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Paradigm Shift In Technology For Public Health Forensics

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1. INTRODUCTION

Recent trends and technological advancements have raised our national awareness and expectations of forensic science and scientific evidence. The scope, role, and tasks of forensic science and its experts currently vary widely between countries and legal systems, which has resulted in barriers to organization, standard setting, and quality assurance. Although the role, jurisdiction, practice, definition and application vary with geographic and jurisdictional boundaries,the primary role of forensic science and medicine has been to find legal facts substantiating with evidence.
The benefits of real-time, on-site forensic investigations are manifold and such technology has the potential to strongly increase the speed and efficacy of the criminal justice system.[1] These platforms enable field investigations, yield robust and validated evidence and allow for forensic intelligence and targeted use of expert capacity at the forensic institutes. This technological revolution in forensic science could ultimately lead to a paradigm shift in which a new role of the forensic expert emerges as developer and custodian of integrated forensic platforms.[1] Technology can be regarded as a vital catalyst in the transition of scientific findings and insights into innovation.[1]
Forensic science can be defined broadly as the application of scientific knowledge to the legal system, and includes disciplines such as serology, pathology, molecular biology, biometrics (fingerprint analysis, voice recognition and identification), trace evidence (hair, fibre, and paint identification) and weapons identification. Forensic technology can be defined as the tools or methods used to apply this scientific knowledge.[2]

Role of Forensic Laboratory:
The science involves not just the trained experts but also the support in terms of newer technology and its operations. From collection of evidence from the site of incidence to labelling, storing, carrying and analysis, the science has been believed to be patchwork of many disciplines. State-of-the-art laboratories where evidence is studied with modern instruments forms an essential component to this field of science. Without this often high-tech and expensive equipment, the forensic expert would not be able to generate the forensic findings that so often are of vital importance to solve a crime and assure high-quality rulings in a court of law.[3]The forensic laboratory and procedures are core elements to this science. And evidence is the fuel that runs the forensic laboratory. The quality of evidence must be

secure.[4]To maintain the viability of collected evidence, forensic science must apply only those scientific techniques and procedures that are solidly grounded through previous experimentation.[1] Standards for qualifying technicians and scientists must be followed. Standard procedures must be adhered to during evidence collection and analysis.the regular use of forensic methodologies outside the controlled laboratory environment by untrained forensic experts requires substantial technological efforts. Quality of the findings must be guaranteed at all times, the equipment needs to function in a robust manner under variable and unfavourable conditions, and it must be very easy to operate. Only through technology can such requirements be met and efforts should be aimed at automated forensic interpretation, reporting uncertainties and minimizing potential errors by the operators. The examination of many different types of forensic evidence must be pursued; some types of evidence may be routine and inexpensive(fingerprinting), while other types may be more time consuming and quite costly (DNA).

The latest developments in forensic science require cooperation among experts, government, its agencies and state. As technology infiltrates every aspect of our lives, it is no wonder that forensic science has become almost futuristic in its advances. From retinal scanning to trace evidence chemistry, forensic technologies have grown over time. With all this forensic technology, it's no wonder that this field is one of the fastest growing.[5]There are a number of incredible forensic technologies that exist which helps in solving major evidence such as investigation in mass disaster, crime scene, DNA analysis etc.

Advancement in Forensic Technology :

1. Laser Ablation Inductively Coupled Plasma Mass Spectrometry (LA- ICP-MS)

When broken glass is involved in a crime, putting together even tiny pieces can be key to finding important clues like the direction of bullets, the force of impact or the type of weapon used in a crime. Through its highly sensitive isotopic recognition ability, the LA-ICP-MS machine breaks glass samples of almost any size down to their atomic structure. Then, forensic scientists along with his team with the help of public health professional are trained to be able to match even the smallest shard of glass found on clothing to a glass sample from a crime scene.[6]

2. Alternative Light Photography

For a forensic team, it is being easy for them to quickly analyse and ascertain how much physical damage a person has suffered, can be the difference between life and death. Although there are many tools at their disposal to help decide quickly and accurately, Alternative Light Photography is one of the tools to help see damage even before it is visible on the skin. A camera such as the Omni-chrome uses blue light and orange filters to clearly show bruising below the skin's surface.[6]

3. High -Speed Ballistics Photography

It is right away not a tool for forensic scientists, but ballistics specialists often use high-speed cameras in order to understand how bullet holes, gunshot wounds and glass shatters are created. Virtually anyone, from a crime scene investigator to a firearms examiner, can operate a high-speed camera without any additional education or training.[6]

4. Video Spectral Comparator 2000

For crime scene investigators and forensic scientists, this is one of the most valuable forensic technologies available anywhere. With this machine, scientists and investigators can look at a piece of paper and see obscured or hidden writing. They can determine quality of paper and origin and "lift" indented writing. It is sometimes possible to complete these analyses even

after a piece of paper has been so damaged by water or fire that it looks unintelligible to the naked eye.[7]

5. Digital Surveilliance for Xbox(XFT Device)

Most people don't consider a gaming system a potential place for hiding illicit data, which is why criminals have come to use them so much. In one of the most ground-breaking forensic technologies for digital forensic specialists, the XFT is being developed to allow authorities visual access to hidden files on the Xbox hard drive. The XFT is also set up to record access sessions to be replayed in real time during court hearings.[7]

6. 3D Forensic Facial Reconstruction

Although this forensic technology is not considered the most reliable, it is definitely one of the most interesting available to forensic pathologists, forensic anthropologists, forensic odontologist and forensic scientists. In this technique, 3D facial reconstruction software takes real-life human remains and extrapolates a possible physical appearance, through which a criminal can be easily identified.

7. DNA Sequencer

Most people are familiar with the importance of DNA testing in the forensic science lab. Still, most don't know exactly what DNA sequencers are and how they may be used. Most forensic scientists and crime lab technicians use this technique called DNA profiling to identify criminals and victims using trace evidence like hair or skin samples. In cases where those samples are highly degraded, however, they often turn to the more powerful DNA sequencer, which allows them to analyze old bones or teeth to determine the specific ordering of a person's DNA nucleobases, and generate a "read" or a unique DNA pattern that can help identify that person as a possible suspect or criminal.[8]

8. Forensic Carbon-14 Dating

Carbon dating has long been used to identify the age of unknown remains for anthropological and archaeological findings. Since the amount of radiocarbon (which is calculated in a Carbon-14 dating) has increased and decreased to distinct levels over the past 50 years, it is now possible to use this technique to identify forensic remains using this same tool. The only people in the forensic science field that have ready access to Carbon-14 Dating equipment are forensic scientists and forensic odontologists. [7]

9 Magnetic Fingerprinting and Automated Fingerprinting Identification (AFISI)

With these forensic technologies, crime scene investigators, forensic scientists and police officers can quickly and easily compare a fingerprint at a crime scene with an extensive virtual database. In addition, the incorporation of magnetic fingerprinting dust and no-touch wending allows investigators to get a perfect impression of fingerprints at a crime scene without contamination. [9]

9. Link Analysis Software for Forensic Accountants

When a forensic accountant is trying to track illicit funds through a sea of paperwork, link analysis software is an invaluable tool to help highlight strange financial activity. This software combines observations of unusual digital financial transactions, customer profiling and statistics to generate probabilities of illegal behaviour. [8]

10. Advanced and Emerging Techniques and Methodologies of DNA Analysis

Since the advent of forensic DNA analysis in the 1980s, it has gone through several stages of development.[9] The first generation of DNA analysis -restriction fragment length polymorphism (RFLP) profiling is used by the forensic community, as it requires relatively small amounts of DNA and degraded samples can be analyzed with accuracy. The second generation of DNA analysis or the current method of choice is short tandem repeat or STR analysis. It does work well for highly degraded DNA samples, such as in cases of mass

disaster situations or accidents where an individual is too badly damaged to identify. [10] More effective, faster and cheaper DNA analysis techniques are continually being developed, which are addressing different targets for forensic applications.

Table 1 shows "Definition of DNA analysis targets and its Advantages"[11]

Target of DNA Analysis	Definition	Advantages
Short Tandem Repeats	Short sequences of DNA that contains short segments consisting of 2-7repeating base pairs	Suitable for the analysis of highly degraded or low copy number DNA samples • Consistency of number of STR markers in different DNA Database
Single Nucleotide Polymorphism	DNA sequence variations that occur when a single nucleotide (A, T, C, or G) in the genome sequence is altered	Suitable for DNA mixtures
Low Copy Number or Low-Template DNA	200 pico-gram of DNA found in a sample	Ease of contamination and amplification of contaminants
Mitochondrial DNA	A circular molecule of DNA 16,569 base pairs in size, obtained from the mitochondrion organelle found within cells	• More discriminatory (maternal inheritance) • But, Relatively time consuming and expensive
DNA Methylation	DNA methylation is a biochemical process involving the addition of a methyl group to the cytosine or adenine DNA nucleotides	Small amount of samples needed • Labor-intensive and time-consuming

2. CONCLUSION:

Economic realities and the change of status of trace evidence undoubtedly present significant challenges for forensic science discipline.[12] There is little doubt that it has become necessary to reassess the place and shape of the trace evidence discipline, as well as the need to think about new models applicable to trace evidence. Challenges bring opportunities. It is needed to seize the opportunitiesand convince the stakeholders that trace evidence plays a crucial role in law enforcement and in the administration of justice.[12] Hence forensic science technology should be implemented in Public health as it can play a major tool in reducing major risk factors such as mass disaster and identification of victim in crime scene through which burden of threat can be eliminated in states and in community as whole.

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