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Dealing with Increasing Casework Demands for DNA Analysis

By Joseph Varlaro[1] and Barry Duceman[2]
[1]Boston Police Crime Laboratory Unit and [2]New York State Police

EDITOR'S NOTE *The following article discusses two approaches to managing backlogged casework, with an introduction by Arni Masibay, Promega Corporation. The first approach focuses efforts on the most probative evidence so that those items most suitable for DNA analysis are typed and results reported. The second approach, involves the use of automation to increase sample throughput.*

INTRODUCTION

By Arni Masibay

No one can argue that DNA analysis has had a tremendous impact on the way business is conducted in forensics, and it continues to do so as the field evolves in response to the new challenges that technology brings. One of the challenges facing every forensic lab is dealing with a backlog of casework and the associated evidentiary samples waiting to be analyzed. One could argue that backlogs have been and will always be an integral part of doing business in forensics. Several labs are operating without any backlogs to speak of; all cases have been processed and those evidentiary items suitable for DNA analysis were typed and results reported. The Boston Police Crime Laboratory is one such lab. Their approach to tackling backlogs requires cooperation and understanding at numerous levels, from the lab director to analysts, from investigators to the attorneys on both sides.

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One reality that cannot be ignored when dealing with the number of backlogged cases is the states' legislative mandate to process samples from offenders of various classes of crimes. The continuing expansion of crimes covered by these mandates results in criminal investigators submitting more evidence to labs, adding to the already large backlog of cases. This is the dilemma faced by a state system such as the New York State Police Crime Laboratory. Perhaps the sheer volume of cases will force labs to look for alternative approaches that will lead to significant progress in reducing the number of backlogged cases. There is a sense of urgency among forensic scientists and legislators to tackle this problem and to maximize the tangible results that DNA information lends to case resolution, perpetrator identification, and exoneration of defendants.

MANAGED FORENSICS

By Joseph Varlaro

The Boston Police Crime Laboratory has developed a multi-faceted strategy using "Managed Forensics" to address the increased amount of DNA casework received in recent years. Practicing "Managed Forensics" allows the Boston Police Crime Lab to process all DNA casework with and without suspects within 2–4 weeks, once a biological sample has been identified. The cases include all types of incidents from rapes, homicides, and other violent assaults to property crimes such as burglary. We have examined all non-suspect cases from 1994 to the present (225 cases total). The STR profiles developed from these cases were uploaded to National DNA Index System (NDIS), resulting in 14 offender hits and 14 case-to-case hits. With money expected from the National Institute of Justice, the lab will expand its cold case project to include unsolved rapes and homicides

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from 1984–1993. The strategy of "Managed Forensics" includes several simple concepts that are described in this article.

STREAMLINING PROCESSES

Federal and state governments have attempted to assist crime labs by making funds available for laboratory improvements, more personnel, and processing convicted felon and casework DNA samples. Crime labs have used this money effectively, but making funds available to crime labs is only a good start. In order for individual crime labs to accomplish their mission, there must be a clear plan and the proper leadership to carry out that plan. Many labs lack personnel who are trained in managing this kind of project. Traditional crime lab personnel are trained to work individual cases in a thorough manner. This approach must be modified so that labs can accommodate the greater caseload without compromising the quality and timeliness of the work product. Processes need to be streamlined and personnel must be trained to operate in a more efficient way.

Modifying the approach to forensic casework is not necessarily agreeable to the traditional forensic scientist. Some scientists feel that the trend is to turn their crime laboratory into a factory assembly line. The reality of the situation is that labs must change if they want to meet the goal of making quality DNA typing available to any case that needs it, regardless of the nature and circumstances of the case. This change is currently not feasible for many laboratories that do not have the necessary project leadership in place.

FOCUSING ON PROBATIVE EVIDENCE

A second important aspect of "Managed Forensics" involves addressing the front-end of casework management. Before any forensic analysis occurs, it is ideal to have collaborative discussions between the investigators, the crime lab, and the prosecutors assigned to a case. Using effective communication, good criminalistic decisions, and value judgments, a streamlined approach can be developed that will focus the crime lab's efforts on only the most probative evidence in a case. Reducing the number of samples processed per case is critical to managing casework in a timely and efficient manner.

When using the "team" approach to evaluating cases, it is important to remember that the forensic scientist is providing scientific consultation on each case, in addition to the actual sample analysis. The forensic scientist must ensure that the only DNA analyses performed are those that will provide scientifically meaningful information to the case. DNA testing should not be done simply to avoid explaining during the trial phase why such testing was not done. It is possible to explain to a judge or jury why additional, and often times unreasonable, testing was not done in a case. Choosing to test extraneous samples consumes time and effort and encourages the same decision in the next case. This can easily contribute to the backlog of cases that laboratories report. Conducting these team meetings, whether in person or by telephone, does take a commitment of time. However, the overall positive effects will be significant. The "team" approach will not only ensure that only the necessary samples are subjected to DNA analysis, it will help foster cooperation between three equally important groups: the investigators, the crime lab, and the prosecutors.

Giving the crime lab a more vocal role in case management also increases the responsibilities of the individual scientists. Forensic scientists should remember that DNA is not a magic bullet that can answer every question asked. Some forensic samples, such as "contact, friction, or wearer" DNA samples, often contain quantities of DNA too small for a reliable analysis.

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Certain steps taken to increase the sensitivity of PCR, like performing additional cycles, can lead to complex, if not unreliable, results. Though technology has changed in recent years, the limitations of PCR have not. Forensic scientists should focus their efforts on conventional body fluids and stains. Most cases surely contain semen, blood and saliva with a sufficient quantity of DNA to perform PCR-based typing according to carefully recommended procedures. DNA analysis is an extension of serology, not fingerprints, meaning that DNA analysis is most effectively applied to body fluids and their stains.

COMMUNICATION AND EDUCATION

Managing forensics relies heavily on the education of both investigators and prosecutors on the "best" uses of DNA technology. Crime labs across the country have spent large quantities of money and time to train

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new staff and implement new technologies. It makes sense that the investigators and attorneys using these forensic tools be given the same attention. Agencies such as the Department of Justice, Federal Bureau of Investigation, and the National Institute of Justice must shift the momentum from the crime labs to the investigators and prosecutors. Crime labs can assist in this process by vigorously educating the agencies that they serve. Creating the "forensic team" as discussed previously will also provide a forum for education, training, and discussion. Investigators and prosecutors must be given the same level of support that crime labs have received in order to maximize the value of DNA analysis.

CONCLUSION

"Managed Forensics" is an approach to casework that has worked for the Boston Police Crime Laboratory for several years. Developing key relationships between investigators, the crime lab, and prosecutors is just as important as developing new technology. As much as this community tries to automate its processes, we must remember that the human factors are essential to delivering the highest quality product to the criminal justice system.

AN AUTOMATION STRATEGY

By Barry Duceman

THE COST OF A BACKLOG

According to a recent U.S. Department of Justice Bureau of Statistics Bulletin at the beginning of 2001, over 80% of the nation's crime laboratories reported DNA analysis backlogs. At that time, in excess of 15,000 cases were awaiting analysis. Under present conditions, despite the best efforts of crime laboratories, the backlog can only be expected to continue to expand as new forensic applications for DNA technology are exploited. The best estimates of the extent of the problem are available for sexual assault cases. For these, the U.S. Justice Department has reported that more than 180,000 rape cases are sitting unanalyzed in evidence lockers throughout the country. Available data indicate that the number of rape cases awaiting analysis nationally certainly exceeds 100,000 and may actually approach as many as 500,000 cases. Analysis of these cases must be approached with a sense of urgency since, as each day passes, more and more of them are slipping past the statute of limitations.

A fair percentage of these cases can be expected to contain the DNA patterns of recidivist and serial sexual offenders whose DNA pattern should be in the CODIS database. The expiration of the time limit for prosecution in these cases should not be allowed to obviate the need for analysis. The absence of analysis in backlogged cases can have real and tragic consequences, the most obvious being avoidable victimization.

The thoughtful design and development of a custom Laboratory Information Management System is foremost in preparing and introducing an automated system into the lab.

AUTOMATION: STEPS TOWARD A SOLUTION

Because of the burgeoning demand for DNA testing services, forensic laboratories must begin to adapt flow processes that have become common to other genotyping applications, such as screening for mutations associated with a predisposition to certain cancers and other heritable diseases. The expected outcomes of an automated process include decreased throughput times, enhanced process quality, improved reproducibility, and superior data traceability.

There are several approaches to laboratory automation. In most crime laboratories, a modular approach is the most practical. This strategy provides scalability of processes as demand grows. It also offers flexibility to accommodate new analytical platforms and provides for an incremental introduction to facilitate analyst training and acceptance with minimal disruption of ongoing service. A modular approach involves less risk and expense than a fully designed and dedicated automated system. Using a modular strategy, the initial step is to determine which processes can be reasonably automated. These are then defined as individual modules. The second step is to develop an electronic Laboratory Information Management System (LIMS), which is the "backbone" that will support the entire automated process. The thoughtful design and development of custom LIMS is foremost in preparing and introducing an automated system into the lab. In terms of sample data acquisition, specimen inventory and tracking, the system must be flexible enough to accommodate controllers for each module and to accept input data. Ideally, the system should incorporate a quality control matrix to ensure compliance with federal guidelines and laboratory accreditation standards.

The next decision is to determine which processes can be fully automated. Some steps in the forensic genotyping process are quite easy to automate. There are several

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functional, relatively inexpensive liquid handling systems that can be customized to accommodate steps in DNA extraction as well as product quantitation and PCR assembly. In general, the downstream amplification of template and subsequent production of DNA patterns already involve little user intervention and can be considered semi-automated. In a modular approach, once the essential component steps for enhancing productivity are integrated into the controlling LIMS, it is possible to implement additional upgrades. For example, once the modules for performing extraction, quantitation and PCR are implemented, it is then possible to add robotic arms for moving microwell plates from the extraction/quantitation platform to the PCR assembly station and then to the thermal cycler. In terms of process, the automation of these sample movements is not critical to reliability, reproducibility of results or sample throughput but can enhance user convenience and walk-away time.

At present, automation of the technical aspects of forensic DNA analysis can only be considered a partial solution to resolving casework backlogs and achieving reasonable turnaround times. The main challenge in achieving those goals involves the steps in the analysis that remain as bottlenecks. In forensic DNA tests, there are still steps in the process that are not currently amenable to automation. Identifiable bottlenecks without an easy or inexpensive solution include some stages of the differential extraction, data interpretation and the accompanying quality review.

The limiting steps also include the identification and isolation of probative stains, a task that, for the foreseeable future, will depend on the talent of forensic scientists. This issue is especially critical since full efficiency of an automated or semi-automated genotyping system will require a steady stream of evidence into the process flow. This supply bottleneck can be addressed by forensic scientists freed from DNA extraction and quantitation tasks. Time spent sifting through large submissions of many items can be reduced by the capacity of the automated system. Instead of screening evidence, the analyst will simply submit the items for DNA analysis, using the final data interpretation step to determine relevance to the ongoing investigation. In this strategy, the bottleneck becomes the interpretation of analytical results and the technical review process. These critical steps to rapid and reliable data production then become the rate-limiting modules. Although these processes are currently dependent upon manual applications, software solutions are emerging that can be integrated into an automated approach.

THE ROLE OF THE FORENSIC SCIENTIST

The modern forensic DNA analyst commands an impressive set of sophisticated skills. These include in-depth knowledge of many diverse disciplines, including forensic science, genetics, and molecular biology. These individuals are self-motivated and especially conscientious with regard to data quality. After all, it is the forensic scientist who must support the conclusions derived from the analytical results in court. This paradigm shift from case-by-case analysis to relatively hands-off batch processes might meet with some opposition from the practicing forensic DNA analyst. It is important to remind individuals that the goal of automation is not simply productivity but an attendant increase in data reproducibility and reliability. It is also important to emphasize that one goal of automation is to free these highly trained individuals from the tedious and repetitive tasks of DNA extraction, quantitation, and PCR reaction assembly. The forensic scientist is then able to devote more time to the more challenging professional tasks of evidence evaluation, stain identification, data interpretation, and courtroom testimony.

CONCLUSION

Not very long ago, when restriction fragment length polymorphism determinations were the standard tests, forensic DNA analyses were commonly limited to cases of sexual assault and homicides. Because the examinations were both time-consuming and labor-intensive, DNA analyses were also limited to only a few items per case. Now, however, criminal investigators are expanding the classes of crimes to which forensic DNA tests are applied and, further, finding new and imaginative uses for the technology. These include non-probative applications such as corroboration of witnesses' testimony and elimination of multiple suspects. The modern crime laboratory should attempt to meet the challenge of this enthusiastic acceptance by the law enforcement community. The response for faster turnaround time and greater analytical capacity need not be limited to a single strategy. In additon to increased staffing levels and new generations of faster DNA tests, the introduction of batch processes and automation must also be considered among the solutions available to the forensic community.