ASJMS
Al-Salam Journal for Medical Sciences
Journal Homepage: http://journal.alsalam.edu.iq/index.php/ajbms
e-ISSN: 2959-5398, p-ISSN: 2958-0870

Forensic Science Techniques: A Focus on Crime Scene Investigation

Saba Raad Jaafar[1]*, Ruaa Hussein Ali[2], Safa Salih Mahdi[2], Nada Hassan Mohammed[1], Basma H. Bedair[3] and Shahrazad H. Muhi [1]

[1] Department of Forensic Biology, Higher Institute of Forensic Sciences, Al-Nahrain University, Baghdad, Iraq

[2] Department of Forensic Chemistry, Higher Institute of Forensic Sciences, Al-Nahrain University, Iraq

[3] Department of Experimental Therapy, Iraqi Center for Cancer and Medical Genetics Research, Mustansiriyah University, Baghdad, Iraq

*Corresponding Author: Saba Raad Jaafar

DOI: https://doi.org/10.55145/ajbms.2026.05.01.001
Received September 2025; Accepted December 2025; Available online Febuary 2026

ABSTRACT: Forensic technology plays an essential function in investigations and guarantees the management of justice, and it is an important thing of modern crook justice. Crime scene investigation (CSI) is considered obviously one of its maximum well-known and large subfields. The numerous forensic techniques used in crime scene investigations are examined on this assessment with a focus on their significance, effectiveness and problems. Present day techniques and technology confirms that it has revolutionized the sector of forensic science on the equal time as focusing at the techniques involved in safeguarding, gathering and evaluating proof. A comprehensive evaluation of the forensic strategies relevant to crime scene investigations is given on this estimate, confirming the critical role that every technique performs particular and unique evidence evaluation. Forensic scientists can significantly assist within the studies of crimes in addition to the aid of the use of those strategies and supporting justice.

Keywords: Forensic science, crime scene, investigation, victims, justice

1. INTRODUCTION TO CRIME SCENE INVESTIGATION

The method of identifying, collecting, maintaining, and evaluating evidence positioned at crime scenes is referred to as crime scene investigation, or CSI. In order to piece collectively what occurred and be part of suspects and sufferers to the crime, this gadget is essential. To make sure that the bodily evidence accrued is honest and supported by era, forensic scientists use numerous techniques that hold the proof's integrity and shield in competition to infection [1].

Because even the smallest information can provide vital information about a case, crime scene investigators are extremely expert experts who want to pay close to interest to detail. To make certain that each one possible evidence is amassed and saved in the first-rate possible scenario, they appoint some of techniques. This fascinating region combines science, era, and investigative paintings. To fully recognize the occasions surrounding a crime and help in fixing it, investigators regularly collaborate carefully with regulation enforcement, forensic experts, and crook experts [2]. This helps to hold offenders to justice. Securing the scene, recording, accumulating proof, studying it,

reconstructing it, reporting, and testifying are normally the primary steps in the investigation system. Crime scene investigators are important to uncovering the reality and making sure justice because they integrate clinical accuracy with investigative techniques [3].

2. THE KEY OF FORENSIC TECHNIQUES IN CRIME SCENE INVESTIGATION

2.1 CRIME SCENE DOCUMENTATION AND PRESERVATION

A hit forensic investigation calls for effective documentation. The crime scene is photographed, the format is sketched, and thorough notes are made that consist of the area of the proof and any applicable environmental information. In order to allow investigators to precisely reconstruct the crime and create a chronology of events, the primary intention is to maintain the scene as it was at first found [3].

•Taking photographs: The stunning snap shots will be needed to adequately capture the scene. To ensure that the integrity of the results is upheld, they ought to cover the whole scene with emphasis on some areas of evidence [4].

•Drawing and mapping: Inclusive sketches and maps of the crime scene assist in constructing a spatial understanding of the location and provide appropriate context to the evidence items [3].

2.2 EVIDENCE COLLECTION AND PRESERVATION

To make physical evidence be acceptable in court, it have to be properly collected and stored. Among the methods used in this procedure are:

• Packaging and labeling: Each piece of evidence is accurately accrued and positioned in the right boxes like vials, packing containers or paper bags. After that these packing containers are categorized and sealed to take away any impendence of go-infection [5].

• Chain of custody: A documented chain of custody is upheld, to warranty the integrity of the evidence. This documents must be protect from infection or tampering, by specifies who handled the proof, when they treated it and why each switch befell [6].

• Biological evidence analysis: Organic evidence which consist of blood, hair, saliva, semen and different body fluids, at crime scenes is automatically accrued. The maximum eminent strategies for linking suspects to crime scenes or victims are DNA identification and analysis [7].

• DNA profiling: One of the most professional strategies in which forensic scientists have at their disposal for connecting suspects to crime scenes is DNA evaluation that is mentioned because the gold preferred in forensic identification. Investigators can find critical connections through evaluating DNA samples taken from recognized humans with the other taken from a crime scene [8]. The important techniques which is used for DNA analysis include:

  • Polymerase Chain Reaction (PCR): This technique used to amplifies smallest hint amounts of DNA, when minute amounts of DNA are available, that is producing enough amount for the next analysis test.

  • Short Tandem Repeat (STR) analysis: This method of analysis targets specific areas of DNA, which vary extremely in human beings. Due to their dramatic degree of variability, STRs are helpful in distinguishing the DNA profiles of various humans.

  • Mitochondrial DNA analysis: This method proves to be beneficial when nuclear DNA is not available for example, from hair shafts or degraded samples. Maternally inherited mitochondrial DNA can yield informative genetic data particularly in cases when other forms of DNA are degraded [9].

These methods together enable forensic scientists to efficiently compare DNA samples from crime scenes and those of potential suspects and yield substantial progress in criminal investigations [10].

• Serology: Presence and nature of biological fluids in the crime scene can be determined by blood typing, forensic serology and other tests, which can help link suspects to the scene [11].

2.3 TRACE EVIDENCE ANALYSIS

Small regularly microscopic substances, which can be considered as a hint proof like; fibers, hair, soil and gunshot residue. These substances have the possibility to transfer between humans or matters and acts as essential connections in a forensic research [12].

• Microscopic analysis: To pick out the supply of evidence along with hair or fibers, can be used light or electron microscopy.

• Chemical analysis: To analyze hint materials and determine their chemical signatures, that are crucial for understanding the context of the crime superior strategies can be used like Gas Chromatography-Mass Spectrometry (GC-MS) and Fourier Transform Infrared Spectroscopy (FTIR) [12].

2.4 FINGERPRINT ANALYSIS

Fingerprints are one of the most credible strategies of personal identity in forensic technology because the fact that they are specific to everyone and may be used to pick out victims or suspects. To find acquire and have a look at fingerprints at crime scenes, investigators use both conventional and modern methods [13].

• Latent print development: Latent fingerprints can be detect by way of quite a few techniques like fuming with chemical compounds like cyanoacrylate, applying chemical reagents or dusting with powders.

• Comparison of fingerprint database: To locate possible fits, a fingerprint can be compared to databases inclusive of the Automated Fingerprint Identification System (AFIS) after it's been identified [8].

2.5 ANALYSIS OF BLOODSTAIN PATTERNS

By looking at the size, form and distribution of bloodstains, evaluation of bloodstain sample may be used to piece together the activities of against the law. Important techniques include:

• Analyzing scatter patterns: entails identifying the perspective and direction of blood droplets to decide the attacker's and victim's places at some stage in the occasion.

•Void pattern analysis: This technique specify the locations in which a person or object blocked blood splatter and reveal wherein they had been on the time of the crime.

•Transfer pattern analysis: Analyzing styles formed when a bloody item comes into contact with another surface is called switch pattern evaluation [10].

2.6 FORENSIC TOXICOLOGY

Finding and analyzing pills, alcohol, poisons, and other materials in someone's body to determine their function in against the law is the principle intention of forensic toxicology. Toxicologists pick out substances in blood, urine, or tissue samples the use of techniques which includes Liquid Chromatography-Mass Spectrometry (LC-MS) and Gas Chromatography-Mass Spectrometry (GC-MS) [14].

2.7 DIGITAL FORENSICS

Digital forensics has emerged as a critical subject of inquiry as crimes increasingly more involve virtual gadgets. The healing and evaluation of information from computer systems, smartphones, GPS devices, and different electronic gadgets is the primary attention of forensic analysts [15].

• Data recovery and analysis: To find evidence that might be vital to resolving a criminal offense, investigators can get better deleted files, emails, textual content messages, and region facts.

• Mobile forensics: As smartphones have grown in reputation, cellular forensics has emerged as essential technique for obtaining facts that may be used to hint criminal hobby [16].

2.8 BALLISTICS

The take a look at of guns and ammunition using lots of techniques is referred to as ballistics. These techniques include:

• Trajectory analysis: This method makes use of the trajectory of a bullet to detect the position of the shooter.

• Firearm identification: is the process of connecting bullets and cartridge cases to a specific firearm, by way of evaluating their markings.

• Gunshot residue analysis: This process confirm recent firearm use, by way of locating residues on a suspect's hands or apparel [14].

3. EMERGING TECHNOLOGIES IN FORENSIC SCIENCE

Several new technologies have had a large effect on crime scene investigations in recent years:

• 3D crime scene reconstruction: By using this technique, forensic scientists can build digital 3D models of crime scenes and supplying an extra thorough know-how of the format, evidence places and potential projectile trajectories [17].

• DNA phenotyping: is an advanced technique that is when no suspect has been identified, can offer beneficial leads by using a suspect's DNA to are expecting positive physical characteristics, include of eye shade, hair color and ancestry [18].

• Forensic robotics: Robots with cameras, sensors and different contraptions are being utilized increasingly more in risky settings to collect evidence from crime scenes that could be dangerous for human investigators such as the aftermath of an explosion [19].

4. CHALLENGES AND LIMITATIONS OF FORENSIC SCIENCE

Though forensic science is a useful device in forensic investigations, it has some of obstacles. The following are some of the number one problems that investigators and forensic scientists face [20]:

1) Evidence contamination: Inappropriate collection, storage or analysis of proof can result in its contamination. The integrity of the research can be endanger and misguided outcomes may additionally cause from this infection. Typical resources of infection involve [21]:

• Human error: Using the improper gloves or equipment when managing evidence.

• Environmental factors: Heat, moisture and different situations that could purpose proof to break down.

• Cross-contamination: Is the practice of integrating statistics from numerous resources which may also result in wrong conclusions.

2) Interpretation of findings: Interpreting forensic proof is often necessary, but in the other hand it may be biased and subjective. This is specifically real in fields wherein specialists may attain distinct conclusions, which including bloodstain pattern evaluation and fingerprint evaluation. Important difficulties consist of [22]:

• Expert bias: Is the time period for character favoritism or preconceptions that affect how the evidence is interpreted.

• Ambiguity: Evidence that is complicated which is consider as a problem to more than one interpretations.

3) Technique reliability: Forensic techniques are not equally dependable and some may additionally produce false positives or negatives. For example:

• DNA analysis: In spite of its high accuracy, contamination or sample confusion can result in false matches.

• Bite mark analysis: This technique has exposed to criticism because of its high error fees and deficiency of scientific validation [23].

4) Technological restrictions: The precision and effectiveness of forensic evaluation can be effected by way of technological barriers. Important worries consist of:

• Equipment sensitivity: Some forensic equipment might also lost credibility because they are not able to determine materials at low concentrations.
• Software limitations: Digital forensics equipment can also have difficulties in processing of encrypted statistics or dealing with big statistics sets [24].

5) Chain of Custody: To maintain the integrity of evidence that is requires a suitable chain of custody. The validity of the proof can be confused if this chain is damaged. Among the problems are:

• Documentation: Poor or incomplete documentation can compromise the chain of custody.
• Storage: Evidence can rot or turn out to be contaminated due to fake storage conditions [25].

6) Legal and ethical issues: Quantities of prison and ethical unrest must be managed via the use of forensic technology. These tools are :

• Privacy concerns: here are serious specific problems with the collection of DNA and other personal information.
• Court admissibility: The clinical validity of forensic methods must be determined and not all of them are accepted in [26].

7) Resource limitations: Forensic labs generally have beneficial resource limitations, which can make it difficult for them to present complete and agitate analyses. Major issues are:

• Funding: Availability of state of the art equipment and dynamic training could be limited with the help of tight budget.
• Workload: Processing of proof may be delayed and accumulated because of excessive case loads. [27].

8) Standardization and accreditation: Misaligned greatness in forensic in addition may offering result from standardization wastage and accreditation. Some among the challenges are:

• Practices variation: Different labs will follow unique procedures and processes.
• Accreditation: Not all forensic labs are accredited; casting doubt upon the credibility of their results [28].

9) Human factors: Finally, the forensic science relies on human behavior, which can be fault-prone. Such faults can also comprise:

• Cognitive biases: Are the tendency to interpret facts in a way that confirms preexisting opinions.
• Fatigue and stress: Long hours and extravagant pressure environments can result in errors [29].

10) Emerging threats: With technological advancements, new challenges are faced by forensic science. These include:

- Cybercrime: Cyber forensics has challenging situations of great importance because of the emerging growing complexity and sophistication of cybercrimes.
- Synthetic biology: Synthetic biology innovations must render it progressively more problematic to understand and evaluate organic evidence [30].

Even with all those problems and constraints, forensic technology still advance and climb higher due to research being constantly conducted, superior technology with a commitment to justice and accuracy. In addition, not all forensic methodologies are universally acceptable in court and the medical reality of such methods have to be established [31].

5. CONCLUSION

Forensic science techniques are highly relied upon by the criminal justice system, particularly in their use within crime scene examination. The techniques provide valuable data that can lead to either exoneration or conviction through the provision of information on what happens among victims, suspects and the crime. Even while high-tech continues to enhance forensic professionals' competency, evidence management, human error to implement and resource availability remain problems. Continuous research and technological advancements are necessary to maximize the advantages and efficiency of forensic science in solving crimes.

FUNDING

None

ACKNOWLEDGEMENT

The authors would like to thank the anonymous reviewers for their efforts.

CONFLICTS OF INTEREST

The authors declare no conflict of interest

REFERENCES

[1] A. Badiye, P. Sulke, H. Sharma, and N. Kapoor, “Crime scene investigation: An introduction,” in Textbook of Forensic Science. Cham, Switzerland: Springer, 2023, pp. 177–196.

[2] H. Druid, “Crime scene and crime scene investigations,” in Handbook of Forensic Medicine, vol. 1. Amsterdam, The Netherlands: Elsevier, 2022, pp. 161–181.

[3] H. Eldridge, Crime Scene Reconstruction and Event Analysis. 2023.

[4] C. D. Duncan, Advanced Crime Scene Photography. Boca Raton, FL, USA: CRC Press, 2023.

[5] M. A. Costache, “Some aspects of crime scene investigation,” in Proc. 15th Int. RAIS Conf. Social Sciences and Humanities. Bucharest, Romania: Scientia Moralitas Research Institute, 2019, pp. 242–246.

[6] P. T. Jayaprakash, Crime Scene Investigation and Reconstruction: An Illustrated Manual and Field Guide. Boca Raton, FL, USA: CRC Press, 2022.

[7] K. Osman, G. F. Gabriel, and N. H. Hamzah, “Crime scene investigation issues: Present issues and future recommendations,” Jurnal Undang-Undang dan Masyarakat, vol. 28, p. 3, 2021.

[8] R. A. van Oorschot, G. E. Meakin, B. Kokshoorn, M. Goray, and B. Szkuta, “DNA transfer in forensic science: Recent progress towards meeting challenges,” Genes, vol. 12, no. 11, p. 1766, 2021.

[9] C. Weyermann and C. Roux, “A different perspective on the forensic science crisis,” Forensic Science International, vol. 323, p. 110779, 2021.

[10] H. N. Singh, “Crime scene investigation,” International Journal of Science and Research, vol. 10, no. 11, pp. 642–648, 2021.

[11] J. Meteňko and M. Meteňková, Significance of the Crime Scene and Specific Principles of Inspection. 2022.

[12] A. Hryhorenko, O. Musiienko, V. B. Dzhumelia, A. Sakovskyi, and A. Myrovska, “Reconstruction as a method of crime investigation,” Revista Amazonia Investiga, vol. 10, no. 45, pp. 113–119, 2021.

[13] S. Wüllenweber and S. Giles, “The effectiveness of forensic evidence in the investigation of volume crime scenes,” Science & Justice, vol. 61, no. 5, pp. 542–554, 2021.

[14] M. Esposito et al., “Advances in technologies in crime scene investigation,” Diagnostics, vol. 13, no. 20, p. 3169, 2023.

[15] G. Horsman, “Digital evidence and the crime scene,” Science & Justice, vol. 61, no. 6, pp. 761–770, 2021.

[16] N. Galante et al., “Applications of artificial intelligence in forensic sciences: Current potential benefits, limitations and perspectives,” International Journal of Legal Medicine, vol. 137, no. 2, pp. 445–458, 2023.

[17] C. Villa, N. Lynnerup, and C. Jacobsen, “A virtual, 3D multimodal approach to victim and crime scene reconstruction,” Diagnostics, vol. 13, no. 17, p. 2764, 2023.

[18] A. M. Smith and T. M. Neal, “The distinction between discriminability and reliability in forensic science,” Science & Justice, vol. 61, no. 4, pp. 319–331, 2021.

[19] A. A. Khan et al., “Digital forensics and cyber forensics investigation: Security challenges, limitations, open issues, and future direction,” International Journal of Electronic Security and Digital Forensics, vol. 14, no. 2, pp. 124–150, 2022.

[20] O. Aleksandrenko, “Problematic issues on the use of forensic analysis during investigation of crimes,” Theory and Practice of Forensic Science and Criminalistics, vol. 27, no. 2, pp. 76–88, 2022.

[21] A. Biju, K. Hambly, and A. Joshi, “The complexity of forensic science in criminal investigations: Is there a gold standard?” Voices of Forensic Science, vol. 1, no. 1, pp. 7–26, 2021.

[22] J. T. Bouzin et al., “Mind the gap: The challenges of sustainable forensic science service provision,” Forensic Science International: Synergy, vol. 6, p. 100318, 2023.

[23] A. S. Chancellor, “Common investigative mistakes,” in Investigating Sexual Assault Cases. Boca Raton, FL, USA: CRC Press, 2021, pp. 473–493.

[24] K. A. Martire et al., “Understanding ‘error’ in the forensic sciences: A primer,” Forensic Science International: Synergy, vol. 8, p. 100470, 2024.

[25] J. Morgan, “Wrongful convictions and claims of false or misleading forensic evidence,” Journal of Forensic Sciences, vol. 68, no. 3, pp. 908–961, 2023.

[26] K. Puddifoot, “Credibility deficits, memory errors and the criminal trial,” in The Social Epistemology of Legal Trials. London, U.K.: Routledge, 2021, pp. 9–29.

[27] B. J. Shapiro, Beyond Reasonable Doubt and Probable Cause: Historical Perspectives on the Anglo-American Law of Evidence. Berkeley, CA, USA: University of California Press, 2023.

[28] G. B. Mensah, A. Addy, and P. O. Frimpong, “Comparative legal analysis of the medical negligence landscape: The Ghanaian and commonwealth criminal jurisprudence,” Journal of Law, Policy and Globalization, vol. 136, p. 21, 2023.

[29] M. Hu and B. Liang, “Continuation of systemic failures: From Cui Ning to contemporary wrongful conviction cases in China,” Asian Journal of Criminology, vol. 17, suppl. 1, pp. 75–94, 2022.

[30] W. A. Bhat, A. AlZahrani, and M. A. Wani, “Can computer forensic tools be trusted in digital investigations?” Science & Justice, vol. 61, no. 2, pp. 198–203, 2021.

[31] W. M. Khalilia et al., “Challenges facing Palestinian crime scene investigators,” Egyptian Journal of Forensic Sciences, vol. 14, no. 1, p. 13, 2024.