Crime Scene Investigation and Examination: Chain of Evidence

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Abstract

A key component to most investigations is the successful recognition, documentation, collection, and preservation of evidence from a crime scene. Many different forms of evidence will be encountered. There are general principles that apply to the proper collection, preservation, and handling of all evidence. Establishing a solid chain of evidence is one of those basic, essential standards. Failure to establish a scientifically sound and legally defensible chain of custody for an item of evidence will likely diminish the value of that evidence in judicial proceedings.

Introduction

Crime scene investigation is integral to an investigation in many aspects. It can provide investigative leads, aid in the identification of suspect/s or victim/s, prove or disprove alibis, identify a modus operandi, establish the corpus delicti, and create linkages and associations among the victim, suspect, scene, and evidence (Lee and Harris, 2000). Evidence may consist of transient, conditional, pattern, transfer, or a diverse variety of physical evidence (Lee *et al.*, 2001).

If the full potential of physical evidence is to be achieved there are certain safeguards and standards that must be met. Evidence must be collected in a manner that will preserve the integrity and evidentiary value. Courts have ruled that failure to properly handle or preserve a piece of evidence may raise to the level of a due process violation if the defendant has been deprived of access to that evidence (Wecht and Rago, 2006). In addition, each piece of evidence must be collected and maintained in such a manner that it can be authenticated and proven to be in the substantially same condition as when initially collected. This so-called chain of custody must be established from the moment evidence is first in custody until the conclusion of analysis and legal proceedings.

Physical Evidence

The role and value of physical evidence to an investigation can be best expressed by the 4-Way Linkage theory (**Figure 1**; Lee *et al.*, 2001). This theory postulates that there are four key components in an investigation: suspect, victim, scene, and evidence, and that a reliable and objective means to solve a case is to establish linkages between these components. The more linkages established, the greater the probability of resolving an investigation. No one component necessarily bears more weight than the other. Ideally, the suspect, victim, scene, and relevant evidence will be identified and associations between them established. However, it is possible to solve a case without locating the primary scene, the actual body of the victim, the exact identity of the offender, or several pieces of key evidence. For example, the trial may proceed without the recovery of the victim's body and only a circumstantial case that established homicide has occurred and an identification of the victim through analysis of partial remains, such as DNA analysis of a bloodstain. Moreover, forensic examinations may identify a common perpetrator in a series of cases through methods such as fingerprint, bite mark, or DNA analysis and yet the true identity of the offender remains unknown. Modern mass media exposure and public interest in crime scenes, forensic science, and investigations has created jury pools that hunger for each of the primary four components, and most particularly physical evidence.

What constitutes physical evidence in a particular case will often vary and be difficult to determine. However, recognition that a particular object is to be a piece of physical evidence is only the first step in a sequential process that must be undertaken with each piece of evidence (**Figure 2**). Recognition of an object as potentially possessing evidentiary value is dependent upon the case particulars and the experience and training of the crime scene investigator. After recognition and

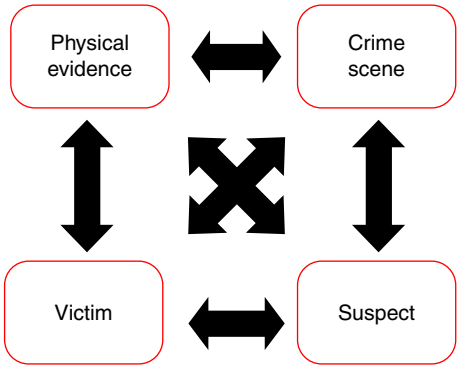

Figure 1 Four-way linkage theory.

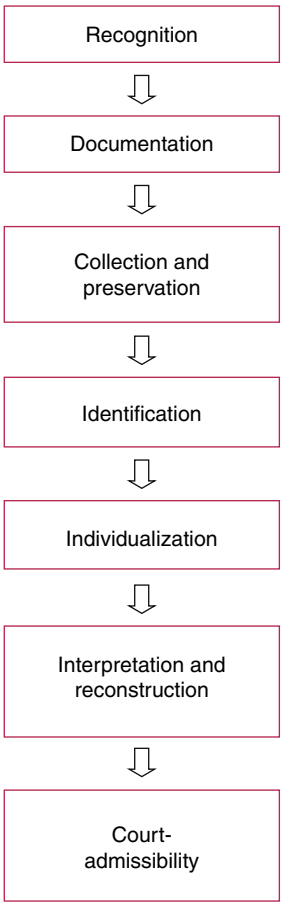

Figure 2 Sequential schematic processing of evidence.

before the evidence is touched or altered in any way, the evidence must be thoroughly documented. Documentation includes a variety of functions, note taking, photographs, videotaping, and sketch preparation. After documentation is complete the evidence may be properly collected and preserved. The nature and method of collection and preservation will depend upon the nature of the evidence, such as whether it is chemical, biological, or physical in nature. After documentation the identification of the evidence is the next logical step. This step may or may not require sophisticated laboratory analysis. Once the item is identified an examination scheme can be implemented to develop further class characteristics and proceed toward an individualizing methodology. Individualization of an object will require comparisons of the object to known standards or the source of origin. For example, a paint chip located on the clothing of a hit-and-run victim may be compared to either known automobile paint databases or to samples of paint obtained from the suspect's car. Once the examination process is complete scientists will need to evaluate and interpret the results in a scientifically reliable and objective manner.

In many instances, such as the example above, a true individualization may not be possible. Rather, the correct conclusion is that the known and unknown samples were similar in all observed characteristics. This information can then be collated with other available information in a reconstruction process. Crime scene reconstruction if done properly is a scientifically valid method for analysis of all the investigative data, laboratory and medical findings, and experimental data for the purpose of testing various relevant hypothesis related to the case.

Documentation

Documentation of physical evidence is best accomplished through a variety of means. The item should be photographed and videotaped in place, showing both overall perspectives and close-up photographs, some taken with scales or rulers in the photograph. In addition, the exact location where the item was located must be recorded. Usually, obtaining fixed measurements for each item of evidence, and incorporating those measurements in a crime scene sketch is the method of choice. Finally, notes should be maintained articulating every aspect of the process from discovery until the examination of the evidence is complete. Documentation functions should occur prior to, during, and after collection of the evidence. For a given piece of evidence there may be numerous photographs or documentations, some obtained at the crime scene and others during the examination process at the Medical Examiners office or forensic science laboratory.

Proper documentation is required for many purposes, to document the crime scene for reconstruction or investigative purposes, to serve as demonstrative aids for legal proceedings, or to help establish and maintain a chain of custody for that particular piece of evidence. Most document methods have moved into a digital format. There are some additional guidelines and precautions that must be followed when dealing with digital images. The Scientific Working Group on Imaging Technology (SWGIT) has published a set of guidelines for reference. Specifically on point is section 13 of these guidelines which articulates best practices for maintaining the integrity of digital images.

Collection

General Considerations

The proper collection of evidence is determined by the nature of the evidence and potential uses or examination schemes to be employed. As a general proposition evidence should be handled and packaged in a manner that minimizes the possibility of contamination, destruction, or spoilage. Methods must be in place to maintain the integrity of evidence throughout the entire time evidence is in custody. Physical evidence may be adversely

affected in many ways: loss by leakage, decomposition, intermingling with other evidence, alteration in any form, contamination, or alteration or damage of digital evidence (Osterburg and Ward, 2014). In addition, packaging and labeling must be sufficient to establish the authenticity and chain of custody in future proceedings.

Size and amount of sample to be collected will vary, but it is better to collect too much sample than an amount so small that full analysis cannot be conducted. In addition to unknown or questioned samples it is important to collect known standards for comparison, such as a carpet sample from the room where the assault allegedly occurred. Also, control samples may be beneficial for analysis and interpretation of the laboratory results. For example, in a suspected arson scene samples of the oak flooring apart from the suspected point of origin should be obtained. Known standards, such as blood, hair, and fingerprints should be taken from the victim at autopsy or during medical evaluation and treatment.

Biological Evidence

Biological evidence or items of evidence containing trace amounts of biological material require special handling and packaging. Commonly encountered biological samples contain blood, semen, saliva, urine, feces, vomit, tissue, bone, teeth. General precautions must be taken to preserve the biological evidence, preventing spoilage or bacterial growth that can negatively impact on subsequent testing.

Thus, items with biological stains must be air dried before packaging and should be placed in non-airtight containers such as paper bags or envelopes. In addition, care must be used to avoid contamination of the samples either from the individual collecting or handling the samples or from cross-contamination between samples. Cross-contamination can occur if collection tools such as forceps or scalpels are not properly cleaned between each sample. Alternatively disposable tweezers, pipettes, or other collections devices can be used. Contamination has always been an issue, but now more than ever it is a concern due to the increased sensitivity of low copy number DNA typing methods. Mitochondrial DNA testing is particularly sensitive, thus even minute amounts of contamination will likely appear in the analysis. Minor components detected in case samples can be very problematic in interpretation and subject one to claims of insufficient evidence handling and preservation. Finally, by their very nature biological materials may contain a wide variety of pathogens or harmful agents so anyone exposed to the evidence must employ universal precautions. Minimally this means handling the evidence with gloved hands, but may also require the examiner to don full protective wear including face masks and hair nets.

Rapid DNA analysis methods are being developed which will allow for the analysis of the collected biological samples at a law enforcement or other designated facility within 84 min. This technology will not minimize the need for proper handling and preservation, but will have tremendous advantages to the investigators by such a rapid turn around and resulting full DNA profile of the source of the DNA. Analysis can be conducted by non-laboratory personnel with a minimal amount of training. The entire process is conducted with a single desk size unit (Figure 3).

Figure 3 A technician is loading the 5 sample Biochip into the Rapid DNA instrument.

Blood

Liquid blood can be collected on a sterilized cotton swab and allowed to air dry. With large amounts of liquid blood the sample can be pipetted, placed in a purple-topped (with ethylenediaminetetraacetic acid (EDTA)) vacutainer test tube, and refrigerated. With dried blood stains there are a few options. First, if possible, collect the entire item with the dried bloodstain or cut out the area containing the blood. Alternatively, the dried bloodstain can be collected on a sterile swab moistened with saline solution or distilled water. Swabs are now available with preservation tubes that contain drying agents to help reduce bacterial growth and sample degradation (Figure 4). Other less desirable options include scraping the stain or lifting the stain with adhesive lifters.

Trace Evidence

A wide variety of trace evidence may be encountered at the crime scene, autopsy, or during the investigation. Trace evidence is essentially a small amount of material, which may be either biological or chemical in nature. Many times this evidence is so small that it is not detected through macroscopic examination. Thus, evidence must be properly handled and preserved such as to maintain the possibility of locating trace evidence during subsequent microscopic or instrumental

Figure 4 Close-up view of a DNA swab, including a drying agent, that is required for Rapid DNA technology.

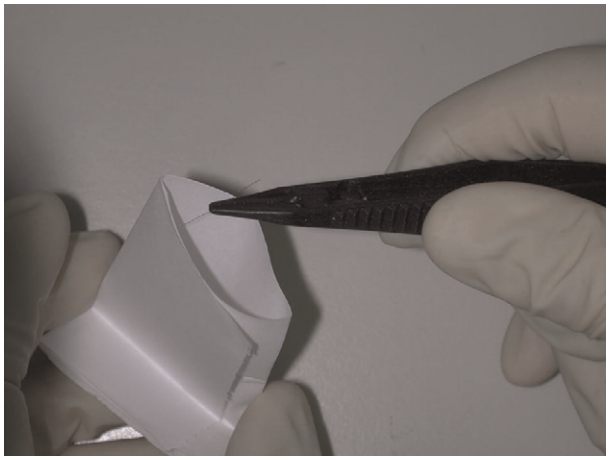

Figure 5 Placing of trace item in a druggist fold.

examination. Commonly encountered trace evidence includes hair, fibers, soil, glass particles, paint, gunshot residue, vegetative debris, organic and inorganic materials, and blood or other biological materials.

Collection methods will vary, but there are essentially three primary option. Collect the item containing or believed to contain trace evidence and package it in a manner such as to prevent loss of trace material. Alternatively, macroscopically or microscopically examine the item and individually remove trace components, such as removing a hair from clothing with a forceps. Once removed place the trace item into a druggist fold, and place that druggist fold in a sealed envelope Figure 5). Finally, utilize a collection method that will remove a majority of trace material from a surface, such as by vacuum methods, tape lifts, or scraping the item down over a piece of clean butcher paper.

Hazardous Materials/Weapons of Mass Destruction

Evidence collection personnel, medical personnel, and laboratory examiners always needed to be aware of potentially hazardous substances, of a chemical,

Figure 6 (a) Testing of a hazardous substance. (b) Traditional forensic testing.

biological, radioactive, or explosive nature. However, with possibility of exposure to weapons of mass destruction individual precautions and refined procedures need to be developed and implemented. Only properly trained personnel, wearing the appropriate level of protection, should handle these types of hazardous materials. In addition, these materials should not be transported to a 'normal' laboratory or facility unless they are conclusively determined to be a nonhazard, rendered safe, or brought to a facility that is designed to safely handle and store such materials. A potential dilemma is the need to conduct traditional forensic testing on an object that may be contaminated with a hazardous substance, such as anthrax (Figure 6(a) and (b)). In this case it would likely be important to process the tainted letter for trace evidence, latent fingerprints, and perform a questioned document examination on the written or printed material. These examinations will normally be done at a forensic laboratory that is not designed to safely handle pathogens. Therefore, the letter must be rendered or determined to be pathogen free, or the forensic scientists will need to go to a facility where they can safely conduct their examinations.

Electronic and Computer Evidence

We live in a highly technological era where it is commonplace to encounter some form of electronic or

computer-based evidence at a crime scene or during the investigation. This type of evidence has unique challenges. Since destruction or alteration of data or information can easily occur it is highly recommended that only properly trained personnel collect and package this type of evidence. Likewise, a forensic data examiner or like specialist will need to respond to a crime scene with computers or electronic evidence and assist in the system shut down, dismantling, collection, and packaging. For the 'traditional' crime scene technician, laboratory scientists, medical examiner, or investigator need to simply be aware of the possibility of this type of evidence and the special handling needs. The Scientific Working Group on Digital Evidence (SWGDE) published a set of guidelines as well as a quality assurance and standard operating procedure manual.

Our everyday lives have numerous interactions with various forms of computers and other electronic devices. Moreover, new and innovative hardware and software technologies are constantly being introduced. Thus there is a need to establish a set of generalized procedures that can be employed for the vast majority of electronic devices commonly encountered in criminal investigations (Reith and Gunsch, 2002).

Chain of Custody

General Information

Regardless of how effective a crime scene search was conducted, resulting in the location and collection of relevant physical evidence, or the quality and breadth of laboratory testing, physical evidence is only as valuable as its ultimate use, such as admissibility in court. Rules of evidence dictate how evidence will or will not be used during the trial, but a foundational rule is a general requirement for the chain of custody to be established, before that evidence may be admitted in the trail.

Real evidence being offered in court will require someone to testify that the piece of evidence being offered is in fact the same piece of evidence seized in conjunction with this case, and that the evidence is unchanged (Broun, 2013). The process by which the identification and lack of spoilage are documented and substantiated is commonly referred to as the chain of custody.

A chain of custody begins once an item of evidence comes into the custody of government personnel or their agents. There is no requirement that a chain be established prior to the government seizure; regardless as to how long the item of evidence has been in existence. Generally, once the item of evidence is presented in court, the stringent chain of custody is no longer required. However, depending upon the nature of the evidence and for what purpose it is being offered in trial the relevant chain may terminate before trial. In several instances the critical chain is concluded once the item has been analyzed in a laboratory. For example, a package of white powder seized from the accused's clothing, subsequently tested at a reliable laboratory, and conclusively determined to be heroin may require a stringent chain of custody only until the laboratory examination is complete. In contrast, take the case where a stolen firearm will be admitted into trial as the tangible property upon which the offense is based. In this case a full chain of custody will need to be established all the way until the gun is offered into trial, and proven to be the same gun law enforcement originally seized. Each of the links in this chain represents a period of time along the chain, and articulate specifically who was in custody of that item during that period of time. Each person, or link, may be called upon to establish that the item of evidence while in their possession was properly secured and preserved such as to assure its identity and prevent spoilage or alteration. It is not necessary to identify every individual that could potentially have access to that item, so long as each custodian or link can establish that they followed accepted protocols, ensuring the safe keeping and integrity of that evidence.

How to Establish and Maintain an Effective Chain

Ultimately, a court must be convinced that the item of evidence being offered is in fact the same item originally seized during the crime scene search, autopsy, or investigation. The goal is to make the item readily identifiable as the original item seized. Some items by their very nature are inherently identifiable, such as an original Claude Monet painting. These relatively identifiable pieces of evidence will require only a minimal chain of custody, generally limited to a showing that the item is substantially unchanged. Other items are quite fungible, such as one of dozens of dried blood stains swabbed from a crime scene. With fungible evidence the necessity for a detailed and strong chain of custody is even more essential.

One method for identifying fungible items at a later point is by uniquely marking the actual item. The practice of actually marking an item, often with the initials of the seizing individual, is effective, but may be detrimental to the evidence. Markings placed on the item of evidence may alter or destroy critical components or characteristics of the evidence that may be needed for laboratory analysis or comparison. Therefore, if the actual item of evidence is to be marked, extreme caution must be employed to place the markings in an area where they will not alter the evidentiary value of that evidence. For example, a bullet recovered during autopsy should never be marked anywhere other than the base of the bullet, and only then when a preliminary macroscopic examination of the base reveals no signs or trace, transfer, or impression evidence in that area. With an item of clothing the markings should be placed in an

area free of all stains, transfers, patterns, or defects to the material.

In many cases the item may be properly marked for future identification by sealing the item of evidence in an appropriate evidence container and placing markings on the packaging. This labeling should include the date and time of seizure, location from where the item was seized, a description of the item, an investigative or case number, and name of the seizing individual. In addition, the seizing officer should place his or her initials on this package, and any interior packaging such as a druggist fold. The actual sealing process will vary depending upon the packaging container. With paper bags, envelopes, and boxes, the container should be closed and any access point sealed with tamper resistant tape. If tamper resistant tape is not available, ordinary tape may be used and the seizing officer may inscribe her initials across the tape. Be sure to use tape that will adhere to the packaging surface for an extended period of time, and be sure that the tape can withstand extreme temperatures if the item needs to be refrigerated or frozen. Heat sealed plastic bags are excellent for securing evidence. However, plastic or airtight bags are not appropriate for a variety of materials like those containing biological stains, such as blood or semen.

In addition to the label or information listed above a bar coded label may be adhered to the package. This bar code can be used to track and identify the item, thus establishing the requisite chain of custody. Bar codes can be purchased as commercially available generic products, or can be custom designed and printed individually by the agency. Custom labels are advantageous in that additional information can be generated and printed on the actual bar code, such as case number, item, and brief description (Figure 7). However this type of label cannot be prepared in advance making it a difficult, though not impossible, option for field or crime scene use. Even with generic labels there are numerous evidence management programs that can capture the bar code and associate it with a particular case, or with an additional bar code printed back at the agency facility or forensic laboratory. Some evidence collection kits, such as a swab for collection of biological samples, are supplied with a series of corresponding bar codes that can be used by law enforcement and forensic laboratory personnel as the evidence is transmitted into their custody.

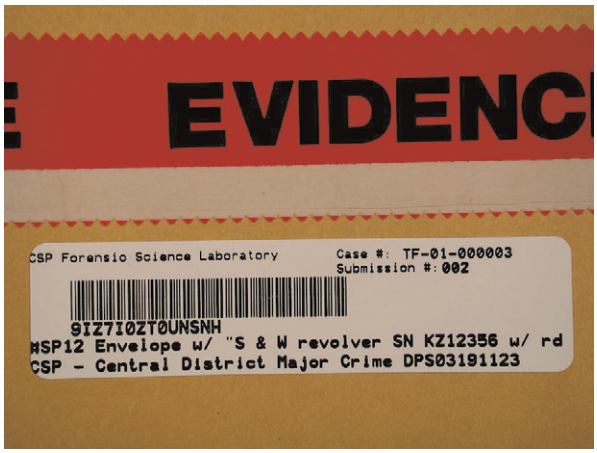

Figure 7 Custom bar code label for physical evidence received at a forensic science laboratory.

The chain of custody must be documented either in a written log or in an electronic medium that captures and maintains relevant data, or a combination of the two options. Chain of custody logs come in many varieties, but should minimally contain, case or control number, individual exhibit number, brief description, location where originally seized, name of seizing individual, date and time of original seizure, and a series of entries for each and every occurrence where there is a change in custody. These transfers should include date and time of transfer, name of person to whom custody of the evidence is being given, and the new location where the evidence will be stored. These transfers should be verified by obtaining a signature from both the individual releasing the evidence and the individual receiving the evidence. Maintaining a chain of custody requires that an examination of the log will show where that evidence was stored for every moment since its original seizure, and who was responsible for that evidence during each of those time intervals.

These logs or forms may be separate forms, one for each piece of evidence, or a log book which lists adequate chains for numerous pieces of evidence. Also, some packaging material, such as a sex crimes evidence collection kit, may have a chain of custody form on the box itself. While the use of the form on the packaging material is acceptable it is recommended that an additional log be maintained and kept with the case file in case the packaging material is damaged, or the item or sections of the item are re-packaged. If bar coding is utilized, then the evidence transfers can be recorded electronically with bar code readers and an appropriate database. However, these types of transfers can be unsecured transactions, thus leaving the integrity of the transfer in question. That is it may be possible for anyone with access to the database to transfer any item of evidence under any individuals name, even without the listed individual authorizing the transfer. This problem can be alleviated by requiring secret PIN entries in conjunction with the transfer, or by incorporating an electronic signature.

One common dilemma is the situation where one piece of evidence is eventually segregated in several sub-items. This separation process may occur at the laboratory once the examination process is commenced. When practical, items should be packaged separately such as to minimize this potential confusion. In order to achieve an effective chain of custody for the item of evidence in its entirety each sub-item must be properly logged and secured, and be clearly associated with the piece of evidence upon which it was derived. For example, consider a loaded handgun that

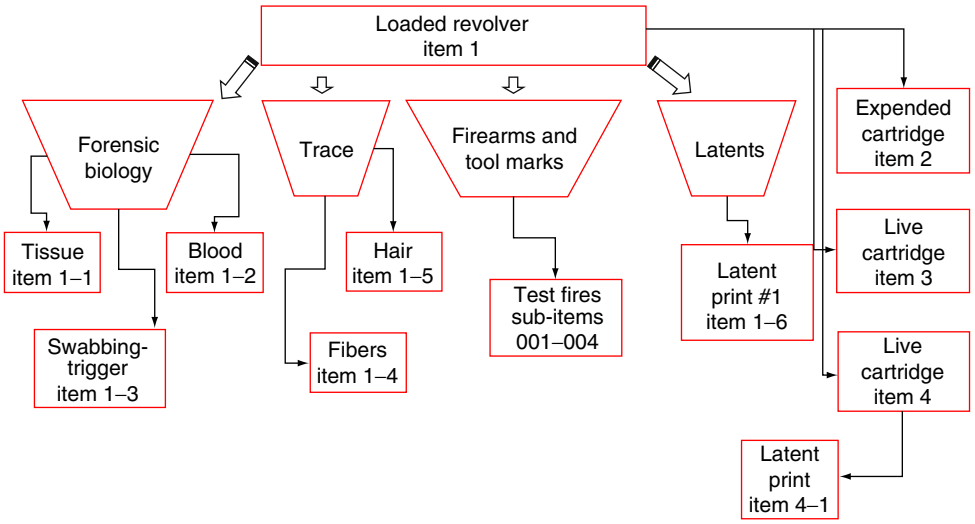

Figure 8 Schematic segregation of evidence into sub-items.

was recovered from an untimely death scene, and all of the potential evidence that may be derived from that one item, and all of the potential necessary transfers for each of those sub-items (Figure 8).

Legal Requirements

The general legal requirements associated with a chain of custody are codified by Federal Rules of Evidence Rule 901(a): "The requirement of authentication or identification as a condition precedent to admissibility is satisfied by evidence sufficient to support a finding the matter in question is what its proponent claims." The burden of proof regarding this requirement rests on the party offering the item into evidence. Generally the offering party need only make a prima facie showing of authenticity to gain admissibility. The offering party need not eliminate every possibility of substitution, alteration, or tampering, rather there is a reasonable probability regarding the identity and substantially unchanged condition of the evidence. Once this burden of proof is established, evidence generally is admitted into evidence and any discrepancies or minor breaks in the chain of custody will go the weight to be accorded by the jury. Since there are no black and white rules as to what constitutes a 'minor' break in the chain going to the weight rather than admissibility of that piece of evidence due diligence should be exercised to maintain an infallible chain.

Generally, the integrity of evidence is presumed to be preserved unless there is a showing of bad faith, ill will, or proof that the evidence has been tampered with. Even clerical errors relating to the chain are not necessarily fatal to the case so long as they occurred in good faith. Moreover, several courts have found that there is a presumption of regularity in the handling of evidence by officers, and there is a presumption that the officers exercise due care in handling their duties. The state is only required to demonstrate that it took reasonable protective measures to maintain the evidence. However, these presumptions are predicate on an adequate foundation that reasonable evidence handling procedures were in place and that they were followed. Yet, the standard may be elevated for fungible items of evidence where the identification of the item is not readily apparent.

The bottom line regarding chain of custody is that every effort should be made to properly handle and preserve a piece of evidence so that there is no doubt as to the authenticity or condition of that item from the time it is first collected until all potential uses are exhausted.

See also: Crime Scene Investigation and Examination: Major Incident Scene Management. Crime Scene Investigation and Examination: Recovery of Human Remains. Crime Scene Investigation and Examination: Suspicious Deaths. Evidence, Rules of. Serology: Overview

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