers could prove they had only reasonable and ethical intentions, and were acting according to legal authority, such as relying on a search warrant that is later found to have been legally defective – then the illegally-seized evidence is found admissible under this rule.

Forensic Errors

In an effort to obtain evidence from his suspect, Detective Luther follows him down an empty alleyway and abruptly punches his suspect in the face, in which he proceeds to bleed from his nose. This act is certainly illegal, thus making his evidence retrieval invalid and inadmissible in a court of law. This conclusion can be made from an analysis of the "Fruit of the Poisonous Tree" doctrine, in which the "tree" is the suspect, and the DNA/blood evidence that Luther obtains is the metaphorical "fruit," (Wired, 2019).

Because of his illegal actions, the evidence is not able to be presented in court to convict the suspect. Proper evidence retrieval should have involved legal means of consent to collect DNA evidence, an abandonment sample from the suspect's garbage disposal bins, or a court order (Wired, 2019). It is important to follow protocol in the collection of evidence because a case could be lost due to improper means of collection in an illegal manner.

V. *Trajectory Analysis*

The Wire, Season 1, Episode 4, "Old Cases," Leading detectives Jimmy McNulty and Bunk Moreland visit the crime scene of a woman who was gunned down in her apartment. The clip presented shows the two perusing the scene, ultimately trying to determine the trajectory of the gunshot from the window onto the target. McNulty removes his loaded pistol and aims it towards his chest, studying the angle at which he believes the bullet entered his victim. Upon detection of the inferred trajectory line and the entrance hole located in the window, the detectives are able to determine that the bullet must have exited the victim's body, resulting in its discovery in the adjacent wall. The ostensible detective then proceeds to use a pair of pliers to recover the bullet to collect for evidence (Wired, 2018).

<u>Background</u>

Primarily, firearms are carried in circles amongst criminals as status symbols in order to induce fear and indicate a deadly threat (Platt, 2003). When a gun is loaded and fired, a wealth of forensic evidence is left, "flying in all directions," to help investigators identify the shooter (Platt, 2003). Ballistics is the study of a projectile in motion, and in forensics, firearm-related ballistics are extremely vital to an investigation in that most violent crimes involve the use of a firearm (Bell, 2014).

The bullet itself, is the first and most lethal piece of evidence (Platt, 2003). An investigator's primary task at the scene is to determine how many shots were fired. Statistically, a prolific criminal does not kill with a sole bullet (Platt, 2003). Because of this, the investigator or analyst's next step upon entry into the scene is to locate any cartridges and discharged shell casings.

The term ‘rifling’, is used to describe the markings left on an ejected bullet (Platt, 2003). Investigators can use this information to piece together which firearm the resulting bullet came from (Figure 1). As a bullet strikes a certain target or surface, it will deform in a number of ways. It can flatten out, hit an object at an angle and become dented, or they can pass through a soft medium and fragment (Bell, 2014). A bullet found embedded in soft material - such as a human body – is especially valuable, since markings or fragments of this type can help propel the investigation by identifying the weapon used to fire it (Platt, 2003). Platt (2003) explains, the second essential piece of evidence is the spent cartridge case, the jacket ejected from the gun. And the third is any residue that blows out of the barrel under high velocity upon use, resulting in a smoky and cone-shaped pattern that could be expelled onto the victim (Bell, 2014).

Figure 1. Rifling

(Platt, R. (2003). Firearms in the Lab. In Crime Scene: The Ultimate Guide to Forensic Science (pp. 102). DK Pub.)

The trajectory of a bullet is the “path of flight it follows from being fired to reaching its target,” (“Trajectory,” 2018). The trajectory, or directionality, can be determined from a variety of phenomena. Understanding trajectory is one of the keys in determining what occurred and how it occurred.

A dispensed bullet will occasionally leave a parabolic shape on the targeted surface as it first comes in contact (Bell, 2014). By examining the parabolic “U” shape left behind, investigators can tell if the bullet came from the leftward direction or the right (Bell 2014). The “pinch point” is also a term used in forensic science to explain the area where the bullet first comes in contact with the surface that can help determine directionality (Bell, 2014). The bullet will hit the surface at an angle, preserve the area where it first touches, and as the bullet travels further, it will cause the substrate to flake off around the hole (Bell, 2014). It will enter the surface and create damage – leaving the pinch point area intact (Bell, 2014).

In the case of a shooting that claims a victim as their objective, – rather than through an inanimate object, such as a wall or door – an investigator can study the projectile by observing the location of the entrance and exit wounds on the deceased body. When a firearm punctures a window or door, analysts must determine whether the bullet was fired and entered from outside to inside or vice versa. In determining entrance and exit placements, it is important to look directly at the bullet hole itself (Bell, 2014). An entrance hole will show “bullet wipe”, the discolored area on the immediate periphery of a bullet hole (Bell, 2014). As the bullet travels down the barrel of the gun, it collects burnt gunshot residue and residue inside the barrel that is picked up from the muzzle of the weapon (Bell, 2014). As it passes through a surface upon ejection, it wipes the residue off. For differentiating exit holes from entrance holes, it is important to look at the surface or target that was impacted (Figure 2). Typically with exit holes, the substrate will be pushed out in the direction of the exiting bullet, and for an entrance wound, the substrate is pushed in.

Figure 2. Entrance and Exit Bullet Holes

(Karger, B. (2014). Forensic Ballistics: Injuries from Gunshots, Explosives and Arrows. In Handbook of Forensic Medicine, B. Madea (Ed.) https://doi.org/10.1002/9781118570654.ch20.)

Investigators must also establish a trajectory line from the bullet hole through the victim to understand where the bullet was intended to go and the path it traveled. If the site of impact occurs through a bony plate, such as the vault of a skull, the resulting hole will be cone-shaped, with the wider end indicating the direction the bullet was traveling (Bell, 2014). If the bullet strikes a long bone, like the femur, a wedge shape of bone will be punched out and will be displaced in the direction of the bullet's path (Bell, 2014).

An accurate reconstruction of a bullet's trajectory can also be approximated using straight lines between two fixed objects in focus, examples being between the firearm and the victim or between the firearm and the wall (Bell, 2014). Often, highly-visible rods, strings and/or laser beams are utilized and centered between each of the holes to estimate the bullet's path (Bell, 2014). Using these techniques, it is the crime scene analyst's task to eliminate any and all locations – based on their trajectory analysis – where a fired shot could not have reached to strike the victim.

In the situation that the ammunition only ruptures one target at the crime scene, the angle of impact can be evaluated by analysis of the shape of the bullet hole. The vertical angle and the azimuth angle (left to right or vice versa) must be measured to interpret the impact angle, and using a plumb bob, the degree of the angle can be determined (Bell, 2014). If the bullet's path cannot be accurately determined, it is crucial to use any information collected in order to eliminate any searchable area of the crime scene, as well as to define the general area that any bullet or expended cartridge casing could be lying (Bell, 2014).

Once a bullet penetrates its intended target, a quantity of it disintegrates or ricochets upon impact (Bell, 2014). A ricochet, or a rebound off of a surface, causes a bullet to lose much of its driving force and ultimately, creates a penetrating wound rather than a perforating wound (Bell, 2014). Ricochets can occur off of every type of surface, including water. In the situation that released bullets are not found entirely intact or even smashed beyond the possibility of analysis, the importance of finding the point of impact is crucial to the investigation – it enables analysts to trace the trajectory and correctly reconstruct the scene (Platt, 2003).

Forensic Errors

As leading detectives, McNulty and Moreland's role at the scene should solely be to observe and analyze the evidence present, in order to make an accurate inference about the case. However, in this featured scene in *The Wire*, the detectives tamper with crucial evidence to the case, without the presence of the Crime Scene Unit to analyze the scene (Wired, 2018). A proper detective collects information processed by the Crime Scene Unit, to apprehend the perpetrator of the crime. There is much more a detective is responsible for that does not include forensic analysts and evidence examiners, although, in this television scene, this was not the case.

In addition, it is a skilled crime scene analyst's task to measure the trajectory of a firearm, insure everyone's safety from a possible loaded weapon, as well as preserve any trace evidence left on the grip (Platt, 2003). For safety, all loaded weapons found at the crime scene should be unloaded by the technician before they are brought to the firearms unit in the laboratory (Wired, 2018). Magazines, clips and live or expended cartridges should also be removed from the weapon and carefully marked for identification (Bell, 2014). Once each chamber in the cylinder has been emptied of possible ammunition, the cartridges and its container should be labeled with the correct chamber it came from for a proper analysis to be made by the forensic firearms team (Bell, 2014).

Moreover, McNulty is guilty of tampering with the murder weapon, as well as removing bullets using incorrect procedure. By picking at the fracture located in the wall, the comedic detective duo could be destructive to any rifling left on the bullet after fire, potentially compromising any evidence that could be used to convict (Wired, 2018). A bullet should be recovered properly from the wall and sent to the lab to be further analyzed to be later compared to the suspect's firearm and photographed to be used in a court of law.

VI. Footwear Impression Analysis

In the film, *Wind River*, special agents Lambert and Banner discuss evidence at a crime scene that has been taped off to the public. The evidence in question is a shoe print that has been found in the snow. Agent Lambert observes the orientation of the footprint impression, analyzing the direction of the print and the speed the person was travelling when the print was left behind. He makes notice of the depth of the heel, indicating that the suspect may have been running. No further forensic analysis is shown on the snowy impression (Wired, 2019).

Background

As a person walks about, their shoes track over surfaces and collect and deposit acquired materials back onto surfaces they track over. As a result, they leave behind either two-dimensional impressions that are found on hard surfaces or substrates, or three-dimensional impressions that deform typically on softer surfaces, such as sand or snow. Three-dimensional impressions remain after a shoe or foot impacts a surface and depending on the composition of the substrate, the amount of moisture and the presence of debris, the resultant quality of the impression can have great detail or none at all (Bell, 2014). For instance, an impression that appears in fresh snow typically retains greater details than a print made in wet or aged snow.

In addition, snow has its own challenges. It is a transient piece of evidence where even in several feet, snow comes and goes (Bell, 2014). Color also complicates a snowy scene. It can be more difficult to photograph because the color is pure white, and also has reflective qualities (Bell, 2014). The greater amount of details, the greater the chance a footwear analyst can determine the individualized or class characteristics made by the questioned crime scene impression.

Footwear impressions are routinely used in investigations to prove a suspect was present at the crime scene. They can provide a variety of information to assist; applications including the identification of footwear, elimination of footwear, gait characteristics, determination of shoe size, tracking, and the location of impressions. In any form of investigation, it is critical to ensure the proper techniques and materials are used to locate, document and recover footprint evidence from a crime scene. Most impressions are most commonly found on the floor or on other surfaces that are walked upon, therefore, a scene must be secured properly and controlled as soon as possible for any outside interference in the case, such as other shoes or equipment of other individuals. It is not likely to simply view a print at a scene and determine its value, as much examination is required to make a positive identification. While it is difficult at times to recover a full print with maximum detail, all impressions – including partial prints – can contain sufficient detail for a meaningful examination result. For elimination purposes, it is necessary to document the specifics of the shoes of any involved persons present at the crime scene including the victim and any officers or medical personnel whose shoes may have left impressions behind (Bell, 2014).

All prints, both partial and full, are of potential value and should be recovered. Any found at the scene that are able to be carefully removed should be brought to the laboratory for further analysis. Prints that cannot be removed such as on concrete or in snow, must be photographed using high-quality forensic photography methods for proper forensic examination (Bell, 2014). In addition, a ruler should be used for scale, and positioned in every photo alongside the impression. For three-dimensional impressions, the best photographs for examination are difficult to achieve with proper contrast. For example, three-dimensional prints found in snow must be recovered using Snow Print Wax (Figure 3) or dark-colored aerosol paint to highlight any ridges or high spots on the impression (Bell, 2014).

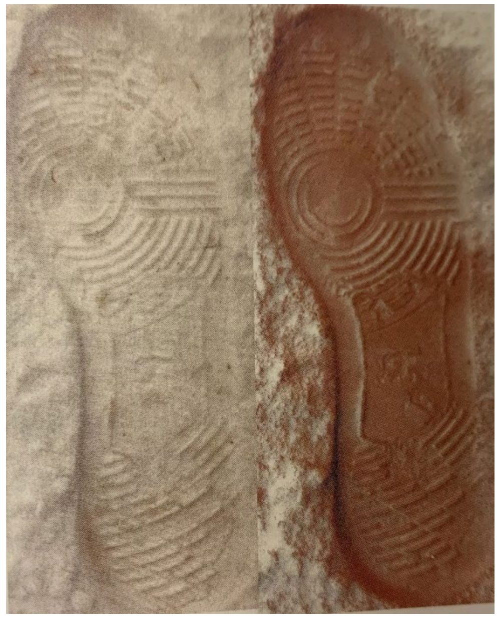


Figure 3. Snow Print Wax applied to Print before (Left), and after (Right).

(Bell, S., James, S. H., & Nordby, J. J. (2014). Tread Impressions. In Forensic Science: An Introduction to Scientific and Investigative Techniques (Fourth ed., pp. 391). Boca Raton, FL: CRC Press, Taylor & Francis Group.)

All three-dimensional prints should be casted using dental stone. Dental stone is a plaster-like material that sets rapidly with strength. A gypsum product that retains great detail, dental stone has a great compressive strength that allows technicians to recover three-dimensional prints with ease (Bell, 2014). In creating the casting mixture, a certain amount of water is needed in addition to the dental stone. This exact amount should depend on the powder-to-water ratio for each particular product (Bell, 2014). The mixture should not be poured directly onto the impression, rather carefully poured and angled next to the print in a way so it naturally flows into the impression (Bell, 2014). The dental stone material will harden in approximately twenty to thirty minutes to create a casting or mold (Figure 4). Bell (2014) suggests another 24 hours may be needed additionally to ensure all moisture has left the cast, after which the material will be fully hardened. After this time, the cast can be cleaned by immersing it into water and using a soft brush to remove any remaining debris.

Figure 4. Dental stone casting of a shoeprint

(Bury, Tyler. "Casting of a Shoeprint." 2020. PNG)

For examination purposes, wear characteristics are extremely useful in identifying a match from a casted impression. When shoes are worn, their sole designs become altered by the abrasive forces created as they make repetitive contact with the ground. The longer a shoe has been worn, the higher the degree of wear the shoe receives. In fact, "the degree of correspondence in wear between a crime scene impression and a perpetrator's shoe recovered soon after the crime is highly significant," (Bell, 2014). When a print at a crime scene and shoe sole in question share sufficient individualized characteristics, a positive identification can be made (Bell, 2014). This confirms that a particular shoe, and no other, could have made the impression located at the crime scene.

Forensic Errors

It can be said that footwear is one of the most overlooked types of evidence (Wired, 2019). Often, the poor quality and wide variability of these impressions, as well as the large number of manufactured outsole patterns makes such analysis and courtroom presentation difficult (Bell, 2014). The agents in the film make observations about the prints in question and are able to decipher that the suspect must have been running. However, this is a questionable statement (Wired, 2019).

As addressed earlier, simply observing a footprint makes it nearly impossible to claim a footprint's speed due to other causes that may give the same appearance that the person was running, such as by the addition of weight (Wired, 2019). A person carrying an item could change the depth of the shoeprint in the snow, as well as the density of the snow itself. A forensic technician would need to analyze multiple shoe wear impressions from the scene to make conclusions such as the one proposed in the film. Firstly, the print would need to be photographed using high-quality photography methods. Next, it should be coated with several layers of an aerosolized snow print wax to develop contrast within the impression. Because of the increased contrast and enhancement of detail, the print should be photographed a second time. The last step would be to cast the impression using a plaster-like material, such as dental stone that would allow forensic analysts to visualize it back in the laboratory.

VII. Fingerprint Analysis

In the film *Seven*, a team of detectives believe that a crucial piece of evidence (a painting) they have recovered and collected is of no use to their investigation. The laboratory technician illuminates the room with a brightening blue alternative light source that is focused on the back of the painting canvas. In discussion, the team then refers to the print left behind as a swirl pattern. The tech then brushes the canvas with a copious amount of fluorescent white powder and uses a can of compressed air to reveal the friction ridges that spell out the words, "HELP ME," (Wired, 2018).

Background

As an evidence category that differentiates individuals further beyond the means of DNA comparison, the process of fingerprinting as a means of personal identification dates back centuries. The earliest records of an organized fingerprinting system begin in Argentina in the year 1891 (Platt, 2003). English fingerprinting specialist, Edward Henry developed a "ten-print" classification system which separated pattern types into two specific groups (Platt, 2003). As the most widely used method for classification until the 20th century – before the emergence of computers – the Henry System was able to group together numerical values of similar worth from certain fingers to form a "fraction-like code" for each set of ten prints taken (Platt, 2003). Throughout all of his work and the development of such a complex method, Henry created a total of 1,024 different codes (Platt, 2003).

However, with the need for a complete set of ten prints, the use of this method at crime scenes was greatly limited. Although the system allowed organized maintenance of the large files maintained by many law enforcement agencies, the files could not easily be searched manually for a single or partial print found most commonly at a scene (Bell, 2014). In the 1930s, a single-print system for classifying and filing prints of individual fingers was introduced. This system is the chosen system of today's fingerprinting examination (Platt, 2003).

In forensic science, fingerprints are used primarily as a means for locating, identifying and eliminating suspects. Prints are especially useful for comparison purposes due to their unique and individualized pattern (Bell, 2014). They are considered biometric identifiers – "automated ways to establish the identity of a person on the basis of his or her physical and behavioral characteristics." (Saini, M., & Kumar Kapoor, 2016). Prints are an efficient means of identification that has become a vital requirement for forensic application and are considered fundamental in the way criminals are detained (Bell, 2014).

Fingerprints have a uniqueness that is unlike any other form of forensic evidence - every single individual has a different and distinguishable set of prints, even identical twins (Bell, 2014). It is known that fingers, palms and soles of a human's foot bear friction ridge skin containing a complicated pattern which remains unchanged throughout a lifetime (Bell, 2014). Each pattern is composed of both hills and valleys, named "ridges" and "furrows" in forensic terminology. Within a pattern are numerous possible variations formed by friction ridge skin that allow each individual's print to be distinctive from one another.

In terms of patterns, fingerprint examiners study three basic types: Arches, Loops and Whorls (Bell, 2014). Smaller subgroups can also be recognized during examination. Arches, for example, can be plain or tented (Bell, 2014). An arch pattern is formed when the finger's friction ridges lie above one another in a triangular-like shape. Whereas a plain arch forms an arching, rounded shape, the tented arch is additionally pointed, giving the impression of a pitched tent

(Bell, 2014). The arch is the simplest, yet most uncommon fingerprint recorded of the three patterns (Platt, 2003).

Loops can be categorized as either radial or ulnar (Bell, 2014). When looking at the right hand with the palm facing inward, the pattern will flow toward the little finger in the ulnar loop (Bell, 2014). In the radial loop, the pattern will flow toward the thumb (Bell, 2014). In the left hand, it is the exact opposite. The loop pattern has two focal points: the delta and the core (Bell, 2014). The delta is the point on a ridge at or nearest the point of divergence of two ridge lines, and located at or directly in front of the point of divergence (Bell, 2014). The core is the approximate center of the pattern.

The whorl pattern occurs when friction ridges revolve around a point on the finger. Similar to loops, a whorl contains definable deltas and cores that are extremely useful in ten-print comparisons (Bell, 2014). Whorls can also be separated into several categories, such as central pocket, double loop and accidental. According to Platt (2003), despite being the most complex fingerprint pattern, whorls are considered the most popular amongst the three basic types (Figure 5).

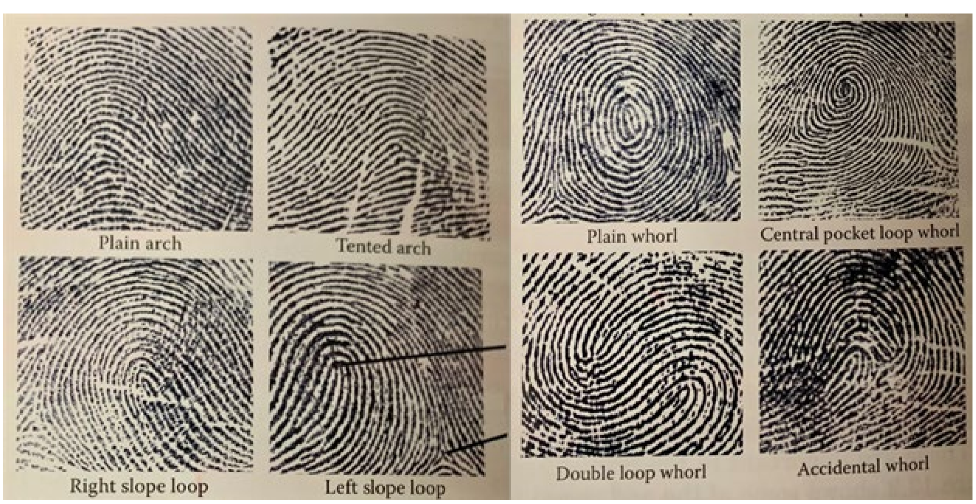


Figure 5. Types of Fingerprint Patterns

(Bell, S., James, S. H., & Nordby, J. J. (2014). Fingerprints. In Forensic Science: An Introduction to Scientific and Investigative Techniques (Fourth ed., pp.330). Boca Raton, FL: CRC Press, Taylor & Francis Group.)

At a crime scene, one could encounter three different types of fingerprints: patent, plastic and latent (Bell, 2014). Depending on specific factors, such as the medium the print was left, a print at a crime scene may need additional processing before it can be recovered properly. A patent print can often be found in a substance such as blood that needs no further enhancement or development to be clearly recognizable and analyzed (Platt, 2003). Other mediums for patent prints include grease, oil, dirt, and ink. A plastic print, also referred to as an impression, can be found in a soft substrate that allows indentations to be made such as melted candle wax or clay (Bell, 2014). It is a recognizable print, visible to the eye that does not require any additional enhancements or processing (Bell, 2014). Lastly, a latent print – the most common type of print to be found at a crime scene – is an undetectable print that requires further physical or chemical processing and visual enhancement to render visible and made suitable for comparison (Bell, 2014). As a formation of residue from a mixture of secretion glands, a latent print is the result of friction ridge skin and the porous glands that empty their contents onto the skin surface (Bell, 2014).

Methods commonly used in the recovery of latent fingerprints can be broadly divided into three groups: physical, chemical and special illumination/alternative light (Bell, 2014). Many factors are involved in how a print is recovered, such that an investigator may need to make a decision based on their proper education and training on the matter. Considered a time-consuming and skilled procedure, proper fingerprint examination looks at the characteristic shape of ridge lines (Platt, 2003). Examiners compare the beginnings of the ridges to the ends, and take note of where they merge and where they split. Also acknowledged are the number of deltas and cores that a print may possess (Bell, 2014).

Within a set of fingerprint patterns are a number of features called *minutiae*, which are formed per the ridges (seen in Figure 6) (Bell, 2014). In finding points of similarity for comparison purposes, forensic fingerprint specialists study the individualized minutiae that a print may contain that deviates it from the others. Examples of minutiae-forming ridges include extremely short lines, lines ending abruptly, or dots, as well as lines that split into two ridges - a defining characteristic named *bifurcation* (Bell, 2014). Combinations of multiple minutiae also exist, such as islands, which form per the result of two bifurcations facing one another (Bell, 2014). Therefore, the comparison of prints is extremely helpful in the processes of making conclusions, making exclusions and for individualization (Platt, 2003).

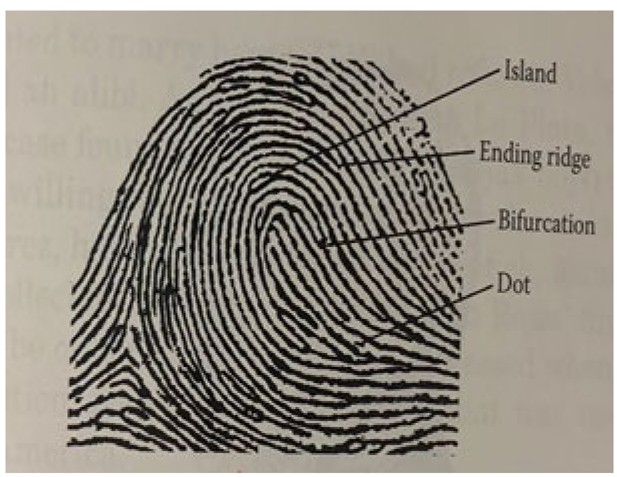


Figure 6. Fingerprint Minutiae

(Bell, S., James, S. H., & Nordby, J. J. (2014). Fingerprints. In Forensic Science: An Introduction to Scientific and Investigative Techniques (Fourth ed., pp.331). Boca Raton, FL: CRC Press, Taylor & Francis Group.)

Identification is based solely on the following knowledge of trained individuals:

1. Friction ridges develop during fetal growth before birth in their definitive form.
2. The friction ridge patterns and their details are unique and not repeated.
3. Friction ridges remain unchanged throughout life with the exception of permanent scars (Bell, 2014).

Fingerprint examiners are highly trained and entrusted with the responsibility of identification after gaining the knowledge and accumulating experience to make the proper conclusions. Amongst one of the most probative forms of evidence one could find to incriminate based on associating people with location, prints must be recovered and collected using proper procedures in order to be employed in court (Bell, 2014). Latent prints found at the scene that can be removed and transferred to the laboratory should always be documented first and photographed prior to any lifting or other collection effort to preserve chain of custody (Bell, 2014). Investigators must make the best decision in deciding whether or not to utilize enhancement techniques at the scene or to submit the item to the identification unit at the crime laboratory for examination (Bell, 2014).

For latent prints - or any other type of evidentiary item – it is quite important in recovery to apply techniques in the proper way that maximizes the number of identifiable prints. The order of techniques should follow sequence in a way that the least destructive procedure is first. Based on the latent print residue composition, the correct method can be chosen (Bell, 2014). Methods commonly used can be broadly divided into three groups: physical, chemical and special illumination (Bell, 2014).

Most methods for the development of latent prints were developed based on the knowledge of the latent print residue composition. Typically, a method is selected due to its ability to detect or visualize a print, without destroying the integrity of the impression pattern (Bell, 2014). Classically, physical methods are those that work by applying materials of fine particles to the fingerprint residue, without the involvement of chemicals or chemical reactions (Bell, 2014). The most well-known and commonly used example of this method is powder dusting. The principle of powder dusting is simply that the powder particles adhere to the latent residue. Color selection is important in providing a strong visual contrast to the surface being processed, with light powders used on dark surfaces and dark powders for light surfaces (Bell, 2014).

The technique of lifting latent prints can be explained using transparent lifting tape. The tape lift is mounted on a backing card with a color maximally contrasting to that of the powder. Careful use of the proper brush and powder color results in the development of excellent proofs (Bell, 2014).

A variant of this technique is called Magna Brush. The principle of magnetic enhancement powder or Magna Brush is the same for the conventional powder dusting in which a small, retractable magnet utilizes special magnetic powders to adhere to the fatty components of the residue (Bell, 2014). This brush technique is often of use in situations involving a surface that needs a gentler approach, in the sense that there is no textured bristles on the brush, thus a more effective method in avoiding damage to the print ridges that may occur with the use of conventional dusting (Bell, 2014).

As of recent, the best techniques have involved chemical methods and/or visual illumination for aid. As for one example of chemical processing, the principle of iodine fuming lies in its unique ability to sublime; that is, it can pass from the solid phase to the gaseous phase without becoming liquid (Bell, 2014). When the vapor is exposed to the latent print, it is directed toward the residue, typically done underneath a chemical hood or closed off area. Interacting with the lipid components in the print, the vapor becomes trapped, giving the ridge features a dirtybrown appearance (Bell, 2014). Iodine fuming is primarily used in situations involving valuable items due to its impermanent nature (Bell, 2014).

Another chemical procedure involves the treatment of latent prints with cyanoacrylate enhancement, or superglue. When cyanoacrylate is induced to fume, the fumes will interact with latent fingerprint residue, resulting in a friction ridge impression off-white in color (Bell, 2014). Glue fuming is a unique technique that has the ability to be employed either at a scene or in the laboratory. Items to be processed by glue fuming are placed into a well-sealed area, with a sufficient amount of humidity introduced. Additionally, a moisture source is needed and placed into the vapor chamber. The process is relatively slow, but is a simple, economical and common method used by forensic services to develop and preserve fingerprint evidence (Bell, 2014). Once the print has settled from this technique, post-treatment typically involves the use of physical developers such as powder dusting (Bell, 2014).

The last method of visualization is laser illumination or alternative light sources. A latent print is amenable to visualization under the condition that some form of the pattern is visible to the eye, in order to prompt the observer to simply illuminate the surface, thus the need to enhance it (Bell, 2014). Alternative light is exceptionally a bright white light source, with a mixture of wavelengths between 300nm and 800nm on the electromagnetic visible spectrum (Bell, 2014). These light sources involve color-based filters, which serve to filter the source light so the developed latent print can be viewed with light of a narrow wavelength range (Bell, 2014). This tool is extremely useful for enhancing observation, photography and collection of evidence of latent prints but not exclusive of body fluids, hair and fibers, wound patterns, gunshot residues, etc (Figure 7).

Figure 7. The use of an alternate light source to view prints

(Platt, R. (2003). Firearms in the Lab. In Crime Scene: The Ultimate Guide to Forensic Science (pp. 102). DK Pub.)

A complete print with an unusual ridge pattern that is found at a crime scene can be quickly matched. However, crime scene finger marks are rarely perfect and intact, and their imperfections often restrict the search (Platt, 2003). Efforts to create systems to aid this issue began in the early 1960s under the FBI, who oversaw the development of a computer storage and retrieval system for fingerprints (Bell, 2014). This law enforcement-based automated system is commonly referred to as the Automated Fingerprint Identification System, or AFIS for short (Platt, 2003).

The main advantage of this system is its usefulness for partial prints. While a manual examination of a partial whorl pattern may be accidently described as a loop, the new system can scan and process the print quickly and suggest possible matches without a completed pattern (Bell, 2014). AFIS relies on two defining principles: searching large files for the presence of a ten-print set of prints and searching large files for single prints (Bell, 2014).

An AFIS database holds two types of files or profiles as well. First are the knowns, which are prints of known individuals often used for any questioned specimen, image or profile (Bell, 2014). The other type can be considered the AFIS forensic file, which consists of images or profiles from unsolved cases, of which the sources are unknown (Bell, 2014). By scanning the prints in question at a crime scene and plotting the relative positions of individualized ridge characteristics, this system can then compare the data retrieved with similar information from prints in the database, and present a ranked list of the most likely matches (Bell, 2014). This file is valuable to investigators in that it allows disconnected cases to be linked by fingerprints.

These connections can allow investigators to share information and leads, thus increasing the probability of apprehending a suspect. In addition, the FBI developed a criminal database of known fingerprints, made available to all law enforcement agencies named IAFIS, or Integrated Automated Fingerprint Identification System (Bell, 2014). IAFIS allows a latent print examiner to search unknown latent impressions in a neighboring state or several states not in close proximity (Bell, 2014). Such an innovation in forensic science has revolutionized fingerprint searches, in that today, the system can perform greater than 40,000 searches per day (Platt, 2003). To date, this system has been notable in developing leads and solving unresolved cases.

Forensic Errors

In an effort to apprehend their unknown subject, Detectives Somerset and Mills attempt to examine the fingerprints left behind on a painting canvas, an item of recovered evidence from the crime scene. The forensic laboratory technician illuminates the canvas using an alternate light source, he brushes fluorescent powder onto the evidence, and then uses a can of compressed air to reveal the fingermarks left behind that spell out, “HELP ME,” (Wired, 2018). The technician then discusses his interpretation of the prints, referring to them as a “swirl pattern,” (Wired, 2018).

Previously explained, the three pattern classifications of prints are Arches, Loops and Whorls. A "swirl" pattern does not exist.

Additionally, the technique that is used to visualize friction ridge lines for examination is depicted incorrectly. The brightening blue illumination and fluorescent powder used in the film scene serves for visual and entertainment purposes only. In reality, a fingerprint examiner would never use such a copious amount of powder as well as utilize compressed air from inside a can to accomplish this task (Wired, 2018). This process may ultimately oversaturate the print in powder or destroy a part of the print or the full print entirely. Rather, a technician may simply just use black/white powder to reveal the ridge line detail, without the use of an alternate light source. Overall, the film demonstrates this process in an unnecessarily extravagant way that would never be seen in the field (Wired, 2018).

VIII. Forensic Technology/Instrumentation

C.S.I: Crime Scene Investigation, Season 1, Episode 7, "Blood Drops," Detective Warrick Brown uses a cotton swab on which he obtains a sample of the victim's blood and deposits a droplet of a clear liquid onto the tip of the swab that results in a bright pink color. The detective is most likely conducting a presumptive test, commonly referred to as the Kastle-Meyer Test: a laboratory method to test for the plausible presence of blood (Bell, 2014). Once a positive result is given, Brown promptly announces the sample is not only blood, but a match to the victim. Later in the episode, an analyst is seen using forensic instrumentation to identify a substance found at the crime scene. Once the substance in question is inserted into the instrument, a piece of paper is next seen in the analyst's hands with data listed as well as the word "Heroin" typed out (Zuiker & Fink, 2000).

Background

The identification of a stain as blood is one of the most important tests performed on physical evidence, one that DNA protocols have not replaced. Typically, the flow of analysis of a stain suspected to be blood moves from a more generalized and less specific form of testing to extremely specific, such as DNA typing (Bell, 2014). Because of the impracticality of treating every stain for DNA that appears to be blood, a series of presumptive tests are commonly employed. A presumptive, or screening test is one that, when positive, would lead forensic examiners to strongly suggest the presence of blood in the tested sample (Bell, 2014). This test is not absolute, as further testing is required to confirm the results, in which a confirmatory test would be needed to clearly establish identification. The test is also useful in helping to eliminate stains that give negative results that need no further consideration. Presumptive tests produce a visible color that relies on the catalytic properties of blood to drive the reaction. Catalytic tests are dependent upon the chemical oxidation of a chromogenic substance, in which an oxidant oxidizes a colorless material to a colored one (Bell, 2014). In the case of bloodstain testing, a peroxide-mediated oxidation occurs as an oxidizing agent is catalyzed by the presence of hemoglobin (Bell, 2014). These tests that produce color reactions are typically carried out by applying a solution of the chromogen to a sample of the suspected material or stain, followed by the addition of the oxidizing agent, or hydrogen peroxide (H_2O_2) (Bell, 2014). A rapidly developed color, dependent upon the chromogen used, constitutes a positive result. A test procedure commonly used in forensic laboratories that utilizes this technique is referred to as the Kastle Meyer test, or the Phenolphthalein reagent. The reagent consists of reduced phenolphthalein (phenophthalin) which is then oxidized by peroxide in the presence of hemoglobin in blood, resulting in a brilliant pink hue (Bell, 2014).

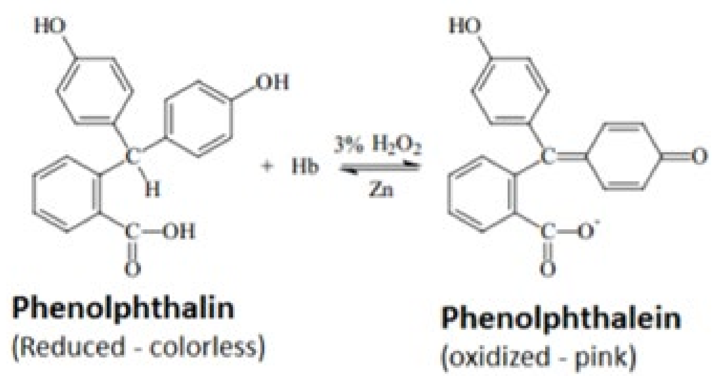


Figure 8. Phenolphthalin oxidation with H_2O_2.

(Bell, S., James, S. H., & Nordby, J. J. (2014). Identification of Blood and Body Fluids. In *Forensic Science: An Introduction to Scientific and Investigative Techniques* (Fourth ed., pp. 211). Boca Raton, FL: CRC Press, Taylor & Francis Group.)

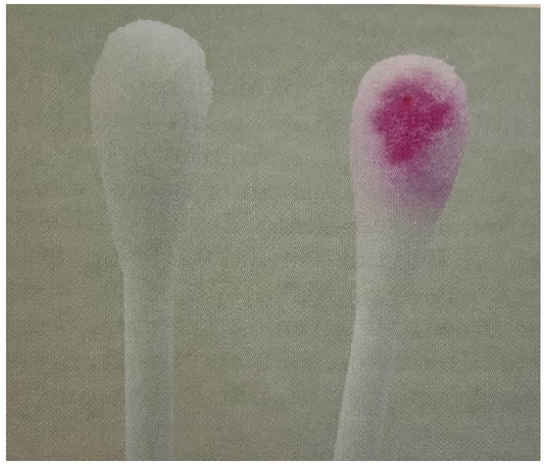


Figure 9. Phenolphthalin oxidation with H_2O_2.

(Bell, S., James, S. H., & Nordby, J. J. (2014). Identification of Blood and Body Fluids. In *Forensic Science: An Introduction to Scientific and Investigative Techniques* (Fourth ed., pp. 211). Boca Raton, FL: CRC Press, Taylor & Francis Group.)

Other examples of peroxide-mediated oxidative reactions include Benzidine and Leuco-Malachite Green (Bell, 2014).

Once a stain has been tentatively identified as blood, the next step is a confirmatory test. In some cases, the analyst may proceed directly to DNA typing, however, in situations where a more definitive identification of a stain is desired, a confirmatory test is done (Bell, 2014). Examples of confirmatory testing include the SERETEC® HemeDirect SemiQuant Assay or Prostate-Specific Antigen (PSA), and Rapid Stain Identification of blood (RSID) (Bell, 2014). These confirmatory tests utilize an immunochromatographic test strip, which is a simple diagnostic device intended to detect the presence or absence of the target analyte – in this case, blood – in the form of a lateral flow assay (Bell, 2014). These strips contain a control line, to confirm the test is working as it should, along with a test line that will appear if blood is present in the sample (Bell, 2014). Although these tests are named as confirmatory, due to a lack of specification between advanced primate species and humans, neither test can be used to make a positive identification of whose blood the sample belongs to (Bell, 2014). Because of this, one must perform an array of tests and receive positive results in order to make the strongest assumption that blood is detected in the questioned sample, and DNA typing should follow (Bell, 2014).

Further, evidence tested by scientific instruments is rarely found to be conclusive; rather, most can conclude identity with a certain probability (Bell, 2014). While many of the instruments used and tests performed on the silver screen are real, their uses and results are often incorrect or overly simplified (Bell, 2014). For one thing, as advanced as modern technology is, it still takes time to run tests on samples. Contrary to belief, many instruments do not present results in seconds, in testing a single sample (Bell, 2014). The length of time is dependent on the instrument's settings and sample preparation, such as what solvent the sample is in, the temperatures of different parts of the instrument, and the speed the temperatures change at - all of which in turn need to be optimized for the specific sample being tested (Bell, 2014). Additionally, some tests take longer due to the number of tests requested daily; for instance, DNA can take weeks to identify due to backlogs of evidence (Bell, 2014).

Instrumentation such as GCMS, or Gas Chromatography Mass Spectrometry, is a commonly used instrument for identification in the forensic field for the purpose of mixture separation of an unidentified substance (Joo et al., 2012). It is an analytical method that combines features of gas chromatography (GC) and mass spectrometry (MS) to separate a drug or metabolite of interest from the blood itself (Bell, 2014).

One of the most effective instruments in identifying chemical compounds is gas chromatography, which separates compounds from one another with a detection system, all contained in one instrument. GC exploits the fundamentals of all forms of chromatography methods, in which separation is based on selective partitioning of compounds between different phases of materials (Joo et al., 2012). The second part of the instrument is the MS, or mass spectrometer, which is responsible for identifying the components on a molecular level based on the mass of the analyte (Bell, 2014).

In simplified terms, the instrument works as described: The column inside the GC is lined with material to differentially attract various components of the gas mixture, thereby separating them (Bell, 2014). They then eluate (emerge from the column) at different times, and are ionized for the MS analysis (Bell, 2014). These combine into what is shown as peaks on a GC-MS chromatogram (Bell, 2014). Once the analyte has entirely passed through the instrument and a series of peaks appear from the detection system, a trained analyst can now compare this data to a reliable standard run under the same GCMS conditions as the unknown sample (Bell, 2014).

Forensic Errors

It is no secret that television perceptions of forensic techniques contain gross simplifications. Detective Warrick Brown's use of the immunochromatographic strip to test his unknown blood sample proves to be the incorrect method for analysis. In obtaining the blood sample, Detective Brown should have run a series of presumptive tests before any confirmatory tests were performed. This would indicate to a trained examiner whether or not it is likely for blood or any other bodily fluid to be present (Bell, 2014).

Running a confirmatory test is the next step in the analysis procedure; giving a positive result would conclude that blood is present (Bell, 2014). It is also obvious that *C.S.I's* recreation of the Kastle-Meyer test is inaccurate. The usage of a lateral flow immunoassay test is not necessary when performing the solely presumptive, chemically- indicative Phenolphthalein test (Bell, 2014). The test can be done as simply as moistening the tip of a cotton swab with a small amount of water and then touching it to the dried blood sample (Bell, 2014). A drop of the indicator can then be added, and a color reaction will ensue in approximately 30 seconds or less if blood is present (Bell, 2014). Detective Brown also makes the proclamation that the sample is not only blood, but is a direct match to the victim. In actual fact, there is no reasonable way to determine a blood match without proper DNA analysis, nor would any of the tests listed previously be able to make that determination (Bell, 2014). Due to limitations of both presumptive and confirmatory blood testing, the ability to decipher between advanced primate and the human species is beyond the test's capabilities, further proving Detective Brown's statements to be inaccurate.

To show how the forensic instrument, GCMS works in the detection of drug compounds or metabolites, an example of data can be shown below:

a.)

b.)

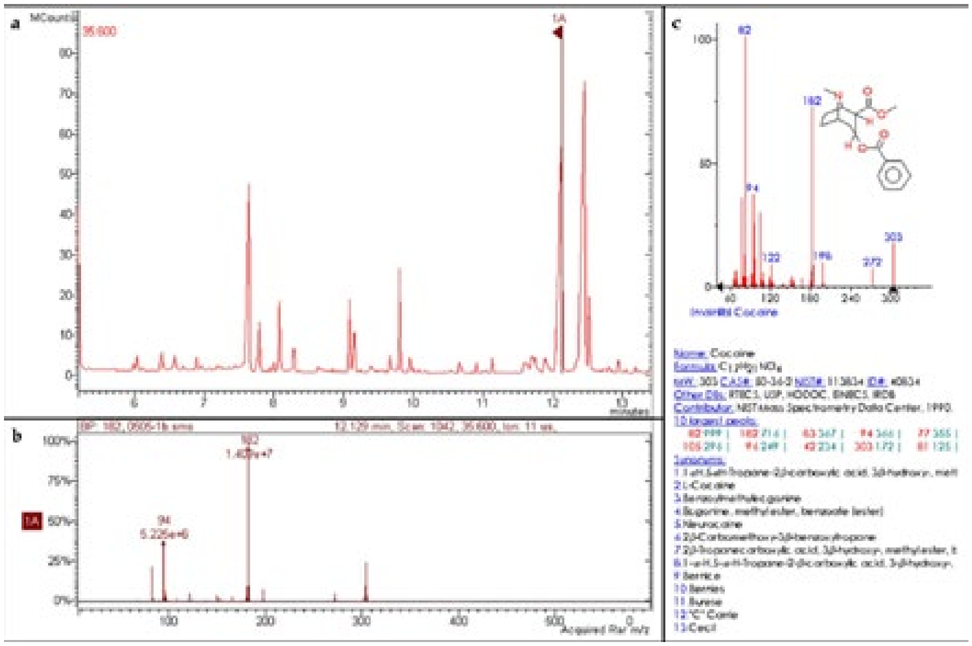


Figure 10. Analysis of a biological matrix containing cocaine and its metabolites, through gas chromatography with detection by mass spectrometry.

(Joo, M., Carvalho, F., Lourdes Bastos, M. D., Carvalho, M., & De Pinho, P. G. (2012). Chromatographic methodologies for analysis of cocaine and its metabolites in biological matrices. Gas Chromatography - Biochemicals, Narcotics and Essential Oils, 181. doi:10.5772/32225.)

The following data represents the identification of cocaine in a biological sample eluted in a GC-MS equipment. The identification of each peak in the chromatogram in Figure 10a can be attained through the comparison of compound peaks in the sample with standard compounds analyzed at the same chromatographic conditions (Joo et al., 2012). Another way to analyze this information is through the comparison of the mass spectrum of the analyte (Figure 10b), provided by the MS detector, with the existing mass spectra in a database (Joo et al., 2012). It is apparent that reading results such as these takes an expert’s knowledge; it is not designed to print a piece of paper that reads the word, “Cocaine.” It is important to remember this while viewing a television show or film with inaccurate depictions, illustrating these simplifications described.

IX. *Bloodstain Analysis*

Blood Spatter

Dexter, Season 1, Episode 1, "Dexter," Dexter attempts to reconstruct a scene using bloodstains left behind by the perpetrator. Upon entering the scene, he first analyzes a large non-patterned bloodstain on the wall, referring to it as a "pond," (Wired, 2018). Using strings to record spatter trajectory, he deduces where and how the knife was swung around and determined that the spatter present at the scene was a result of that specific event.

Next, he turns around towards a set of mist-like patterns seen on the near wall. Dexter makes reference to the "clean and easy" appearance of the slices and slashes that must've occurred using a weapon in a quick manner to avoid any drips or slashes as the body was punctured (Wired, 2018). He takes one photograph of the stain adjacent to him and exits the crime scene, announcing what he will be eating on his lunch break (Wired, 2018).

Background

Spattered blood is defined as a random distribution of bloodstains that vary in size that may be produced by a variety of mechanisms (Bell, 2014). Determining the mechanism in which blood is spattered upon a surface typically requires more information than merely visualizing the pattern (Bell, 2014). Identifying spatter patterns are significant for the following reasons:

- Spattered blood may allow for the determination of an area or location of the origin of the blood source when the spatter-producing event occurred.
- Blood found on clothing may place a specific person at a scene or violent altercation.

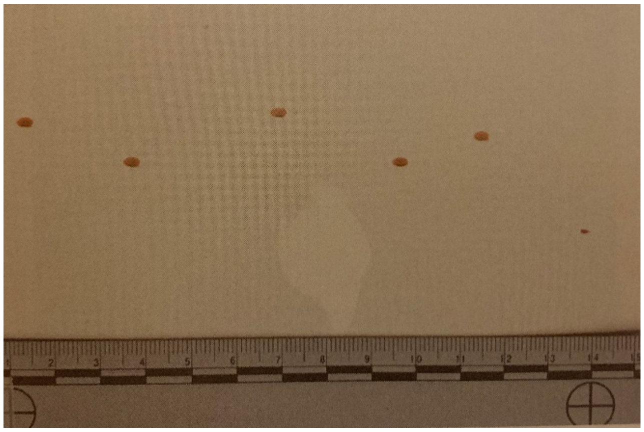
- The discovery of spattered blood may allow for the determination of a specific mechanism by which a pattern was created (Bell, 2014).

Bloodstains can be classified into three basic types: passive stains, transfer stains and projected or impact stains (Bell, 2014). Passive stains include drops, flows and pools (Bell, 2014). Transfer stains result from objects coming into contact with existing bloodstains and leaving wipes, swipes or pattern transfers behind (Bell, 2014). Impact stains result from blood projecting through the air and are usually seen as spatter, but may also include gushes, splashes and arterial spurts (Bell, 2014).

Each spatter pattern is created using a distinctive amount of force and impact mechanism (Bell, 2014). For example, a "cast-off" impact spatter may result from the beating with a blunt object, such as a metal pipe (Figure 11a). When the pipe hits the target with a certain amount of force and subsequent blows, a centrifugal force is generated and will create a pattern that appears linear in distribution (Bell, 2014). Observing this pattern can help analysts determine if the perpetrator swinging is right-handed or left-handed based on the directionality of the resulting stains (Platt, 2003).

Similarly, a unique pattern may occur due to a breached artery, in which the projected pattern results from the varying amounts of spurted blood (Figure 11b) (Bell, 2014). An analyst may review and verify an arterial spurt pattern with the arterial damage suffered by the victim. In comparison to a cast-off pattern, a much larger volume of projected blood can occur as well as a lack of pronounced directionality in this form of impact spatter (Bell, 2014).

a.)



b.)

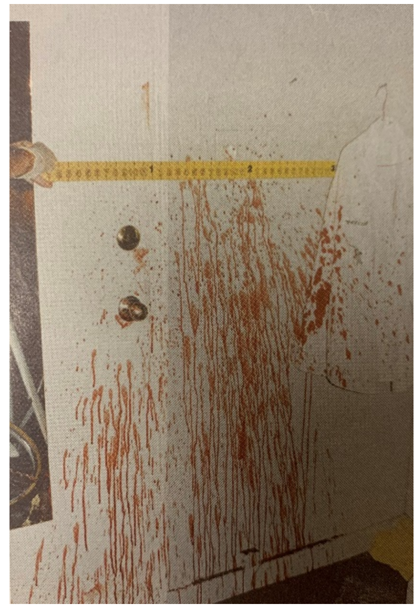


Figure 11. Pattern formed by means of Cast-Off (a),
Arterial Spurting (b)

(Bell, S., James, S. H., & Nordby, J. J. (2014). Bloodstains. In *Forensic Science: An Introduction to Scientific and Investigative Techniques* (Fourth ed., pp. 81, 84). Boca Raton, FL: CRC Press, Taylor & Francis Group.)

When blood is impacted, droplets are dispersed through the air. When these droplets strike a surface, the shape of the stain changes depending on the angle of impact, velocity, and distance traveled and type of surface impacted (Platt, 2003). Bloodstain pattern analysis is performed in two phases: Pattern Analysis and Reconstruction (Bell, 2014). Pattern Analysis looks at the physical characteristics of the stain to interpret what pattern types are present and what mechanism may have caused them (Bell, 2014).

Reconstruction utilizes the physical data collected to put contextual explanations to the stain patterns themselves (Bell, 2014). To help reconstruct events that caused the bloodshed, analysts use the direction and angle of the spatter to establish the origin and the area of convergence.(Bell, 2014). To find the area of convergence for impact spatter, investigators typically use string to create straight lines through the long axis of approximately 6-10 individual drops, following the angle of impact along a flat plane (Bell, 2014). Following the lines to where they intersect shows investigators where the victim was located when the drops were created. Typically, stringing analysis is done when an origin reference is needed, such as with radial spatter, where a specific origin or area of convergence of spatter cannot be exacted by eye (Bell, 2014).

Forensic Errors

Dexter makes a true statement regarding blood spatter in that it tells a story, yet his other statements are not true at all. Upon entering the crime scene, he looks towards a large stain on the wall and refers to it as a "pond" of blood (Wired, 2018). A "pond" is not used in forensic terminology nor would it be used to describe a bloodstain that resembles the one in the episode (Wired, 2018). In addition, the large pond-like stain on the wall is unlike any other from an actual crime scene.

The stringing that is utilized to measure the convergence for this stain is completely incorrect in that the strings attached to the wall are meaningless in relevance to the type of stain and would not lend investigators any aid in determining the events that occurred (Wired, 2018). In Dexter's interpretation of the impact bloodstain patterns - that could be considered television's rendition of cast-off, - he is able to enter the crime scene and indicate exactly how and what events occurred to produce the patterns in front of him.

In reality, analysts are able to correlate stains with the dynamic forces that created them (Wired, 2018). In doing so, it is possible to make educated inferences of how they were created and estimate a small window of time in which they occurred (Wired, 2018). However, without further information, an analyst would never be able to assume the weapon that created the patterns, especially when patterns closely resemble and cannot be differentiated between that of a knife wound or other sharp object (Wired, 2018). Thus, Dexter's conclusions about a knife plunging into the victim's shoulder and severing the carotid artery are certainly rash and would need to be supported with further evidence and information to be deemed valid. Crime scene reconstruction is extremely detailed and objective, therefore this scene from *Dexter* proves that entering a crime scene and positing what might have happened without consulting the other forensic evidence in the case, is entirely fictional.

Luminol Blood Testing

How to Get Away with Murder, Season 1, Episode 12, "She's a Murderer," the scene begins as the camera focuses in on a particular analyst performing a luminol test on some surface that appears to be a door. With a chaotic scene filled with officers and investigators, he sprays the luminol chemical and then uses a UV blue light to scan for any trace of blood the chemical may have detected (Wired, 2018).

<u>Background</u>

As Bell (2014) explains, luminol is a chemiluminescent compound that when sprayed on a suspected bloodstained area – along with hydrogen peroxide – it will react with the heme in hemoglobin and cause the oxidation reaction to catalyze, producing a bluish-green glow (Figure 13) (Bell, 2014). A search for blood at a crime scene normally occurs using visual examination, however, the possibility exists that blood may be present in amounts too little to see with the unaided eye, or that the blood at the scene has been “cleaned up” prior to arrival of the crime scene team (Bell, 2014).

Besides being useful in locating minute amounts of blood, the luminescent pattern observed on surfaces can indicate such things as the route of exit from the crime scene or drag marks in blood (Bell, 2014). An additional light source and excessive spraying are not necessary to observe the reaction (Bell, 2014). Luminol is an extremely sensitive presumptive testing method and is capable of detecting blood in parts-per-million concentration (Bell, 2014).

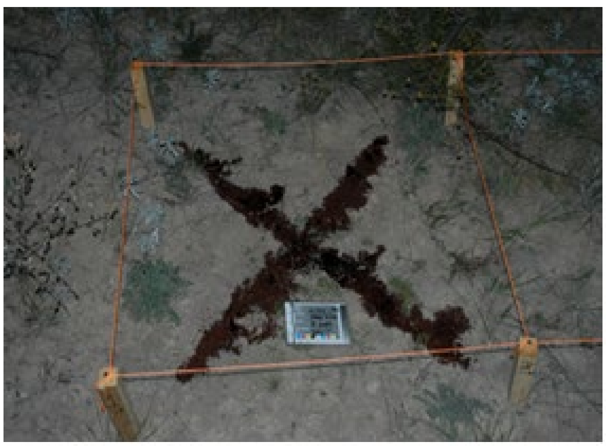


Figure 12. Luminol reaction

(Gabel, R., Shimamoto, S., Stene, I., & Adair, T. (2017, February 20). Detecting Blood in Soil after Six Years with Luminol. ACSR. https://www.acsr.org/journal-archives/abstract/detecting-blood-in-soil-after-six-years-with-luminol.)

Forensic Errors

To begin, this scene is entirely too crowded with an excess of people and a lack of protective gear for proper forensic analysis to be done. When conducting luminol testing, the item of clothing or surface should generally be away from the public, most likely in a laboratory environment (Wired, 2018). Luminol has been suggested as a possible carcinogen, thus it is important to conduct this test in a secure area wearing the proper protective equipment (Wired, 2018). As explained, luminol does not need a UV light source to visualize results. The room should be dim or dark to observe the luminescent glow and the chemical can be sprayed with hydrogen peroxide to determine if blood is present (Bell, 2014).

The correct usage of luminol can be observed in a scene of *C.S.I: Miami*, in which a technician sprays the chemical on an item of clothing that was recovered with the possibility of blood (Wired, 2018). However, the technician is informed by a fellow analyst a moment later that due to his incessant spraying of luminol on the item of clothing, the DNA search resulted in a negative outcome. When using luminol, it is also crucial to be cautious in that using too much can ultimately dilute the sample and affect the results (Bell, 2014). This chemical is visually appealing to witness on television, yet, although it may look attractive, the process and usage of it can be both complicated and dangerous if not done correctly.

X. Transient Evidence/Locard's Principle of Exchange

Sherlock, Season 1, Episode 1, "A Study in Pink," Sherlock enters a room where a body has been found. He asks for silence of the other analysts who have entered the crime scene. In doing so, he leans down near the body and begins to analyze the smallest of details. Notorious for his prowess at using logic and astute observation to solve cases, Holmes takes note of the transient nature of evidence all around the body; the umbrella that is dry, the victim's jacket that appears wet, and her fingernail paint that has been chipped on her left hand. Based on his examination, he is able to make conclusions regarding the time frame that the crime may have occurred within (Wired, 2019).

Background

"Transient evidence is a type of evidence that is, by its very nature, temporary, easily changed or lost," (Lee & Pagliaro, 2013). Common examples of transient evidence that can be found at a crime scene include odors, colors, temperatures and other physical or biological phenomena (Bell, 2014). Because transient evidence is temporary, it requires documentation immediately, as soon as it has been observed (Bell, 2014).

Transient evidence is commonly used by forensic scientists to pinpoint a specific time frame of when a crime has transpired (Bell, 2014). Although it is temporary, the nature of transient evidence occurs solely by contact of more than one entity (Bell, 2014). When two objects – a scene and a person, a person and a person – come into contact with one another, a mutual exchange of materials will result, which can then be identified and analyzed by a forensic technician. This interaction is referred to as "Locard's Principle of Exchange," and is considered the basic founding principle of forensic science (Bell, 2014).

In 1910, Edmond Locard established the first, primitively equipped, forensic laboratory in Lyon, France (Bell, 2014). Interested in microscopy and trace evidence, Locard studied and believed in the idea that "every contact leaves a trace," and that the analysis of trace evidence – particularly dust – is crucial in linking people to places (Bell, 2014). Among many of his inspirations, the feat and imagination of Arthur Conan Doyle's *Sherlock Holmes*, proved to be the most impactful for Locard (Bell, 2014). Doyle himself was a doctor, a scientist and a great influence on the field of forensics, most notably in his revelations about the importance of observation and logic in investigations. *Sherlock Holmes* motivated many other scientists, including Edmond Locard, to further the principles of the newly developing field of forensic investigation. Bell (2014) states, the success of Locard's methods encouraged other European nations to develop their own forensic laboratories in the late 1940s, and his renowned credibility remains a dominant presence in the world of forensic science today.

Forensic Errors

It can be acknowledged that a majority of the other elements of the *Sherlock* scene are falsified, in which Holmes - and frankly any of the other men in the scene - are not wearing any proper protective equipment while observing a body. In addition, Sherlock is lifting items off of the victim, prior to any documentation (Wired, 2019). These discrepancies in the episode illustrate the enormity of inaccurate concepts of forensic science throughout television. Yet, unlike most television depictions of forensic techniques, this episode of *Sherlock* accurately demonstrates how transient evidence is useful in crime scene investigation. It nods to the importance of Locard's

Principle of Exchange and offers insight to the proper amount of detail recognition that is needed by investigators at an actual crime scene.

XI. A Comparative Analysis of the C.S.I Effect

In the Courtroom:

There has been more than 30 years of research examining the concepts of television viewers' social reality being shaped by the amount of television exposure an individual has (Podlas, 2017). Sitting on the edge of a seat, completely caught up in the latest crime drama unfolding on the television screen is an image everyone can picture. A desirous daughter murders her parents for their life insurance payout. Newly discovered DNA is used to determine an unsolved crime from many years ago. No matter the times of repeated exposure to similar storylines, the public still remains captivated.

For better or for worse, the C.S.I Effect has entered the courtroom and is responsible for its role in altering modern-day proceedings. As seen in numerous pieces of literature on this topic, there are varying opinions on the influence that crime-related television shows hold over society. It may be difficult to believe that deniers of this phenomenon actually exist after demonstrating its validity through a myriad of examples in previous chapters, yet they do. Some believe the sole existence of the C.S.I Effect is the issue. Some blame technology as a whole. Regardless of the belief, the matter remains persistent – crime-based entertainment has infiltrated the legal system – predominantly, its jurors (Alldredge, 2015).

The more an individual is exposed to television, the more accessible the concepts displayed on the television are to memory (Shelton, 2008). According to Shelton (2008), in the early 2000s, *CSI: Crime Scene Investigation* was named the most popular television show in the world. Due to its increasing fame, *CSI's* worldwide popularity spawned other forensic dramas that dominate the traditional television ratings today, such as *NCIS, Sherlock,* and *Dexter*. Based on a program rating in 2006:

- 30 million people watched *CSI* on one night.
- 70 million watched at least one of the three versions of *CSI*.
- 40 million watched other forensic dramas, resembling *CSI* (Shelton, 2008).

Together, the ratings translated to over 100 million viewers. Today, these statistics are so much greater. So how many of those viewers reported to jury duty the next day?

Many attorneys, judges, and journalists have claimed that watching crime-related television programs like *CSI* has led jurors to wrongfully acquit guilty defendants when a lack of scientific evidence has been presented, along with many other adverse effects. The mass media quickly picked up on these complaints, leading to the promptly dubbed term the "*CSI* Effect."

Research has shown that frequency of television viewing is directly correlated to the viewers' mirrored perceptions of the items, which are heavily shown on television (Alldredge, 2015). As a result, the viewers start experiencing the blurred lines of reality and fiction, especially when there is heavy dependence on the specific medium (Alldredge, 2015). This occurrence is commonly seen in court; a jury is dependent only upon the hard evidence such as a gun recovered with prints and the DNA proof that points directly to the perpetrator. High- profiled defendants such as Casey Anthony and Robert Blake were acquitted when a jury expected "sophisticated science," to be presented at trial, ultimately undermining any form of circumstantial evidence and eyewitness testimony that were crucial to the case (Call et al., 2013).

In addition, some states have admitted difficulty in choosing jurors due to their plethora of knowledge and bias regarding forensic material based on crime-filled television (Alldredge, 2015). Lawyers may flag and remove jurors that commonly enjoy *CSI* and other crime programs. This is starting to limit the pool of potential candidates to serve in criminal court cases (Alldredge, 2015). On the contrary, Gerbner (1972) alluded to how the combination of a lack of knowledge and being easily impressionable could lead viewers to believe the media is accurately depicting information. In this circumstance, one can assume that all may work out for the defendant, yet, that is not exactly the case. The C.S.I Effect's impact on jurors has left defense lawyers with the task of meticulously presenting and explaining DNA and other forensic methodologies to the jury – defining what is expected and what exists solely on the silver screen (Alldredge, 2015).

Case Study:

In 2006, research was completed in Ann Arbor, Michigan to observe the influence on jurors' expectations in regards to the C.S.I Effect. A written questionnaire was composed and distributed to over 1,000 participants, assuring that responses would remain anonymous and unrelated to their possible selection as a juror (Shelton, 2008). Demographic information was also collected to wager the prospective jurors' television-watching habits. The survey asked questions about different case scenarios including:

- "Murder or attempted murder
- Any form of physical assault
- Rape
- Breaking and entering
- Any theft case
- Any crime involving a firearm" (Shelton, 2008).

With respect to each of these categories of crimes, the survey then asked what types of evidence the prospective jurors expected to see:

- “Eyewitness testimony from the alleged victim or at least one other witness
- Circumstantial evidence
- Scientific evidence of some kind
- DNA evidence
- Fingerprint evidence
- Ballistics or other firearms laboratory evidence” (Shelton, 2008).

Not only did the survey seek to find whether participants were familiar with such scenarios, the study was also set to determine whether prospective jurors would demand to see scientific evidence before finding a defendant guilty (Shelton, 2008). The next section of the survey asked participants how likely they would be to find a defendant guilty or not guilty based on certain types of evidence presented by the prosecution and the defense. Using the same cases and evidence described above, potential jurors were given different scenarios and five choices for each:

1. “I would find the defendant guilty.
2. I would probably find the defendant guilty.
3. I am not sure what I would do.
4. I would probably find the defendant not guilty.
5. I would find the defendant not guilty” (Shelton, 2008).

The results of the survey are as followed:

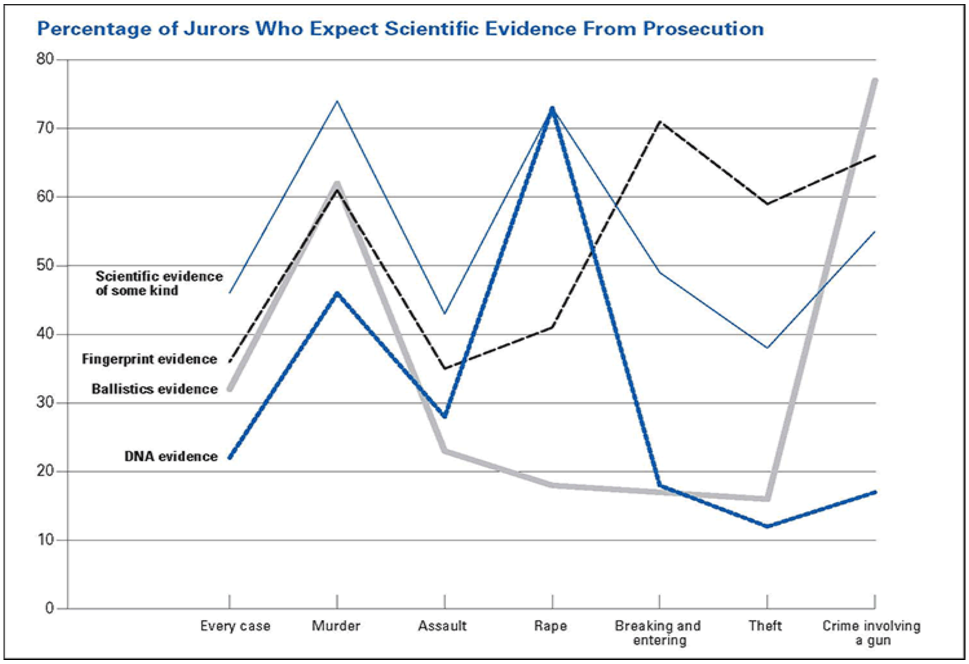


Figure 14. Table illustrating the percentage of jurors who expect scientific evidence from the prosecution

(Shelton, D. E. (2008, March 16). *The 'CSI Effect': Does It Really Exist?* National Institute of Justice. https://nij.ojp.gov/topics/articles/csi-effect-does-it-really-exist.)

- 46 percent expected to see some kind of scientific evidence in *every* criminal case.
- 22 percent expected to see DNA evidence in *every* criminal case.
- 36 percent expected to see fingerprint evidence in *every* criminal case.
- 32 percent expected to see ballistic or other firearms laboratory evidence in *every* criminal case (Shelton, 2008).

The findings also suggested that the jurors' expectations were not just blanket expectations for scientific evidence. For example, a higher percentage of respondents expected to see DNA evidence in the more serious violent offenses, such as murder or attempted murder (46 percent) and rape (73 percent), than in other types of crimes (Shelton, 2008). A higher percentage also wanted to see fingerprint evidence in breaking and entering cases (71 percent), any theft case (59 percent), and in crimes involving a gun (66 percent) (Shelton, 2008). Furthermore, the findings suggested in physical assault, rape and murder scenarios, participants were less likely to convict if DNA evidence was not presented (Shelton, 2008). In conclusion, a definite correlation between evidence and conviction can be seen by these results, in which the less scientific evidence found that a juror associates with a certain crime, an acquittal is much more likely to occur.

Across Universities:

Several scholarly articles continue to expound upon the C.S.I Effect and its relationship to the courtroom. However, Cole and Dioso-Villa (2007) further explained the C.S.I Effect by stating that there are actually many versions that affect even those outside of the courtroom: (a) prosecutor's effect, (b) defendant's effect, and (c) professor's effect. The most widely researched and discussed incarnation of the C.S.I Effect is known as the prosecutor's effect (Alldredge, 2015). This intuitively pleasing version of the effect posits that regular *CSI* viewers come to believe that forensic science is commonplace, precise, and performed with a high degree of technological sophistication (Alldredge, 2015). Therefore, when these individuals eventually become jurors, they possess unreasonably high expectations about the type of forensic evidence that will be proffered by the prosecution.

The defendant's effect, or the "reverse" C.S.I Effect, proposes a counter theory to the prosecutor's effect, in which the prosecution purportedly benefits from the jury's exposure to crime-related programming (Chin & Workewych, 2016). A common worry of defense lawyers is the juror's perception of the trial process itself, and how it has changed due to television (Chin & Workewych, 2016). Crime shows focus on the investigation, and therefore, jurors may come to view the trial as "a mere formality" to an investigation that was dispositive of guilt (Chin &

Workewych, 2016). In terms of both the prosecutor and defendant's effects, a negative connotation surrounds these perspectives and encourages the idea that the C.S.I Effect has been solely problematic in today's world.

However, an opposing theory exists that supports the phenomenon, as it has brought about an overwhelming amount of attractiveness to forensic science. The professor's effect, also termed the educator's effect, claims that crime-related entertainment has had a positive educational impact by popularizing forensic science and glamorizing the careers within the field (Chin & Workewych, 2016). When examining the professor's effect within this phenomenon, the enrollment numbers of academic degree programs related to forensic science and criminal justice have increased over the years, especially since the turn of the century (McCay, 2014). Tregar and Proni (2010) stated that in 1975 there were only 21 colleges or universities that were offering degrees in forensic science, whereas in 2007, there were over 120 colleges or universities that offered some version of the program.

In a university setting, the C.S.I Effect has influenced several areas including a significant increase in the interest in forensic science in the general population, as well as the interest of the incoming college student (McCay, 2014). It promotes the misconception that forensic science is not the application of science to a criminal investigation, but Hollywood's portrayal of the criminal investigation itself. Thus, when students enter their university programs, they are confused and often disappointed in the reality (McCay, 2014).

Nauta (2007) stated the level a student is satisfied with his or her major is important from practical and theoretical standpoints. No matter what the reason, students have a mental picture of what they expect in the major and their future job field. It is when there is a discrepancy between their expectations and reality that the student becomes less satisfied.

Researchers Krimmel and Tartaro (1999) sought to gather demographic information on forensic science students and their career choices. It was discovered that family and friends did not influence the selection of a forensic science major; however, the selection of a forensic science degree was often due to the individual finding the subject matter interesting (Krimmel & Tartaro, 1999). Krimmel and Tartaro (1999) also claimed a majority of students select their college major because of their career choice post-graduation. Additionally, researchers stated a majority of responses to the question when asked: “why was the criminal justice major selected?” was due to the field being interesting (McCay, 2014). The second strongest response was the major’s relevance to criminal justice (McCay, 2014). Therefore, if students are interested in a major, then they may have a set expectation before entering the degree program.

Student Survey

Introduction: With mainstream media sources attributing the rise in popularity in forensic studies to the heightened profile of the profession because of these shows, it is timely to assess the ways in which forensic students engage with popular culture depictions of their future profession. A study was done to collect data on student’s perceptions of forensic science television programs. The purpose was to enhance the understanding of how forensic science students engage with popular images of their profession and to consider pedagogical implications of the findings.

Study Sample/Design: The study took place at a university located in New South Wales, Australia, in the year 2011. Forensic science students enrolled in all years of their undergraduate program were asked to volunteer to participate by completing surveys. Of the 215 students who were enrolled in the forensic science program, 135 (63%) completed the survey (Weaver et al., 2012). The average age of a participant was 20.6 (SD 4.4), and approximately two-thirds of the sample were female (68.1%) (Weaver et al., 2012). The study's focus was to explore the mindset of students who have chosen forensic science as a degree and interpret the cause of their decision-making when declaring their career path.

Data Collection: Participants' television viewing habits are summarized in the table below:

Table 2. Television viewing habits of forensic science students of forensic science dramas.

Forensic drama	Ever watched (%)	Watched ≥ once/ week (%)	Watched with family or friends (%)
NCIS	81.1	27.9	50.9
CSI	79.8	19.3	44.7
CSI: Miami	66.0	12.3	34.7
Bones	64.7	24.5	39.8
Dexter	61.9	24.8	33.0
CSI: New York	47.6	5.8	21.1
Criminal Minds	10.4	8.9	6.7
NCIS: LA	7.4	5.2	5.9

Figure 15. Table illustrating television viewing habits of forensic science students of forensic science dramas. (Weaver, R., Salamonson, Y., Koch, J., & Porter, G. (2012). The CSI Effect at University: Forensic Science Students' Television Viewing and Perceptions of Ethical Issues. *Australian Journal of Forensic Sciences*, *44*(4), 381–391. https://doi.org/10.1080/00450618.2012.691547.)

Results: Forensic science shows were watched by 91.1% of the sample (Weaver et al., 2012). Of these programs, *N.C.I.S* (81.1%) and *CSI* (79.8%) had been viewed by the most students at some stage (Weaver et al., 2012). Around two-thirds had seen versions similar to *CSI* such as

CSI: Miami and CSI: New York. (Weaver et al., 2012). However, the most frequently watched shows (at least once a week) were *N.C.I.S, Bones* and *Dexter* (Weaver et al., 2012). Approximately a third reported watching the top five most-frequently watched shows with family or friends (Weaver et al., 2012).

Discussion: Although these values support the idea that students who find interest in the forensic sciences are typically viewers of crime television, the students also expressed their dissatisfaction with its portrayal and its effect on the understanding of the reality of the field. As one participant stated, "'It gives an idea of different types of forensics you can go into but not accurate or realistic in what they actually do beyond the general role,'" (Weaver et al., 2012). Similarly, another said: "'TV show characters aren't exactly going to get fired for not taking responsibility or contaminating evidence but, in reality of course, you would be fired,'" (Weaver et al., 2012).

One student found more of value, writing, '"watching forensic television shows, I learn more about techniques and critical thinking towards ethical and practical views."' (Weaver et al., 2012). Overall, the findings of this study acknowledge the theory that students are heavily influenced by forensic science dramas and their glamour, rather than the reality. Yet, as the participants noted, one of the positive elements of these shows is that portraying forensic science in popular television programs can enhance recruitment and provide ideas about the spectrum of technologies and specialties available in the career. The data collection, as well as the participants' comments confirm the research pointing to the existence of the C.S.I Effect throughout universities, as well as both the positive and negative aspects of these shows in attracting people who may otherwise be unaware of the profession.

VII. Conclusion

From fingerprints to fluid analysis, post-mortems and profiling, the field of forensic science continues to progress despite its recent setbacks due to the C.S.I Effect in the area of criminal investigations. Based on the increasing popularity of forensic dramas like *CSI: Crime Scene Investigation, Sherlock* and *Dexter*, the public's perception of certain methodologies has been affected. Regarding perceptions of the C.S.I Effect, empirical and qualitative studies find that lawyers and law enforcement personnel believe that forensic dramas hold sway over jurors and the public at large.

These negative perceptions appear to be self-serving, with prosecutors claiming that the C.S.I Effect makes it more difficult to convict guilty parties and defense attorneys claiming the C.S.I Effect biases jurors against the defense. Positive effects include a greater interest in the field and overall awareness of forensic science. The goal of these shows is strictly to entertain, and they certainly accomplish that. However, there is work yet to be done in attempting to measure this phenomenon.

While researchers have not discovered an entirely reliable effect of *CSI* viewership on conviction or acquittal, they have found evidence suggesting that the perceived realism of *CSI* and the expectations created by the show may be impactful (Wired, 2018). To conclude, the C.S.I Effect presents a considerable challenge to both courtrooms and academics. It can be assumed the C.S.I Effect will continue to be studied as long as forensic and crime-based television shows continue their popularity. Expanding the current knowledge of its impact on the criminal justice system will help further develop additional solutions, which can overcome any unjust influences this effect creates.

VIII. References

Alldredge, J. (2015, May). *The "CSI Effect" and Its Potential Impact on Juror Decisions*. SJSU ScholarWorks. https://scholarworks.sjsu.edu/themis/vol3/iss1/6/.

Baldwin, H. B., & Puskarich May Ph.D, C. (2017, August 18). Crime Scene Contamination Issues. https://www.crime-scene-investigator.net/crime-scene-contamination-issues.html.

Bell, S., James, S. H., & Nordby, J. J. (2014). Bloodstains. In *Forensic Science: An Introduction to Scientific and Investigative Techniques* (Fourth ed., pp. 73, 76, 80, 81, 83). Boca Raton, FL: CRC Press, Taylor & Francis Group.

Bell, S., James, S. H., & Nordby, J. J. (2014). Evidence: Origins, Types and Admissibility. In *Forensic Science: An Introduction to Scientific and Investigative Techniques* (Fourth ed., pp. 25-26). Boca Raton, FL: CRC Press, Taylor & Francis Group.

Bell, S., James, S. H., & Nordby, J. J. (2014). Fingerprints. In *Forensic Science: An Introduction to Scientific and Investigative Techniques* (Fourth ed., pp. 327-346). Boca Raton, FL: CRC Press, Taylor & Francis Group.

Bell, S., James, S. H., & Nordby, J. J. (2014). Firearms and Toolmarks. In *Forensic Science: An Introduction to Scientific and Investigative Techniques* (Fourth ed., pp. 362, 374). Boca Raton, FL: CRC Press, Taylor & Francis Group.

Bell, S., James, S. H., & Nordby, J. J. (2014). Identification of Blood and Body Fluids. In *Forensic Science: An Introduction to Scientific and Investigative Techniques* (Fourth ed., pp. 208-212). Boca Raton, FL: CRC Press, Taylor & Francis Group.

Bell, S., James, S. H., & Nordby, J. J. (2014). Justice and Science. In *Forensic Science: An Introduction to Scientific and Investigative Techniques* (Fourth ed., pp. 9-10). Boca Raton, FL: CRC Press, Taylor & Francis Group.

Bell, S., James, S. H., & Nordby, J. J. (2014). Tread Impressions. In *Forensic Science: An Introduction to Scientific and Investigative Techniques* (Fourth ed., pp. 384-399). Boca Raton, FL: CRC Press, Taylor & Francis Group.

Bury, Tyler. “Casting of a Shoeprint.” 2020. PNG

Call, C., Cook, A. K., Reitzel, J. D., & McDougle, R. D. (2013). Seeing Is Believing: The CSI Effect Among Jurors in Malicious Wounding Cases. *Journal of Social, Behavioral, and Health Sciences*, *7*(1), 52–66. https://doi.org/10.5590/JSBHS.2013.07.1.04

Chin, J. M., & Workewych, L. (2016). The CSI Effect. *Oxford Handbooks Online*. https://doi.org/10.1093/oxfordhb/9780199935352.013.28

Cole, S., & Dioso-Villa, R. (2007). CSI and its effects: Media, juries, and the burden of proof. New England Law Review, 41, 435-470.

Encyclopedia.com. (2018, May 29). *Trajectory*. Encyclopedia.com. https://www.encyclopedia.com/social-sciences-and-law/law/crime-and-law-enforcement/trajectory.

Gabel, R., Shimamoto, S., Stene, I., & Adair, T. (2017, February 20). *Detecting Blood in Soil after Six Years with Luminol*. ACSR. https://www.acsr.org/journal-archives/abstract/detecting-blood-in-soil-after-six-years-with-luminol.

Gerbner, G. (1972). Communication and Social Environment. Scientific American, 227, 153-160.

Hayes-Smith, R. M. & Levett, L. M. (2011). Jury’s still out: How television and crime show viewing influences jurors’ evaluations of evidence. Applied Psychology in Criminal Justice, 7(1), 29-46.

Houck, M. M. (2006). CSI: Reality. *Scientific American*, *295*(1), 84–89. https://doi.org/10.1038/scientificamerican0706-84

Joo, M., Carvalho, F., Lourdes Bastos, M. D., Carvalho, M., & De Pinho, P. G. (2012). Chromatographic methodologies for analysis of cocaine and its metabolites in biological matrices. *Gas Chromatography - Biochemicals, Narcotics and Essential Oils,* 181. doi:10.5772/32225

Karger, B. (2014). Forensic Ballistics: Injuries from Gunshots, Explosives and Arrows. In Handbook of Forensic Medicine, B. Madea (Ed.). https://doi.org/10.1002/9781118570654.ch20

Krimmel, J., & Tartaro, C. (1999). Career Choices and Characteristics of Criminal Justice undergraduates. Journal of Criminal Justice Education, 10(2), 277-289.

Lee, H. C., & Pagliaro, E. M. (2013). Forensic Evidence and Crime Scene Investigation. *Journal of Forensic Investigation*, *01*(02), 2–3. https://doi.org/10.13188/2330-0396.1000004

Legg, K. M. (2013). *Development and Testing of a Rapid Multiplex Assay for the Identification of Biological Stains* (dissertation). U.S. Department of Justice.

McCay, Megan Dutton, (2014). "CSI Effect and Forensic Science/Criminal Justice Degree Programs."

Nauta, M. (2007). Assessing College Students' Satisfaction with Their Academic Majors. Journal of Career Assessment, 15, 446-462. doi: 10.1177/1069072707305762

Platt, R. (2003). Bloodstains. In *Crime Scene: The Ultimate Guide to Forensic Science* (pp. 84–85). DK Pub.

Platt, R. (2003). Fingerprinting. In *Crime Scene: The Ultimate Guide to Forensic Science* (pp. 46-47). DK Pub.

Platt, R. (2003). Firearms at the Scene. In *Crime Scene: The Ultimate Guide to Forensic Science* (pp. 100-101). DK Pub.

Platt, R. (2003). Firearms in the Lab. In Crime Scene: The Ultimate Guide to Forensic Science (pp. 102). DK Pub.

Podlas, K. (2017). The "CSI Effect." *Oxford Research Encyclopedia of Criminology and Criminal Justice*. https://doi.org/10.1093/acrefore/9780190264079.013.40

Saini, M., & Kumar Kapoor, A. (2016). Biometrics in Forensic Identification: Applications and Challenges. *Journal of Forensic Medicine*, *1*(2), 2. https://doi.org/10.4172/2472-1026.1000108

Shelton, D. E. (2008, March 16). *The 'CSI Effect': Does It Really Exist?* National Institute of Justice. https://nij.ojp.gov/topics/articles/csi-effect-does-it-really-exist.

Thomas, Andrew P. "The CSI Effect: Fact or Fiction." *The Yale Law Journal - Home*, 1 Sept. 2006, www.yalelawjournal.org/forum/the-csi-effect-fact-or-fiction.

Tregar, K., & Proni, G. (2010). A review of forensic science higher education programs in United States: Bachelor's and Master's degrees. Journal of Forensic Sciences, 55, 1488-1493.

Weaver, R., Salamonson, Y., Koch, J., & Porter, G. (2012). The CSI Effect at University: Forensic Science Students' Television Viewing and Perceptions of Ethical Issues. *Australian Journal of Forensic Sciences*, *44*(4), 381–391. https://doi.org/10.1080/00450618.2012.691547

Wex Definitions Team. (2020, June). *Mapp v. Ohio (1961)*. Legal Information Institute. https://www.law.cornell.edu/wex/mapp_v._ohio_(1961).

Wex Definitions Team. (2020, June). *Fruit of the Poisonous Tree.* Legal Information Institute. https://www.law.cornell.edu/wex/fruit_of_the_poisonous_tree

Wex Definitions Team. (2017, June). *Exclusionary Rule*. Legal Information Institute. https://www.law.cornell.edu/wex/exclusionary_rule.

Willing, R. (2004, August 5). *CSI Effect has Juries Wanting More Evidence*. USA Today. https://usatoday30.usatoday.com/news/nation/2004-08-05-csi-effect_x.htm.

Wired. (2018, June 21). *Forensics Expert Examines 20 Crime Scene Investigations from Film & TV | Technique Critique | WIRED*. YouTube. https://www.youtube.com/watch?v=YHTz66Jq0Dg.

Wired. (2019, Nov 5). *Forensics Expert Examines 25 More Crime Scene Investigations from Film & TV | Technique Critique | WIRED*. YouTube. https://www.youtube.com/watch?v=xJcNa2-jprs.

Zuiker, A.E & Fink, K. (2000, November 17). Blood Drops. In Zuiker, Anthony, E. *C.S.I: Crime Scene Investigation*. CBS Studios.