



# Kristu Jayanti College

**AUTONOMOUS**

**Bengaluru**

Reaccredited A++ Grade by NAAC | Affiliated to Bengaluru North University



## DEPARTMENT OF FORENSIC SCIENCE

### A Bi- Annual Publication



# VERITAS

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# MESSAGE FROM THE PRINCIPAL

Rev. Fr. Augustine George



Forensic science plays a pivotal role in the criminal justice system of any country. As it deals with the scientific examination of evidence, it makes it more valuable in assisting the court to make the correct judgement. Initiating from the scene of crime, forensic science is a discipline which should be highlighted efficiently throughout the process of criminal justice.

Forensic science has evolved along with science in the implementation of technology to aid in the process of investigation of crime and analysis of evidence. Fields like digital forensics have paved the way for investigation of new age crimes.

The Department of Forensic Science at Kristu Jayanti College (Autonomous), Bengaluru, has progressed very well and in the fifth year of their existence have achieved a lot. The department runs a Bachelor's (single major), Bachelor's (Double major)

in Biotechnology and Forensic Science and Master's in Science in Forensic Science programmes. The department ensures to conduct sessions for students from experts in the field at an international level.

The Forensic Science newsletter, 'Veritas' is a bi-annual newsletter published by the department of forensic science which compiles articles written by the forensic science students on matters relating to research areas, case studies, newer technologies etc. I am happy to state that the department has procured an ISSN number for the newsletter, therefore making the newsletter and the articles in it more valuable. This edition of Veritas will ensure to bring to the readers more scientific information and articles. The faculty and students of the department have worked tremendously to ensure this edition comes out well to its readers.

On this occasion, I congratulate the department of Forensic Science and the editorial board of Veritas for the successful and effective issue of the third issue of the first volume.

# MESSAGE FROM THE DEAN

Dr. Calistus Jude A.L.



It is a delight that the Department of Forensic Science, Kristu Jayanti College has come out with its fifth edition of newsletter “Veritas”. This edition is a testament to the dedication and passion of the students, alumni and faculty members of the department.

The academic community of the Department consider Veritas as a platform to showcase the achievements, research and contributions of the department, its students and faculty members. It reflects the impressive growth of the department and highlights the role played by the students and faculty in creating awareness on the latest trends in forensic science.

This edition has in store insightful articles, research updates and reports of the myriad programmes organised by the department. The flipbook version makes the newsletter more interactive. I congratulate the department for procuring an ISSN number for Veritas which makes this publication more valuable.

I would like to extend my heartfelt gratitude to the editorial team, student and faculty contributors and the creative team who have worked tirelessly to bring this newsletter to fruition. Their efforts have truly captured the spirit and vibrancy of the department.

I look forward to the continued growth and success of the department and the contributions we will make to the field of forensic science in the years to come.

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# SILVER JUBILEE OF KRISTU JAYANTI COLLEGE AUTONOMOUS



Amidst the bustling streets of Bengaluru, India, an educational institution has stood the test of time and left a lasting mark on the world of higher education. With a history of 25 years, Kristu Jayanti College is more than just an academic institution. It is a testament to the founding visionaries and the countless others who contributed to its growth.

Kristu Jayanti College was established in 1999 and is managed by the Bodhi Niketan Trust. It was founded by the members of the Carmelite Province of St. Joseph of Mary Immaculate (CMI), which is India's first indigenous religious congregation. This community is the epitome of the dreams and visions of the 19th century Indian educator and social reformer St. Kuriakose Chavara. The university started with 1 course, 9 students and 3 faculty members and has now grown rapidly to 10,000 students, 33 UG programmes, 17 PG programmes, and 3 PG diploma programmes. Over the years, Kristu Jayanti College has embarked on a journey of academic expansion.



New courses and programmes are being introduced to meet the changing needs of a globalised world.

The institute's commitment to educational excellence has paid off, achieving consistently high rankings and accreditation from prestigious educational organisations. Carefully selected for their expertise and passion for teaching, our faculty has played an important role in shaping our academic community. The institute's commitment to research and innovation is evident in the numerous publications, patents, and projects undertaken by both faculty and students. The physical infrastructure of Kristu Jayanti College has developed in parallel with its academic activities. State-of-the-art classrooms, well-equipped laboratories, and modern recreational facilities have transformed the campus into a vibrant centre of learning and collaboration. In addition, the institute's eco-friendly initiatives and green spaces on campus reflect its commitment to environmental sustainability.

The college is affiliated with Bengaluru North University and was reaccredited with the 'A++' grade by NAAC in 2021. It has been an independent institution since 2013. "Light and Prosperity" is the institution's vision; its mission is to provide educational opportunities to all ambitious young people, enabling them to excel in all aspects of life.



**Quick  
READ**

**Mr. Siva Prasad  
Nanduri  
Appointed As  
The CEO Of DTL**

Diamonds Tech Ltd. (DTL), a leading Tachno Staffing Organisation dedicated to empowering businesses through technology-driven solutions, has announced the appointment of Mr. Siva Prasad Nanduri as its new CEO. At DTL, Mr. Nanduri will be primarily responsible for building, nurturing, and growing the company into India's largest publicly run IT staffing organization. With a distinguished career spanning over two decades in IT Recruitment and Sales at well-known organizations like Team Lease Digital, the

**Kristu Jayanti's Silver Jubilee Celebrations; A  
Journey Of Empowering Youth And Enriching Lives**

Kristu Jayanti College marked a significant milestone as it kicked off its Silver Jubilee celebrations on Thursday, commemorating 25 years of academic excellence. The event witnessed the presence of esteemed guests, with Shri KJ George, Minister for Energy, Government of Karnataka, serving as the chief guest and Prof Niranjana Vinallu, Vice



their shoulders. Shri KJ George also encouraged students to take a stand against corruption and highlighted the importance of respecting all forms of labor, from pournakarmikas to teachers. Furthering his commitment to societal progress, Shri KJ George emphasized the significance of

women's empowerment. He proposed providing free bus passes to women, recognizing that nearly 50 percent of the population comprises women, and enhancing their access to essential services would empower them in their roles. Turning the spotlight onto Kristu Jayanti College, Prof Niranjana

Vinallu, Vice Chancellor of Bangalore North University, commended the institution for its exceptional dedication to providing quality education to the younger generation. He noted that the college's excellence in academics had been instrumental in achieving the remarkable milestone of 25 years, attributing this success to the vision and commitment of the CMI fathers towards society. In his presidential address, Fr Dr Abraham Velayudhan, Provincial of CMI Congregation, St Joseph Province Kottayam, reflected on the humble beginnings of Kristu Jayanti College and the overarching vision of the CMI St Joseph Province Kottayam.

**Keng  
For R**

Transport Minister at Thiruvananthapuram, a long-awaited project of the urban bus track and will public use by January. Full operation of Upanagar to discussions with the government. However, he the counter within the bus

Kristu Jayanti College, celebrating its 25th anniversary, stands as a beacon of educational excellence and a testament to the transformative power of education. The college's rich history is more than just a chronicle, it is a story of resilience, growth, and an unwavering commitment to shaping the minds and characters of the next generation. Ever-evolving, Kristu Jayanti College continues to be a dynamic force in the world



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NATIONAL SCIENCE DAY

# INTERNATIONAL CONFERENCE ON ADVANCES IN FORENSIC SCIENCE [ICAFS] 2023

**Date:** 20/04/2023 & 21/04/2023

**Details of participants:** External delegates 109; Internal delegates 336.

## **Resource Persons:**

1. Dr. V V Pillay, eminent forensic toxicologist, Amrita Institute of Medical Sciences and Research Centre, Kochi,
2. Shri. Keshav Kumar, IPS (retd.), Former ADGP, Gujarat state police,
3. Dr. William Goodwin, Reader in Forensic Genetics, University of Central Lancashire, UK,
4. Dr. Carlos A Guitierrez, Secretary of Consensus body of ASB CSI from AAFS Standards Board (ASB), USA,
5. Dr. S Venkata Raghava, Professor And Head, Department Of Forensic Medicine And Toxicology , Bangalore Medical College And Research Institute and
6. Dr G B Aravind, Associate Professor and Coordinator of Forensic Science, Department of Forensic Medicine and Toxicology, JSS Medical College, Mysuru

## **Brief Summary of Expert Guest lecture**

The department of Forensic Science at Kristu Jayanti College (Autonomous), Bengaluru organised the 2nd International Conference on Advances in Forensic Science (ICAFS), 2023 on 20th and 21st April 2023 at the college campus. The conference was organised in a hybrid manner with delegates joining in person and over online video conferencing platforms.

The conference witnessed 6 plenary sessions addressed by eminent forensic science researchers and professionals and 76 research paper and poster presentations both offline and online. The plenary speakers included Dr. V V Pillay, eminent forensic toxicologist Amrita Institute of Medical Sciences and Research Centre, Kochi, Shri. Keshav Kumar, IPS (retd.), Former ADGP, Gujarat state police, Dr. William Goodwin, Reader in Forensic Genetics, University of Central Lancashire, UK, Dr. Carlos A Guitierrez, Secretary of Consensus body of ASB CSI from AAFS Standards Board (ASB), USA, Dr. S Venkata Raghava, Professor And Head, Department Of Forensic Medicine And Toxicology , Bangalore Medical College And Research Institute and Dr G B Aravind, Associate Professor and Coordinator of Forensic Science, Department of Forensic Medicine and Toxicology, JSS Medical College, Mysuru. The plenary sessions covered topics ranging from quality assurance to advanced forensic techniques of the future.



The conference was attended by more than 150 delegates from across India. It also witnessed 76 presentations by researchers and academicians of research in the various disciplines of forensic science. The paper and poster presentations were assessed by scientific panels and best papers and posters were awarded.

The conference was inaugurated on 20th April by Shri. Keshav Kumar, IPS (retd.), Former ADGP, Gujarat state Police who listed the challenges facing the forensic science fraternity and outlined the government's focus on improvement and modernisation of forensic services in the country. Fr. Jais V Thomas, Financial Administrator, Kristu Jayanti college presided the inauguration and exhorted the delegates to make good use of the 2 days and aspire for greater heights in the field of forensic science. Mr. Don Caeiro, Coordinator, Department of Forensic Science listed the progress made by the department and outlined the need for delegates to deliberate and discuss the techniques and tools available to utilize them in their full potential.

The conference generated a lot of interest all around India and had delegates from neighbouring states and many faraway states of India.

### Photographs:







# INTER-COLLEGIATE FORENSIC SCIENCE FEST 'INQUISITOR'

**Title:** Inter-collegiate Forensic Fest- INQUISITOR 2023

**Date:** 10/03/2023

**Number of participants:** 17

## **Objective:**

To stimulate and promote students to improve their understanding in their core skills and channel their participation to extra-curricular and co-curricular events.

## **Brief write-up:**

The Forensic Science club, Unit of Forensic Science organised Inquisitor 2023, inter-collegiate forensic fest for students of forensic science in other colleges based in India. This forensic fest aimed at discovering students' knowledge and understanding of the subject as it offered a wide science related events.

The event was organised by the student coordinators of the Forensic Science club at Kristu Jayanti College, Bangalore. The BSc Forensic Science students at Kristu Jayanti College formed the working group and were event and team organisers. The participants included the Forensic Science students from 4 different institutes across India.

The fest was executed with a total of 7 events and was organised at its best of quality. The fest was conducted offline in the college campus. The high-spirited forensic fest started with preliminary rounds of various events on 10th March, 2023.

The participants were given participant codes to ensure fairness and none of the internal students participated and the event was open only for external participants.

7 events were organised which included - Crimetoologist (Sketching), i-witness (Observation test), X-Word (Crossword), Cross examination (Case study presentation), Wiz Quiz (Forensic Quiz), Room of Opinions (Debate), and Sherlock Holmes (Personality contest).

The inaugural ceremony of the fest was presided over by Fr. Augustine George, Principal, Kristu Jayanti College, Bangalore and the guest of honour was Mr. Premjith, Director, Infosec-Textual Cyber Security, Bangalore. In his presidential address, Father enlightened about the importance of forensic science and its scope in everyday life. Mr. Premjith spoke about the existing avenues in Forensic Science and the future scopes. He encouraged students to take up newer domains and fields which are coming up in the field. He exhorted the faculty members to take up newer topics and help the students evolve into newer and brighter minds.

In the valedictory ceremony, Fr. Jais V Mathew, Financial Administrator and



Dr Calistus Jude, Dean, Faculty of Science, Kristu Jayanti College felicitated the winners of various events and appreciated the Forensic Science club coordinators for having conducted the forensic fest successfully.

### List of Winners

SNo	Prize	Organisation
1.	Overall Winners	National Forensic Sciences University, Goa
2.	Runners up	Jain University School of Sciences, JC Road, Bengaluru



# KRYPTOS – FORENSIC SCIENCE EXHIBITION

**Date:** 27 February 2023

**Details of participants:**

Students from different Higher secondary (PU) schools and colleges teaching forensic science and allied programmes (120)

Students of the department of forensic science (360)

**Venue:** M1 Audi, Main Block

**Resource Persons:**

Dr. Hemalata M, Principal, Dr. MR Ambedkar Dental College, Bangalore

Brief Summary of Expert Guest lecture

Kryptos the forensic science exhibition was organised by the department of forensic science, Kristu Jayanti College on 27th February 2023. Being the first time, the exhibition garnered a lot of interest among students of the department and among nearby institutions.

Dr. Hemalata M, Principal, Dr. MR Ambedkar Dental College, Bangalore inaugurated the event along with Fr. Dr. Augustine George, Principal, Kristu Jayanti college. During the inauguration the presidential address was delivered by Fr. Augustine George who stressed on the need for such events to improve the skill sets of students and he applauded the students and teachers of the department for the effort in organising the exhibition. The inaugural address was delivered by Dr. Hemalata M, Principal, Dr. MR Ambedkar Dental College, Bangalore who explained the need for exhibitions and how these events help in developing the psycho-motor skills and the experiential skills among students. She also exhorted the students to never stop learning and to keep the mindset of challenging defiance in times of uncertainty.

A total of 15 chart posters, 23 digitally created infographic posters, 40 static models, 10 dynamic models were created by the students, and teachers of the department. A total of 15 institutions visited the exhibition during the day and gave very positive feedback.





# FORENSIC PSYCHOLOGICAL TECHNIQUES IN FORENSIC INVESTIGATION

**Date:** 17 February 2023

**Details of participants:** B.Sc. Forensic Science students IV semester (122 students)

**Resource Persons:** Dr. Priyanka Kacker, School of Forensic Psychology, National Forensic Sciences University, Gandhinagar

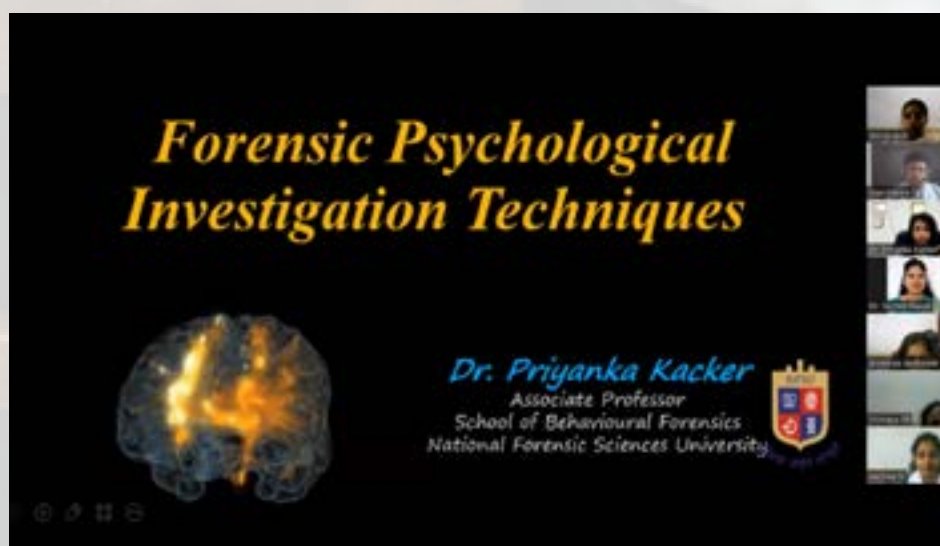
## **Brief Summary of Expert Guest lecture:**

The expert talk on Forensic Psychological techniques in Forensic Investigation was held on 17th February 2023 with the resource person Dr. Priyanka Kacker, School of Forensic Psychology, National Forensic Sciences University, Gandhinagar. The session was aimed at orienting the students of IVth semester BSc Forensic Science to the different Forensic Psychology techniques used in forensic investigation.

Techniques like polygraph, narco-analysis and brain fingerprinting were discussed in detail by the resource person. The different strengths and weaknesses of each technique was explained with different case studies to help students understand the application of these techniques.

Legal admissibility of each technique was the next part of the lecture and the resource person took the students through the different landmark cases which led to use of these techniques in India and alongside the different recent legal admissibility issues these techniques were held into were explained in great detail.

Students could also ask questions to the expert person and discuss some of their queries. The session was interactive and much useful in strengthening the knowledge learnt by students through the curriculum during this semester.





# FORENSIC ASPECTS IN DISASTER VICTIM IDENTIFICATION

**Date:** 09/03/2023

**Details of participants:** B.Sc. VI Semester Forensic Science students.

**Resource Persons:** Ms. Hansi Bansal, Assistant Professor, Government Institute of Forensic Science, Nagpur

## Brief Summary of Expert Guest lecture

The department of forensic science, Kristu Jayanti College, Bangalore organised an expert lecture titled 'Forensic aspects in Disaster victim Identification' on 09/03/2023. The resource person for this session was Ms. Hansi Bansal, Assistant Professor, Government Institute of Forensic Science, Nagpur. The session was conducted online over the ZOOM platform.

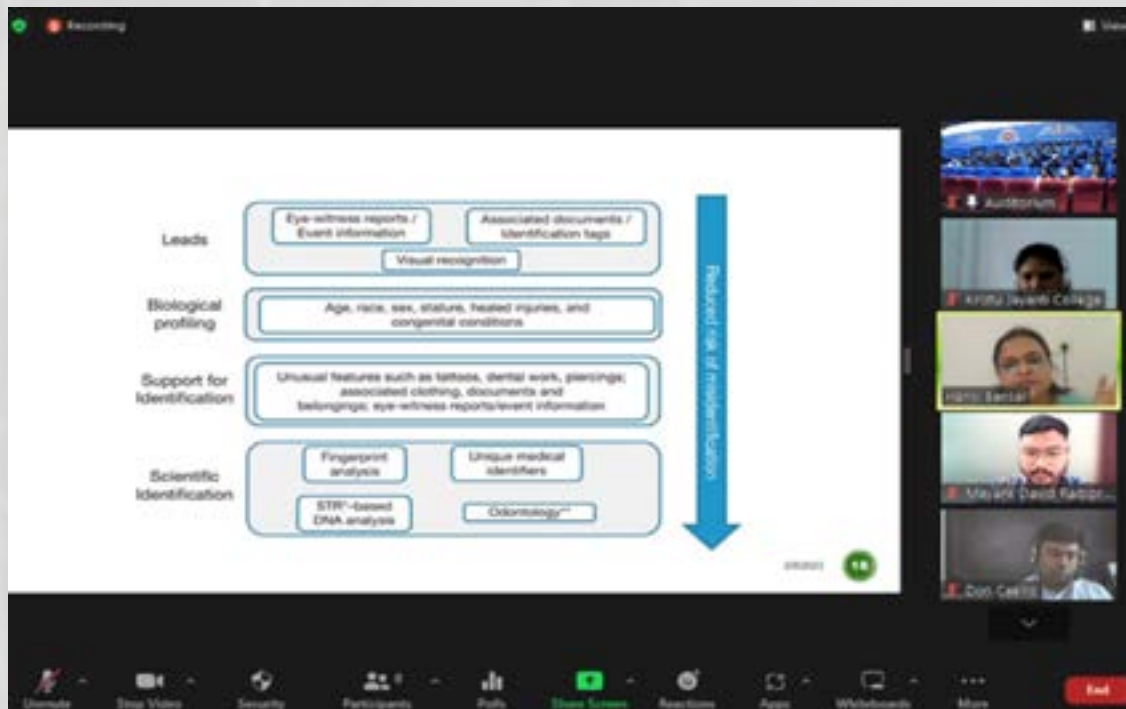
The session highlighted the different tools and techniques available for disaster victim identification. The students of 6th semester BSc Forensic Science have a course titled 'DNA Typing' where disaster victim identification forms a major portion of their training.

The resource person started the lecture by explaining the need and significance of disaster victim identification. The Red Cross guidelines and the formation of a new division in forensic science called 'humanitarian forensics' was underlined.

The tools which were used traditionally and the newer more robust and skilled techniques were outlined and discussed in detail by the resource person. Tools like anthropology, DNA, heredity testing etc. were explained in great detail.

The resource person also outlined the case studies where these tools and techniques have been used in the recent past both in India and abroad.





# BIOLOGICAL SAMPLES AND FORENSIC ANALYSIS

**Date:** 9 March 2023

**Details of participants:** IV semester B.Sc. Forensic Science. (121)

## **Resource Persons:**

Dr. Ajay Rana, Scientist B, CFSL Hyderabad

## **Brief Summary of Expert Guest lecture**

9th March 2023

The Department of Forensic Science, Kristu Jayanti College, Autonomous organised the third expert lecture for the academic year Jan-June 2023 on the theme “Biological sample and forensic analysis” on March 9th, 2023. The session was held online via the ZOOM platform. Dr. Ajay Kumar Rana, Scientist B, CFSL, Hyderabad, was the resource person. The session started with a brief introduction of the speaker to the audience. Soon later, the session was taken over by the resource person. Sir introduced Forensic Science and the first case of Julius Cesar in forensic evidence. Sri explained that biological samples commonly detected blood, sperm, saliva, bone, flesh, bone, and saliva. Sir explained the notion of presumptive, confirmatory blood and species tests. . Sir also noted that FSL and CFSL removed blood grouping due to low discriminatory power. The secretors and non-secretors tests, as well as the saliva examination utilising the Phadebas test, were explained. Hair’s position as an exhibit has been expanded. Microscopic study of spermatozoa, P30 immunoassays, and SERATEC for vaginal cell secretion have all been explained. Sir mentioned the reference samples acquired from the accused or victim as blood or cheek swab, as well as biological samples collected for DNA profiling on mobile phones, glass bottles, bite marks, toothbrushes, and so on. The DNA profiling procedures, types of DNA polymorphisms such as autosomal STR, Y STR, X- STR, DNA extraction methods, DNA quantification in kits quantifier HP and DNA Trio kit, DNA amplification by thermal cycler, and

DNA amplification by thermal cycler are all explained in depth. Finally, the floor was offered for questions, and each question was enthusiastically accepted and appropriately answered.




### Sources of Biological Evidences



Blood



Semen



Bone



Teeth



Hair



Skin/Flesh/Sweat



Saliva



Urine



### Automated - RapidHIT ID instrument









# CYBER SECURITY AND DIGITAL FORENSICS

**Date:** 17 April 2023

**Details of participants:** VI semester B.Sc. Forensic Science.

**Resource Persons:** Ms. Brunda Anil Sastry, PG diploma student, Lambton College, Canada

## **Brief Summary of Career orientation session**

17th April 2023

The Department of Forensic Science, Kristu Jayanti College, Autonomous hosted the third career orientation lecture for the academic year Jan-June 2023 on the topic “Cyber-security and digital forensics” on April 17th, 2023. The session was held offline in the A1 Auditorium, Admin Block. Ms.Brunda, a PG diploma student at Lambton College in Mississauga, Canada, was the resource person. The event began with a brief introduction of the speaker to the audience. The resource person swiftly took over the session. Madam clarified the fundamental distinction between digital forensic science and cyber-security. She went on to explain the various certifications available and touched on the employment roles of a digital forensic specialist. She then narrowed her discussion to cyber forensics fields such as red team and blue team. • She also informed the students about blue team certifications such as CompTIA Security+, Certified Information Systems Security Professional (CISSP), Global Information Assurance Certification (GIAC Certification/GSEC), as well as red team certifications such as Certified Ethical Hacker (CEH)- EC Council, Cisco Certified Network Associate (CCNA) Security, and Certified Red Team Operations Professional (CRTOP)- CompTIA+. She also described in detail the application process for a postgraduate diploma/degree overseas. She talked about her college experience, graduation curriculum, and teaching learning pedagogy. Finally, the session was opened up for questions, and each question was positively accepted and appropriately answered.





# INDUSTRIAL VISIT

**Title :** Industrial Visit to Hyderabad

**Date:** 12/04/2023-15/04/2023

**Batch-** B.Sc Forensic science

**Semester-** VI semester

**Total student participants-** 54

## **Objective:**

1. To provide practical exposure to a state-of-the-art research and diagnostic facility in the field of DNA fingerprinting and diagnostics.
2. To interact with renowned scientists, researchers, and experts in the field of DNA fingerprinting

## **Write up on the Programme**

***Date: 12th and 15th April 2023***

An industrial visit was organised for the B.Sc. 6th Semester students total number of 54 students, from April 12 to April 15, 2023, with the primary objective of providing them with practical insights into the field of DNA fingerprinting and diagnostics. The visit also offered an opportunity for the students to explore the rich cultural heritage and popular tourist attractions in Hyderabad.

***Day 1:*** Visit to the Centre for DNA Fingerprinting and Diagnostics (CDFD) On the first day of the industrial visit, the students visited the Centre for DNA Fingerprinting and Diagnostics (CDFD) in Hyderabad. The centre is renowned for its cutting-edge research and advancements in the field of DNA fingerprinting. The visit began with a guided tour, where the students were given an overview of the centre's facilities and research activities.

During the visit, the students had the privilege of witnessing various laboratories equipped with state-of-the-art technology used for DNA analysis. They interacted with the scientists and researchers at CDFD, who shared their knowledge and experiences regarding DNA fingerprinting techniques. The students learned about the applications of DNA fingerprinting in forensic science, paternity testing, and genetic research. The visit to CDFD provided a practical understanding of the concepts taught in their curriculum and exposed them to the latest developments in the field.

***Day 2 to Day 4:*** Tourist Attractions in Hyderabad

Apart from the industrial visit, the students also had the opportunity to explore the cultural and historical landmarks of Hyderabad. The following popular tourist attractions were included in the itinerary:

*Charminar:* The iconic monument of Hyderabad, Charminar, was the first stop on the second day. Students marvelled at the architectural brilliance of this historical structure and learned about its cultural significance.

*Snow World:* The visit to Snow World offered a unique experience to the students as they enjoyed the thrill of the snow-clad environment, engaging in various snow activities and rides. It provided a refreshing break from the scorching summer heat.

*Golconda Fort:* Known for its grandeur and historical significance, Golconda Fort was a highlight of the tour. The students explored the massive fort complex, learned about its architectural features, and enjoyed panoramic views of the city from the top.

*Salarjung Museum:* The Salarjung Museum houses an extensive collection of art, artefacts, and historical items. The students had the opportunity to appreciate the diverse exhibits, including sculptures, paintings, textiles, and weaponry, showcasing India's rich cultural heritage.

*Ramoji Film City:* The visit to Ramoji Film City provided insights into the world of Indian cinema. The students witnessed various film sets, experienced behind-the-scenes activities, and learned about the filmmaking process.



# INDUSTRIAL VISIT

**Title :** Industrial Visit to RFSL, Mysore

**Date:** 02/05/2023

**Batch-** M.Sc Forensic science

**Semester-** II semester

**Total student participants-** 39

## **Objective:**

1. To Observe State-of-the-Art Equipment in RFSL
2. To provide Exposure to Different Forensic Disciplines

## **Write up on the Programme**

**Date:** 12th and 15th April 2023

The Industrial Visit to the Regional Forensic Science Laboratory (RFSL) in Mysore, Karnataka was organized for the M.Sc. Forensic Science 2nd semester students on 2nd of May 2023. The visit aimed to provide students with practical exposure to the various aspects of forensic science and its applications in real-world scenarios. The RFSL in Mysore is a well-established laboratory known for its advanced forensic facilities and expert professionals. The visit was headed by Dr. Suchita Rawat and Mr. Jeremiah Justus, Assistant Professor, Dept. of Forensic Science, Kristu Jayanti College (Autonomous), Bengaluru.

The industrial visit commenced at 9:00 AM with a warm welcome by the laboratory staff. The students were divided into smaller groups for better engagement and facilitated learning. The visit comprised the following activities:

### **1. Orientation and Introduction:**

The visit began with an orientation session where the laboratory's objectives, functions, and the scope of forensic science were discussed. The students were introduced to the diverse forensic disciplines practised at the laboratory.

### **2. Forensic Laboratory Tour:**

The students were taken on a comprehensive tour of the laboratory facilities. The tour covered various sections, including the DNA analysis, toxicology, fingerprinting, ballistics, and questioned documents sections. The students observed first-hand the state-of-the-art equipment and techniques used in each department.

### **3. Demonstrations and Hands-on Experience:**

The laboratory staff conducted interactive demonstrations to illustrate the techniques and methodologies used in different forensic analyses. Students were given opportunities to participate in simple hands-on activities, such as lifting fingerprints, analysing crime scene evidence, and observing microscopic slides.



#### **4. Interaction with Forensic Experts:**

The students had the opportunity to interact with forensic scientists, experts, and analysts. They were encouraged to ask questions and clarify doubts regarding various aspects of forensic analysis, career prospects, and challenges faced in the field.

#### **5. Case Studies and Presentations:**

The laboratory personnel presented intriguing case studies, highlighting the role of forensic science in solving complex crimes. Students were engaged in discussions to analyse the presented cases and understand the significance of forensic evidence in criminal investigations.

#### **6. Q & A Session and Feedback:**

A dedicated question and answer session was conducted, allowing students to seek further clarifications and gain insights into specific areas of interest. Feedback forms were distributed to the students to gather their thoughts and suggestions about the visit.

The industrial visit to Regional Forensic Science Laboratory, Mysore, was an enriching and informative experience for the M.Sc. Forensic Science 2nd semester students. It provided them with valuable practical knowledge.



# NATIONAL SCIENCE DAY

On 28th February, the Deanery of sciences, Kristu Jayanti College Autonomous organised various events commemorating National Science Day. This year, the theme was 'Global science for global wellbeing'. As a part of its enterprise to conduct a wide range of extra-curricular programmes and activities to ignite the students on the development in science and technology.

The department of Forensic science organised a range of events for the students of the undergraduate program. For the I year B.Sc. Forensic science students 'Quizological' - a quiz competition and Kaleidoscope - collage competition were conducted. For the II year B.Sc. Forensic science students 'Quizological' - a quiz competition and Point of order - elocution competition were conducted. For the III year B.Sc. Forensic science students 'Quizological' - a quiz competition was conducted. Students from undergraduate participated enthusiastically in these events. All the events were organised and conducted by students of postgraduate and undergraduate programs under the supervision of teachers. As a part of the valedictory program, the result of various events were announced and winners were presented with certificates.



# RESEARCH ARTICLES

**1**

**Dna Extraction From Dandruff For Genetic Analysis**

**2**

**Skeletal Dna And Its Degradation**

**3**

**Comparison Of Walkers And Griess Assay On The Basis Of Acquisition Time**

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**Impact Of Family Factor Leading To Criminal Behaviour In Adulthood**



# DNA EXTRACTION FROM DANDRUFF FOR GENETIC ANALYSIS

## ABSTRACT

Dandruff is a skin condition that causes the skin to peel. The most common cause of dandruff is dry skin, including other causes such as poor hygiene or illness. Some people may also develop dandruff due to allergies. Dead skin is usually shed from the scalp, but with dandruff, the removal of these dead cells is usually faster and causes dead cells to accumulate on the scalp. If nucleated cells are found among these dead cells, DNA (deoxyribonucleic acid) extraction may be possible. This article presents a protocol for extracting DNA from dandruff flakes collected from the scalp. The extracted DNA can be used for a variety of genetic analyses, such as genotyping, gene expression studies, and microbial community analysis. The method described here provides a reliable and efficient way to obtain DNA from dandruff samples. DNA extraction from dandruff can provide information about individual genetic characteristics, scalp microbial communities and potential genetic factors that influence dandruff.

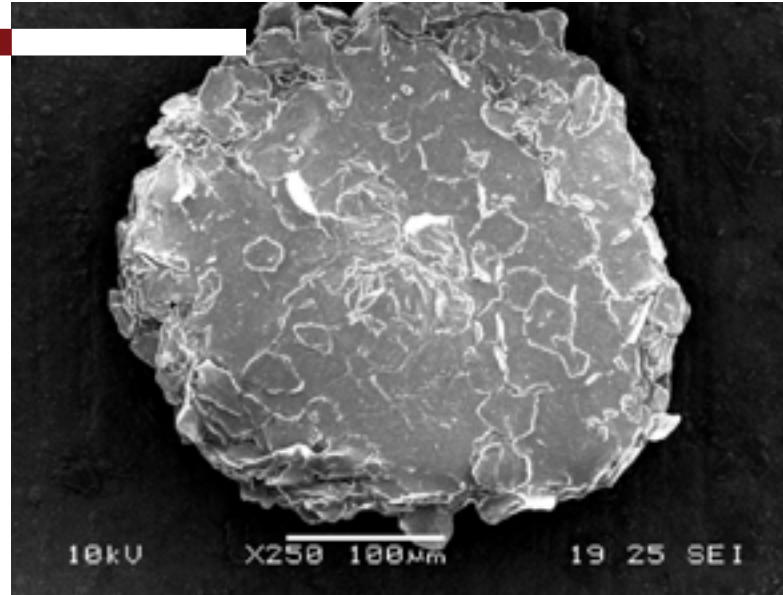


Image 1: Microscopic image of dandruff

## MATERIALS AND METHODS

### 1. Sample collection:

The dandruff flakes are collected from the scalp by gently shaking or brushing. A sufficient amount of dandruff is collected for DNA extraction.

### 2. Cellulolysis:

Caspa flakes are treated with a cellulolysis buffer containing detergent and proteinase K. This buffer breaks cell membranes and cleaves proteins, releasing cell contents, including DNA.

### 3. Proteinase K Digestion:

Proteinase K is added to the cell lysate

to digest proteins that may interfere with DNA extraction. The sample is incubated at a suitable temperature to facilitate melting.

#### **4.DNA precipitation:**

Cold ethanol is added to the sample to precipitate DNA. DNA forms visible strands because it does not dissolve in ethanol.

#### **5.Centrifugation:**

The sample is centrifuged to collect the DNA precipitate at the bottom of the tube while the liquid containing impurities is removed.

#### **6. Washing and purification:**

The DNA pellet is washed with ethanol to remove residual impurities. For higher quality DNA, additional purification steps can be performed using DNA purification columns.

#### **7. DNA resuspension:**

The DNA pellet is resuspended in a suitable buffer or distilled water, making it ready for later use.

### **DISCUSSION**

Isolation of DNA from caspa is a valuable source of genetic material for various research purposes. The method described here provides a relatively simple and efficient approach to extract DNA from caspase. Factors such as sampling, lysis

and purification steps can affect the quality of extracted DNA.

### **CONCLUSION**

Isolation of DNA from dandruff is a useful and informative method to obtain genetic material from scalp cells. The extracted DNA can be used for genetic studies, microbial analysis and other molecular studies related to dandruff and scalp health.

### **FORENSIC SIGNIFICANCE OF DANDRUFF**

1. Soon, only flake or hair will be needed to describe hair colour, the eyes, hair and skin of the suspect and whether they have a full or long face and even the shape of their earlobes.
2. Caspa particles contain a significant proportion of nucleated cells in aggregated nucleated corneocytes. Caspa can detect the wearer of plain clothes or a person who just used it.
3. Dandruff can also occur around the collars and shoulders of clothing on the upper body.
4. DNA extracted from dandruff can be used for criminal profiling, creating a database.

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Bhavya Kamath



# SKELETAL DNA AND ITS ITS DEGRADATION

## INTRODUCTION

DNA, also known as deoxyribonucleic acid, is the genetic material present in all living organisms. Most of the DNA is present in the nucleus of the cells of all animals and is a unique blueprint that helps in the functioning of the body. Some DNA can also be found outside the nucleus and is called mitochondrial DNA, while the ones found inside the nucleus are called nuclear DNA.

In the field of forensic science, DNA is a very crucial piece of evidence. DNA is used in processes such as DNA profiling and DNA fingerprinting, through which we are able to identify the person who is the source of the DNA. Hence, DNA is useful in identifying individuals as well as confirming their relation to a particular scene of crime or to a person. In the field of forensic science, DNA is regarded as an individual characteristic as it helps in the identification of a single person. Each person's DNA sequence is unique to them and cannot be found in anyone else. The only exception for this statement is in the cases of identical twins

who share the same genetic material.

In a crime scene, DNA can be obtained from many different sources, like blood, dead skin cells, semen, hair, and saliva. These pieces of evidence are then collected and sent to forensic laboratories for identification. The DNA found at the scene can help reduce or establish the involvement or presence of suspects and can help narrow down the list. In cases where blood, hair, or saliva may not be available for the extraction of DNA, forensic scientists may instead use the skeletal remains to extract the DNA. This method is also used in the identification of unknown remains in archaeological findings.

DNA extraction from skeletal remains is important for the purpose of identification in cases related to mass disasters and unidentified persons' cases. In cases where the body has been exposed to extreme environmental conditions and decay and the process of DNA extraction from tissues and biological fluids is not possible, we resort to the extraction of DNA from the skeletal remains, as these are the ones

often left behind in such cases. The extraction of large quantities of DNA from skeletal matter is a rather complicated process, and there are many factors that can affect the DNA extraction. Environmental factors play a huge role in the extraction of DNA evidence, as they can adversely affect the bone structure and its composition. Even though the genetic material is protected by a hard structure, when combined with environmental factors such as UV radiation, temperature, humidity, and microorganisms, the DNA gets degraded over time.

Although skeletal DNA is much less prone to destruction in comparison to its other sources, the degradation of the genetic material is inevitable. The quality of the DNA obtained from the skeletal remains depends upon the conditions to which it could have been subjected. One of the terms to keep in mind while studying the DNA from skeletal remains is “taphonomy.” Taphonomy is the study of postmortem changes to human remains. It is a discipline related to palaeontology and studies the process of fossilisation. This process could also encompass the decay of soft tissue, the deterioration and separation of the bones, and alterations in the organism’s composition after burial. Various environmental factors can lead to different levels of DNA preservation in different skeletons as well as in the same bones within a particular skeleton. Therefore, the environment in which the

skeletal remains have been deposited plays a crucial role in determining the rate at which the DNA molecules will degrade. The less favourable the conditions are, the faster they will degrade. Hence, understanding this process will help investigators better collect the samples from the remains.

## **FACTORS AFFECTING DNA EXTRACTION**

### **1. Temperature:**

High temperatures can promote chemical reactions that can degrade DNA molecules. It can accelerate the breakdown of the genetic material. The various methods by which temperature can degrade DNA include processes like: Heat-Induced denaturation,

Thermal hydrolysis and oxidative damage. Heat-Induced Denaturation occurs when the protein is heated, and this heating causes thermal motion and other factors to break down the structure of the protein, resulting in its denaturation. Thermal degradation of genetic material can occur above 190°C. Thermal degradation of DNA at high temperatures includes the breaking down of the covalent bonds within the DNA strands. High temperatures increase the rate of hydrolysis, and the water molecules interact with the DNA sugar-phosphate backbone, leading to its degradation. Oxidative damage to the DNA occurs, as the name suggests,

due to the oxidation reaction that takes place as the temperature rises. The DNA is oxidised, leading to the production of free radicals that damage the DNA structure. Hence, it results in the degradation of the genetic material.

## **2. Microorganisms:**

Microorganisms in soil can release enzymes that separate and breakdown natural materials, including DNA. The microorganisms do not destroy the DNA directly; instead, they digest the protein components of the bones, making the skeletal DNA more susceptible to destruction. These proteins can increase the rate of breakdown of the phosphodiester bonds that hold the DNA strands together. Both endogenous and exogenous organisms contribute to the decomposition process. Hence, microorganisms play a huge part in the degradation of genetic material.

## **3. Moisture:**

The presence of moisture in the environment can lead to the biological decomposition of DNA. The water molecules take part in hydrolytic reactions that lead to the fragmentation and modification of the DNA molecules. If there is more humidity in the area of the skeletal remains, the greater the likelihood of DNA damage.

## **4. Oxygen levels:**

The oxygen molecules participate in oxidative reactions and can modify the DNA backbone and create lesions in the DNA strand. This then leads to further degradation as well as helical distortion, which can complicate genetic analysis. Oxygen also influences the rate and extent of decomposition by microorganisms. Soils that have higher oxygen levels lead to higher rates of DNA degradation.

These are some of the factors that lead to the destruction of the genetic material from the skeletal remains. A forensic scientist must keep these in mind if they wish to collect a feasible DNA sample for examination. DNA analysis is a very crucial part of forensic investigation and must be handled with the utmost care. Since a mistake on the forensic expert's part can lead to severe consequences for those involved in the case, One wrongful conviction can ruin the lives of many.

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Pavithra Manoj

# COMPARISON OF WALKERS AND GRIESS ASSAY ON THE BASIS OF ACQUISITION TIME

## ABSTRACT

Gunshot Residue (GSR) analysis is one of the major steps to be done in case of firearm investigation. The study focused mainly on the analysis of simulated GSR samples collected from different surfaces using Walker's, and Griess Assay by taking acquisition time as a parameter. Gunshot residue helps to determine whether a shooting has taken place, whether the suspect himself has done the shooting, whether shooting has done with the suspected firearm and the GSR distribution pattern will help to establish the distance from muzzle end to target.

The result of our study was the detection of nitrite residue will be more in freshly collected samples than the samples which are tested after a particular period of time and also Griess test was comparatively reactive with old samples than Walker's. The tests are based on chromophoric reactions and Walker's test gave red colour and Griess test gave pink colour. The intensity of the colour was analysed using Munsell's chart.

According to the analysis using Munsell's Chart not only the intensity of colour but also the reactivity of both assays based on the colour they produced as result on gauze cloth with sample, sample collected from the surface based on the time chart and different clothes were also analysed. And also, a time period chart was prepared. It was found that Griess test has greater reactivity with older samples than Walker's test. From my research it was also found that proper preservation plays a pivotal role in the yielding of good quality results.

## KEYWORDS

Gunshot residue, Walker's Test, Griess Test, Acquisition time, Munsell chart.

## CHAPTER I

### 1. INTRODUCTION

#### 1.1 BALLISTICS

Ballistics is the study of firearms and ammunition. Calvin Hooker Goddard

is known as the father of modern firearm identification. There are mainly three subdivisions that come under ballistics and they are internal ballistics, external ballistics, and terminal ballistics. Internal ballistics deals with the study of things happening inside an ammunition. It includes the firing mechanism which begins with cocking, chambering, locking, loading, unlocking, extraction, ejection. It involves the whole mechanism that begins from loading till the ejection of projectile out of the muzzle end of a firearm. External ballistics deals with the events that are happening outside the firearm. It involves all the mechanisms of a projectile which leaves the muzzle end and lasts until it reaches the target thereby the path travelled by projectile, range, shape of trajectory, spin of bullet, drift, angle of fire all comes under this category. It also deals with the motion of projectiles in an open atmosphere. The terminal ballistics deals with the effect of a projectile on hitting a target and based on this factor there is another classification called wound ballistics. Wound ballistics means the effect of a projectile on hitting a living organism or target and if a projectile is hitting on a non-living thing then its effect is called terminal ballistics. When a projectile strikes the human body, it depresses and compresses the skin, flush and the bone and thereby leaving permanent or temporary damage to the tissue and this plays an important role in identification of that

particular firearm or ammunition. There is one more classification called translational ballistics which deals with the study of projectiles between external ballistics and terminal ballistics. It involves the gap or time period between external and terminal ballistics. Dealing with firearms, first primitive firearm is known as cannon lock which was later suppressed by matchlock and this was first automatic firearm which brings fire into the pan placed of gunpowder to ignite with a single pull of a trigger and then came wheel lock and this was suppressed by flint lock and later came percussion cap which was called the modern primitive firearm. Earlier most of the firearms used muzzle loading mechanism and now there are breech loading firearms too. The examination of arms and ammunition is essential in reconstruction of a crime scene.

## **1.2 FORENSIC BALLISTICS**

Forensic ballistics deals with the study of firearms and ammunition and its application in legal perspective. It deals with the investigation of a shooting scene and it requires knowledge in firearms, external ballistics, internal ballistics, wound ballistics etc. Shooting deals with serious crimes like murders, kidnapping, robbery, attempted murders, terrorism and this often leads to death or serious injuries to the victim. The court seeks the help of experts in ballistics to reach a conclusion and thereby ensuring that not a single



innocent person is punished and the culprit is to be found guilty. The shooting location provides evidence that help us to establish corpus delicti, link criminal victim and crime scene, appraise the pattern, find modus operandi, identify suspect, help in reconstruction of incident. The identification of firearms which have released bullet or projectile, fired incriminating cartridges is the most important aspect of forensic ballistics. When a trigger is pulled it will cause the firing pin to strike at the base of cartridge causing the igniting of primer and it further leads to the ignition of propellants and thereby causing the build-up of gases and creates a pressure which will finally leads to the expulsion of projectile out of the firearm through muzzle end. While a cartridge case passes through a barrel it is forced to face the breach end and certain individual marks are being imparted into the case and projectile and thereby these individuals characteristics helps in the identification of a firearm and play an important role in firearm investigation. The position, size and the general shape of a firing pin, extractor and ejector marks on cartridges are the class characteristics of a firearm and the finer marks on a projectile or cartridge case constitute individual features of a firearm. No two firearms, even of the same make and model, produced one after the other can also differ from each other and thereby making it stands out. The firing pin mark alone had helped in

identification of the weapon and thereby solving about 95% cases. The high velocity rifle and automatic and semiautomatic firearms, imprint identifiable breech face marks on cartridges fired from them. When the chamber portion has some defects then it would imprint some markings on the tubular portion of the cartridge. The linkage of buckshot with shotgun is of great importance in forensic ballistics as in India. Nowadays people make use of shotguns to commit crimes because of the ease of availability of firearms. The spreading of these pellets helps in establishing the suspect to target distance.

The stereomicroscopic examination of bullets helps in establishing class characteristics and a comparison microscope is used to compare both test bullets and the evidence (bullet fired collected from victim or crime scene) to see whether both bullets have same individual and class characteristics and thereby linking the crime scene to the suspect.

### **1.3 TRANSFER OF GSR**

The transfer of GSR occur in two ways they are,

1. Primary Transfer: occurs immediately after shooting has taken place and mostly deposits on the hands of the shooter mainly the index and thumb fingers and also the web region. GSR also gets deposited on other surfaces

like cloth, face, person standing next to the shooter, sometimes inside of ears and nostrils.

2. Secondary Transfer: Transfer of GSR to another surface and usually it occurs without direct contact between the shooter/donor and the target/surface.

The distribution of GSR is influenced by various factors such as the firearm used, the surface, environmental factors like indoor or outdoor, airflow, humidity, rain and distance.

There are different methods employed for collection of samples, each collection techniques are important when it comes into analysis. The methods used are tape lifting method, swabbing method, vacuum lifting method, washing method etc.

1. Tape lifting method: An adhesive tape is pressed on the suspected areas of hands of the person it is then stuck to a glass slide.
2. Vacuum lifting method: Suitable method for collection of GSR from clothes.
3. Washing method: The hands of the person are washed using a diluted solution of  $\text{HNO}_3$ . It is collected in a flat tray.
4. Swabbing Method: A clean gauze cloth moistened with 5%  $\text{HNO}_3$  is taken, and the site suspected of containing GSR is swabbed.

Swabbing method is used in our study to collect the gunshot residue from the surface.



Figure 1.2: Collection of Gunshot residue using Swabbing method.

The collected swab was then placed in a zip lock bag and analysis was done on freshly in a zip lock bag and analysis was done on freshly collected samples and according to the time chart after acquisition of GSR, further analysis was performed. Two different ways were used for the analysis of the sample; one is by performing analysis on the gauze cloth with GSR according to the time chart and next way is by performing analysis on samples



Figure 1.3: different GSR analysis methods

collected directly from the surface according to the time period that we have set. And also, analysis is done on different fabric materials.

The Analysis method of GSR is mainly of two types, advanced method and conventional method. Conventional methods include colour-based analysis and instrumentation.

#### 1.4 COLORIMETRIC TESTS

3. Dermal Nitrate Test: .25% solution of Diphenyl benzidine (now Diphenylamine) in conc. Sulphuric acid is used. The presence of nitrate produces a deep blue coloration.
4. Walker's Test: 5% 2 naphthylamine 4,8-disulphonic acid and 20% acetic acid, these are the reagents used. Presence of nitrite produces a bright red spot.
5. Griess Test: This test is similar to the Walker's test but instead of 2 naphthylamine 4,8-disulphonic acid, naphthylamine is used. The nitrite residue will produce orange spots.
6. Modified Griess Test: Procedure is same as that of Griess test. But it includes a step of using filter paper which is sprayed with 2 naphthylamine sulphanilic and citric acid. Positive result will give a pink colour.
7. Sodium Rhodizonate Test: Saturated solution of sodium rhodizonate and 0.1 N HCL are the reagents. Presence of lead particles will produce purple colour,

3. likewise presence of barium gives a red or brown colour.

#### 1.5 INSTRUMENTS USED TO DETECT ORGANIC GSR

8. Gas Chromatography- Mass Spectrometry (GC-MS): combines features of both gas Chromatography and Mass Spectrometry. The operation of GC-MS comprises the following steps;
  - a. Sample preparation: dissolved or diluted sample in a solvent is injected into the inlet port.
  - b. Vaporisation: The liquid sample is vaporised and it becomes a gas.
  - c. Separation: The sample is carried through the column by the mobile phase. Due to their own chemistry, different substances travel at different speeds through the column. This causes their separation at different time
  - d. Detection: The separated sample then enters into a detector, here it is the mass spectrometer. It then detects the retention time.
9. High Performance Liquid Chromatography (HPLC): Works by the principle of adsorption and also partition chromatography. High pressure is used.
10. Thin Layer Chromatography (TLC): Works by the concept of separation of each component at different time
11. Raman Spectroscopy: Method which uses the molecule's vibrational mode. Other states such as rotational states are also detected.



## 1.6 INSTRUMENTS USED TO DETECT INORGANIC GSR

12. Atomic Absorption Spectrometry (AAS): Nanogram and picogram ranges are detected. Works based on the factor that the element when excited will emit the wavelength it absorbed.
13. Neutron Activation Analysis (NAA): Antimony and Barium are detected. Bombarding neutrons give radioactive barium and radioactive antimony.
14. Scanning Electron Microscope-Energy Dispersive X-ray (SEM-EDX): Quick and non-destructive method. Barium, lead, potassium etc are detected.

Advanced method in GSR analysis includes the following;

For OGSR detection;

1. Cyclic Voltammetry (CV): detect oxidation and reduction.
2. Nitrite test based on amperometry: Measured dropping current in mercury electrode at constant time.

For IGSR detection;

1. Infrared Photography: In case of gunshot residue being present on dark coloured cloth use of infrared photography reveals its presence.
2. Soft X-rays Radiography: Lead metal is opaque to X-rays. So, use of soft X-ray detects a hole as a gunshot wound hole if the presence of opaque

lead is observed

3. X-ray fluorescence: A useful technique to carry out both qualitative and quantitative detection of gunshot residue. It is easy to implement and is cheap when compared to. The technique as well as operation is simple, convenient and also reliable results given by it make it a very useful method. Apart from this Autoradiography, Photoluminescence, lead isotope, emission spectroscopy and polarography can also be used.

In this experiment we are also performing analysis on different types of cloth apart from the gauze cloth we commonly used for collection. It is because the GSR can be present on various clothes if the target is a person. The types of clothes also play an important role in the detection of GSR, because the persistence of GSR on a cloth is really dependent on the material of cloth.

## 1.7 THE FABRICS USED IN THIS ANALYSIS

15. Cotton gauze cloth: Cotton gauze cloth is the traditional item used in every discipline of forensic science to collect evidence. It's very absorbent in nature and mostly does not interfere with the analysis.
16. Linen: It is a flax-based textile. It is similar to cotton but takes a long time to harvest. It's commonly used to

to make shirts, pants, other dresses, pillow cases, napkins etc. That means, it's a widely used cloth material. It also has absorbance similar to cotton.

17. Jute: It is a plant fibre. It is soft and shiny and is widely available. Being plant fibres jute have a high absorbance capacity. It readily absorbs water and also other substances but dries quickly.

18. Wool: Wool is made from animal fibre, mostly from fleece and sheep. It's comparatively heavier than other cloth materials. Wool has more absorbance capacity. Since it is heavier with much more thick threads, it absorbs more.

Presence of GSR on clothes is very common. It gets transferred by various ways;

If the target is a human, GSR will be present on the body of the victim as well as his/her clothes. Definitely on the hands as well as clothes of the shooter. There are possibilities of transferring of GSR to the clothes of a person standing near to the shooter if any. Clothes can be used to clean the firearm, in this case GSR can be found on the cloth.

Studies report that GSR stays up to seven hours on a shooter's skin, whereas it can be present on clothes up to a month when it is kept undisturbed. Usually, gun powder stain can be seen easily on light coloured clothes, but if the residue is present on dark or blood-stained clothes then it requires several techniques to reveal

the presence, and those techniques are the one we already discussed, that is the colour-based tests, several instrumentalizations, IR photography, use of alternative light sources etc.

Since GSR being the major evidence to prove and disprove a shooting, the analysis is also at an important scale. Analysis of GSR has many uses, but altogether it can be divided into two, the first one is to identify whether a firearm has been used recently by a person and the second is to determine the muzzle to target distance based on the GSR pattern formed. In this study we mainly focus on the reactivity of Walker's test, Griess test and Modified Griess test. Also the effect of acquisition time on the reactivity of these tests and also analysis is done on different fabrics.

In this study we mainly focus on the comparison of two tests based on the acquisition time. It is mainly done by collecting the simulated sample on a gauze cloth and by directly collecting the sample from the surface at a specific time. In a crime scene we encounter different situations like getting GSR from floor, wall, clothes, glass surfaces etc. The surface used in this study is glass. Glass is a transparent, solid, brittle material made by raw materials such as sand, soda ash and limestone. Glass is made by the melting of these materials at high temperatures. At high temperature glass is similar to solid and when cooled down it acts like solid. Some other prop

erties of glass are dimensional stability, heat resistance, low thermal conductivity, electrical insulation etc. GSR can also be used to determine the distance between target and the shooter. It is a major aspect that should be discussed in detail. It is of great forensic relevance as it is the major way to prove or disprove the fact of shooting at a particular distance claimed by either the shooter or the victim. It can be done by analysing the pattern distribution on the target clothing or the target surface. Another way to determine the distance between the target and the victim is based on the firearm wounds. diluted solution of  $\text{HNO}_3$ .

## CHAPTER II

### 2. REVIEW OF LITERATURE

Muneeba Butt, M.S published an article on “Trace analysis of Gunshot Residue on different fabrics using locally manufactured ammunition” in the year 2016. The objective of the study was to analyse the composition of GSR and they used scanning electron microscopy with energy dispersive X-ray spectroscopy to look into the elemental structure and the composition was analysed using different chemical tests producing different intensities of colours. For Modified Griess Test 15% Glacial acetic acid solution, 0.5 gm sulphanilic acid, 0.28 gm alpha naphthol in 100 ml methanol was required. The fabrics were soaked in these solutions and

then sprayed by 15% Acetic acid. Orange colour indicated the presence of nitrite residues. The modified Griess test results show different colour intensities within different fabrics with different firing distances. The more/less intensity of the colour shows more/less presence of GSR on fabrics. The information obtained from this study was that the persistence of GSR residues on different fabrics cannot depend upon the variable firing distances rather it depends on the texture of the fabrics. As the distance was increased the GSR intensity was decreased, which was observed by this research.(3)

Priya Shrivastava, V.K studied “on Gunshot residue detection technologies” in 2011. This study aimed at finding different instrumentation and analysis methods to detect the presence of residue, its constituents, elemental form etc. It covers almost all techniques and culminates the merits and demerits of these analysis methods. This paper helps the scientist to know about the advanced tools in finding GSR analysis. (14)

R.K Mishra focused on “The involvement of GSR in a crime case” in 2022. GSR plays an important role in linking a crime to crime scene, victim and suspect. In this study they try to seek answers for two hypotheses and one is whether the suspect has shot at a specific site and whether the suspect has not shot ie; whether he is innocent or not. In this study they took



a case and found GSR residue on the hands of a male (shooter) who was found dead beside women. So the analysis provided clues to the investigation officer that the male had done the firing and killed the women and he himself shot to death. Their case review study proved the important GSR analysis in criminal disputes. (11)

Siti Nurhazlin Jaluddin focused on “The preliminary evaluation of GSR using 3-Aminophenol as a substitute in Modified Griess test” in 2021. The aim of the study was to find a rapid test instead of Modified Griess test where heating is not required and also less toxic and less expensive substance used as a main reagent compared to the one used in Modified Griess test. The rapid Griess test reagent was prepared using 28 gm of 3-Aminophenol in 100 ml methanol was added to 5 gm of sulphanilic acid solution. And this was further stored in a sealed bottle. The result obtained from the test was the presence or formation of orange colour in presence of nitrite residue and also the intensity of orange colour formed by Rapid Griess test is more compared to Modified Griess test and this was analysed using a calorimeter. (17)

Ellen Goudsmits focused on “The analysis of organic and inorganic gunshot residue from a single sample” in 2019. The main aim of the study was to detect GSR residue from a single sample collected

the hands of the shooter and to differentiate it from the environmental factors by using solid phase microextraction gas chromatography mass spectrometry and also using SEM-EDX which is a non-destructive technique. Here the samples are collected from the hands of the shooter using adhesive carbon aluminium stubs and blank samples were collected before shooting. Organic residues were analysed first in order to minimise any potential loss of organic residue. From a single sample almost 100 known organic residues were detected. This result showed the successful application of these techniques in this field. (5)

Kelsey E Seyfang focused on “Glass containing gunshot residues and particles of industrial and occupational origins and its evaluation for traces of GSR “. The aim of the study was to find Glass containing GSR from the samples collected from different locations which were mixed with firework residues. The analysis of the sample was done using SEM-EDS. Aluminium pin stubs covered in carbon adhesive were used to collect the samples. This work highlighted the particles that contribute a level of particles which is indistinguishable from GSR and in particular glass containing GSR. If in a sample more amount of  $\text{KClO}_3$  is found then it shows that the source is from a firework and not from ammunition and also when the amount of Mg is considerably more than it shows the contribution of it towards

fireworks to produce colours which are absent in ammunition. This study proved that fireworks do not appear to be capable of generating particles that would resemble glass containing GSR. (15)

Joshua Hallet focused on “Examination of gunshot residue arising from shotgun cartridges containing steel, bismuth or tungsten pellets” in 2019. The aim of the study was to determine GSR constituents from a shotgun as the cases of suicide and homicide has shown an increased use of shotguns which is easily available compared to rifled firearm and this was studied in Australia. The collection was carried out in 2 days and a 12 inch conventional pin stubs with carbon adhesive tape was used to collect the residue from the barrel, base of primer cap, the firing pin position and the shattered residue from the surface. Pb, Sb, Ba particles obtained from a steel shotgun were classified according to a defined standard system and it was counted using the Zeiss instrument. The study showed that when a steel shot was fired it ejected Fe particles in GSR at the breech end and not from muzzle end and in Bi or W shot it did not produce Fe residue discharge from muzzle end but in breach portion and this study also showed that the particles found in GSR residue is not alone formed from the ammunition but also from barrel and this was clearly understood by detecting presence of Fe from Bi shot. (7)

Chavez focused on “The analysis of GSR

as trace in nasal mucus by GFAAS” IN 2016. The objective of this study was to detect the presence of gunshot residue from nasal aperture since the mucus layer inside the nasal cavity trap the entry of foreign particle and also if we are collecting sample from the hands of the shooter the chance of detecting residue would be comparatively very lower after 8 hours where in former one the residing time is larger and another big advantage is that it can be used as a complementary evidence instead of the one collected from hand and the chance of instrumental contamination is lower. Here they collect the samples from the nasal aperture using a cotton swab moistened with EDTA and it was analysed using Graphite Furnace Atomic Absorption Spectrometry and searched for Sb, Pb, Ba. They even collected blank samples too. The result of their study was that the concentration that we found from the nasal region is lower than the one found from hands of the shooter but the detection of residue was possible and could be used as complementary evidence in future. (10)

Bailey, Casanova, and Bufkin conducted a study on “A Method for Enhancing Gunshot Residue Patterns on Dark and Multi-coloured Fabrics Compared with Modified Griess Test “. The microscopic GSR particles are enhanced under infra-red photography and Modified Griess test was performed to compare with patterns developed by treating Sodium hypochlo

rite. The GSR patterns developed as a result of MGT were measured and photographed. Likewise, the pattern developed after treatment with Sodium hypochlorite was also measured and photographed. Both were compared. In conclusion, according to the study, use of sodium hypochlorite from enhancing GSR patterns provide the investigator an option for evaluating both dark and multi-coloured fabrics that can be bleached; if the fabric cannot be bleached, then enhancing with IR photography and Modified Griess test are opted.(20)

Berendes, Neimke, Schumacher and Barth conducted a study on “A Versatile Technique for the Investigation of GSR Patterns on Fabrics and other Surfaces”. They conducted study on samples such as cloths, foils, human tissue etc. The samples of clothing were stretched on a frame and kept in place by clamps. The cloth samples were analysed by Midex M. Human tissue required a special type of holder to enable cooling during measurement. A gel-filled cryo-table was used for this purpose. The M-XRF method combines resolution, speed, detectable elements, sample preparation etc as is very useful in GSR detection from different surfaces like cloths, foil, pork skin. Based on this study the Spectro Midex M is a prominent tool for GSR analysis and shooting range estimation. This method can be used instead of the other common technique as it is a non- destructive method and access to

GSR distribution of any element is accessible for the XRF method.(21)

Kersh, Childers, Justice and Karim focused on the topic “Detecting GSR on Dark Coloured Clothing Prior to Chemical Analysis”. This study is mainly concerned about the detection of GSR using alternate light sources (ALS). Study was preceded by using three dark fabrics collected from three different shirts. The ALS used by them for the study was model: MIS400. As a result of the study the wavelength 415 and below gave little to no illumination for GSR but a high one for the surroundings. 445 nm provided great distinction between GSR and surrounding. GSR appeared as bright neon green against a black background. 455 nm and 475 nm also gave good contrast. In CSS filter the GSR fluorescence as yellow/gold against a dark orange background. 495 nm showed the same result as CSS but appeared against a brown background. 500 nm caused GSR to fluoresce red on black, purple or orange background and so on. They analysed till 630 nm and it gave a very poor result with little to no contrast between GSR and background. In this particular study they proved that while using ALS, different fabric blends had varying results on visualisation of GSR and gave results at particular wavelengths.(22)

Brozek-Mucha Zuzanna, 2017 focused on the topic “Trends in Analysis of Gunshot



Residue for Forensic Purposes”. Study focused on analysis using SEM coupled with Energy dispersive X-ray. Conducted study on analysis of both organic and inorganic components of gunshot residue. According to the study, the solid particles from the unburnt or partially burnt propellant particle distribution pattern around the wound and the on-target’s clothing paved the way to estimate the shooting range. It also provided information about vibrational spectroscopy, which offers great opportunity in the analysis of both organic and inorganic components of GSR that are usually mixed together.(23)

Mahony and Wang conducted a study about “Electrochemical Detection of Gunshot Residue for Forensic Analysis”. The study focused on the use of electrochemical devices for the detection of GSR. They used Anodic Stripping Voltammetry for the detection of the metallic components of GSR. They also relied on SEM/EDX, Raman Spectroscopy and AAS/ICP-OES for chemometric treatment. In this study they are showcasing electrochemical devices as one of the most effective and faster methods for the detection of GSR. This article also reviewed the recent improvements in the electrochemical detection system with chemometric analysis.(24)

Azie Azyanti Mohd, Ratae, S.T focused on “Colourimetric based detection of GSR on gloves worn during shooting” in 2019. The objective of the study was to

detect the nitrite residue from gloves using modified Griess test and calorimeter instead of SEM-EDX. SEM-EDX was somewhat complicated because it requires the transfer of residue from one surface to another and it would be difficult to transfer using a tape lifting method from a fabric. They used a Modified Griess test to determine nitrite residue from gloves and it was placed over a calorimeter and a pink colour was obtained as a result. Their statistical study showed that the chances of finding nitrite residue from the gloves from both left and right hand would be the same and the chances of the residue being deposited and settled for a long time would be greater in gloves palm and finger region than hands of a shooter which could be easily removed by washing. The result of the study proved the link between gloves worn during shooting to the crime scene, suspect, victim and also modified Griess test could be employed in crime scene investigation to provide a vital clue in GSR analysis. (12)

Abdul Halim, Ahmad, Hooi, and Jasmani conducted a study on “Analysis of Gunshot Residue Deposited on Cloth”. Chemical analysis was done using the Modified Griess test. The study provided information about the presence of GSR on target cloth and the detection of GSR on target cloth up to a distance of 15 inch and also about the possibility of finding GSR on different cloth material with increase in

time. Also provided information about the determination of distance between shooter and target based on the GSR distribution pattern on target cloth.

## **CHAPTER - III**

### **3. METHODOLOGY**

#### **3.1 PROBLEM STATEMENT**

The study emphasises on the reactivity of GSR with Griess and Walkers test taking time of acquisition as a parameter and to find whether the fabric material affects the analysis.

#### **3.2 AIM AND OBJECTIVES**

##### **3.2.1 AIM**

1. To assess the reactivity of gunshot residue with Griess test and Walkers test :
  - i. Analysis of samples collected on gauze cloth.
  - ii. Analysis of samples at various intervals of time after acquisition.
2. To assess the reactivity of gunshot residue collected with different fabric materials with Griess test and Walkers test.

#### **3.2.2 OBJECTIVES**

To compare the reactivity of Griess test with the simulated sample collected on gauze cloth taking acquisition time as parameter.

1. To compare the reactivity of Walkers test with the simulated sample collected on gauze cloth taking acquisition time as parameter.
2. To compare the reactivity of Griess and Walkers test with the sample collected on different fabric material.

#### **3.3 PROCEDURE**

##### **3.3.1 PREPARATION OF SIMULATED SAMPLE**

1. Flowerpot (firecracker) was taken and lit using a fire source (matchstick or lighter) to simulate the firearm's confined barrel.
2. Wait for the cracker to burst and the residues are formed due to combustion of the chemicals present in the cracker.
3. The swab of the simulated GSR is taken using a gauze cloth both from the surface and inside of the confined space of the flowerpot.
4. A negative control sample is taken from the surface before bursting the cracker
5. A positive control from an actual firearm is taken
6. The samples are stored in a Petri dish and the analysis using Griess test and

Walkers test takes place for samples at different time intervals like

a. ~ Fresh, 24 hours, 5 days, 10 days, 15 days, 30 days

7. Freshly prepared sample of simulated GSR is collected using different fabric materials like cotton gauze, jute and linen.

### 3.3.2 PROCEDURE

#### 1. GRIESS TEST FOR NITRITES

1. A drop of the neutral or acetic acid test solution is mixed on a spot plate with a drop each of sulfanilic acid and  $\alpha$ -naphthylamine solutions. According to the nitrite content, a red colour is formed either at once or after standing for a short time.

2. Reagents :

i. Solution of sulphanilic acid in acetic acid : 1 g sulphanilic acid is dissolved by warming in 100 ml of 30% acetic acid.

ii. Solution of  $\alpha$ -naphthylamine-acetic acid : 0.03 g  $\alpha$ -naphthylamine is boiled in 70 ml water; the colourless solution is decanted from the blue-violet residue and mixed with 30 ml glacial acetic acid.

#### 2. WALKERS TEST FOR NITRITE

1. Glossy photographic paper is fixed thoroughly in hypo solution to remove all the salts and then washed and dried.

2. It is soaked in a 0.5% solution of sulphanilic acid, dried, then swabbed with a 0.5% solution of Alpha-Naphthylamine in methyl alcohol, and again dried.

3. A sheet of the prepared paper of sufficient size is placed with a thin dry cloth or towel or cotton cloth and the material to be tested is placed face down on the prepared paper.

4. The whole preparation is then covered with a thin dry cloth or towel slightly moistened with 20% solution of acetic acid and then by another layer of dry cloth.

5. The entire pack is then pressed with a warm iron for several minutes.

### 3.3.4 UNDERSTANDING MUNSELL'S COLOUR CHART THE COLOUR ATTRIBUTES

1. Hue is a colour, like red, green, or blue, for example. These are assigned letter codes in the Munsell system, such as Red (R), Yellow-Red (YR), Green (G), Green-Yellow (GY), and so on.

2. Value is a colour's lightness or darkness. Value is denoted by a number in the Munsell system, such as 2, 4, 6, and so on. A 2 will be darker than a 6 because the value scale runs vertically and goes from lightest (at the top) to darkest (at the bottom) in descending order.

3. Chroma is how weak or strong a colour is. In the Munsell system, Chroma



is indicated with a number, typically in the range of 2-14 (upwards of 30 for colours in the fluorescent family). The Chroma scale runs horizontally and moves from weak (from the left) to strong (to the right), in ascending order, so a 2 is going to be weaker than a 6.



Fig 3.1 Hue



Fig 3.2 Value



Fig 3.3 Chroma

## PRECAUTIONS

1. Wear the proper personal protective equipment (PPE) to shield yourself from any risks. Gloves, a lab coat or other protective equipment, safety glasses or goggles, and, if required, a facemask are usually included in this.
2. To avoid breathing in potentially harmful vapours or particles, carry out GSR handling and testing in a well-ventilated location or within a fume hood.
3. Keep GSR particles away from your skin. To avoid contamination and skin exposure, always use gloves.
4. Maintain an organised and clean workspace to reduce the danger of cross-contamination. Decontaminate and disinfect surfaces and tools used for GSR testing on a regular basis.
5. To reduce the danger of infection, use disposable items whenever possible. This covers swabs, filters, containers, and disposable gloves.
6. When handling GSR samples, take care to prevent any needless agitation or particle dispersion. Use careful handling techniques to reduce the production of aerosols or dust.
7. Keep GSR samples in the proper containers that are securely and legibly labelled. This lessens the chance of confusion or unintentional exposure.
8. Dispose of GSR-contaminated items in accordance with regional laws and regulations. Use the authorised trash cans and adhere to the correct disposal procedures.
9. Ensure that everyone handling or testing GSR has received the necessary training. Keep current with the most recent GSR analysis best practices and guidelines.
10. Perform a risk analysis prior to beginning a GSR analysis. Develop an emergency response strategy for accidents or spills, identify potential hazards, and put appropriate controls in place.

## CHAPTER – IV

### 4. OBSERVATIONS AND ANALYSIS

Table 4.1: Observation of Griess and Walkers test from surface

Fabric type	Time interval	Griess test	Walkers test
	Control positive	+ve	+ve
	Control negative	-ve	-ve
Cotton gauze cloth	Fresh	+ve	+ve
	24 hrs	+ve	+ve
	5 days	+ve	+ve
	10 days	+ve	+ve
	15 days	+ve	+ve
	30 days	+ve	+ve

The above table shows the reaction result of griess and walkers test with the GSR sample that was collected from the surface where control negative shows negative result and control positive shows positive result and rest of the samples tested show positive results as Gunshot Residue were present.

Table 4.2: Observation of Griess and Walkers test from the barrel

Fabric type	Time interval	Griess test	Walkers test
	Control positive	+ve	+ve
	Control negative	-ve	-ve
Cotton gauze cloth	Fresh	+ve	+ve
	24 hrs	+ve	+ve
	5 days	+ve	+ve
	10 days	+ve	+ve
	15 days	+ve	+ve
	30 days	+ve	+ve

The above table shows the reaction result

of Griess and Walkers test with the GSR sample that was collected from the surface where control negative shows negative result and control positive shows positive result and rest of the samples tested show positive results as Gunshot Residue were present.

Table 4.3: Observation of Griess and Walkers test on different fabric materials

Fabric type	Time interval	Griess test	Walkers test
Cotton gauze Control negative	Fresh	-ve	-ve
Cotton gauze Sample	Fresh	+ve	+ve
Joze Control negative	Fresh	-ve	-ve
Joze Sample	Fresh	+ve	+ve
Linon Control negative	Fresh	-ve	-ve
Linon Sample	Fresh	+ve	+ve

The above table shows the reaction result of griess and Walkers test with the GSR sample that was collected on different fabric materials where the control negative samples shows negative for GSR and for the freshly collected samples it shows positive result due to the presence of GSR in them.

Table 4.4: Munsell's colour chart readings for Griess test for GSR samples from the barrel and the surface

Time interval	GSR Residue on gauze	From Surface
Standard : SRP 4/14		
Fresh	SRP 4/14	SRP 4/14
24 hrs	SRP 5/18	SRP 5/18
5 days	SRP 5/14	SRP 5/16
10 days	SRP 6/18	SRP 6/14
15 days	SRP 6/16	SRP 6/12
30 days	SRP 5/14	SRP 6/12

The above table shows the colour gradient values of the reaction from the munsell's colour chart where it is seen that the difference between the sample collected from the barrel and the surface is minimal for griess test. The colour gradient values are stronger in the less aged samples than the other is. The value for the 30 days goes high due to an excess of sample.

Table 4.5: Munsell's colour chart readings for Griess test on different fabric material

Fabric	Reading
Gauze	5RP 4/14
Jute	5RP 4/14
Linen	5RP 4/12

The above table shows that cotton gauze is more reactive than with jute and jute is more reactive than linen when samples are collected using these fabric materials.

Table 4.6: Munsell's colour chart readings for Walkers test for GSR samples from the barrel and the surface

Time interval	GSR Residue on gauze	From Surface
STANDARD : MIDDLE : 5R 4/10, PERIPHERY : 7.5 RP 6/16		
Fresh	5R 4/10	5R 3/8
24 hrs	5R 4/10	5R 4/10
5 days	5R 5/10	2.5R 4/16
10 days	2.5R 4/14	10 RP 5/16
15 days	2.5R 4/8	10 RP 5/12
30 days	7.5RP 6/16	5RP 7/8

The above table shows the colour gradient values of the reaction from the munsell's colour chart where it is seen that the difference between the sample collected from the barrel and the surface is large. The colour gradient values are stronger in the less aged samples than the other is.

Table 4.7: Munsell's colour chart readings for Walkers test on different fabric material

Fabric	Reading
Gauze	5R 3/10
Jute	5R 4/12
Linen	2.5R 3/10

The above table shows that cotton gauze is more reactive than with jute and jute is more reactive than linen when samples are collected using these fabric materials.

## 4.2 OBSERVATION IMAGES

### 4.2.1 GRIESS TEST FOR RESIDUE ON GAUZE



Figure 4.1: Standard sample reacting with the Griess test



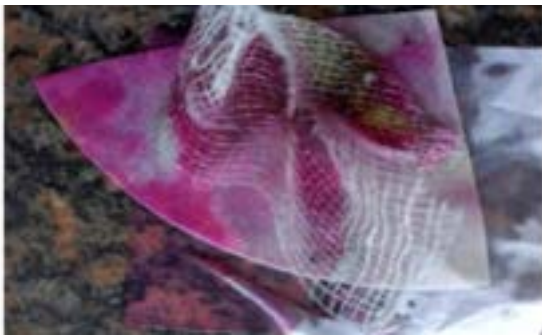


Figure 4.2: Freshly collected sample from the barrel reacting with the Griess test



Figure 4.3: Sample tested after 24 hours of collection from the barrel reacting with Griess test



Figure 4.4: Sample tested after 5 days of collection from the barrel reacting with Griess test



Figure 4.5: Sample tested after 10 days of collection from the barrel reacting with Griess test



Figure 4.6: Sample tested after 15 days of collection from the barrel reacting with Griess test

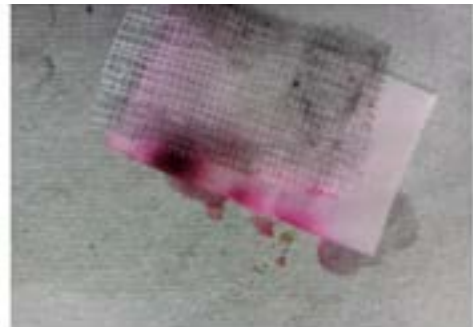


Figure 4.7: Sample tested after 30 days of collection from the barrel reacting with Griess test

## 4.2.2 GRIESS TEST FOR RESIDUE FROM SURFACE



Figure 4.8: Freshly collected sample from the surface reacting with the Griess test



Figure 4.9: Sample tested after 24 hours of collection from the surface reacting with Griess test

### 4.2.3 GRIESS TEST FOR RESIDUE ON DIFFERENT FABRIC MATERIAL



Figure 4.10: Sample tested after 5 days of collection from the surface reacting with Griess test



Figure 4.11: Sample tested after 10 days of collection from the surface reacting with Griess test



Figure 4.12: Sample tested after 15 days of collection from the surface reacting with Griess test



Figure 4.13: Sample tested after 30 days of collection from the surface reacting with Griess test



Figure 4.14: Freshly collected sample on cotton gauze reacting with the Griess test



Figure 4.15: Freshly collected sample on Jute reacting with the Griess test



Figure 4.16: Freshly collected sample on Linen reacting with the Griess test

#### 4.2.4 WALKERS TEST FOR RESIDUE ON GAUZE



Figure 4.17: Standard sample reacting with the Walkers test

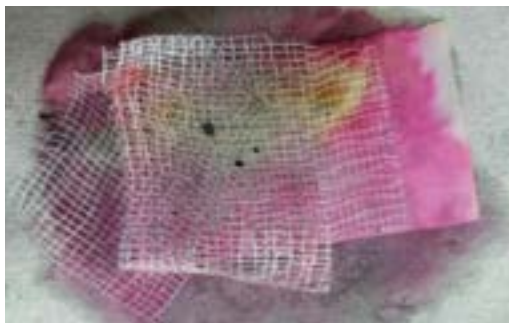


Figure 4.18: Freshly collected sample from the barrel reacting with the Walkers test



Figure 4.19: Sample tested after 24 hours of collection from the barrel reacting with Walkers test



Figure 4.20: Sample tested after 5 days of collection from the barrel reacting with Walkers test

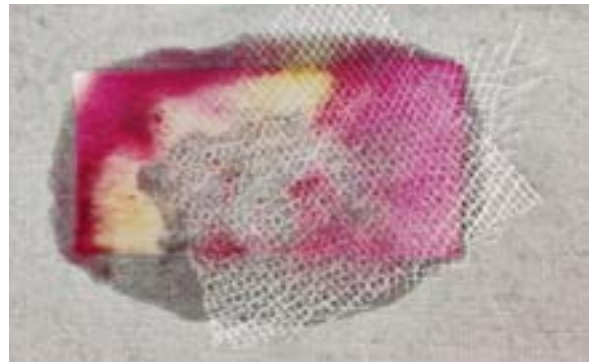


Figure 4.21: Sample tested after 10 days of collection from the barrel reacting with Walkers test



Figure 4.22: Sample tested after 15 days of collection from the barrel reacting with Walkers test

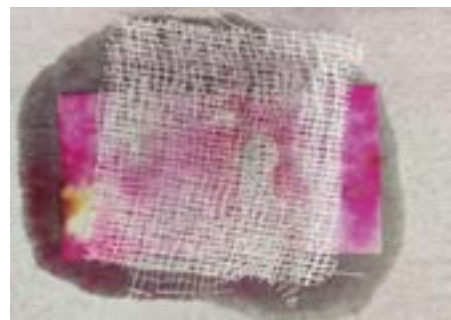


Figure 4.23: Sample tested after 30 days of collection from the barrel reacting with Walkers test

#### 4.2.5 WALKERS TEST FOR RESIDUE FROM SURFACE



Figure 4.24: Freshly collected sample from the surface reacting with Walkers test





Figure 4.25: Sample tested after 24 hours of collection from the surface reacting with Walkers test



Figure 4.26: Sample tested after 5 days of collection from the surface reacting with Walkers test



Figure 4.27: Sample tested after 10 days of collection from the surface reacting with Walkers test

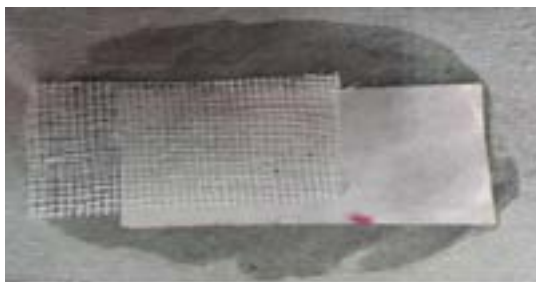


Figure 4.28: Sample tested after 15 days of collection from the surface reacting with Walkers test

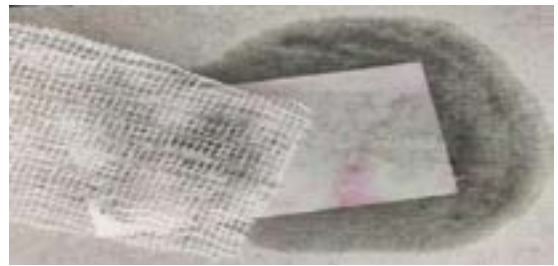


Figure 4.29: Sample tested after 30 days of collection from the surface reacting with Walkers test

## 4.2.6 WALKERS TEST FOR RESIDUE ON DIFFERENT FABRIC MATERIAL



Figure 4.30: Freshly collected sample on cotton gauze reacting with Walkers test



Figure 4.31: Freshly collected sample on jute reacting with Walkers test



Figure 4.32: Freshly collected sample on linen reacting with Walkers test

## CHAPTER – V

### 5. RESULTS AND DISCUSSIONS

1. the GSR samples. As per the observations, it is seen that the Griess test is more effective and sensitive than the Walkers test with the GSR.
2. The sample collected using gauze cloth from the surface is slightly less sensitive with the Griess test when compared with that of the sample collected from inside the barrel (chamber of the firecracker) which is highly sensitive even after the sample has aged.
3. The sample collected using gauze cloth from the surface is least reactive with the Walkers test when compared with that of the sample collected from inside the barrel (chamber of the firecracker) which is sensitive even after the sample has aged.
4. The sample tested at different intervals of time showed good sensitivity with the Griess test, the colour concentration drop is very minute in the Griess test and gives better results for an aged sample for both samples collected from the surface and from the chamber.
5. The sample tested at different intervals of time showed a decent sensitivity with the Walkers test, the colour concentration drop is enormous between different timelines when the samples were tested, the sample from the surface showed the highest variation in the concentration of the colour for an aged sample whereas the sample from the chamber gave decent results.
6. When tested for nitrite residues on different fabric material it is seen that the Griess test shows better results than the Walkers test and it is seen that the reactivity of GSR with the test is better in cotton than jute and better in jute than linen (cotton>jute>linen)
7. Griess' test is more sensitive than the walkers test as per the observations made even after the samples are old and aged.
8. The colour concentrations are measured using Munsell's colour chart to provide results that are more accurate in a scientific manner.
9. Griess' test is more sensitive than the Walkers test and it is better to use Griess test for spot tests to identify the presence of GSR. We can see that there are many methods like SEM, SEM/EDX, Spectroscopy, Spectrophotometry and many other chemical techniques which are time consuming and expensive. To identify the shooter immediately we cannot wait for the results from the instrumental techniques, by the time the results are obtained the perpetrator might try to escape. Whereas the Griess test is less time consuming and more reactive with the samples that are new and old as well. For example, take Walker's test that requires heating, which is not a feasible step when the sample must be analysed in a scene of crime, it requires

additional equipment ment to be carried, and it requires drying of the chemical components used one after the other and then the sample is tested. Griess test is a very simple and conventional method to use on the spot and the results are mostly instantaneous.

## CHAPTER – VI

### 6. CONCLUSIONS

The Griess test has shown better reactivity with the samples than the Walkers test and the aged samples give better results with the Griess test. The Griess test helps save time and conduct more tests when compared with the walkers test, which is a time consuming process and the reactivity of the test with the samples is lesser when compared with the Griess test. The analysis and comparison started with the freshly collected samples which are highly sensitive where the GSR was simulated with the help of the flower pot which is a firecracker and swabbed with cotton gauze and other fabric materials like jute and cotton, later tested for the presence of nitrite with the help of Griess and Walkers test where the Griess test was superior to the Walkers test. As the samples aged, the reactivity of the sample with the Walkers test reduced whereas the Griess test was still effective and highly sensitive for the samples that were collected from the surface as well as from the inside the chamber of the cracker. Therefore, the Griess test is recommended as the better practice

than the Walkers test when it comes to identifying the nitrite residues in the GSR sample, which gives the best sensitivity when both the tests are compared.

### LIMITATIONS

The samples analysed for the nitrite residues are not the actual GSR that is produced by ammunition of a firearm. The sample obtained in the crime scene can be very minute and the results can vary from the simulated sample used in this study. The samples used for analysis are in good quantity for the reaction to occur whereas the actual samples from the scene of crime can be in trace amounts. The test conducted in this study is only for the samples that are aged until 30 days but in the actual crime investigation, the age of the sample can be more than 30 days.

### FUTURE PROSPECTS

The Gunshot residue (GSR) can be tested using other methods such as Scanning Electron Microscopy with Energy Dispersive X-ray Spectroscopy (SEM-EDS), Atomic Absorption Spectroscopy (AAS) and Inductively Coupled Plasma-Mass Spectrometry (ICP-MS), Infrared Spectroscopy that are the instrumentation techniques, which can give accurate results along with the details like composition of the GSR, concentration of the GSR and many such details. The usage of actual GSR will give more accurate results than




the simulated GSR and the test will have results that can be seen in real life scenarios. The time durations can be increased to check the reactivity of the Griess and Walkers test with the GSR collected on different materials, as it would show the maximum GSR containing capacity of the fabric materials and reveal the test that is suitable.

## CHAPTER – VII

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# IMPACT OF FAMILY FACTOR LEADING TO CRIMINAL BEHAVIOUR IN ADULTHOOD

## ABSTRACT:

The goal of the current study was to identify family characteristics that affected men and women's behaviour in social settings, including whether they became lawbreakers or showed signs of becoming socially responsible. The self-reporting format of the prepared questionnaire was used to conduct this comparison study. 50 samples made up the study's subject, out of which 15 were female and 35 were male. Crime-committing individuals believed their parents to have higher levels of dysfunctional parent-partner interactions, poor family functioning, and higher levels of family violence than socially organised persons. Additionally, criminals were found to have higher rates of psychosomatic symptoms, antisocial personality traits, and frustration, hatred, anger, and other strong emotions that were interpreted negatively and led to criminal behaviour. In contrast, anyone who had grown up in a social setting and faced similar circumstances still emerged as a social being when they approached it as a challenge and came to a positive conclusion.

**Key words:** Family environment, Parental up-bringing, socio-economic status.

## INTRODUCTION

Cognitive theory of psychology focuses on how human thinking processes can affect a certain person's life in a given situation. Family is the first place where we learn about all the values as well the kind of behaviour we must replicate in the society in order to survive in the outside world. Also by the social learning theory of Albert Bandura, it is mentioned that a growing kid will learn and pursue things as they are thought by their parents and every individual as a kid will grow up under the supervision of their parents and family members, so the kid here tries to follow and pursue things as their parents do and teach them. (McLeod, 2023)

Cohesiveness of family is defined as the emotional bonding of the family members towards each other. While this cohesiveness of the family is also,



considered as the most effective factor for protection against the external stressors.

Economic condition of the family impacts the family in both positive and negative altitudes. In a nuclear family, pressures like unemployment, foreclosure, or loss put a strain on the ties between the parents and the family as a whole. (Dicke et al., 2018)

If a family's basic necessities, such as access to food security, healthcare, and housing, are not met, their position may be much more dire. When basic conditions are improper and the kids who develop in this kind of socio-economic condition will tend to develop deviation from the society. There are researches to prove that worsening in the economy can led to impact the raise in the family conflict, child neglect and child abuse also the inmate partner violence. (Dicke et al., 2018) Research consistently demonstrates that parental factors play a critical role in shaping an individual's behaviour and can contribute to the risk of criminality in adulthood. Parental factors encompass a range of dimensions, including parenting styles, parental involvement, family dynamics, parental criminality, and the presence of abuse or neglect within the family. (Fergusson et al., 2019)

Parenting styles, parental involvement, the presence of abuse or neglect, parental criminality, and socioeconomic status

all interact to shape an individual's development and subsequent engagement in criminal activities. Understanding these factors is crucial in designing effective prevention and intervention strategies that promote positive parenting practices, provide support to at-risk families, and address the root causes of criminal behaviour. By fostering healthy family environments, we can contribute to the reduction of criminality and create a more supportive and inclusive society. (Fergusson et al., 2019)

## **METHODOLOGY:**

### ***Aim:***

To determine the impact of family factors, leading to criminal behaviour, in adulthood.

### ***Objectives:***

1. To study the socio economic factors inducing criminal behaviour in adulthood
2. To find the most affecting and least affecting social and economic factors contributing to criminal behaviour.
3. To study the percentage of the subjects that fall for criminality due to family factors .
4. To study and understand family situational factors which impact on the person's life leading them to criminal and hence to provide preventive steps and rehabilitation

## SAMPLE COLLECTION

A standard questionnaire was formulated with the help of guides and psychologists by referring to a standard set of protocols that must be followed. The questionnaire consists of 90 standard simple yes or no questions related to family environment and family situation. A consent form was firstly taken pertaining to the confidentiality of the agreement for the sample collection including age, sex, parental background, education and so on.. The consent form was taken with a signature or thumb impression from the subject.

### **Intrusion factor includes**

- The criminals from heinous crime such as murder, rape etc
- The convicted inmates from the prison
- The inmates with no psychological issues
- Both literates and illiterates of same kind
- Only socio economic factors such as occupation, family, income play a major role.

### **Extrusion factors includes**

- The inmates who are not convicted.
- The inmates who are from a non heinous crime background.
- The inmates with psychological issues.
- The inmates are in custody.
- The inmate's age group is not a criteria.

## SAMPLE SIZE

The subject consisted of a total of 50 samples of which 35 male convicted inmates and 15 female convicted inmates serving their punishment at prison were considered. Sampling was done using convenience sampling technique. None were given parole as per records and had minimum connection with the family environment after their conviction. The conviction period of the convicted was in between 6 months to 20 years of the subject samples obtained.

### **Process of collection of samples**

1. The rapport was established with the subject.
2. The questionnaire sheet was provided to the subject.
3. The instruction was given to the subject priorly; as to read the question and answer them accordingly (for literates).
4. The questionnaire should be read out to the subject carefully and the answers must be recorded accordingly (for illiterates).
5. Right tick on the correct answer with the help of a pencil was considered.
6. The first thought in mind for the answer was collected in the format of yes or no.
7. The time limit of 20 - 30 minutes was provided.

Table 4.1: Showing subject's Age.

Age	No of samples	Percentage
20-29	23	46%
30-39	6	12%
40-49	7	14%
50-59	6	12%
60-69	6	12%
70-79	2	4%

The table 4.1 provides information on the age distribution of convicted criminals in a specific dataset. Out of the population chosen for this study, 46% of respondents are between the ages of 20 and 29. which amounts to 23 individuals out of the total population of 50 individuals.

Table 4.2: Showing gender of the individuals.

Gender	No of samples	Percentage
Male	35	70%
Female	15	30%

Table 4.2 provides information about individuals convicted, categorised by gender. The total population of this study includes 50 individuals convicted.

Table 4.3: showing education of the subject.

Education	No of samples	Percentage
No education	23	46%
Primary education	9	18%
High school	7	14%
10 <sup>th</sup>	7	14%
12 <sup>th</sup>	2	4%
Graduate	2	4%

Table 4.3 provides information about the education levels of a group of subjects. According to the table, there is a total of 50 of subjects considered.

Table 4.4: Showing subject's Occupation.

Occupation of subject	No of samples	Percentage
Farmer	20	40%
Daily wage labour	8	16%
Driver	8	16%
Own business	6	12%
Government jobs	1	2%
Homemaker	2	4%

The table 4.4 provides information on the occupation of the convicted criminals in a specific dataset. Out of the population chosen for the study 40% of respondents fall in the category farmer, which amounts to 20 individuals out of the total population of 50 individuals.



Table 4.5: Showing subject's income.

Income of subject	No of samples	Percentage
0-5000	23	46%
5000-10000	14	28%
10000-15000	5	10%
15000-20000	7	14%
20000+	1	2%

The table 4.5 provides information about the income of the convicted criminals in the specific data table

Table 4.6: Showing subject's Type of family

Type of family	No of samples	Percentage
Joint family	26	52%
Nuclear family	24	48%
Orphan	0	0%

The table 4.6, provides information on the type of family of the convicted criminals in a specific dataset.

Table 4.7: Showing Parenting of subjects

Parenting	No of samples	Percentage
Single parenting	13	26%
Both parent	32	64%
Custodial/relatives	1	2%
Orphanage	4	8%

Table 4.8: Showing Parental education of subjects

Parental education	No of samples		Percentage	
	Mother	Father	Mother	Father
No education	35	26	70%	52%
Primary education	10	14	20%	28%
High school	4	5	8%	10%
10th	1	4	2%	8%
12th	0	1	0%	2%
Graduate	0	0	0%	0%

Table 4.9: the subject's parental occupation

Parental occupation	No of samples	Percentage
Farmer	17	34%
Daily wage labour	12	24%
Driver	6	12%
Own business	2	4%
Government jobs	0	0%
Homemaker	12	24%
Machine operator	0	0%
Tailoring	1	2%
Private sector	0	0%

Table 4.9 provided information about the parental occupation of the convicted subjects .

Parental income	No of samples	Percentage
0-5000	24	48%
5000-10000	11	22%
10000-15000	3	6%
15000-20000	8	16%
20000+	4	8%

Table 4.10: Showing subject's Parental income.

Parental income	No of samples	Percentage
0-5000	24	48%
5000-10000	11	22%
10000-15000	3	6%
15000-20000	8	16%
20000+	4	8%

The table 4.10 provides information on the parental income of the convicted criminals in a specific dataset.

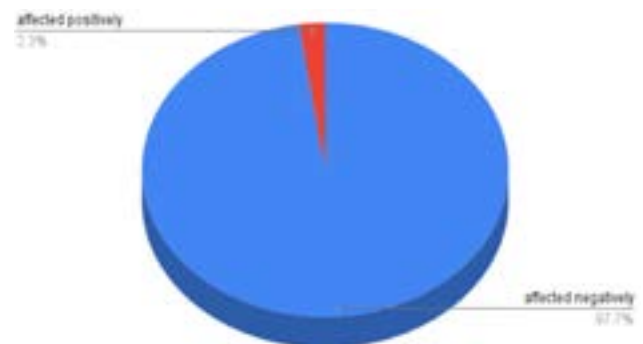
Table 4.11: Showing subject's crime type

Type of crime	No of samples	Percentage
Robbery	7	14%
Murder	16	32%
Rape	4	8%
Human trafficking	4	8%
POCSO	4	8%
Sexual assault	1	2%
NDPS	3	6%
Half murder	11	22%

## Result:

Influence of social character in the sense of relationship within the family including parental relationship, relationship with siblings, neighbours, relatives, are the major factor in the people's behaviour, giving out the largest difference in the society as social people and criminals. In conclusion, it is found that family is an affecting factor as explained in the analysis. However, the goal of this study is to

determine how much of a family's influence on a person's decision to commit a crime. The result of this study provides preventive steps and rehabilitation of the individuals who fall for criminality due to family factors.



The above pie chart explains the amount of effect caused because of a family's socio-economic factors like poverty, education, occupation, type of family, and parenting type being responsible for criminality. The subject's response showed that more than 97.7% of the data sampling believed that due to impairment in their familial situation as explained in the tables in the above analysis, are the factors responsible for turning them into criminals.

## DISCUSSION:

In the analysis, socioeconomic disparities and social inequality contribute to feelings of marginalisation and exclusion, which can foster criminal behaviour. When individuals perceive unfairness or a lack of opportunities for upward mobility, they may resort to illegal means to express their frustrations or seek a sense of empowerment.

Additionally, social exclusion can lead to social disorganisation within communities, weakening social bonds and increasing the prevalence of criminal activities.

Parenting style and family dysfunction significantly influence a child's socialisation and moral development. Authoritarian or neglectful parenting styles, characterised by lack of warmth, inconsistent discipline, or excessive control, have been linked to an increased risk of criminal behaviour in children. Similarly, dysfunctional family dynamics such as violence, substance abuse, or neglect can contribute to the development of criminal tendencies in individuals. Children growing up in such environments may lack positive role models, experience a lack of emotional support, and internalise negative behaviours and values.

One of the most significant socioeconomic factors associated with criminality is poverty. Numerous studies have consistently found a correlation between poverty and crime rates. Poverty creates an environment characterised by limited access to basic needs, inadequate education, and limited employment opportunities. These situations may push people to turn to crime as a method of surviving or as a way to better their financial status. Additionally, the lack of social support and resources in impoverished communities may contribute to the formation of

criminal networks and a higher prevalence of criminal behaviour.

Education and employment play crucial roles in shaping an individual's socioeconomic status and their susceptibility to criminal behaviour. Limited access to quality education and job opportunities can hinder social mobility and increase the likelihood of engaging in criminal activities. Without adequate education, individuals may struggle to find stable employment, leading to economic insecurity and potential involvement in illegal activities as an alternative source of income. Furthermore, unemployment and underemployment can create frustration, resentment, and a sense of hopelessness, which may increase the risk of criminal behaviour.

## CONCLUSION:

In conclusion, the impact of the family factor on leading to criminal behaviour in adulthood is undeniable. Research consistently shows that a dysfunctional or troubled family environment increases the risk of criminal behaviour. Parental influence, family structure, parental substance abuse, socioeconomic factors, and the presence of protective factors all play a role in shaping an individual's propensity for criminal activity.

The behaviour and actions of parents significantly influence the development



of children, and parental neglect, abuse, or inconsistent discipline can increase the likelihood of criminal behaviour in adulthood. Family structure, such as single-parent households or high levels of conflict, can contribute to an increased risk. Parental substance abuse, particularly when exposed to children, has a strong association with an increased risk of criminal behaviour.

Socioeconomic factors also come into play, as low-income families often face greater challenges and have limited access to resources, education, and employment opportunities. These circumstances can increase the likelihood of criminal involvement. However, the presence of protective factors, such as supportive relationships, positive peer influences, access to education and employment opportunities, and community involvement, can mitigate these risks and promote positive outcomes.

To address the impact of the family factor on criminal behaviour, it is essential to implement preventive measures and intervention strategies that consider the multifaceted nature of the issue. This may involve providing support and resources to families, promoting positive parenting practices, addressing substance abuse issues, and improving access to education and employment opportunities. By addressing these factors comprehensively, we can work towards reducing the risk of


criminal behaviour in adulthood and fostering healthier and safer communities.

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# GLOBAL NEWS UPDATE

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**1**

Nexus Between Tailored Access Operations And Digital Forensics

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**2**

Cerumen – A Potential Source Of Help In Detection Of Toxins

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**3**

SmartWater

# NEXUS BETWEEN TAILORED ACCESS OPERATIONS AND DIGITAL FORENSICS

## INTRODUCTION

As we move ahead in the revolutionary world of cybersecurity and intelligence, two prominent and interconnected domains have emerged: tailored access operations (TAO) and digital forensics. These fields, though distinct, share a complex relationship as they navigate the intricate world of cyber operations, intrusion detection, and information analysis. This article delves into the nuanced interplay between TAO and digital forensics, shedding light on their respective roles, methodologies, and implications for the realm of cybersecurity.

## THE TAILORED ACCESS OPERATIONS (TAO)

Tailored Access Operations, often abbreviated as TAO, represents a clandestine facet of cyber espionage orchestrated by intelligence agencies. TAO's modus operandi involves deploying advanced hacking techniques to infiltrate target

computer systems, networks, and devices. Driven by intelligence-gathering objectives, TAO operatives meticulously craft custom exploits, develop intricate malware, and employ covert methodologies to breach security measures. These operations are executed with the utmost precision, aiming to remain undetected while extracting sensitive information for intelligence analysis.

## THE DIGITAL FORENSICS

In contrast to the covert manoeuvres of TAO, digital forensics is a transparent and systematic process employed to investigate cyber incidents. This discipline revolves around collecting, analysing, and preserving digital evidence originating from compromised systems, networks, and electronic devices. Digital forensics experts painstakingly reconstruct the chronology of events, discern the extent of breaches, and identify the perpetrators responsible. Through a meticulous examination of system logs, network traffic, and file systems, digital forensics serves as the investigative backbone for unravelling the mysteries of cyberattacks.

## THE NEXUS: HOW TAO AND DIGITAL FORENSICS CONVERGE?

While TAO and digital forensics might seem disparate, they are intertwined in ways that illuminate the intricate facets of modern cybersecurity.

### DATA COLLECTION AND ANALYSIS

**TAO:** Tailored Access Operations thrives on collecting sensitive information from compromised systems. The data extracted is later funnelled to intelligence agencies for comprehensive analysis, shaping national security strategies.

**Forensics:** Digital forensics professionals, too, engage in data collection and analysis, albeit for different ends. Their efforts focus on deciphering the tactics and techniques employed by cybercriminals, thereby contributing to the development of robust defence mechanisms.

### TECHNIQUES AND TOOLS

**TAO:** The arsenal of TAO encompasses cutting-edge hacking techniques, zero-day exploits, and meticulously designed malware. These tools enable TAO operatives to infiltrate systems with remarkable stealth and precision.

**Forensics:** Digital forensics experts em

ploy an array of specialised tools to reconstruct cyber incidents. These tools aid in deciphering the intricacies of cyberattacks and empower analysts to unravel the methods used by attackers.

### ATTRIBUTION AND COUNTER-MEASURES

**TAO:** Intelligence agencies executing TAO operations often seek to mask their identity, employing deception and misdirection to deter attribution.

**Forensics:** Digital forensics plays a pivotal role in attribution by meticulously tracing digital footprints and discerning the origin of cyberattacks. This attribution is instrumental in devising effective countermeasures and proactive strategies.

### IMPLICATIONS AND FUTURE DIRECTIONS

The convergence of TAO and digital forensics carries profound implications for the realm of cybersecurity. As intelligence agencies continue to harness TAO for espionage and national security, the need for skilled digital forensics professionals becomes ever more critical. Robust digital forensics capabilities enable the detection, investigation, and mitigation of cyber threats, thus fortifying cyber defences on a global scale.

Looking ahead, the synergy between

TAO and digital forensics is poised to evolve. Intelligence agencies may refine their TAO tactics in response to advances in digital forensics, prompting a perpetual cycle of innovation and adaptation. Moreover, the growing emphasis on international collaboration in cybersecurity efforts underscores the importance of aligning TAO operations with ethical considerations and legal frameworks.

## CONCLUSION

In the dynamic landscape of cybersecurity, the relationship between tailored access operations and digital forensics is a testament to the multifaceted nature of modern espionage and threat detection. While TAO operates in the shadows, digital forensics brings these covert activities to light through meticulous analysis and investigation. This symbiotic relationship underscores the importance of a comprehensive and holistic approach to cybersecurity, where offensive and defensive strategies converge to safeguard digital landscapes in an interconnected world.

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**Debashis Das**



# CERUMEN – A POTENTIAL SOURCE OF HELP IN DETECTION OF TOXINS

## INTRODUCTION

Worldwide we come across a lot of drug cases with urine, blood, nails and hair being analysed in the forensic labs, but these often have a lot of limitations to it. Many of the drugs or toxins are not administered in the urine and blood due to its short half-life and also due to less convenient collection methods. Similar is the case with the nails and hair, as they are part of external cartilage, they seem to be more prone to damages or loss of drug content due to various contaminants from the external environment. So, in such cases it may occur that by the time these biological samples are analysed it may lose all the potential clue pertaining to the drug which was initially present and thus seem to prove useless.

Until recently earwax was not given that much of importance and only viewed as a waste or neglected body secretion. Concerns were rising and there was a quest regarding an alternative to a biological fluid which can aid in toxicologi

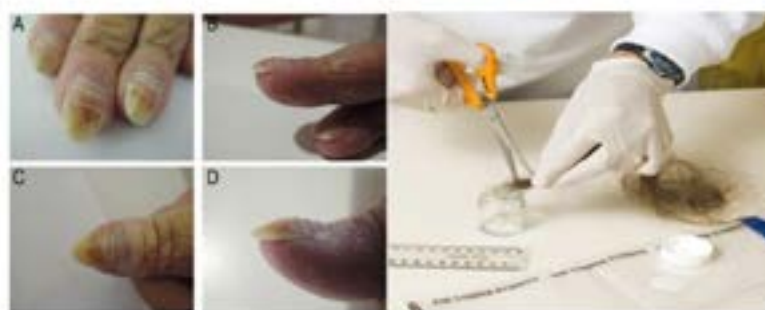


Image 1: Depicting Biological Sample analysis

cal analysis. Studies and researches were made and CERUMEN- also called as ear-wax was found to be a good source to detect toxins which even persisted for a longer duration as compared to the other biological fluids.

### What exactly is cerumen?

Cerumen also called as earwax is a naturally occurring wax like substance present in the external auditory canal which prevents the dust from entering inside the ear and also provides lubrication. It is composed of epithelial cells and certain secretions from sebaceous glands and modified apocrine sweat glands.

## Why is it better to the other fluids?

It is exactly not considered better but due to its durability for a longer time it cannot be neglected either.

As cerumen is secreted from apocrine sweat glands, they have high chances of transporting any drug molecules being administered in the body via the sweat glands surrounding these ceruminous glands. It could aid in gaining information about an individual such as the ethnicity, the race, the food eaten and certain diseases. Also, as it is not exactly in contact with the external environment it can be detected even after a few days as compared to urine or blood which can wash off its presence.

Research was made on this and 17 patients were administered with 12 different types of drug whose molecules were later found to present in the earwax which was a major deciding point about its accuracy and feasibility.

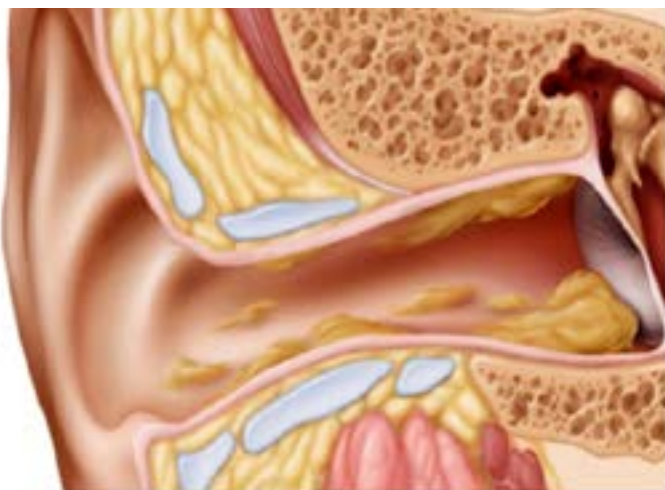


Image 2: biological image of earwax

## CONCLUSION

CERUMEN being a good storage for toxins for a longer duration can be considered as an alternative for the detection of toxins and drugs. The research thus being successful showed the usefulness of earwax as a tool to detect drugs or toxins being present in the body which can further aid in the investigation of cases related to drug abuse, poisoning and case of death to rule out any foul play.

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**Pereppaden Ancila Robinson**

# SMARTWATER

## INTRODUCTION

Taggants are a class of materials that can be applied to or incorporated into an object to make it identifiable. This is done by producing individual and specific batches of taggant with unique formulation, to make it unique and easy to detect once recovered. Thereby making themselves markers. When it comes to a forensic taggant, it should be of low cost to produce, be non-toxic to individuals and the environment, be simplistic and inexpensive to detect and easy to analyse through non-destructive methods and be complex enough to prevent duplication. As these taggants are invisible to the naked eye, there is a need for localization to recover this back for analysis. The easiest and effective way of achieving this is by adding fluorescent compounds to it so that fluorescence can be achieved when they are introduced to UV or visible spectrum.

## SMARTWATER

SmartWater technique isn't new to the crime or forensic spectrum, we have been using this for a very long time to prevent burglary and deter thieves. This technique has been employed to



Image 1. The cloth is subjected to SmartWater emitting fluorescence under UV. Credits: BBC

protect antiques and national treasures which are under risk of being stolen. The application of this technique to tackle domestic violence is very new, thanks to Lee Berry, the detective superintendent of West Yorkshire Police, who came up with this implementation.



Image 1. The cloth is subjected to SmartWater emitting fluorescence under UV. Credits: BBC

SmartWater is a forensic theft deterrent marketed as a long-lasting, traceable chemical taggant that contains distinctive, identifiable and traceable elemental composition, used to label valuable property or monitor criminal activity. It is also used as a biological marker. The procedure of implementation is simple, inexpensive, rapid, and environmentally safe. Moreover, the detection for the presence of the mark does not require sample preparation or an assay. Each produced bottle or canister will have a unique composition of the components making it hard to duplicate, by making each product unique, it is easy to locate categorically. The effectiveness of the product lies in the fact that it stays on the skin for up to six weeks and longer on clothes. Domestic abuse is difficult to prove due to the lack of evidence and eyewitnesses. If the culprit is forensically marked, the association of the perpetrator to the crime scene is clear, it also links the perpetrator to the specific batch of Smart



Image 3. Each bottle is filled with a different and unique composition. Credits: BBC

Water produced, making this technique valuable evidence.

As an initiative, The West Yorkshire Police have given 200 women, the SmartWater package, which consists of a hand-held canister for spraying to use it like a pepper spray, there is a gel for door handles and gates- when the someone touches this surface, it immediately links them to the scene, and an automatic trap that sprays if someone approaches the house under SmartWater protection.

This surely doesn't prevent the crime from happening, to prevent the crime from happening warnings are given at various stages of attack to show that the victim is protected. This warning clearly asks the perpetrator to deter but doesn't inform the mechanism through which the victim is protected. But to feel safer, the targeted or vulnerable women and men are given the kit. The kit also contains stickers to be put in windows stating that the house is protected by forensic marking. The canister containing the taggant has a coverage up to 10m in distance.

## STATISTICS

- In 2014, Fort Lauderdale Police Department reported the use of SmartWater products with a reduction in burglaries of 14%.
- SmartWater has helped bring down domestic burglary by 25 per cent in UK



## CONCLUSION

There is a rapid use of taggant to mark in a forensic perspective and has become a significant part of the national crime reduction strategies. SmartWater helps to prevent and monitor criminal offences, as this technique is becoming frequent to widespread to the public, there might be a decrease in taggant efficiency as the perpetrator or the offender is familiarised with this technique.

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**A. Sherlin Gomez**

# CASE STUDIES

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**1**

The Vampire Rapist

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**2**

The Green River killer

# THE VAMPIRE RAPIST

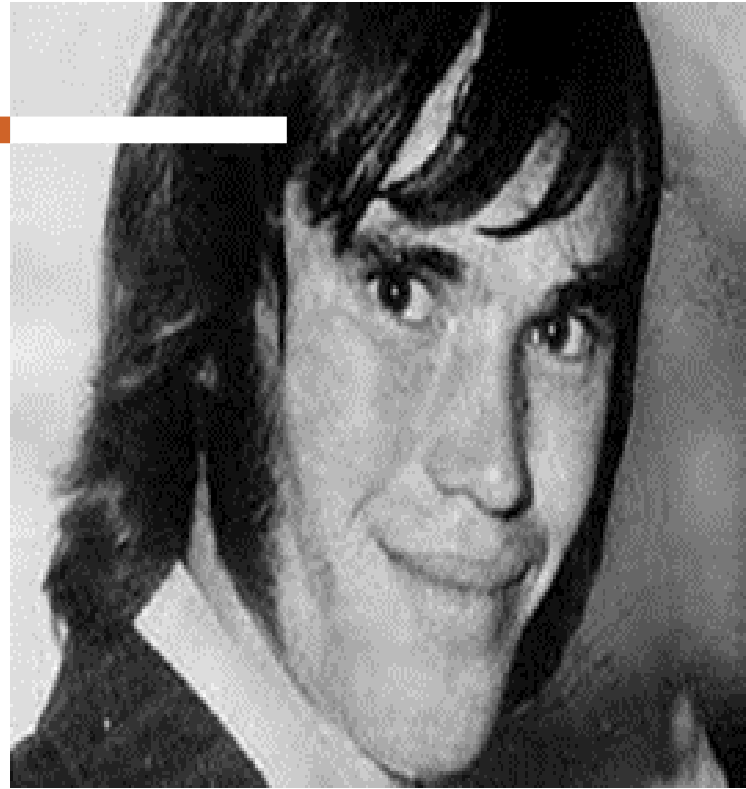
*'The Vampire Rapist's reign of terror in Ontario, Canada'*

Ontario, Canada experienced a very terrorizing period from the year 1969-1971 when a serial killer went on a rampage killing and raping girls. As many serial killers used to leave a signature, he too left a bite on his victim's breasts. Hence he got the moniker The Vampire Rapist. Wayne Clifford Boden was known as a quiet kid who played football in school. Boden used to go by the name 'Bill' and entrap these innocent girls by his charms. He was a sexual sadist who was driven with desire to bite female breasts. The investigators saw that there were no signs of forced entry in the apartments of these girls who were found naked and decapitated.

## **These were the unfortunate girls: -**

### **1. Shirley Audette**

She was a 20-year-old who lived with her boyfriend in Montreal and was found dead in her apartment on October 3rd 1969. She lived next door to Boden. There were no signs of struggle and she was wholly covered but upon investigation, the investigators found out that she had been raped and bitten on her breast and that she was strangled to death.



Image(1)

### **2. Marielle Archambault**

Marielle was a jewellery clerk who on November 23rd left work with 'Bill' who was introduced to her co-workers who pointed out that Marielle was enthralled by him. The next morning, Archambault didn't show up to her workplace, so her employer went in search of her to her apartment. Along with the landlady, they both found Marielle dead and she was fully clothed. They found the room to be well kept which indicated that there was no forced entry nor any struggle. The medical report of Archambault was similar to that of Audette's description. A photograph was found in the apartment which was confirmed by her co-worker that the person in the picture to be that of 'Bill'

### 3. Jean Wray

After 2 months, Boden made an appearance on January 16th 1970 where he killed Jean Wray aged 24 in her Montreal apartment. Wray was found dead by her boyfriend who had come to pick her up but got no response at first. He then came back again and this time he found her front door to be open, he rushed inside to find her naked and her breasts had bloody bite marks.

### 4. Elizabeth Pourteous

Elizabeth Anne Pourteous who was 33 years old was reported to be missing on May 18th as she didn't show up for work. Hence, a call was placed to her apartment manager who then went up to her room only to discover the room to be in a mess with her dead on her bedroom floor. She was raped and decapitated with evident bite marks on her breasts. The investigators found a cufflink which appeared to be broken near the body. Pourteous was seen with a young looking fellow in a blue coloured Mercedes on the night she died by 2 of her colleagues. A friend of Elizabeth pointed out that she had been going out with an acquaintance named 'Bill' who perfectly fit the descriptions of the Vampire Rapist.

The next day, May 19th, a patrolman found the car which was under suspicion. The blue Mercedes was parked near the crime scene. The police arrested Wayne Boden half an hour later when he was walking towards the car. Boden admitted that the cufflink was his and that he was indeed dating Elizabeth and had met her on the night that she was murdered. A cast had been made of Boden's teeth which was compared with the bite marks that were present on the victims by an Odonatologist. This proved that Boden was the man behind the rape and murder of these innocent girls and he ultimately attained life imprisonment.

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**Plathothathil Rachael  
Rajath**



# THE GREEN RIVER KILLER

## INTRODUCTION

Gary Leon Ridgway, or the Green River Killer, is an American serial killer, necrophiliac, ephebophilia, and sex offender responsible for murdering around 80 women, half of whom were prostitutes, teenage girls, and other women. Ridgway only confessed to 49 murders, which made him the second most prolific serial killer in the history of the United States, according to the confirmed murders during the 1980s and 1990s.

## BACKGROUND

Born dyslexic on February 18, 1949, in Salt Lake City, Utah, and raised in SeaTac, Washington, His father, Thomas Newton Ridgway, was a bus driver who used to criticise the prostitutes he saw on the streets. Mary Rita Ridgway was an abusive mother to her three children and her husband. She had the behaviour of washing young Gary's genitals as he had the habit of wetting his bed, which continued till his teenage years and led to Gary fantasising about killing his mother. When Ridgway was 16 years old, he stabbed a boy through the ribs into his liver after

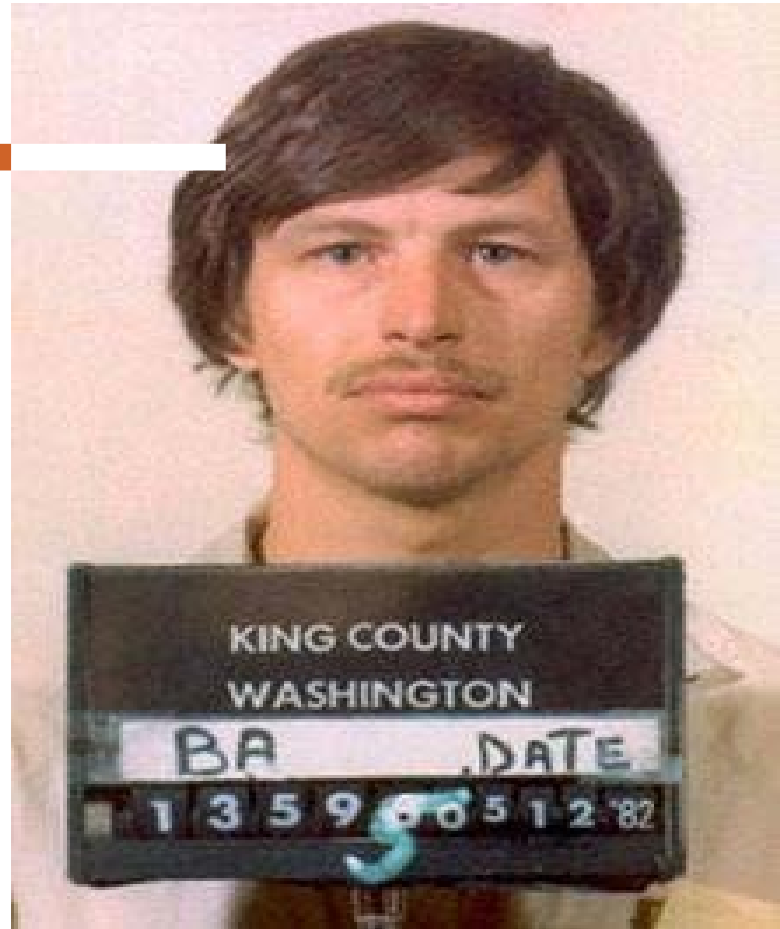


Image 1: The accused Gary Leon Ridgway.

leading him into the woods. The boy survived the attack. He also used to torture animals and had to redo a year in school. At age 18, Gary joined the Navy, served in Vietnam, and married his girlfriend Claudia Barrows, whom he later divorced due to extramarital affairs. He married Marcia Winslow later in 1973, which also ended in divorce for the same reasons, though he had a son with her named Matthew. She later claimed that he had placed her in a chokehold.

According to most women in Ridgeway's life, he had a crazy sexual drive and would pressure them to have sexual intercourse several times a day. Gary was a big hypocrite, as he enjoyed sexual services from sex workers but also complained about them frequently.

In 1988, he married his third wife, Judith Mawson, whom he was still married to while his final arrest took place. He shared a more intimate relationship with her and had less urge to kill.

## MURDERS

The majority of Ridgeway's murders started taking place in the 1980s and went on until the 1990s in the cities of Seattle and Tacoma. Most victims were either runaways or sex workers. Gary used to lure women by earning their trust using his son's pictures, which eventually ended up with sexual intercourse and afterwards strangling the women by choking them. Most were killed in his truck, his house, or a very secluded area. He often used to use his arms to choke, but in time, he started using belts, rope, fishing line socks, and even t-shirts and dumped their bodies, naked or in a pose, in rivers and the wilderness. Ridgeway would sometimes go back to the dumped bodies and conduct sexual intercourse, not because he enjoyed it but because he believed that having sex with the

deceased would reduce the need for a living victim, thus reducing his possibility of being caught. To avoid forensics leading to him, he would dump garbage and other things on the dump sites and would occasionally transport bodies to other states.

The Green River Task Force was formed early in the 1980s to investigate the murders. In 1984, Robert Keppel and Dave Reichert interviewed the imprisoned serial killer Ted Bundy regularly. According to him, the killer was returning to the dump sites to have sex with his victims, which proved true, and the police should stake out a new grave and wait for the killer to return.

#	Name	Age	Disappeared	Body found
1	Wendy Lee Coffield	16	July 1, 1982	July 15, 1982
2	Gosia Ann Lowson	17	July 12, 1982	September 25, 1982
3	Debra Lynn Bonner	23	July 25, 1982	August 12, 1982
4	Marcia Fay Chapman	31	August 1, 1982	August 15, 1982
5	Cynthia Jean Hinds	17	August 11, 1982	August 15, 1982
6	Opal Charmaine Mills	16	August 12, 1982	August 15, 1982
7	Terry Rose Miligan	19	August 29, 1982	April 1, 1984
8	Mary Bridget Mochan	18	September 13, 1982	November 13, 1983
9	Debra Lorraine Eilers	15	September 29, 1982	May 30, 1984
10	Linda Jane Rule	16	September 26, 1982	January 31, 1983
11	Denise Carol Bush	23	October 8, 1982	June 12, 1985
12	Shawnda Leana Summers	16	October 9, 1982	August 11, 1983
13	Shirley Marie Sherrill	18	October 20-22, 1982	June 14, 1985
14	Rebecca "Becky" Marnett	29	December 3, 1982	December 21, 2019
15	Colleen Renee Brockman	15	December 24, 1982	May 26, 1984
16	Sandra Denise Meyer	20	December 24, 1982	December 30, 1985
17	Wendy Stephens	14	Died circa spring 1983 <sup>14</sup>	March 21, 1984
18	Alma Ann Smith	18	March 3, 1983	April 2, 1984
19	Delores LaVerne Williams	17	March 8-14, 1983	March 31, 1984
20	Gail Lynn Matthews	23	April 10, 1983	September 18, 1983
21	Andrea Marion Childers	19	April 14, 1983	October 11, 1989
22	Sandra Kay Gilbert	17	April 17, 1983	April 1, 1984
23	Kim Kai Pisor	16	April 17, 1983	December 18, 1983

Image 2

25	Carol Ann Christensen	21	May 3, 1983	May 8, 1983
26	Martina Theresa Authorlee	18	May 22, 1983	November 14, 1984
27	Cheryl Loo Wini	18	May 23, 1983	March 22, 1984
28	Yvonne "Shelly" Antosh	19	May 31, 1983	October 15, 1983
29	Carle Ann Reis	15	May 31 - June 13, 1983	March 10, 1985
30	Constance Elizabeth Naon	19	June 8, 1983	October 27, 1983
31	Kelly Marie Vitari	22	July 18, 1983	October 29, 1983
32	Tina Marie Thompson	21	July 25, 1983	April 20, 1984
33	April Dawn Eutnam	16	August 11, 1983	August 30, 2003
34	Dorbie May Abernathy	26	September 5, 1983	March 31, 1984
35	Tracy Ann Winston	19	September 12, 1983	March 27, 1986
36	Maureen Sue Feeney	19	September 26, 1983	May 2, 1986
37	Mary Sue Bello	25	October 11, 1983	October 12, 1984
38	Pammy Annelle Juert	15	October 26, 1983	August 16, 2003
39	Debra Louise Ploger	22	October 30, 1983	February 14, 1984
40	Kimberly L. Nelson	21	November 1, 1983	June 14, 1986
41	Lisa Yates	19	December 23, 1983	March 13, 1984
42	Mary Elizabeth West	16	February 6, 1984	September 8, 1985
43	Cindy Anne Smith	17	March 21, 1984	June 27, 1987
44	Patricia Michelle Barczak	19	October 17, 1985	February 3, 1993
45	Robert Joseph Hayes	21	February 7, 1987	September 11, 1991
46	Marta Reeves	36	March 5, 1990	September 20, 1990
47	Patricia Yeloverbe	38	January 1986	August 6, 1986
48	Unidentified White Female (Jane Doe B-17)	14-15	December 1983 - January 1984	January 2, 1986
49	Unidentified Female (Jane Doe B-20)	13-24	1973-1983	August 21, 2003

Image 3

Images 2 and 3: Information regarding the victims' disappearance and their bodies recovered.

## CONFESSIONS AND ARREST

Ridgway had been apprehended twice, in 1982 and 2001, for offences linked to prostitution.

He was identified as a potential culprit in the Green River murders in 1983. Ridgway took and passed a lie detector test in 1984. In 1987, law enforcement obtained hair and saliva samples from him. Some samples collected in 1987 were provided as evidence for Ridgway's arrest warrant, and he was finally arrested at his workplace on November 30, 2001. In a plea agreement that arrived in June, Ridgway agreed to plead guilty to 48 charges of aggravated first-degree murder in exchange for his cooperation in locating his victims and providing other details. Ridgway pleaded guilty to the 48 charges on November 5, 2003. In 2003, Ridgway was sentenced to serve 48 consecutive life sentences with no chance of parole. Additionally, he received 10 years for tampering with evidence in each of the 48 victims' cases, which added up to 480 years. He currently resides at the Washington State Penitentiary.

I'm sorry for killing all those young ladies. I have tried hard to remember as much as I could to help the detective find and recover the ladies. I'm sorry for the scare I put in the community. I want to thank the police, prosecutors, my attorneys and all others that had the patience to work with me and help me remember all the terrible things I did and to be able to talk about them. I know how horrible my acts were. I have tried for a long time to get these things out of my mind. I have tried for a long time to keep from killing any more ladies. I'm sorry that I've put my wife, my son, my brothers and my family through this hell. I hope that they can find a way to forgive me. I am very sorry for the ladies that were not found. May they rest in peace. They need a better place than what I gave them. I'm sorry for killing these young ladies. They had their whole life ahead of them. I am sorry I caused so much pain to so many families.

Gary J. Ridgway

Image 4. Letter written by Gary Leon Ridgway.





Image 5

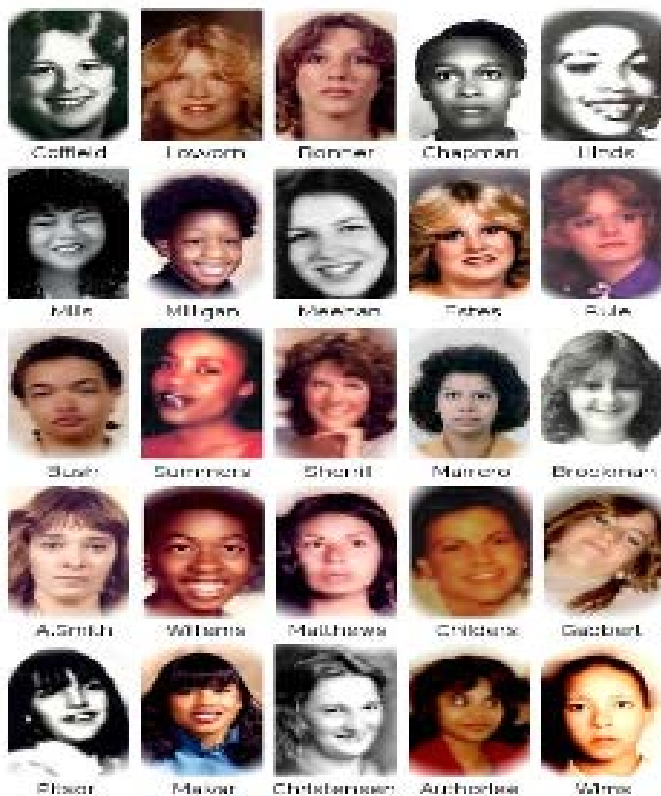


Image 6

Images 5 and 6: Photographs of Gary's victims.

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**Anashwara Pramod**  
**Allen Jose Tomyachen**



# FEATURE ARTICLE

**1**

**The Gaze of Truth: How Eyewitness Testimonies Shape Forensic Verdicts**

**2**

**Cracking Cases From The Clouds: Significance Of Drone Forensics**

**3**

**Forensic Genetic Genealogy**

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**AI In Digital Forensics**

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**Kevlar – The Reinforced Ballistic Vest**

# THE GAZE OF TRUTH: HOW EYEWITNESS TESTIMONIES SHAPE FORENSIC VERDICTS

## INTRODUCTION

In the realm of criminal justice, eyewitness testimonies have long held a prominent position. These firsthand accounts from individuals who claim to have witnessed a crime have historically played a significant role in shaping forensic verdicts. However, as our understanding of memory, perception, and the fallibility of human observation deepens, the impact of eyewitness testimonies on legal outcomes is being critically reevaluated. Eyewitness testimonies are more than mere statements – they are windows into the human experience of crime. They recount the visceral reactions, the heart-pounding moments, and the fear that grips individuals when they find themselves unwittingly cast in the role of observer to unlawful acts. Their narratives offer glimpses into the lives of victims, the minds of perpetrators, and the web of events that led to the courtroom.

**The Fallibility of Memory:** Human memory is not an infallible record of events. Rather, it is a complex and malleable construct that can be influenced by a myriad of factors.



Image 1

Rather, it is a complex and malleable construct that can be influenced by a myriad of factors. Emotions, stress, suggestibility, and the passage of time can all distort the accuracy of recall. This inherent fragility of memory casts a shadow of doubt over the reliability of eyewitness testimonies. While eyewitnesses may be completely sincere in their recollections, the nature of memory makes it susceptible to distortions, leading to potentially erroneous accounts of events.

**The Power of Suggestion:** Eyewitnesses can be unintentionally influenced by external cues, such as leading questions from investigators or media coverage of the crime. The mere presence of authority figures during identification procedures can lead witnesses to make choices based on implicit cues, rather than their true recollection. Such instances underscore the need for meticulously designed procedures to minimise suggestive influences.

In one study, participants were shown a video of a staged crime. Afterward, they were asked leading questions that contained false information about the event. Shockingly, many participants incorporated this fabricated information into their accounts when questioned later. This phenomenon, known as the misinformation effect, highlights how even well-meaning witnesses can be susceptible to suggestion, leading to the creation of false memories.



Image 2

**Memory Reconstruction and Cognitive Biases:** Memory is not a static playback of past events but rather a dynamic process of reconstruction. In recalling an event, individuals fill in gaps with assumptions, perceptions, and even information acquired after the fact. Cognitive biases, such as confirmation bias or the tendency to see what one expects to see, further contribute to the distortion of eyewitness accounts.

Consider a witness who sees a fleeting glimpse of a suspect during a high-stress situation. Their mind may unconsciously fill in details to create a more coherent narrative. Over time, these reconstructed details become intertwined with the original memory, blurring the line between what was actually witnessed and what the witness believes was witnessed.



Image 3

**Unconscious Transference and Misidentification:** Eyewitnesses may inadvertently misidentify innocent individuals due to a phenomenon known as unconscious transference.

This occurs when a familiar face from another context is incorrectly associated with the crime scene. The witness genuinely believes they saw the perpetrator, even though the person was not involved. Such misidentifications can have dire consequences for both the accused and the pursuit of justice.

Imagine a scenario where a witness recognizes a person from their neighbourhood in a police lineup. Unbeknownst to the witness, they had seen this person at a store a few days prior to the crime. Despite the absence of any criminal involvement, the witness identifies the innocent individual due to the blurred lines between memory and recognition.

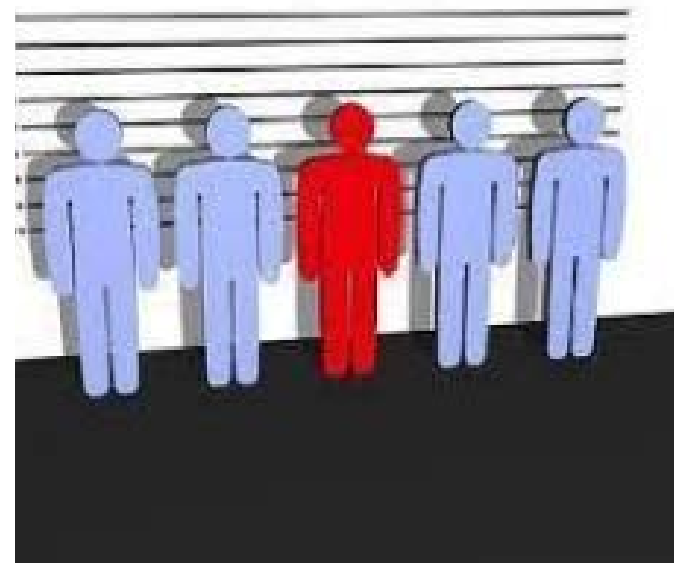


Image 4

**Reforming the Legal Landscape:** Recognizing the limitations of eyewitness testimonies, legal systems around the world

are adopting reforms to mitigate potential injustices. Sequential lineups, which present suspects one at a time instead of in a group, also help prevent relative judgments that might occur in simultaneous lineups. Moreover, some jurisdictions are implementing expert testimony on the fallibility of human memory during trials. Forensic psychologists and experts in human memory now play a critical role in courtrooms, educating judges and juries about the fallibility of eyewitness accounts. By explaining the science of memory, cognitive biases, and the potential for misidentification, these experts help decision-makers critically evaluate the weight they give to eyewitness testimonies.

## CONCLUSION

The gaze of truth is a powerful concept, but it is one tempered by the complex nature of human memory and perception. While eyewitness testimonies have historically held sway in forensic verdicts, their role is now under scrutiny. The delicate balance between justice and the potential for error necessitates a multidisciplinary approach that incorporates the latest findings from psychology, neuroscience, and forensic science. As legal systems evolve to embrace more informed and scientific approaches, the path to truth becomes clearer, ensuring that the pursuit of justice is not compromised by the fragility of human memory.



While eyewitness testimonies will likely always have a place in the courtroom, understanding their limitations empowers us to interpret them with caution, ensuring that the pursuit of justice remains steadfast even in the face of the imperfections of human perception and memory.



Image 5

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Riya Ghosh

# CRACKING CASES FROM THE CLOUDS: SIGNIFICANCE OF DRONE FORENSICS

In the rapidly growing domain of technology, the skies have now become the new limit not only for innovation and investigation but also modern mediums for offenders to perform unlawful activities.

Drones, also referred to as Unmanned Aerial Vehicles (UAVs), are flying robots that are remotely controlled or can fly on their own using flight plans that are controlled by a radio controller which is practically a handheld device by software and onboard sensors and a global positioning system (GPS).

Drones when we usually think about our day-to-day life the first application that comes to our minds is for photography and videography purposes. Nevertheless, drones are being used in a plethora of sectors, right from the military for security purposes to criminals for illegal activities and hence it also marked the start of a very engrossing field called drone forensics.

Some of the many illegal uses of drones may include:



Image 1

- Smuggling of illegal substances, drugs, weapons, etc.
- It's widely used as an instrument that leads to terrorism by putting in the ground into stadiums and other public gatherings.
- One of the most common illegal uses of drones is that they are used to intrude into one's personal space and capture private images and video recordings of individuals and later use these recordings against them and blackmail them.
- Stalking, harassing, and other unethical reporting is another illegal application of drones.

## RELEVANCY OF DRONE FORENSICS

Today society places a high value on drone forensics. With adequate training and equipment, a forensic data analyst can extract plenty of data from one of such drones that has been seized by a forensic team.

This device is then prepared for examination and gathers crucial digital shreds of evidence that can reveal many facts about that particular case.

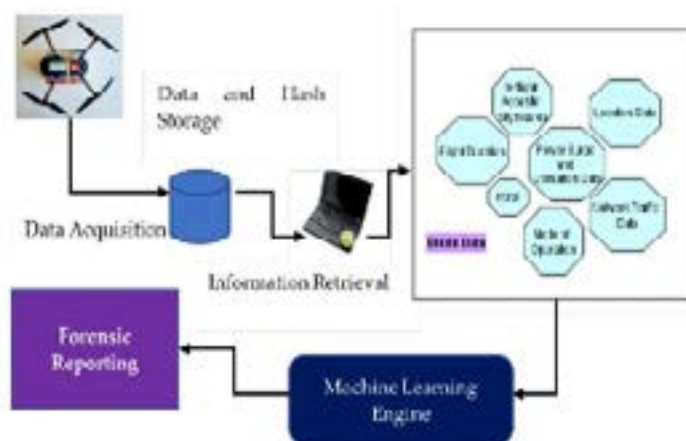
A drone operates similarly to a computer, in addition to having a central processing unit (CPU), Universal Serial Bus (USB) ports and a data storage device like a Secure Digital (SD) card, camera, and other sensors may also be added to it. This enables a digital forensic film analyst to utilise cutting-edge techniques like VIP 2.0 to put together the events using the footage captured throughout the trip and recover the missing details. A digital forensic investigator must adhere to stringent criteria and industry standards for the information recovered from drones to be admitted into evidence in court.

Crucial data that can be retrieved from a drone includes:

- Images/Videos captured
- Landing, launching, returning, and home location.

- Intention and motive of that particular flight.
- Atmospheric conditions.

It also reveals data such as GPS status, Wi-fi data, Drone serial number, Internet protocol (IP), Bluetooth, 3G and 4G connectivity status, and Pilot control output. Just as a wise man once said, 'Nothing is perfect in this world, everything has its pros and cons' hence this amazing field of drone forensics has its limitations.



[Image 2: Working of drone forensics]

The challenges faced by drone forensic investigators are:

- Damage caused to the storage media and scattering components. This may include cases if the drone has been damaged during the flight or because the landing was not appropriately done.
- High cost of investment and maintenance.

- Lack of GPS information.
- Not all flights will have great connectivity. There might be instances where the GPS signal will be lost.
- Absence of suitable digital forensic instruments.
- Trouble connecting to the drone's USB port.

Points to be noted during the search and seizure of suspected drones:

- If the drone is on, take images of the controller's display then switch the drone and its components off.
- The investigator must identify the mode of communication between the controller and the drone.
- Identify the make and model of the drone.
- Isolate the drone from GPS satellites and other devices to ensure that GPS signals are not picked.
- A search for any external storage devices such as SD cards should be conducted.
- Photograph and label the status of the drone and its components.

## CONCLUSION:

Concerns about privacy invasions, illegal and malicious use of drones, among To gather important forensic evidence about an incident involving the drone, it is needations recorded inside the drone during ed for the digital investigator to possess the knowledge and comprehension of the key processes, characteristics, and functionalities of drones.

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**Sasha Vassula  
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# FORENSIC GENETIC GENEALOGY

## INTRODUCTION

Forensic Genetic Genealogy (FGG), also known as Investigative Genetic Genealogy, is one of the most unique forensic investigative tools that emerged in 2018 which uses the conventional methods of genealogy and genetics to identify the perpetrator of a heinous crime. FGG is based on the fundamental principle of genetics that an individual will share a common DNA with their ancestors and if there is a generational gap between the individuals, they can still carry some amount of the same DNA. DNA can play a very crucial role in solving cases such as violent crimes or even cases of missing or unidentified individuals.

## EMERGENCE OF FGG

Genetic genealogy uses DNA typing and DNA testing in combination with conventional genealogy methods to find the relationships between individuals. Earlier genealogy started using Y chromosome testing in which the Y chromosome that was passed down by the male line was used to identify individuals. People study surnames and build a family tree. These



Image:1

tests help to know if two families are related. Now we can look for people who are not just related through the male line but also the female line. The case of the Golden State killer is considered to be the birth of Forensic Genetic Genealogy. He committed over 50 rapes and 200 burglaries from 1974 to 1976 and was unidentified for a long time. After more than 40 years of being unidentified, the golden stake killer was finally found using GEDmatch, a genealogy site with a genetic database.

## HOW DOES FGG WORK?

FGG collects DNA from an unknown sample encountered at a crime scene and does DNA typing to establish the identity and family relationship of the individual. This is then uploaded to the Genetic Genealogy database which previously has stored the DNA of many individuals. FGG compares the unknown DNA with the database and looks for people who share a certain amount of DNA with the perpetrator. Based on the amount of DNA shared, the perpetrator could be a close or even a distant relative of the person with a match. These genetic matches are taken and a genetic tree is built. For example, there is a family A which got married into family B. There is a huge possibility that the perpetrator could be a descendant of that,

marriage and hence he/she might share some DNA from both families. The work is carried out by genetic genealogists along with investigators to narrow down to a set of individuals based on information predicted such as the perpetrator's gender, hair, and eye colour. Once a person is suspicious, his/her DNA sample is collected and compared with that of the unknown sample collected from the crime scene.

## HOW IS FGG USEFUL IN SOLVING CRIMES?

FGG has a broad reach into the data. The most common type of DNA profiling used by forensics in criminal cases is called Short Tandem Repeat (STR). It is used to identify missing individuals and also to link a suspect to a crime scene. However, DNA STR analysis can only provide connections to close relatives and not to distant ones. Whereas, single nucleotide polymorphisms (SNP) used in FGG help to identify the paternal lineages from deep ancestry. The SNP data obtained is uploaded to the genetic genealogy database in which the DNA of those members who have voluntarily provided their DNA for SNP analysis is present. The unknown SNP data is compared with other member's SNP data and a list of people who share the DNA with the unknown person is generated.

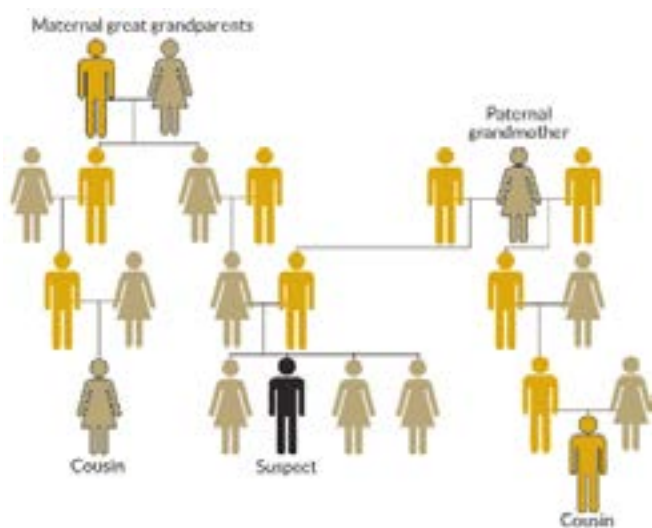


Image:2

## CASES SOLVED USING FGG

- Murder and sexual assault of Jodi Loomis, 1972: The case of Jodi Loomis remained unsolved for almost 47 years. Jodi Loomis's body was identified on August 23, 1972, with DNA evidence preserved on her body and boots. Years later, DNA genetic genealogy was utilised to identify 78-year-old Terrance Miller as the killer
- 16-year-old double murder in Sweden: On October 19, 2004, an eight-year-old boy and a fifty-six-year-old woman were stabbed to death in the city of Linköping, Sweden. After 15 years of investigation, DNA sets were formed and searched with databases of GEDmatch and Family tree DNA genealogy. FGG helped to identify two brothers, one of whom matched with DNA taken from the crime scene.

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# AI IN DIGITAL FORENSICS

## INTRODUCTION

The study of digital forensics is vital to identifying and combating cybercrimes in the modern digital age, where information and communication technology have permeated every aspect of our lives. Traditional methods of analysis are losing their effectiveness as the complexity and volume of digital data continue to rise. In this situation, artificial intelligence (AI) transforms the field of digital forensics. In this essay, we examine the numerous applications of AI in digital forensics to strengthen cybersecurity and improve investigations.

## UTILISING AI IN DIGITAL FORENSIC

### AI-Assisted Evidence Analysis

The enormous volume of data that needs to be sorted through throughout an investigation is one of the most difficult problems in digital forensics. Large datasets may be quickly analysed by AI-driven algorithms, which aids investigators in finding patterns, anomalies, and possible evidence. Predictive modelling, made possible by machine learning techniques, assists in predicting upcoming cyber-threats and spotting potential weaknesses before they are used against you.



Image 1

### Automated data recovery

Tools that are AI-powered help speed up the process of recovering data from digital devices. These programs are capable of reassembling fragmented data, retrieving deleted files, and even obtaining data from corrupted storage media. Digital forensic specialists can recover more data in less time by using AI algorithms, which increases the effectiveness of investigations.

### Behavioural Analysis

By examining patterns and actions, AI can understand the behaviour of digital objects, such as malware. This makes it possible



to spot harmful activity and create stronger defences against it. Investigators can play the cat and mouse game of cybercrime by using AI to comprehend and anticipate attacker behaviour.

### **Natural Language Processing (NLP) for Communication Analysis**

With the proliferation of digital communication platforms, analysing text and conversations has become a critical aspect of digital forensics. NLP, a subfield of AI, enables the extraction of meaningful insights from vast amounts of textual data. This is particularly useful in detecting cyberbullying, online fraud, and other forms of digital misconduct.

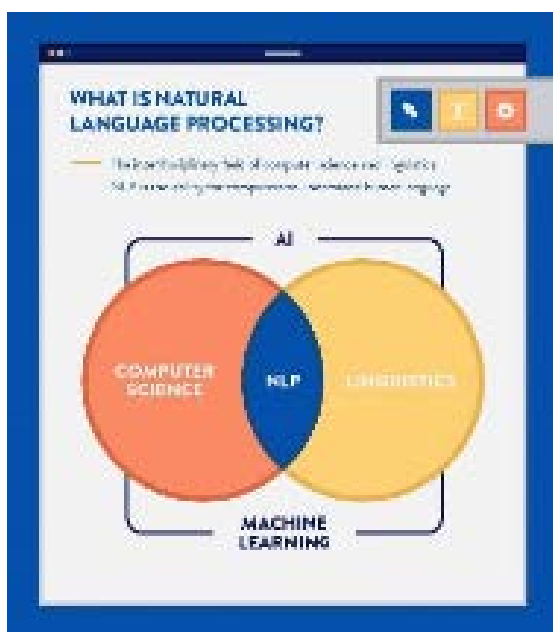


Image 2

### **Image and Video Analysis**

AI-powered image and video analysis tools assist in the examination of multimedia files to identify forged or altered content.

Detecting deep fakes, where AI-generated media is used to create misleading or false information, is a challenging task that AI algorithms can help address. By analysing metadata, pixel-level alterations, and inconsistencies, digital forensic experts can determine the authenticity of visual evidence.

### **Ethical considerations and Challenges**

While incorporating AI into digital forensics has many advantages, there are also some difficulties. The possibility for bias in AI systems, which could produce unreliable findings, is a serious worry. To keep investigations' integrity, it is crucial to guarantee the fairness and dependability of these algorithms. When using AI technologies in digital forensic procedures, it's also important to carefully evaluate ethical issues related to privacy and data protection.

### **CONCLUSION**

By combining AI and digital forensics, we might potentially improve the effectiveness, accuracy, and proactiveness of cybercrime investigations. AI is proving to be a helpful ally for digital forensic specialists, automating data recovery procedures, assessing multimedia content, and foreseeing cyber dangers. To ensure that AI-driven investigations respect the ideals of justice and fairness in our increasingly digital society, it is vital to establish a balance between technological breakthroughs and ethical issues.

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**Shreya Gupta**

# KEVLAR – THE REINFORCED BALLISTIC VEST

## INTRODUCTION

Testing and evaluating bulletproof vests and jackets—commonly referred to as “soft body armor”—is one of the crucial tasks assigned to the forensic examiner. This element falls under the realm of ‘terminal ballistics’. One of the essential items of security equipment that law enforcement and corrections professionals require for personal protection is body armour. Lightweight body armour was first developed by the National Institute of Law Enforcement and Criminal Justice in 1971, and testing on it commenced in 1978. ‘Super fibres’, which were introduced by DuPont, are generally regarded as the biggest advancement in soft body armour.

Kevlar has a high tensile strength-to-weight ratio and is best recognised for its usage in ballistic body armour, but it also has many other uses. Kevlar is exceptionally robust due to the many interchangeable bonds in its molecular structure. Its fibres are tightly spun, making it impossible to separate them. Kevlar’s strands grab and absorb the projectile’s energy



Image.1 Military armour vest made from Kevlar material.

when it collides with a bullet or other low-velocity projectile. It is a well-known para-aramid fibre that is mostly utilised in fabric-braced radial tires. Because of its resilience, this fibre could be utilised to create soft body armour that is resistant to bullets. The fibres are woven into sheets using various yarn thicknesses. Kevlar, the multi-layer web of woven fabrics, catches

the bullet and provides protection as body armour. The density of the weave, also known as denier, gives it the required properties. The sheets are securely sewn into a vest-shaped container. Kevlar is a lightweight, highly functional, and flexible jacket. This is designed to essentially stop any handgun missile.

The main focus of terminal ballistics is the behaviour of the bullet after impact. It largely focuses on the investigation of missile and bullet penetration into various target categories. This involves the study of bullet-resistant materials such as jackets and vests. The implementation of Kevlar technology in ballistics applications has enhanced safety for law enforcement officers.



Image.2 Kevlar fibres used in manufacturing of body armour

## THE ADVANTAGES OF KEVLAR VEST

Kevlar body armour provides ballistic protection, and the extra layer also extends to some rifle ammunition. These vests are dependable, lightweight material, which makes them the perfect option for a variety of settings and circumstances. Due to the material utilised historically as protective panels, such as steel plates, bulletproof panels have always been hefty. The DuPont business discovered Kevlar in the 1970s after extensive research. Kevlar has been demonstrated to be significantly stronger than steel because of its robustness and lightweight, as well as after further development and testing. This enables its application in ballistic body armour. These Kevlar panels come in several levels of protection, allowing armour wearers to choose the amount that best suits their requirements. To keep these Kevlar vests as effective as possible, they should be handled and stored appropriately.

## THE DISADVANTAGES OF KEVLAR VEST

**Bulky and Heavy:** Kevlar body armour can be fairly heavy and bulky, which in some circumstances may impair movement and agility.

**Water Absorption:** When exposed to damp conditions, Kevlar has a tendency to absorb water, which can lower its



ballistic performance and add weight to the fibre.

Despite being effective against the majority of frequent threats, Kevlar body armour has limits when dealing with numerous high-velocity strikes in a small space.

Poor compressive strength: hard to be crushed or squeezed; more sensitive to environmental factors than other materials.

Requires specially-made scissors to cut dry fabric. Once laminated, only specially designed drill bits will penetrate it. Kevlar leverages its ability to deflect bullets when wet as well as being highly vulnerable to many common home chemicals.

## CONCLUSION

Kevlar has a long shelf life and can last for a very long time with proper care. Since its creation, Kevlar has saved countless lives, particularly in the field of law enforcement. Body armour is anticipated to get even lighter, more flexible, and more comfortable as technology develops. We appreciate Stephanie Kwolek for her work. Today, Kevlar is still demonstrating its value!

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**Anna Roy**  
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# LITERATURE REVIEW

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**1**

AI- Enhanced Forensic Medicine And  
Toxicology

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**2**

Digital Steganography As A Threat

# AI- ENHANCED FORENSIC MEDICINE AND TOXICOLOGY

## ABSTRACT

Artificial intelligence (AI) is identified as a specialised branch in software engineering that examines how computer systems emulate human actions and cognitive processes. Researchers might eventually build systems capable of understanding and reasoning about anything ahead of humans. AI will play a key role in framing various opinions of medicolegal importance. Advanced software has streamlined forensic inquiries, elucidated the diverse rationale behind various algorithms, and diminished errors arising from cognitive prejudices. Yet, no technology is exempt from constraints. Intelligent systems, for instance, demand extensive knowledge databases, potentially leading to incorrect conclusions when inputs deviate from trained datasets, resulting in false positives or negatives.

## PROLOGUE

AI is a pillar for all digital transformations. AI is overarching in the field of toxicology to analyze biological samples. Forensic medicine applies

medical expertise within legal frameworks.

Toxicology delves into understanding how various chemicals impact human health, with sub-disciplines including clinical toxicology for toxin-related illness, medical toxicology for poison treatment. Occupational toxicology focuses on health risks posed by toxic substances, analytical toxicology for poison detection, and forensic toxicology for legal contexts.

## REVIEW

Conventional forensic analysis uses physical data for age, gender, and facial assessment, employing medical, biological, and mathematical assessments for identification. Investigator expertise is influenced by factors like fatigue and emotions, impacting undesirable forensic outcomes. AI can mitigate time-intensive and potential issues in this approach.

AI has triggered a fundamental transformation within the realm of medical sciences, enabling precise diagnosis, individualised treatment strategies, and heightened patient well-being. Machine learning (ML) algorithms possess the capability to meticulously analyse extensive datasets, facili-



tating early disease detection and offering customised therapeutic suggestions. AI-powered imaging technologies have significantly elevated the field of radiology, expediting, and refining the interpretation of medical visuals like X-rays, CT scans, and MRLs. Furthermore, AI accelerates drug discovery by analysing molecular structure, thus propelling advancements in the developmental landscape.

## **FORENSIC ODONTOLOGY**

A convolutional neural network (CNN) is a type of deep learning model capable of receiving an input image, assigning significance to various features/objects in the image, and distinguishing between them. Commonly utilised AI technologies in this field consist of deep neural networks (mostly applied in age estimation, sex determination, and conducting dental comparisons), artificial neural networks, ML, and computational techniques. AI algorithms with sophisticated computations were developed to identify individuals based on dental records in mass disasters. Neural network-based algorithms are accessible to users without extensive expertise, offering precision while minimising human bias in the gender assessment of skeletal remains. Neural networks have the potential to significantly impact fields ranging from archaeology to forensics.

## **POST-MORTEM INTERVAL (PMI)**

An investigator, when he comes across a cadaver, needs to determine the interval between the time of death and the discovery of the body. PMI signifies the duration since death occurred. This PMI, coupled with forensic reports, holds significance in legal proceedings, influencing the court's decision to accept or reject claims made by suspects and witnesses. The process of assessing the time since death during forensic examinations relies on the application of AI technology. This involves estimating markers in the blood, such as lactate dehydrogenase (LDH) and aspartate aminotransferase (AST) as protein indicators, and cholesterol as lipid indicators. Once the data is entered into the system, it generates an accurate prediction about PMI.

## **AI IN 3D CEPHALOMETRIC LANDMARK IDENTIFICATION**

The examination of intricate cranial and facial formations falls within the domain of orthodontics. Historically, these structures were crucial for accurate treatment planning, deleting lines, angles, and planes on craniofacial structures, particularly visible in lateral X-rays. An automated 3D cephalometric algorithm with reliable precision identifying specific points consistently could serve as a valuable tool. This tool isn't designed to

replace humans, but rather to address human errors which are impossible to eliminate due to interobserver variability

## **TOXICOLOGY AND DRUG ANALYSIS**

Various contemporary techniques for toxicological assessment exist. A few methods encompass photometric analysis, chromatography, neutron activation analysis, and high-performance liquid chromatography. Despite the advancements, human errors persist. AI plays a pivotal role in mitigating this issue. By imparting a machine with a set of algorithms, it analyzes with enhanced precision. AI can be integrated with robotics to automate specific toxicological aspects to perform computations to solve chemical equations and theories, along with predicting reaction products. It has also advanced statistical methods for evaluating chemical data and aiding in compound and spectrum analysis.

## **CONCLUSION**

AI offers benefits to forensic medicine experts in autopsy and toxicological analysis. Global forensic experts must provide accurate data initially, including autopsy findings, images, injury patterns, biomarker stats, and algorithms. ML excels at data processing, identifying complex patterns, and consistent decision-making, but it has limitations like inflexibility and is unsuitable for certain cases. AI enhances forensic practice, but ethical and legal challenges must be addressed to its full potential.

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**R Bhavitha Sri**

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# DIGITAL STEGANOGRAPHY AS A THREAT

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## INTRODUCTION

Digital steganography was coined at the end of the 15th century. Steganography, the art of concealing messages or information within seemingly innocuous files, has transcended its historical role as a tool for covert communication and espionage. The purpose of steganography is covert communication to hide a message from a third party. Steganography hides the covert message but not the fact that two parties are communicating with each other. This hidden technique enables the embedding of data within images, audio files, videos, and even seemingly harmless text, creating a veil of secrecy that can be exploited by cybercriminals, state actors, and malicious entities. This hidden avenue poses a unique and potent threat as it allows for the clandestine exchange of information, from leaking sensitive data to facilitating cyber-attacks, thereby challenging the conventional paradigms of digital security and surveillance.

## UNDERSTANDING DIGITAL STEGANOGRAPHY

Digital steganography refers to the disguising and transferring of computer data so that the true nature of the data being transferred is hidden from all but the sender and receiver. In some cases, it could pose a security risk if used for malicious purposes, but it's not inherently a threat on its own. Security measures and vigilant monitoring can help mitigate potential risks associated with digital steganography.

## MOTIVE

There are a number of motivations for criminals and terrorists to use digital steganography. Digital steganography can be used to hide internet communications among conspirators as they plan their criminal activities. Also, insiders who have access to financial or other types of sensitive information in a computer data system can use steganography to conceal the theft and unauthorised transfer of the data to outside sources.

## STEGANOGRAPHY AS A THREAT

Steganography can be a threat because it allows individuals to hide sensitive in-

formation within seemingly innocuous files, like images or audio files. This hidden information could include anything from confidential documents to malicious code. Since it's hard to detect, it can be used for covert communication, data exfiltration, or even to deliver malware undetected. This makes steganography a potential tool for cybercriminals, terrorists, or espionage activities. Hackers can hide data inside images using a technique called least significant bit (LSB).

## MANAGEMENT OF STEGANOGRAPHY AS A THREAT

- 1. Information Leakage:** Malicious actors can hide sensitive information such as trade secrets, military plans, or personal data within harmless-looking files. This information can then be transmitted or leaked without raising suspicion, potentially causing financial, political, or personal harm.
- 2. Insider Threats:** Employees with access to sensitive information might use steganography to leak company data, intellectual property, or customer information without detection. It can cause data breaches, sensitive data leakage, production loss, and organisational reputation damage.
- 3. Terrorism and Organised Crime:** Terrorist organisations and criminal

networks could use steganography to communicate plans, coordinate attacks, or traffic illegal goods without drawing attention from law enforcement agencies.

- 4. Blackmail and Extortion:** Hidden messages could be used to threaten individuals or organisations with the exposure of sensitive or embarrassing information, which leads to potential blackmail or extortion scenarios.
- 5. Recruitment and radicalization:** Extremist groups might use steganography to distribute propaganda, recruit new members, and radicalise individuals while evading online monitoring.
- 6. Financial Fraud:** Criminals could see steganography to embed instructions within images to manipulate financial systems, execute fraudulent transactions, or carry out phishing attacks.
- 7. Malware Distribution:** Malware creators can embed malicious code within images or other files using steganography. When a user unknowingly opens or downloads these files, hidden malware can be unleashed, leading to data breaches, system compromises, and even more.



**8. Censorship circumvention:** In regions with strict internet censorships, steganography can be employed to transmit restricted content, allowing individuals to bypass government filters and access information or communicate freely.

**9. Cyber Espionage:** State-sponsored or criminal groups might use steganography to communicate covertly, enabling them to plan and execute cyber-attacks, gather intelligence, or engage in espionage without being detected by traditional security measures.

**10. Disinformation Campaigns:** Hidden messages could be used to spread false or misleading information, contributing to disinformation campaigns that manipulate public opinion, incite fear, or create confusion.

Overall, the covert nature of steganography makes it a versatile tool for evading detection and carrying out a wide range of malicious activities, posing serious threats to society's security, privacy, and stability

## CONCLUSION

As a result, steganography presents a significant threat to society due to its ability to conceal information within seemingly

harmless files. This technology can be exploited by cybercriminals, hackers, terrorists, and other malicious actors to facilitate various illicit activities. From leaking sensitive data and distributing malware to coordinating cyberattacks and evading censorship, the covert nature of steganography allows these threats to operate under the radar of conventional security measures.


As society becomes increasingly dependent on digital communication and data exchange, it is crucial for individuals, organisations, and governments to be aware of the potential risks posed by steganography and to implement robust security measures to detect and counteract its misuse.

Though steganography is not implemented in wider ways, it can be used as the best security tool. The main problem in today's world is securing their data confidentially. The techniques used currently are not considered the best; this can only be replaced by steganography.

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