NPIA
National Policing Improvement Agency

PRACTICE IMPROVEMENT

THE JOURNAL OF HOMICIDE AND MAJOR INCIDENT INVESTIGATION

Volume 6, Issue 1
Spring 2010

Produced on behalf of the ACPO Homicide Working Group
by the National Policing Improvement Agency

THE JOURNAL OF HOMICIDE AND MAJOR INCIDENT INVESTIGATION

The Journal of Homicide and Major Incident Investigation encourages practitioners and policy makers to share their professional knowledge and practice. The journal is published twice a year by the National Policing Improvement Agency (NPIA) on behalf of the Association of Chief Police Officers (ACPO) Homicide Working Group (HWG). It contains papers on professional practice, procedure, legislation and developments which are relevant to those investigating homicide and major incidents.

All contributions have been approved by the Editorial Board of the ACPO HWG. Articles are based on authors' operational experience or research. The views expressed are those of the authors and do not represent those of the NPIA, nor of ACPO. Unless otherwise indicated they do not represent ACPO policy. Readers should refer to relevant policies and practice advice before implementing any advice contained in this journal.

All enquiries about the journal should be addressed to:

Dr Peter Stelfox
Head of Investigative Practice
National Policing Improvement Agency
Wyboston Lakes
Great North Road
Wyboston, Bedford
MK44 3BY

Email: homicide.journal@npia.pnn.police.uk

Contents

Organ and Tissue Donation Opportunities during Police Investigations into Suspicious Death or Fatal Road Traffic Collisions

Detective Chief Superintendent Ian Scott
Durham Constabulary

Abstract

The guidance outlined in this article has been developed in consultation with organ donation teams, pathologists and coroners to assist investigating officers in their decision making when organ donation requests are made during suspicious death or fatal road traffic collision investigations. A positive approach to supporting a donation request would be well received by organ transplant teams, as well as the families of the deceased who may seek to progress the deceased's wishes and obtain something positive from a tragic event.

Detective Chief Superintendent Scott has completed thirty-three years police service. He has been the Head of CID for Durham Constabulary for the past nine years and has served in every detective rank. A member of the ACPO Homicide Working Group, he has successfully dealt with three organ donation requests during homicide investigations.

Contents

All correspondence should be addressed to:
ian.scott@durham.pnn.police.uk

1 Background

In 2006 an organ donation taskforce was established by the Department of Health (DoH) in England to identify the barriers to organ donation and to help increase transplant rates. In 2008, the DoH published *Department of Health (2008) Organs for Transplants: A report from the Organ Donation Taskforce.* This report was agreed by all four UK health departments with one of the fourteen recommendations coinciding with the need to provide guidance to optimise organ donation.

The organ donation taskforce is convinced that a 50 per cent increase in organ donation after death is achievable in the UK within five years. This would enable an additional 1,200 transplants a year, of which over 700 would be kidney transplants. The UK currently has one of the lowest rates of organ donation in Europe, at just thirteen donors per million of the population. The taskforce estimated that in 2006 the active transplant waiting list stood at 7,235 and was rising by approximately 8 per cent each year.

A national survey showed that the public are very supportive of organ donation. The NHS currently has nearly fifteen million people on the organ donation register and further proactive work is being undertaken to increase the number of people registering.

A patient may become a potential organ donor when death is confirmed following clearly defined tests of the brain stem, in which case donation after brain stem death may be possible. Potential also exists for donation when a decision has been taken in the best interests of the patient, that further active treatment is no longer appropriate and should be withdrawn, in which case donation following non-heart beating donation may be possible. In these cases, death is confirmed by cardiac criteria.

It is, however, donation after brain stem death (death confirmed by neurological criteria) typically involving those patients who are being cared for in intensive care units following catastrophic brain injury, that provides organs for virtually all heart and lung transplants, the majority of liver transplant and many kidney transplants.

Given this background, in cases of suspicious death or fatal road traffic collision investigations, the investigating officer may be involved in some discussion around the possibility of organ donation. The guidance outlined in this article has been developed in consultation with organ donation teams, pathologists and coroners to assist investigating officers in their decision making when such requests are made.

A positive approach in supporting a donation request by the investigating officer, would be well received by organ transplant teams, as well as the families of the deceased who may seek to progress the deceased's wishes and obtain something positive from a tragic event.

2 Authority for Donation

The coroner or Crown Office and Procurator Fiscal Service (COPFS) in Scotland have a legal duty to enquire into deaths in their jurisdiction where the cause of death is unknown or where the death is violent or unnatural. In these circumstances, organ or tissue donation cannot proceed without the agreement of the coroner or COPFS, who must be satisfied that donation will not interfere with their duty to investigate the death. It is important to recognise that in cases of referral to a coroner, that whilst they must agree to the donation, they have no power to authorise donation. This decision is an important one with no expectation of any proposed delegation of this responsibility. Authorisation can be made by the COPFS.

The coroner or COPFS will ensure that there is a full investigation into the death and where necessary that any evidence relevant to the investigation is preserved. A principal concern would be to ensure that any forensic examination and criminal proceedings arising from the death are not compromised by the donation or any other interference with the body. Before giving agreement in a particular case, the coroner or COPFS should, therefore, ensure there is discussion with the senior investigating officer (SIO) and the pathologist.

Providing positive consultation with interested parties is followed and there is consent from the deceased's next of kin, the coroner or COPFS should have no reason to object to organ or tissue donation in most circumstances.

Even in deaths that are being investigated by the police and where there is a likelihood of criminal proceedings, if full information is provided, the coroner or COPFS in consultation with both the police and the pathologist may be able to agree to the donation of some organs and/or tissue.

3 What can be Donated?

Where there is potential for organ or tissue donation, many parts of a body can be used to save a life or significantly improve a patient's quality of life. These include all or parts of the:

Heart	Small bowel
Lungs	Eyes
Liver	Bone
Kidneys	Skin
Pancreas	Tendons

4 Timing of the Donation

In all cases, time is of the essence. Donation can occur either from a heart beating or a non-heart beating donor. Heart beating donors will have been confirmed dead by neurological criteria (eg, brain stem death).

There are different types of non-heart beating donors, described as either controlled or uncontrolled.

4.1 Controlled non-heart beating donors

Controlled non-heart beating donors are those where further treatment is deemed futile and is withdrawn. Here, organ donation, with appropriate consent, may be possible after the confirmation of death by cardiac criteria.

4.2 Uncontrolled non-heart beating donors

Uncontrolled non-heart beating donation can occur, for example, following a failed resuscitation in the Accident and Emergency department. In these cases, death is unexpected and greater urgency for the donation will be required. The quicker the response, the better the opportunity for a donation.

5 Donation Requests Prior to Death

There is no formal jurisdiction for a coroner or COPFS to agree to organ or tissue donation from someone who is still alive. On occasions an approach for donation may be made when someone is still alive and in such circumstances it would be helpful for the coroner or COPFS to provide a provisional indication of their likely view, following consultation with the SIO and the pathologist.

However, the coroner or COPFS is not authorised to direct the placing of catheters and artificial perfusion for the purposes of preservation. The coroner or COPFS can indicate if such a step is likely to interfere with the investigation into the death or not.

Donation requests prior to death are usually in circumstances where it has been deemed not to be in the patient's best interest to continue treatment and a decision has been made to withdraw active treatment.

6 Securing the Coroner's Agreement and the Views of Interested Parties

The investigating officer should recognise that the potential for organ and tissue donation could arise at different stages of an investigation. For example, many transplant authorities are proactive both within hospitals and with the families of victims in securing family consent for organ or tissue donation. At the same time, it has to be recognised that many victims may be in possession of organ donation cards and the transplant authorities will be proactive in ensuring that the victim's wishes for donation are pursued. The investigating officer must, therefore, recognise that their first involvement in donation potential may be after consent for donation has been secured by the victim's family and before any involvement of appointed family liaison officers (FLOs). This consent may also occur before the investigating officer has had an opportunity to clearly establish what may have occurred during the incident under investigation. This should not, however, provide the basis for objections to a donation.

The transplant authorities are aware that in cases of suspicious death or fatal road traffic collision, the police will undertake an investigation and therefore have an interest in assisting the coroner or COPFS to make an informed decision about donation.

Whilst there is no nationally agreed method of commencing the obtaining of the coroner's agreement, the normal procedure would be for contact to be made, initially through the coroner's officer. It is, however, recognised that in many areas there are processes in place for contacting the coroner directly for out-of-hours enquiries.

Whilst there may be variation across the UK in the initiation of securing the coroner's agreement, the transplant authorities and the coroners understand that both the police and pathologists should have the opportunity to make observations about the donation.

7 Information to be Provided to the Coroner or COPFS

The information given to the coroner or COPFS should be as full as possible and include the following:

- Where did the incident leading to admission occur;
- Circumstances surrounding the death;
- Details of injuries/trauma sustained;
- Known natural disease;
- Suspected alcohol or drug involvement;
- Treatment given in hospital;
- Any suggested neglect during treatment;
- Whether the potential donation is heart beating or non-heart beating;
- Which potential organs or tissue may be suitable for donation;
- Whether the deceased was on the organ donor register/carried a donor card/expressed a wish to donate during their lifetime;
- Whether the wishes of the deceased or relatives are known.

It is possible for the coroner or COPFS to agree either to the removal of all proposed organs and tissue or to the retrieval of those parts of the body which are not likely to be significant in any subsequent post-mortem examination.

For the investigating officer and the pathologist, it is important to recognise that this opportunity for consultation is an important matter to consider. Whilst the final decision rests with the coroner or COPFS, it is appreciated by all parties, that in the majority of cases, a post-mortem examination will be carried out to establish the cause of death and secure evidence, and it is recognised that any donation must not compromise this.

The coroner or COPFS must be satisfied that any donation will not interfere with their duty to investigate the death. Clearly, this will involve both the establishment of the cause of death as well as the preservation and securing of forensic evidence during the course of the police investigation.

The investigating officer should recognise that even if the coroner or COPFS is unable to agree to all requested organs or tissue being removed, other organs may be removed without compromising a police investigation, the interpretation of the cause of death or any criminal proceedings that may follow.

Successful donation is often possible, particularly where there is good communication between coroners and clinicians, donor transplant coordinators, pathologists and the police.

The Police Service should encourage regular meetings with interested parties locally, as well as utilising debriefing opportunities, where donation has been undertaken, to ensure good practice and learning opportunities are captured. In particular, meetings between organ donation staff and FLOs should be encouraged.

8 Issues for the Investigating Officer to Consider

The investigating officer may become aware of organ or tissue donation potential at different stages during an investigation. Whenever this occurs the investigating officer should confirm the extent of consultation at that time. It is important to confirm the level of consultation with either the coroner or COPFS and to ensure that contact is made with all interested parties.

It would be good practice for the SIO to personally retain this responsibility, as experience has shown that donation potential has been frustrated by the negative observations of FLOs and coroners officers, who others perceive are acting on the authority of the SIO, and who may not be aware of any request. Where FLOs have been appointed, and if time allows, experience has shown that a meeting between the organ donation coordinator and the FLO has proved beneficial in portraying a united front.

In addition, dependant upon the current status of an investigation, there is the possibility of the existence of another interested party, the legal representative of a person charged or detained. Where this is the case, the issue surrounding potential donation should be communicated to the legal representative and their views should be obtained and shared with the coroner or COPFS. It has to be recognised, however, that the final agreement rests with the coroner or COPFS.

The SIO should record, as a matter of policy, the representations that were made by interested parties, as well as the decision of the coroner or COPFS arising from these discussions.

9 Strategies for Avoiding the Loss of Medical or Forensic Evidence when Donation is to Follow

Whilst the SIO may have a view as to the extent of the organ or tissue donation, they also have an opportunity, in consultation with interested parties, to introduce strategies for avoiding the loss of medical or forensic evidence.

The following list is not intended to be exhaustive, but presents opportunities for the SIO to consider:

- Clarify the opportunities and objectives of any forensic strategy prior to any retrieval.
- Formal identification of the body prior to the deceased going to the operating theatre.
- The pathologist to be given the opportunity to externally examine the victim and inspect relevant records before any retrieval of organs and/or tissue.
- Discuss with the pathologist about their attendance at the organ and/or tissue retrieval. This decision is very much a matter for the pathologist. However, experience has shown that there have been benefits in proceeding this way.
- Obtain photographs of injuries or forensic swabs before retrieval. Consideration should also be given to obtaining police photographs during retrieval, particularly when a pathologist is in attendance. This should not, however, be allowed to infringe upon the medical procedures. If this were to be considered there should be close liaison between all interested parties before this course of action is taken. Health and safety and welfare considerations of persons involved in this process should also be recognised.
- Ensure continuity of the victim transfer between organ and/or tissue retrieval and subsequent transfer to the mortuary and the security of medical records.

- Secure the documentation and records of the transplant team regarding the condition of the donated organ and/or tissue and records leading up to the coroner's referral.

- Ensure compliance with the Human Tissue Act.

All the strategies above would be beneficial in ensuring the integrity of the investigative process as well as minimising the opportunity for any legal challenge in subsequent criminal proceedings. Where such strategies are introduced, the investigating officer should record these as a matter of policy.

10 Conclusion

Donation opportunities during police investigations into suspicious deaths and fatal road traffic collisions are rare events and arising from this infrequency, provide challenges to the investigating officer at times of additional operational pressures.

It should, however, be recognised that transplant teams are unlikely to remove an organ or tissue which is not healthy and which would not benefit another person. Furthermore, in the majority of investigations, the likely cause of death is anticipated and communicated to the transplant team, before their procedures commence. With good communication and partnership working between all interested parties, opportunities do exist for successful donation without compromising any police investigation.

References

Department of Health (2008) *Organs for Transplants: A report from the Organ Donation Taskforce.* London: DoH.

Low Template DNA Profiling: A guide for Senior Investigating Officers

Chris Porter, Head of Specialist Evidence Recovery and Imaging Services (SERIS), SCD4, Forensic Directorate Metropolitan Police Service

Abstract

Analysis methods are available to forensic scientists to recover DNA from crime scene samples considered to have a small amount of DNA (Low Template DNA (LTDNA)). These methods can be powerful investigative tools providing valuable intelligence, but their use should be carefully considered against the context of the case and the limitations of the evidence they can provide.

The purpose of this article is to set out the recent history surrounding the use of LTDNA profiling, discuss the issues arising and outline the current state of technology and new developments. Importantly, it will attempt to inform the Senior Investigating Officer (SIO) community and identify issues and areas for consideration for both investigators and forensic staff in the light of increased public and media scrutiny following concerns over forensic evidence in a number of high profile cases.

The author has worked in the forensic arena for over twenty-five years, initially as a fingerprint expert and then in crime scene examination. He is currently the Head of Specialist Evidence Recovery and Imaging Services (SERIS) within the Metropolitan Police Service (MPS). As such, he is responsible for the delivery of specialist fingerprint, scientific and forensic imaging services to homicide and serious crime, specialist scene recording and other photography, the delivery of forensic firearms services, including National Ballistics Intelligence Service (NABIS), image production, DNA submissions and matches and the production of graphic court presentations. He holds the homicide portfolio within the MPS Forensic Directorate, is a member of the ACPO Homicide Working Group and has a BSc (Hons) in Policing and Police Studies.

Contents

All correspondence should be addressed to:
chris.porter@met.pnn.police.uk

1 Introduction

The Forensic Science Service (FSS) introduced the technique known as Low Copy Number (LCN) in 1999 as a tool for casework. However, over the last decade two cases particularly, have opened a debate on LCN and other techniques that can be used to obtain profiles from small amounts of DNA.

LCN received significant media attention in December 2007, when the judge in the Omagh bombing trial questioned its scientific validity. At the trial of Sean Hoey for the 1998 bombing, Mr Justice Weir expressed doubts over the validity of the FSS's LCN testing.

For a short time thereafter, the use of FSS LCN was suspended, until Professor Brian Caddy confirmed that the technique was fit for purpose for use in police investigations in his review, *Caddy, B., Taylor, G.R and Linacre, A.M.T (2008) A Review of the Science of Low Template DNA Analysis.* He did, however, question whether it was being used as effectively as it might be and made twenty one recommendations for improving its use.

Prior to this, the FSS LCN process undertaken between 2000 and 2005 was scrutinised following a review of the 1992 murder of Rachel Nickell. This scrutiny subsequently led to the re-analysis of samples from over two thousand cases where the LCN technique had been used, under 'Operation Cube'. This nationwide review has focused on homicides and sexual offences where LCN was used to develop DNA from what were believed to be samples that contained small quantities and/or deteriorated DNA between that time period.

2 Background

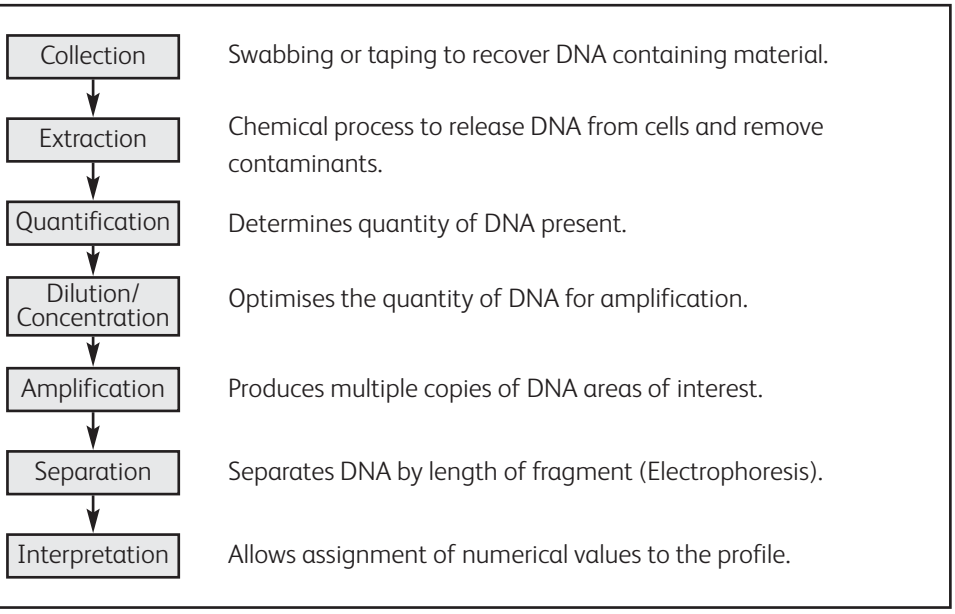
The following is a 'non-scientist's' view of specialist DNA profiling techniques and is written to assist investigating officers. The author apologises to any scientific readers for over-simplification in explanation of this extremely complicated subject.

The current system for DNA profiling used in the UK is known as Second Generation Multiplex Plus™ (SGM+). This method analyses ten loci (areas) of the DNA molecule plus a gender marker to produce a DNA profile which is used for loading onto the National DNA Database (NDNAD) and for evidential comparison purposes. The discriminating power of SGM+ is such that the probability that two unrelated people would have the same SGM+ profile is greater than one in a billion.

The standard profiling technique involves examining the item, extracting and quantifying the DNA and amplifying it (copying it twenty-eight times) to provide sufficient material for processing. The amplified DNA is then subjected to electrophoresis which separates the DNA components according to their size and produces the result in a graphical format which is then used to determine the profile. The interpreted graph is translated into a string of twenty numbers and two letters (sex test).

All the work is carried out under clean, purpose-built laboratory conditions.

Figure 1 General DNA Profiling Method SGM+



LTDNA profiling analysis is the term used for 'non-standard' DNA profiling of extremely small amounts of DNA (generally known as 'touch DNA') or degraded samples. The standard method of profiling is effective when examining identifiable body fluids. There are situations, however, when the body fluids are not identifiable such as 'touch DNA' or when examining bone or teeth samples and material on microscope slides. As a result of the increasing desire to produce profiles from these extremely small amounts of DNA material, research has been carried out and three methods of LTDNA profiling have been developed:

- LCN (FSS);
- DNA Enhanced/3100 Enhancement – Cellmark Forensic Services (Cellmark);
- DNA SenCE – LGC Forensics (LGC).

The FSS introduced the technique known as LCN in 1999. The difference between standard profiling and LCN is that a specialist extraction method is used and the extract is subjected to 34 cycles of Polymerase Chain Reaction (PCR), thus amplifying the extract more than in the standard SGM+ technique (theoretically a 64-fold increase).

DNA Enhanced analysis developed by Cellmark involves specialist DNA extraction followed by quantification to measure how much DNA material is present. Standard 28 cycle analysis is then carried out and the result evaluated. If required, additional purification and electrophoresis injection modifications are carried out and then subjected to either 28 or 30 cycles of PCR. Until recently, DNA Enhanced profiles were only speculatively searched on the NDNAD, however, the Custodian has now approved the technique for permanent loading.

DNA SenCE developed by LGC involves specialist DNA extraction followed by quantification to measure how much DNA material is present. Standard 28 cycle analysis is then carried out and the result evaluated. If required, additional purification, concentration and electrophoresis modification are conducted. Profiles raised from DNA SenCE can be loaded onto the NDNAD.

All of these methods are extremely sensitive and additional efforts have to be made to minimise contamination within the laboratory. As a result, they are all carried out in sterile laboratory conditions and systems are employed to minimise contamination, thus, ensuring the most useful and relevant results.

The LCN method relies on using additional cycles of amplification (34 cycles), whereas the emphasis of the other two methods is on cleaning up the DNA sample to achieve the best results. The main advantage of the staged LTDNA techniques are that if a result is obtained after 28 cycles, it can negate the need to use 34 cycles. The processes are therefore more controlled, allowing 'fine-tuning' and less of the sample extract is used as the clean up processes and modifications in electrophoresis use the PCR product. This allows the sample to be retained for use in the future with new technologies. At present, it is not possible to determine if any of the methods are superior to the others. However, scientific publications by Cellmark and the LGC suggest that they provide similar levels of sensitivity to the FSS LCN technique but with fewer interpretation issues encountered.

Whilst the LCN process previously subjected the extract to 34 cycles, the FSS have been considering on a case-by-case basis, requests to revert to the 28 cycle method should sufficient DNA be located at the quantification stage. Furthermore, they have now introduced a new product called DNA Select which has replaced LCN and replicates the methodology of the other forensic service providers in terms of a staged approach. It includes a different quantification method which measures both the total amount of DNA and the proportion of male to female DNA. Samples may be amplified using 28 or 34 cycles and the decision to do so is based on the quantification value and made by the reporting scientist to optimise the DNA profile obtained.

Each of the three original LTDNA processes were reviewed by Professor Brian Caddy on behalf of the Forensic Regulator. He found that 'the organisations providing such a DNA service in terms of LTDNA analysis have complied with a normal in-house validation process based upon sound scientific principles.' In addition, the methods have either been accredited for use by the Custodian of the NDNAD or are currently in the process of accreditation. All methods are therefore valid for use in criminal investigations.

The validation of LCN, first introduced by the FSS, is covered in Professor Caddy's report and includes the fact that both Cellmark and LGC have validated the 34 cycle method and are able to employ it if requested.

Although LTDNA is not used universally, the 34 cycle method is used in the Netherlands, New Zealand, New York State, Bosnia-Herzegovina, Spain, Italy and Germany. Bosnia-Herzegovina is the location of the International Commission on Missing Persons, which is internationally acclaimed and uses DNA in the identification of persons. It was set up to assist in the identification of victims of the conflicts in the 1990s in South-East Europe and has also been used in the 2004 tsunami in Thailand and the 2005 Hurricane Katrina in the USA.

3 Development and History

The possibility that DNA could be used for human identification and relationship testing had been considered from the time that DNA was first revealed as the molecule which makes individuals unique. It was not, however, until the discovery of the first Variable Number Tandem Repeats (VNTR) probe by Professor Alec Jeffreys of Leicester University in 1984 that the first practical testing system became available. The first use of DNA testing for human identification anywhere in the world was in the UK as part of an immigration case, *Sarbah v The Home Office* [1985]. In this case, DNA testing was used to prove the mother and son relationship between Christiana Sarbah and her son, Andrew.

By 1986, Multi Locus Probe (MLP) DNA profiling had identified Colin Pitchfork as the perpetrator of two murders in Leicestershire after it was established that he had avoided providing a sample during a mass screen exercise, by paying an associate to provide a sample on his behalf. By 1992, Single Locus Probe (SLP) DNA profiling enabled DNA to be extracted from smaller samples and it was this technique that was originally undertaken in the case of Rachel Nickell. SGM profiling was available by 1995 and in 2001 scientists were able to carry out LCN DNA analysis on tapings from Rachel's body but with no result. The case had been reviewed a number of times before a request was made to carry out further analysis of an extract from the original tapings. In late 2004, a major profile of Rachel Nickell and a minor male component was obtained. With further detailed DNA analysis of the extract and tapings, a full male DNA profile (Robert Clive Napper) was obtained with a match probability of 1 in 12 million.

Although it has since been established that the technology and processes used in 1992 would not have detected the minor DNA profile, it was necessary to understand why the LCN profiling technique did not obtain the male profile in 2001. The minor profile was found when the DNA extract was diluted before amplification and separation. It is, therefore, likely that the sample contained inhibitors. The phenomenon of inhibition was well documented at the time and occurs when a chemical, such as indigo dye from denim, is present at high concentration in the DNA sample. An inhibitor stops or affects the amplification process from working with the result that no DNA profile is obtained. In the case of Rachel Nickell, there was more DNA present in the sample than expected and the sample was put through the LCN process unnecessarily.

The Rachel Nickell case highlighted that the quantification and dilution stages of the process were not routinely undertaken in the FSS LCN DNA profiling process. A review of over two thousand cases nationally, identified five thousand samples of relevance between 2000 and 2005. These samples were consequently subject to an assessment and prioritisation process under 'Operation Cube' which was led by ACPO and managed nationally by the ACPO Criminal Records Office Team with input from the Home Office, CPS, NPIA and the interim Forensic Regulator.

It should be emphasised that the FSS has taken steps to address this issue and has since changed its processes, both in LCN and its replacement, DNA Select, to include both a quantification and dilution stage.

The review carried out by Professor Brian Caddy (discussed at the beginning of this article) at the request of the Forensic Science Regulator, was instigated as part of the response to the issues raised in the Rachel Nickell case and took account of the results of the Omagh bombing trial in 2007, where Sean Hoey was acquitted. The LCN results in the Hoey case were challenged by defence experts who claimed that the scientific community was divided over the reliability of the technique. Mr Justice Weir questioned the validation of LCN, its reliability and lack of international agreement on its value.

Whilst issues regarding the integrity of exhibits during collection and storage contributed to the acquittal, the impact of the judgment cast serious doubt over the validity of the technique of LCN which led to the brief suspension of its use. Much of Mr Justice Weir's judgment is relevant to crime scene examiners and investigators alike and serves to remind that the application of sensitive DNA techniques relies on stringent practices at the point of collection, preservation and subsequent movement of exhibits through all processes, including storage and examination. However, whilst appropriate preservation and recovery methods must be considered for standard DNA profiling, it may not be practical to approach every crime scene with a view that LTDNA profiling will be required.

Professor Caddy's review, published in 2008, examined and affirmed the validity of LTDNA analysis and endorsed its continued use in police investigations. It made a number of recommendations, however, regarding training, standards, validation, outcomes, research, funding and processes. See *Caddy, B., Taylor, G.R and Linacre, A.M.T (2008) A Review of the Science of Low Template DNA Analysis.*

December 2009 saw what was anticipated to be the most recent challenge to the use of LTDNA in criminal investigation as a result of appeals in two cases *R v Reed and Reed* [2009] and *R v Garmson* [2009]. David and Terence Reed had been convicted of murder in 2006 and Neil Garmson had been convicted of rape in 2005. Although one of the initial grounds of appeal had been a general attack on the reliability of LTDNA evidence, this was abandoned after quantification of the amount of DNA present was undertaken shortly before the hearing and it was found that the amount of DNA was at a level found in conventional SGM+ DNA profiling. The lack of quantification was a result of the issues highlighted earlier in LCN DNA profiling as applied by the FSS prior to September 2005. Should SIOs or Prosecutors find themselves acting on the results of LCN analysis undertaken by the FSS between 1999 and September 2005, then they should consider re-analysis or at least assessment of the levels of DNA present.

The issue of the reliability of LTDNA analysis did not therefore directly arise, but the court considered the value of the DNA evidence which resulted in two important conclusions. Firstly, that evidence from an expert witness with appropriate scenes of crime experience was admissible to give possible explanations for the presence of DNA where it had been found and to evaluate prosecution and defence propositions. Although not definitive in itself, the court should evaluate that expert evidence on a case-by-case basis.

There are three levels at which propositions can be constructed to evaluate scientific evidence: source, activity and offence. Whilst the type of cellular material from which the profiles in the Reed case were obtained were unknown (source level), the issue at appeal was whether any evidence could be admitted which addressed an activity level proposition such as 'the suspect handled the knife' rather than a source level proposition of 'the suspect's DNA was on the knife handle'.

Secondly, that LTDNA could be used to obtain profiles capable of reliable interpretation if the quantity of DNA was above the threshold of 'randomness'. Furthermore, subject to new, relevant, scientific evidence becoming available, a challenge to the validity of the method of analysing such DNA by the LCN process should no longer be permitted at trials where that threshold was exceeded.

Lord Justice Thomas, giving the judgment of the Court of Appeal, said that in all respects the court considered that none of the grounds of appeal were well founded and that the convictions were safe. Importantly however, he also set out in very clear terms how evidence involving DNA analysis must be dealt with during case management and well in advance of the trial. This is detailed in paragraph 131 of the full judgment (*R v Reed and Reed, R v Garmson* [2009] EWCA 2698. Available at: http://www.bailii.org/ew/cases/EWCA/Crim/2009/2698.html).

Lord Justice Thomas emphasised that it is the duty of the police and prosecution to ensure that DNA evidence complies with the requirements of the Criminal Procedure Rules (2005), as amended. That is, it is in the interests of justice (Rule 1) to ensure early identification of the issues (Rule 3) by all parties. It is then important to ensure that experts for both parties agree the areas that are non-contentious and contentious (Rule 33). The judge is expected to ensure that this is done before the trial.

4 Considerations for Investigators and Forensic Staff

There are currently three LTDNA products available to the Police Service in the UK, see **2 Background**. There has been no independent evaluation of the products and, as outlined earlier, it is not possible to say whether one method is superior to the others. If LTDNA profiling is considered, it should only be carried out after consultation with all relevant parties and the forensic service provider that originally examined the case.

With this in mind, and in the shadow of two high profile cases where LTDNA in addition to the integrity and preservation of items requiring LTDNA have been questioned, the following sections outline considerations and limitations and offer some guidance with regard to future use.

5 Interpretation of Results

Due to the extremely small amounts of DNA involved in LTDNA analysis, the interpretation of results is challenging. In addition to the phenomenon of inhibition, there are other issues which affect scientists' ability to report on results, which are summarised below.

In a full profile, each of the loci has two alleles which appear as either one or two peaks on the profile graph. As LTDNA involves extreme sensitivity, the results can produce 'drop in' and 'drop out' of alleles and 'stutter' (a term used to describe where peaks can be present which is an artefact of amplification). These are all recognised problems and the interpretation of the results can be extremely challenging. The review by the ex-Director of the Federal Bureau of Investigation DNA Laboratory, Dr Bruce Budowle, provides a detailed description of the strengths and weaknesses of LTDNA. See *Budowle, B., Eisenberg, A. and van Daal, A., (2009) Validity of Low Copy Number Typing and Applications to Forensic Science.*

At present, the body fluid from which the DNA originated cannot be determined. It is only possible to say that a DNA profile was found on an item, not what the cell type was (eg, blood, saliva or semen). Because LTDNA is often used for the examination of degraded material, and degradation is affected by a number of factors, it is rarely possible to comment on the age of the DNA. Unless there is other information available to the investigation, it is not possible to determine the nature, time and how the DNA was left on an item.

6 Contamination

As LTDNA is particularly useful when dealing with DNA transferred through touch, the issue of contamination must be considered. Contamination can occur in many ways and having established that DNA has been detected on an item, investigators must question how the DNA came to be there.

Contamination can occur prior to, and during police involvement. When a person comes into contact with a surface, the deposit of DNA on that surface is known as primary transfer. The DNA on that surface can subsequently be transferred to another surface by direct contact; this is known as secondary transfer. It is widely accepted that tertiary transfer is also a possibility. The amount of secondary transfer depends on a number of factors and will involve a smaller amount of material (which may only be detected using LTDNA). For example, if a gun is found wrapped in cloth and DNA is detected on the gun, the question has to be asked: 'Did the DNA on the gun come from primary contact by a person with the gun or from secondary contact from a different person via the cloth?' In this circumstance, the argument regarding the transfer of DNA from a non-evidential item to a key evidential item exists.

Research has shown that different people shed DNA in differing amounts and this can lead to problems with secondary transfer. For example, person A is a 'good' shedder of DNA and person B is a 'poor' shedder. If person A handles a knife which is then used by person B, it is possible for person A's DNA to be detected on the knife and not person B's. The question must then be asked: 'Was person A holding the knife when it was used in the offence?' In conclusion, the presence of (touch) DNA cannot be used to specifically link a person to an offence or specific time. Also, the presence alone, of DNA on a knife handle, does not make that attributable to the person handling it.

Contamination prior to police involvement can also occur as a result of the involvement of innocent people. This could include witnesses to an offence or other persons involved in the incident such as the emergency services. Activities that occur during the initial response to a crime may result in biological materials being transferred inadvertently to what is later identified as a 'target' or 'critical' item that is then subsequently identified as requiring LTDNA analysis. Such items may have been contaminated by biological materials from the victim, or via secondary transfer as described above.

Additionally, individuals may have legitimately left DNA at the scene or on an item prior to, or following, an offence. These people may have handled items such as knives, door handles or household items which have in a number of past cases been swabbed and submitted for LTDNA analysis. Every effort must be made to be able to exclude these persons' DNA from the examination result and so elimination samples should be requested. However, without having specific knowledge, it would not be possible to eliminate them from any subsequent profile that may be obtained and as such the presence of their DNA may greatly weaken the evidential value obtained from such samples.

Contamination can also occur during police involvement. It is, therefore, essential that precautions are taken to prevent inadvertent contamination during any police intervention at the earliest point possible, after the primary objective of preserving life has been achieved. Access to a crime scene should be limited to essential personnel only and they should be correctly wearing full protective clothing. It is also essential that suitable collection equipment and storage containers are used.

Once an exhibit is seized for analysis, contamination can occur within the examining laboratory environment, if stringent anti-contamination procedures are not followed. Furthermore, it is known that in some instances DNA from the manufacturers of laboratory consumables, such as microfuge tubes, has been detected. This should not present a problem, however, the presence of DNA from a manufacturer may result in a mixed or complex DNA profile to be interpreted.

Particular consideration must be given when items are identified for LTDNA analysis from cold cases. By their very nature, the age of the cases may invariably mean that exhibits were unlikely to have been recovered and handled in a manner conducive to the prevention of DNA contamination. The procedures and standards followed may not meet current stringent standards. In many instances, the handling and examination of the evidence in its initial examination is unknown and those involved in the initial examinations may no longer be available to have elimination DNA samples taken to eliminate them as a possible source of any DNA detected.

The production of a contaminant DNA profile has the possibility of undermining an investigation. All forms of contamination should, therefore, be considered when dealing with any DNA profile, but especially when dealing with a profile produced by LTDNA profiling.

In any investigation involving DNA, consideration needs to be given to the circumstances surrounding the finding of DNA on an item, not just that DNA has been found on it. Police and Crown Prosecution Service (CPS) policy is to only use DNA in evidence in association with other evidence and, this is particularly applicable with LTDNA.

7 Relevance and Evidential Value

Establishing that the appropriate exhibits and samples have been recovered and examined is crucial. Investigators may have experience of instances where forensic providers, in their quest to support the investigation, suggest that LTDNA analysis is undertaken on exhibits without knowledge of, or access to, the information that would best determine their appropriateness. The evidential value of a DNA profile within the crime scene and police investigation must be established.

In many instances, mixed DNA profiles will be obtained. The interpretation of these results rely on the skills and experience of the analyst and therefore peer review and confirmation is important.

Determining the success rates of LTDNA profiling has been problematic. It is argued that the presence or absence of a person's DNA in an LTDNA sample provides evidential value for inclusion or exclusion in a case. In many instances LTDNA profiles are submitted as 'intelligence only', which means that the profile obtained may not always be capable of being reliably reported in a statement or produced as evidence in court. However, all results should be disclosed to the court.

8 Case Studies

8.1 Case Study 1: Operation Andlor

On the 22 October 2005, Mohammed Ashraf drove his car to Philip Street E13, London, a dead-end road, on the request of two suspects who intended to steal his car that he was attempting to sell. They repeatedly stabbed and beat him with a metal bar and he died of his injuries. Two main suspects, who both lived near to the scene of the attack, came to police attention. One of the suspects had asked his father to dispose of clothing and when the father was interviewed by police, he identified where this clothing was.

The second suspect, Nathan Johnson, denied any involvement. A search of his home address produced a pair of trainers that it was believed he may have worn at the time of the attack. From a weak blood stain on one of the trainers, a mixed SGM+ profile of some of the components of the suspect and victim were produced, but the scientist was unable to state which profile came from the blood. Although, as the suspect denied ever having contact with the victim, it was still strong evidence. A statistical interpretation was not however possible therefore LCN analysis was undertaken. This resulted in an 80,000 to 1 probability that it was the suspect's profile within the mixture, confirming Johnson as a contributor.

This profile from a weak stain was crucial. There had been no previous contact between Johnson and the victim and it was the only concrete evidence linking him to the attack. He received a life sentence with a minimum tariff of seventeen years.

8.2 Case Study 2: Operation Connersville

On the 2 October 2007 in Kennington, South London, Robel Tewelede was fatally shot whilst fleeing a gunman in the stairwell of a block of flats. Three shots were fired from a self-loading weapon. Two casings were recovered at the scene, the third was never located. Two bullets hit the victim; one lodged inside him, the other exited and struck a wall in the stairwell. The third missed the victim and struck the same wall. The bullet that passed through the victim is believed to have struck the wall with a lower velocity and remained relatively intact. The third bullet hit the wall with greater velocity and disintegrated on impact. Of the recovered fragments, the bullet jacketing was subject to sampling, pooled together and processed using LCN.

A full male profile was generated but did not belong to either of the two suspects who were later convicted of this offence through CCTV and identification evidence. This introduced an unidentified profile from the ammunition used to kill the victim. Whilst this required the enquiry team to consider the possibilities surrounding its provenance, a search of the NDNAD generated two scene-to-scene matches to serious offences in 2002. Whilst this had the potential to cloud the trial, the strength of the other evidence in this case secured the convictions. The profile remains unidentified.

8.3 Case Study 3: Operation Anflora

This investigation covered a series of sexual assaults committed on women, predominantly in the Wandsworth area of London, between 2001 and 2007. Kirk Reid was convicted of these assaults in June 2009 and received a life sentence.

A full DNA profile of Reid was obtained from one of the victim's fingernails and two partial profiles were obtained from a further two victims. From one of these victims, a weak mixed profile using SGM+ was obtained which matched Reid, estimated at 1 in 6.9 million. From another victim (the only rape victim) a weak mixed profile was obtained from an area of staining, where seminal fluid was detected on the victim's skirt. The mixture matched both the victim and Reid but in order to improve the likelihood ratios, the two mixed profiles were subjected to LCN analysis. From the first victim, confirmation of the match was achieved through LCN with the likelihood ratio increasing to 1 in 1 billion.

Unfortunately, the increased sensitivity from LCN produced a mixed profile which introduced a third person. This necessitated the retraction of the original numerical weighting because it was undermined by the third profile. The defence contended that without a statistical evaluation there was no certainty that Reid was a contributor to the profile. The scientist, who undertook the LCN analysis and presented in court, although not attributing a likelihood ratio, commented that his findings provided moderately strong support for the view that DNA from Reid was present on the skirt. Combined with the full profile on another victim, identification and bad character evidence, the skill of the scientist in presenting his evidence contributed to a successful outcome.

In undertaking this LCN analysis, the introduction of a potential third profile caused concern to investigators and presented a situation where the evidence was not necessarily strengthened, but in fact weakened by further analysis.

These cases serve to show that proceeding with LTDNA analysis will not always have set outcomes and can introduce other issues, which need to be dealt with by the prosecution when presenting the case.

9 Forward View of Technology

The advances in DNA techniques to analyse LTDNA by forensic service providers will increase the success of obtaining a DNA profile from a crime stain. Other advances in DNA technology have supported the analysis of samples that are highly degraded. When a DNA sample is degraded it can be difficult to obtain a DNA profile because the areas that need to be amplified and copied many times are too short to allow copying using the conventional SGM+ analysis. Future techniques focus on smaller loci which have a greater chance of withstanding degradation and allow copies to be made in order to produce a full DNA profile. The AmpFlSTR® MiniFiler™ analysis kit is currently being used by some forensic service providers and is currently undergoing the appropriate validation and accreditation for its use in casework. It looks at eight loci and of them, five are comparable with profiles obtained using the SGM+ analysis kit. This compatibility means that it is possible to compare MiniFiler profiles against SGM+ profiles.

Forensic service providers and academic organisations both in the UK and internationally have been working on speeding up the time taken to analyse DNA and produce a DNA profile. The new technology would mean that analysis would take place in a fraction of the time that it currently takes. An application is under development for the use of rapid DNA analysis within the custody environment to conduct an identity check, complementary to fingerprints, which allows the suspect's DNA to be checked against outstanding crime profiles on the NDNAD before release.

Even when it is possible to get a DNA profile from a crime stain, there may be issues regarding interpretation. For example, a mixed DNA profile may be obtained which contains two or more individuals DNA. When it is not possible to subtract the victim's DNA profile from the mixture, or no other information is available, the profile can be difficult to interpret. To tackle this, last year the FSS launched a service called DNAboost. DNAboost is a computer algorithm that allows searching of a complex mixture against the NDNAD. The FSS can carry out searches of the NDNAD, overseen by the NPIA NDNAD Delivery Unit, to highlight potential DNA matches that may assist an investigation.

10 Conclusion

The necessity and value of obtaining a useful DNA profile from extremely small samples is accepted and the current methods of LTDNA profiling have made great strides in doing so. It is likely that in the future, new products from forensic service providers will provide greater options around a staged approach within LTDNA processes. The ability to obtain profiles using these methods over and above standard profiling techniques, has provided, and should continue to provide, increasing benefit to police investigations and the criminal justice process.

Questions have been raised regarding LTDNA analysis and it is likely to be debated and challenged in the future. The recent Court of Appeal ruling in the cases of *R v Reed and Reed* and *R v Garmson* [2009] have clarified some issues and provided useful guidance, albeit the appeal in the end did not rely on LTDNA confirming results.

Additionally, the scientific methods have been reviewed independently and validated to ensure that they are currently suitable for use. Providing LTDNA is used with full consideration to the individual piece of evidence, the circumstances of the case and possible likely outcomes, combined with an appropriate interpretation of results, there is no reason for it not to continue to be used in criminal investigations, case management and judicial proceedings.

References

Caddy, B., Taylor, G.R and Linacre, A.M.T (2008) *A Review of the Science of Low Template DNA Analysis.* London: Home Office.
Available from http://www.police.homeoffice.gov.uk/publications/operational-policing/Review_of_Low_Template_DNA_1.pdf?view=Binary

R v Reed and Reed, R v Garmson [2009] EWCA 2698. *Court of Appeal (Criminal Division) Judgement, 21 December 2009.*
Available from http://www.bailii.org/ew/cases/EWCA/Crim/2009/2698.html

Budowle, B., Eisenberg, A. and van Daal, A. (2009) *Validity of Low Copy Number Typing and Applications to Forensic Science.* Texas, USA: Medicinska Naklada.
Available from http://scholar.google.co.uk/scholar?hl=en&as_sdt=0&as_vis=1&q=+author:%22Budowle%22+intitle:%22Validity+of+low+copy+number+typing+and+applications+to+forensic+science%22

Sources of Information

Association of Chief Police Officers http://www.acpo.police.uk

Crown Prosecution Service http://www.cps.gov.uk

Cellmark Forensic Services http://www.cellmarkforensics.co.uk

Forensic Science Service http://www.forensic.gov.uk

LGC Forensics http://www.lgcforensics.com

HOLMES: From inception to modern day via lessons learned

Detective Superintendent John Mooney
HOLMES Liaison Officer, National Policing Improvement Agency

Abstract

This article outlines the advances in major incident room (MIR) business processes from the mid-1970s to the present day. Developments in technology together with the lessons learned from high profile and high volume investigations such as the 'Yorkshire Ripper' enquiry, the murders of Holly Wells and Jessica Chapman in Soham (Operation Fincham) and the linked series murders of five women in Ipswich (Operation Sumac) have shaped how MIRs currently function.

John Mooney joined Strathclyde Police in September 1975; his career has concentrated on the investigation of major crime, in particular homicide. His current role as HOLMES Liaison Officer, firstly with PITO as Detective Chief Inspector and then as Detective Superintendent with the NPIA, affords him the opportunity to apply his operational experience together with the knowledge and best practice gained from high profile enquiries throughout the UK.

John has provided advice, support and assistance on many recent high profile incidents for all aspects of HOLMES including: Operation Orb (sexual attacks around the M25 area in 2001-2002); Operation Trinity (historic murders in Scotland); the development of the MIRweb system to assist future incidents similar to Operation Fincham; Assisting the MPS deal with some of the mutual aid aspects for the attacks on London on 7 July 2005; the murder of five women in Ipswich in 2006 (Operation Sumac); development of HOLMES use for intelligence sharing in relation to Human Trafficking (Operation Pentameter2 2007/08); assisting the States of Jersey Police resourcing the MIR for the Historic Abuse Enquiry 2009 (Operation Triangle).

Part of John's current duties also entails organising conferences for the HOLMES community, providing the most up-to-date advice and best practice on complex incidents where the HOLMES system and processes have been used.

Contents

All correspondence should be addressed to:
John.Mooney@npia.pnn.police.uk

1 History of the Business Processes for Major Investigations

1.1 Different Cultures – Different Methods

Prior to any form of standardised business practice or computer system, police forces dealt with major incidents in very disparate ways. This meant that although there were many similarities in the methodology of how an investigation was run, there could be fundamental differences according to each individual senior investigating officers (SIOs) experience. This could be particularly problematic when a decision was taken to link enquiries for operational reasons. Whilst a basic 'card carousel' filing system was most common, the methods of administrating that system and the ancillary duties varied widely.

Up until at least the 1980s, a different culture of investigating major crime was apparent between the larger towns and cities as opposed to rural constabularies. Investigative methods were very different in tackling serious crimes, including murder. The 'Yorkshire Ripper enquiry', not too many years after many force amalgamations in the mid-1970s, was an example of these differences. The old West Riding force had a paper-led system which was time consuming in the short-term but, in a protracted enquiry, garnered evidence in statement form from witnesses which could prove crucial in mounting a successful prosecution.

Prior to force amalgamations in the mid-1970s, most provincial borough and county force murder enquiries involved bringing in a senior detective from Scotland Yard because historically, the Metropolitan Police was the only force in England and Wales with wide experience and the resources to offer mutual aid to rural forces. Therefore, county forces tended to adopt the Metropolitan Police way of doing things. The bigger cities like Leeds, Manchester, Bradford, Birmingham and others, had the resources and experience to run their own murder enquiries without help from Scotland Yard. Thus, two very distinct systems of investigation evolved; both with their advantages and disadvantages.

For example, many large city forces in the 1970s and early 80s took very few statements in a major investigation until they were needed for court proceedings, with SIOs never immersing themselves in detail until it was absolutely essential. As a consequence they rarely needed to read reams of paperwork.

SIOs would often rely on their experience and extraordinary knack of solving murders by getting the best from their officers and having the key skill of weighing up suspects psychologically, 'hunches' a skill which proved to be correct time and again. These hunches were the result of years of experience, observation and a deep understanding of people.

Expert and confident SIOs also realised that the best opportunities for all aspects of homicides came in the early days of it being discovered while people's memories were still fresh, what we now term 'The golden hours'.

1.2 Major Incident Project

In 1974 the then Police Scientific Development Branch (PSDB) of the Home Office commenced a research project known as the Major Incident Project. Its objectives were to consider how the Police Service might use computers for the investigation of major crimes.

Between 1974 and 1985 the overall project development comprised a number of sub-projects, some of which have become widely known by their acronyms and other shortened forms:

- MIRIAM – Major Incident Room Index and Action Management;
- AIM – Automatic Index and Action;
- MICA – Major Incident Crime Administration;
- HOLMES – Home Office Large Major Enquiry System.

During this time a number of major crime investigations had led to very large incident rooms being set up, notably the 'Black Panther' (see Text Box 1) and the 'Yorkshire Ripper' (see Text Box 2 and Text Box 3) investigations.

Text Box 1

The 'Black Panther' Investigation: Crimes committed by Donald Neilson

Donald Neilson was born Donald Nappey on 1 August 1936. By 1967 Neilson was committing crimes including armed post-office robberies. He committed at least nineteen over a seven-year period. Neilson's practice of wearing a dark-coloured balaclava during his robberies earned him the sobriquet 'The Black Panther' from the media.

In 1972, one of these raids resulted in the non-fatal shooting of a Lancashire postmaster, who put up resistance during the raid. Then on the 15 February 1974, during a raid on a Harrogate sub-post office, Neilson shot dead the postmaster, Donald Skepper. Seven months later, when postmaster Derek Astin was shot dead in Lancashire during the course of another raid the police quickly came to the conclusion that they were looking for the same killer in both cases. Just nine weeks later a third postmaster, Sidney Grayland, was shot dead during the commission of a robbery in the West Midlands. Forensic evidence at the scene linked this death to the first two.

Following these offences Neilson settled on kidnapping as his best way of achieving a 'big payout'. His target was a seventeen year old heiress to a transport fortune, Lesley Whittle. On 14 January 1975, Neilson broke into the Whittle family's Shropshire estate and abducted Lesley, leaving a ransom note that demanded £50,000. Lesley Whittle was held in a drainage shaft beneath Bathpool Park in Staffordshire.

Ignoring Neilson's instructions not to notify the police, the Whittle family informed both the local police and Scotland Yard of the kidnap. Three ransom delivery attempts were bungled, as a result of poor police coordination, communication and bad luck. However, the police were sure that Lesley was still alive at this time because it was her voice that recorded the details for the second failed ransom drop in Bathpool Park. Unbeknown to the police, the second failed attempt ended just yards from the drainage shaft where Lesley was imprisoned, but no search of the immediate area was carried out at the time. Furious that his instructions had not been followed, Neilson waited nearby for the police to leave, before entering the drainage shaft and killing Lesley.

On the same night as the last aborted ransom drop, Neilson was involved in a freight train terminal robbery, in which a security guard, Gerald Smith, was fatally injured. Forensic evidence again linked the crime to the 'Black Panther' post-office heists, but no connection was made to the Whittle kidnap at that time. It took police more than a

week to discover Neilson's stolen getaway vehicle, which he had abandoned close to the train terminal. Inside the vehicle, tapes were found of Lesley Whittle's voice and ransom drop instructions.

Finally, making the connection between the 'Black Panther' and kidnap of Lesley Whittle, and given that ten days had passed without word from her kidnapper, a full search of Bathpool Park was instigated, and the news blackout, that had proved so ineffective, was lifted. A televised interview with Lesley's father, Ronald Whittle, and public assistance, led to the discovery of Lesley Whittle's body nearly two months later on 7 March 1975. Post mortem evidence revealed that she had been killed within days of her kidnapping.

Donald Neilson was arrested on 11 December 1975. His trial commenced on the 14 June 1976 and he was convicted on 1 July 1976 of the murder of Lesley Whittle, three post masters and the attempted murder of a security guard and police officer.

(Source: http://www.crimeandinvestigation.co.uk/crime-files/donald-neilson-the-black-panther/crime.html)

There was little glory for the detectives who had led the hunt for the notorious 'Black Panther'. In August 1976, MPs in the House of Commons voiced deep concerns about the concluded police investigation that had tragic results. Like the Yorkshire Ripper case years later:

- The hunt involved several police forces;
- There was a great deal of resistance for mutual aid;
- It was two uniform officers in a patrol car who made the arrest.

Some MPs demanded an enquiry into the whole conduct of the Black Panther investigation, however, the Home Office Minister at the time, Dr Shirley Summerhill, refused, stating at Parliament:

> The case has been discussed by Chief Officers and I am sure they are fully aware of the need to learn lessons from such an investigation. The responsibility of deciding how a crime should be investigated is for them and them alone.

What was apparent five years later in 1981, when the Yorkshire Ripper investigation was concluded, was that the Police Service had completely failed to learn the lessons from the Black Panther investigation.

Text Box 2

Murders Committed by Peter Sutcliffe: The Yorkshire Ripper Enquiry

Peter Sutcliffe murdered at least thirteen women and attacked several others over a five year period from October 1975 to November 1980. As the number of victims increased, media interest soared and the police came under intense pressure to catch the 'Yorkshire Ripper', as the killer became known.

The murdered victims

30 October 1975: Wilma McCann, 28, Leeds
20 January 1976: Emily Jackson, 42, Leeds
5 February 1977: Irene Richardson, 28, Leeds
23 April 1977: Patricia Atkinson, 32, Bradford
26 June 1977: Jayne MacDonald, 16, Leeds
1 October 1977: Jean Jordan, 20, Manchester
21 January 1978: Yvonne Pearson, 21, Bradford
31 January 1978: Helen Rytka, 18, Huddersfield
16 May 1978: Vera Millward, 40, Manchester
4 April 1979: Josephine Whitaker, 19, Halifax
2 September 1979: Barbara Leach, 20, Bradford
20 August 1980: Marguerite Walls, 47, Leeds
17 November 1980: Jacqueline Hill, 20, Leeds

(Source: http://www.crimeandinvestigation.co.uk/crime-files/peter-sutcliffe--the-yorkshire-ripper/timeline.html)

The investigation team had to sift through vast amounts of information. Making sense of this mountain of evidence pre-computerisation was no easy task and severely hampered police progress (see Text Box 3).

Text Box 3

Card Indexing System – Yorkshire Ripper Enquiry

By 1979 there were four separate index cards relating to Sutcliffe in the centralised Nominal Index. Two cards each for Peter William Sutcliffe and William Peter Sutcliffe, each had different dates of birth. The problems that had developed in the incident room were in no small way due to the masses of documents, statements, actions and index cards either 'missing' (eg, removed by someone without leaving a marker), held pending or incorrectly completed or filed.

Tyre Imprint enquiry

To ensure that nothing was missed for a line of enquiry in relation to tyre imprints left at the murder scene of Irene Richardson, senior investigators instructed a manual search process of some 53,000 vehicles be conducted. These index cards were also cross-checked against index cards compiled by the investigative team of people visiting one, or two or more red light districts in the Leeds area. This part of the enquiry remained secret for several years.

The index card system provided a means of eliminating those of no interest, leaving a far smaller number of owners that required home visits. The index cards used, however, were filed in 'registration number order' and then carried the owners' names. Tragically, no index cards were made out for the owners as a cross-check reference against other nominal cards. Had such an index been operating within the incident room, the name Peter William Sutcliffe would have been referenced in relation to the tyre tracking enquiry. Any officer looking up his name in relation to any other aspect of the investigation would have immediately seen that he owned a car which could have been used in the murder of Irene Richardson.

£5 Note enquiry

In December 1979, a cross-checking and elimination process of those individuals who could have received a £5 note found on one of the victims, Jean Jordon, reduced a possible list of suspects to a manageable 241 males. As a further elimination process, additional information in relation to these 241 males (eg, sightings in red light districts) was sought. Only seven of the 241 names had any additional information discovered about them in the incident room and Sutcliffe was not amongst those seven. Much later it was discovered that there was in fact an additional eighteen individuals who had been

wrongly marked as 'no trace', whose cards were either missing or misplaced in the Nominal Index. Sutcliffe had been questioned six times, including the two £5 note interviews in 1977. Among the eighteen 'phantoms' only Sutcliffe featured as a triple red light area sighting and featured in the £5 note and tyre tracking enquiry.

(Source: Bilton, M (2003). *Wicked Beyond Belief. The Hunt for the Yorkshire Ripper*)

2 Byford Report: The turning point in UK Police Service major crime enquiries

As a result of the protracted Yorkshire Ripper investigation, Sir Lawrence Byford, a member of Her Majesty's Inspectorate of Constabulary (HMIC), was asked to conduct a review of the enquiry. The Byford Report stated that the ineffectiveness of the MIR was a serious handicap to the investigation. While the MIR should have been the effective nerve centre of the whole police operation, the backlog of unprocessed information resulted in the failure to connect vital pieces of related information. The report stated that, with hindsight, Peter Sutcliffe should have been identified as a prime suspect. If the errors of judgement and inefficiencies in the conduct of the operation had not taken place, Peter Sutcliffe could have been caught at least eighteen months before he was finally arrested.

The Home Secretary, Mr William Whitelaw, in a statement to the House of Commons on 19 January 1982, summarised the recommendations outlined in the Byford Report:

> They deal comprehensively with the management requirements of the investigation of a series of major crimes, the training of senior detectives and personnel working in major incident rooms, the command of investigations involving a number of crimes which cross force boundaries, the harnessing for such investigations of the best detective and forensic science skills in the country, and the use of computer technology.

The Byford report made two important recommendations concerning the standardisation of incident room procedures and the computerisation of major investigations and in this respect was a turning point in the business of major crime enquiries within the UK Police Service.

2.1 Major Incident Room Standardisation

The report outlined how:

> The single most important lesson for major incident rooms is that the standardisation of procedures must be achieved so that compatible systems capable of being interfaced in appropriate cases are introduced in all police forces (para 628, pg 153).
>
> The operational efficiency of an incident room will greatly depend on the extent to which the staff allocated to it are specially trained (para 632, pg 154).
>
> A major incident room index system particularly in a large scale investigation should be subjected to a continuous process of audit. The crucial consideration is that the misplacing of a single card in a nominal index system can jeopardise a whole inquiry and with this is mind, systems management should ensure errors are kept to a minimum (para 633, pg 154).

2.2 Computerisation of Records

In relation to the computerisation of records it was recommended that:

> Computers should be able to offer a SIO in a major crime inquiry, a more simple and effective means of handling the information flow generated (para 635, pg 154).

Reference was made to the computer project designed to meet this need (eg, Major Incident Project) which was to be given a full-scale trial and Chief Constables were advised to seek guidance from the Home Office on the use of computers in crime investigations.

Other recommendations included:

- Arrangements to be made for the command of coordinated enquiries where connected series occur across different force areas (eg, officer in overall command).
- Better training for ACPO officers to equip them with the management skills required for such critical incidents. And the development of interview techniques and specialist training for incident room staff.

- A means of harnessing the best detective and forensic science talent available in the country in major series investigations.

2.3 HOLMES Systems and MIRSAP

As a result of the Byford recommendations, the first version of the Major Incident Room Standard Administrative Procedures (MIRSAP) was published by ACPO in 1985.

The Home Office had already initiated the Major Incident Project to define the requirements for a major investigation computer system. The first generation of HOLMES was developed by four different suppliers, at their own expense, in accordance with the HOLMES Application Design Specification (HADS) published by the Home Office. The software was validated by the Home Office and forces then procured the application from one of the four suppliers: Burroughs (now Unisys), Hoskyns, McDonnell-Douglas (now part of Northgate) and Honeywell (became Bull). By the mid-1980s all UK forces were using a HOLMES system.

The linking of original HOLMES systems (eg, Honeywell to Honeywell) was very limited. To share information with a different HOLMES(1) system required a HADS transfer on a reel-to-reel tape, and not all of the data was contained within the HADS files.

The West Yorkshire Police investigation into the murder of Sarah Jayne Harper in March 1986 was one of the first enquiries to widely use the HOLMES computer system, following recommendations in the aftermath of the Yorkshire Ripper investigation.

The circumstances surrounding this murder led to a conference being convened at the Home Office for senior police officers who were involved in the investigation of unsolved child murders. The purpose of the conference, which was held in August 1986, was to discuss the problems of comparing such a murder to other outstanding similar crimes, due to the lack of any comprehensive records. Specific reference was made to the possibility of linking the murder of Sarah Jayne Harper to the murders of Susan Claire Maxwell aged eleven in 1982 and Caroline Hogg, aged five, who was killed in 1983 (see Text Box 4).

The three bodies were found within twenty-six miles of each other, and police already believed that the murders were linked. Detectives also thought that, because all three victims had been left long distances from where they had been abducted, that the killer travelled as part of his occupation, and was possibly a lorry driver.

Text Box 4

Child Murders committed by Robert Black

Murder of Susan Maxwell

On 30 July 1982, eleven year old Susan Maxwell from the village of Cornhill on Tweed, on the English side of the English/Scottish border left her home to play a game of tennis across the border in Coldstream. Several local witnesses remembered seeing her until she crossed the bridge over the River Tweed, after which there were no sightings of her. Susan was abducted, raped and strangled. Her body was discovered by the side of a road at Loxley, Ashby de la Zouch, 264 miles away from where she was abducted.

Murder of Caroline Hogg

In the evening of 8 July 1983, five year old Caroline Hogg from Portobello on the outskirts of Edinburgh went out to play near her home and never returned. Many witnesses reported seeing a scruffy-looking man watching a young girl, believed to be Caroline, in the playground near her home, then holding hands with her in a nearby amusement arcade. Caroline's body was found ten days later in a ditch 308 miles away at Twycross, Leicestershire. The cause of death could not be determined due to decomposition (as had been the case with Susan Maxwell).

Murder of Sarah Harper

Three years later, on 26 March 1986, ten year old Sarah Harper went missing from Morley in Leeds after leaving her home to go to the corner shop to buy a loaf of bread. The shopkeeper remembered Sarah coming in to the shop, but she never returned home. The last sighting of Sarah was her walking towards home. Her body was recovered a month later from the River Trent near Nottingham, 81 miles away from where she was last seen.

(Source: http://en.wikipedia.org/wiki/Robert_Black_(serial_killer)

HMI Brownlow requested that the murders of Maxwell, Hogg and Harper be formally linked together and the result of the conference was to first commence research into the feasibility of their unification, bearing in mind that they were being run on different police enquiry systems. The Maxwell enquiry was held on a non-standard card index in Staffordshire, whereas the Hogg enquiry was retained by Lothian and Borders. The Harper enquiry was run entirely on HOLMES, which was by then the national standard system for murders and other major crimes.

Up until this point, enquiries on the Harper murder, although not formally linked to the other two investigations, had taken them into account. Research involved checking across all three systems prior to action being carried out which took around eight weeks.

At this time, McDonnell-Douglas had a pilot scheme to test the HOLMES Central Facility (HCF) running at Bradford and they offered space on this computer for the three murders to be placed together. Back record conversion was approved for the two earlier enquiries (Maxwell and Hogg) and the three murders were recorded and open-linked on HOLMES. They sat together within a Child Murder Bureau, which operated as a research database for these enquiries. Mr Hector Clarke, having been involved in the Maxwell enquiry in Northumbria and later Deputy Chief Constable at Lothian and Borders, had unofficial overall command of these cases.

The second recommendation from the conference was to examine all outstanding undetected murders and missing person enquiries to establish if consideration should be given to linking any others to these three cases. This collation of information was also to ensure that, should they arise, any similar future cases would be brought to the attention of the combined enquiry. This was the origin of the Centralised Analytical Team Collating Homicide Expertise and Management (CATCHEM) database which contains information on the murders of all female victims, age twenty-one or under, and all male victims, age sixteen or under. The CATCHEM database, is currently maintained by NPIA Crime Operational Support.

In December 1988, HOLMES became the engine of the biggest mass murder investigation ever mounted in Britain, when Pan Am flight 103 was blown up by a terrorist bomb over Lockerbie, killing 270 people. By coincidence, Andrew Sloan (part of the Byford team and then Chief Constable of Strathclyde Police) was again involved when he offered mutual aid assistance to Dumfries and Galloway.

Chief Constable Sloan sent his most experienced senior investigators, together with a Strathclyde HOLMES team to assist. From their base in Lockerbie Academy they were connected to an additionally rented HOLMES system at the force headquarters in Glasgow. The Lockerbie investigation involved forces from the USA, Britain and Germany. The HOLMES system in Glasgow was linked to New Scotland Yard, the FBI in Washington DC, the local incident room in Lockerbie and the West German Police in Frankfurt.

3 HOLMES2

In 1993, with the need for a single national system to replace the ageing and disparate HOLMES(1) systems becoming increasingly apparent, the HOLMES2 project was initiated. The contract for this work was awarded to Unisys who delivered a second generation HOLMES system, HOLMES2 in the late 1990s. It uses commercial off the shelf (COTS) components mixed together with bespoke software in a familiar Windows environment. As a result of nearly twenty years of constant effort and development refinement, the UK Police Service now has a twenty-first century computer system which their counterparts not so long ago could only have dreamed of.

One of the main features of HOLMES2, beyond the original HOLMES systems, is the ability of all forces to be able to link with any other force that they believe have a series of similar crimes. It also allows searching across both structured (indexed) and unstructured (free text) information, giving SIOs confidence that nothing is being missed. The increasing use of web-technology to enhance the capability of the HOLMES2 system, and its flexibility depending on business processes required, means that the investigation of a wide range of serious and series crime can keep apace with technology and the criminal mind.

3.1 Casualty Bureau

At least one of the original HOLMES suppliers had sold a Casualty Bureau (CB) application to several forces, which shared much of the HOLMES MIR functionality. It was decided that HOLMES2 should, therefore, include a CB application. This would prove to be very forward thinking given the interaction required between MIR and CB for various criminal attacks that have ensued in recent years.

3.2 Disclosure Package

The Criminal Procedure and Investigations Act (1996) brought fundamental changes to the ways in which the Police Service are required to reveal material, collected during an investigation, to the defence. The HOLMES2 disclosure package ensured that all forces in England, Wales and Northern Ireland (and Scotland with the release of version 14 in December 2009) prepared disclosure schedules, knowing that all material had been assessed through the applications registration and queuing functionality, making disclosure material less vulnerable to challenge in the courts.

By mid-2002, all UK forces, including British Transport Police (BTP), the Ministry of Defence Police (MOD) and the Royal Military Police (RMP), had procured HOLMES2 systems. Other police organisations have also bought HOLMES2, including the Independent Police Complaints Commission (IPCC), the National Policing Improvement Agency (NPIA), the Scottish Crown Office Procurators Fiscal Service (COPFS) and the Criminal Cases Review Commission (CCRC).

4 Development of HOLMES2 Suite Ancillary Products

The investigation into the murders of ten-year olds Holly Wells and Jessica Chapman by Ian Huntley in August 2002 (Operation Fincham), involved one of the most highly publicised missing person searches in British history. The findings of the Bichard Inquiry which were published in June 2004 were highly critical of Humberside and Cambridgeshire police forces failings in maintaining intelligence records on Ian Huntley. This led to the recommendation that a national system should be set up for police forces to share intelligence information and that there should be a clear code of practice on record-keeping by all police forces.

However, for all the criticism levelled at Cambridgeshire Constabulary, as a result of the vast amount of information gathered during Operation Fincham that required inputting and prioritising, they developed the kernel of what is now recommended as good practice for critical incidents that attract huge public awareness and media interest, ie, MIRweb (HOLMES Messaging on the web). This investigation can, therefore, be viewed as the origins of the development of part of the HOLMES2 suite ancillary products, ie, MIRweb and National Mutual Aid Telephony (NMAT).

4.1 MIRweb/Casweb

MIRweb is the web-based input to HOLMES2 that provides a data-entry facility for police call-takers to add information from the public to the specific incident. The development of MIRweb to be used in this manner came from recommendations from the work carried out by the ACPO Homicide Working Group (HWG) via Chief Constable Jon Stoddart (then ACC Lincolnshire) in response to the Bichard Inquiry and the NPIA (then PITO) HOLMES Team in consultation with the forces involved and other members of the HOLMES community.

MIRweb allows mutual aid forces to record messages on the 'host' force's HOLMES2 system. This works in conjunction with NMAT, described below, to assist high volume crime enquiries or major disasters. By filtering the calls and their content, the management team is able to focus prioritised information towards their lines of enquiry or objectives.

The MIRweb process of inputting, assessing and prioritising information received from the public stems from the process developed by Cambridgeshire staff during Operation Fincham. Albeit, they used the only means available to them at that time to store all of the large amounts of information being received. By cutting and pasting from the information taken by their call-takers, it allowed all of the information to be searched and researched within that separate database. It was, of course, not the ideal method as the database remained outside of the main system being used to investigate the murders (HOLMES2). However, it provided one additional store of information to be searched in conjunction with the HOLMES2 account.

As a result of Operation Fincham and the Bichard Inquiry recommendations, a number of changes were made to policing systems to ensure that any future investigations would benefit from the lessons learned and the development of using such a process. The MIRweb/Casweb and NMAT system that now form part of the HOLMES2 suite of products was a means of quickly inputting data in times of mutual aid, from remote locations, by officers and police staff in their own forces. It does not, therefore, require large numbers of people to travel to the host force to take calls and input data within an already resource stretched host force.

4.2 National Mutual Aid Telephony (NMAT)

NMAT is the telephony solution to assist in taking information from the public during high profile and high volume incidents such as Operations Fincham and Sumac, by directing calls to a single 0800 or 0207 number to forces assisting via mutual aid.

Recent investigations, such as the linked series murders of five women in Ipswich in 2006 (Operation Sumac), have benefited greatly from these developments by having the ability to input vast quantities of data (approx 10,000 messages in ten days at the height of the investigation) using mutual aid from twenty-five forces and therefore providing them with the ability to search, assess and prioritise all of the material for any intelligence or evidential lead (*NPIA (2008) Tactical Debrief Operation Sumac*). These developments place the UK Police Service in a resilient position to deal with national crime and disaster incidents.

4.3 Operation Sumac: Effect on MIR Process

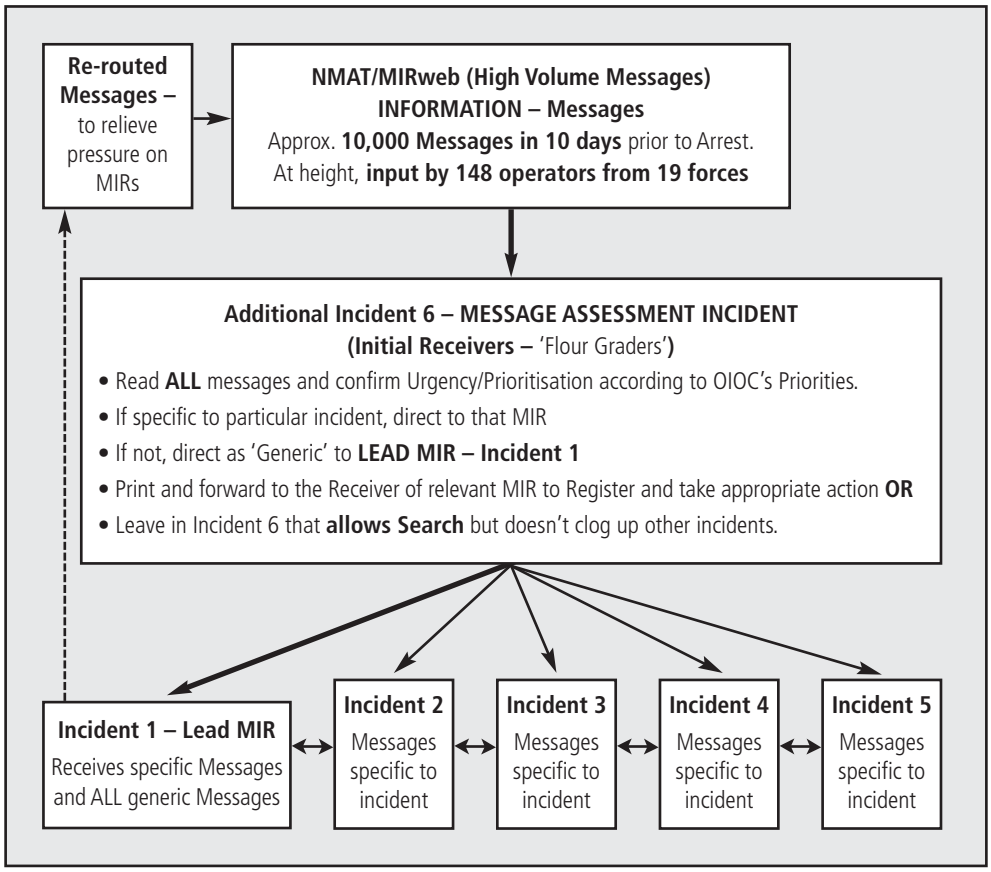
Some bold and innovative steps were taken during the 'crime in action' phase of Operation Sumac in relation to the processing of vast quantities of information being fed into Suffolk Constabulary by both the public and other police forces.

Whilst initially set up as five separate MIRs, it was always on the minds of those involved in the investigation that the same person was responsible, albeit a 'copy cat' or accomplice could not be ruled out. It was also of significance that the eminent pathologist, Dr Nat Carey, was unable to absolutely establish cause of death in three of the murders. Given this background it was a correct decision by the Operation Sumac management team to retain the integrity of the individual incidents.

As information flooded in, mainly via mutual aid telephony and MIRweb, it became apparent that most of the messages were generic in nature from people trying to assist the police. For example, a common message would be along the lines of "I think the police should look at Mr 'X' as I think he is violent towards women". In relation to the five investigations, this was relevant for all of them. To avoid duplication and unnecessary effort by the already stretched MIR resources, a decision was taken, based in part via consultation and advice from an ACPO support team, to deal with such generic messages and actions sourced from them via a 'Lead MIR'. The terms of reference for the lead MIR to accept this type of work were clearly defined in consultation with the OIOC and SIOs. The extra resources required were addressed and alleviated the need to add additional staff to the other four MIRs.

An additional feature, specifically for this enquiry, was the addition of a sixth MIR to act as a Message Assessment Centre (MAC). In effect this was a clearing house for the thousands of incoming messages with the vital factor being that all of the information that was not thought a priority, or did not fit with the SIOs lines of enquiry, was still able to be searched across from the five incident rooms dedicated to the individual murders (see Figure 1).

Figure 1 Operation Sumac Model using NMAT and MIRweb



The innovative process work and the first real mass input to MIRweb has led to further thinking around best practice and different models for linked series incidents that are complex in a number of ways and require some form of overview or centralisation of the aspects mentioned.

Operation Sumac together with other incidents and exercises has also led to current and future work on the HOLMES2 system, and will take cognisance of the advantages of having the ability to quickly search across many incidents, raise actions in a 'crime in action' scenario and input large quantities of data from other sources, if properly evidenced.

5 The Future

It has been a long road from the days of the Yorkshire Ripper enquiry. As a result of the incidents highlighted, such as Operation Fincham and Operation Sumac, further learning towards refining MIR systems and processes will enhance the ability of future high profile and high volume investigations to reach an earlier conclusion in the knowledge that we can be confident nothing has been missed. We must continue to properly invest and develop MIR business processes, whilst remembering that our biggest assets remain our investigative experience, knowledge and dedication to ensure we do learn from what has gone previously.

Work towards achieving these goals continues and a few examples of current developments are:

- The ACPO Homicide Working Group is considering various models for complex linked series investigations. This includes the 'traditional' method via a Central Research Incident (CRI) as well as using tools such as NMAT and MIRweb and business process models used for Sumac, ie, a Message Assessment Centre or Incident and a lead MIR for information generic across all of the incidents.

- The HOLMES2 community are currently developing a 'Fast Action' module in partnership with the NPIA and Unisys. This will allow actions to be raised and distributed to relevant users involved in the incident without the current necessary rigour of a MIRSAP action. This will be of great benefit to forces for investigations such as Kidnap and Extortion (including Child Rescue Alert) or when they want to use HOLMES2 in a 'lite' fashion. This version is targeted for release in December 2010.

- A further enhancement to the HOLMES2 system for delivery in December 2010 will be the ability to import large quantities of data electronically; with the necessary quality assurance. This major enhancement will enable itemised telephone billing, ANPR lists or lists of names from trusted sources to be quickly processed.

References

Byford, Sir. L. (1981). *Report into the Yorkshire Ripper Enquiry*. London: Home Office.

Bichard, Sir M. (2004). *The Bichard Inquiry Report*. London: The Stationery Office.

Bilton, M (2003). *Wicked Beyond Belief. The Hunt for the Yorkshire Ripper*. London: Harper Collins.

Crime and Investigation Network (2010) Peter Sutcliffe: The Yorkshire Ripper [Internet]. Middlesex: Crime and Investigation Network. Available from http://www.crimeandinvestigation.co.uk/crime-files/peter-sutcliffe--the-yorkshire-ripper/timeline.html [Accessed 12 February 2010]

Crime and Investigation Network (2010) Donald Neilson: The Black Panther [Internet]. Middlesex: Crime and Investigation Network. Available from http://www.crimeandinvestigation.co.uk/crime-files/donald-neilson-the-black-panther/crime.html [Accessed 12 February 2010]

NPIA (2008) *Tactical Debrief Operation Sumac.* London: NPIA.

Wikipedia (2010) Robert Black [Internet]. Available from http://en.wikipedia.org/wiki/Robert_Black_(serial_killer) [Accessed 12 February 2010]

Professionalising Investigation: An update on the SIO development programme PIP Level 3

Steve Maher, National SIO Registrar (PIP Level 3)
National Policing Improvement Agency

Abstract

This article outlines the significant progress of the PIP Level 3 programme nationally and aims to raise awareness of the key issues still affecting full compliance in some forces.

Steve Maher retired from the Metropolitan Police Service in October 2008 to take up his current role as National SIO Registrar at the NPIA. His police career spanned thirty-two years, finishing as an SIO within the Homicide and Serious Crime Command.

Contents

All correspondence should be addressed to:
steve.maher@npia.pnn.police.uk

1 Introduction

The Professionalising Investigation Programme (PIP) was a major change programme initiated by ACPO and the Home Office in 2004. PIP aims to provide a professional investigation capability for the Police Service by developing investigative skills, knowledge and practice, through training and work based experience which is assessed against National Occupational Standards (NOS).

To support the aims of PIP at Level 3, a National SIO Database was created utilising an existing IT platform (eg, Expert Advisers Database) to capture all those aspiring SIOs entering the SIO Development Programme (SIODP) as 'under assessment'. Thereafter, their progress is tracked whilst they complete their Professional Development Portfolio (PDP), through to final registration, whereupon their status is changed to 'Registered-PIP Level 3'. A PIP Level 3 certificate is issued at this stage, and SIOs are, in effect 'licensed' to practice at the more critical end of criminal investigation, ie, leading homicide and other major crime investigations. Implementing such a major programme across all Home Office Police Forces was a significant challenge. Whilst there is national policy accompanying the SIODP, interpretation has on occasion varied across forces, sometimes causing confusion and inadvertent non-compliance with the policy.

2 Recent Developments

In 2008, to support the infrastructure around compliance and uniformity at PIP Level 3, a sub-committee of the ACPO Homicide Working Group, the Professional Development Committee (PDC) was set up to deal with PIP Level 3 specific issues together with the creation of a National SIO Registrar post.

I was appointed as the first National SIO Registrar (PIP Level 3) in October 2008. In general terms, my remit is to advise and support all forces in achieving greater compliance with PIP at Level 3, whilst maintaining the National SIO Database, administering the process and issuing SIO certificates when the programme has been successfully completed by candidates. Another integral part of my remit is to engage with colleagues supporting other areas of the SIODP such as the maintenance of the national SIO training course and ACPO Murder Investigation Manual to ensure a cohesive and holistic approach to the development of SIOs from start to finish.

3 Registrar's First Year

My first year has involved visits to all forces, developing close relationships with Heads of Crime and/or others who lead on PIP Level 3 issues within force. These visits have provided the opportunity to discuss the aims of PIP Level 3 and to identify weaknesses in force structures and processes at a strategic level.

Developing SIOs need to have consistent exposure in a major crime environment with associated assessor and structural support, allowing them to incrementally progress to registered SIO status. The process ensures that by the end of the work-based assessment stage, SIOs will be best equipped to deal with a wide range of major crime investigations and be a true asset to their force. Robust processes are essential because developing aspiring SIOs in any other way tends to deny them the breadth and depth of exposure and support that is required, and risks compromising the individual and organisation as a whole.

Those forces that have fully adopted PIP Level 3 are those which have invested resources into the programme, clarifying to their staff through clear policies what is expected of them, whilst providing the supporting infrastructure and opportunity. There needs to be tangible synergy between major crime SIOs, crime training and human resources to ensure the developmental process is catered for end-to-end, including a strong Continuing Professional Development (CPD) regime for those having achieved registration. An identified PIP 3 lead is essential to proactively manage the process and drive it forward. The programme was designed with the acknowledgement of the pressures on SIOs and their workload and is therefore a practical approach to providing the recognition and confidence SIOs and their forces deserve.

As part of the support structure for my role, I report to the PDC and ACPO Homicide Working Group who guide and influence the agenda of the PIP Level 3 programme. Their strong support is pivotal to the success of the programme, which is gradually evolving to make the programme as accessible and practical as possible within the constraints of the original concept.

As the first National SIO Registrar, I needed to establish the status quo in order to identify my priorities, hence my personal visits to each force to 'benchmark' the national position. I have been assisted in this task by the National Standardisation Team who provide a tactical aspect to the process. This team, staffed by occupationally knowledgeable qualified assessors and internal verifiers, visit forces and inspect individual PDPs, examine assessing and internal verification processes, and report on their findings and give recommendations where appropriate. Once I have signed off their report, it is sent to the force ACC (Crime) for their consideration.

The continuing investment in the SIODP in terms of both finance and service commitment is considerable, ensuring the longevity of the robust and defensible system of accreditation that now exists.

4 Continuing Professional Development (CPD)

CPD is an integral component of the SIODP. The requirement for SIOs to complete the minimum CPD activity annually starts from their first PDR date following registration. I have responsibility for assessing all CPD activity for SIOs to ensure its relevance and suitability and attribute a value to the activity in terms of CPD hours. In order for registered SIOs to maintain their registration at PIP Level 3, they MUST complete a minimum of twenty recognised[1] hours of CPD per year[2].

The National Registration and CPD Policy for SIOs recommends that only four of the twenty hours of CPD annually should be nationally recognised. This was amended by the PDC almost a year ago, so that ALL CPD should be recognised by the National SIO Registrar with the assistance of the PDC. This change, which will be reviewed in due course, was made to add rigour to the process during the first full year of enforcement.

Those forces actively embracing the programme tend to have well developed systems for providing locally or regionally organised events, ensuring all SIOs have the opportunity to benefit from them. This support is unfortunately not evident everywhere, with some forces stating that the requirement is too difficult or costly to manage. This suggests a lack of understanding of what counts towards recognised CPD and a lack of pro-activity to achieve it. Activity can include anything from relevant academic study to assessing aspiring SIOs. Sharing good practice around recent successful (or unsuccessful) homicide and other major crime investigations can be recognised, as can relevant formal courses. If in doubt about the relevance of any CPD activity, please contact me.

It is also evident that some SIOs, particularly those employed in dedicated homicide commands fail to recognise the concept of CPD, or understand why the investigation of homicide itself is not a recognised CPD activity. From personal experience, I know that investigating homicide almost to the exclusion of everything else is not necessarily the best way to develop personal skills, and that is where CPD can bridge the gap.

[1] Recognised and certified by the National SIO Registrar.
[2] The requirement (20 hours) runs in tandem with the force PDR year.

5 SIO Database

At the end of December 2009, the National SIO Database contained details of 1,202 individuals; 453 of those were 'Registered-PIP Level 3' with a further 424 'under assessment'. The remainder are either in 'holding' due to their circumstances, or at their force request, or have been archived because of retirement or re-deployment. These figures compare favourably with the position at the end of 2008, when the database recorded 381 SIOs Registered-PIP Level 3 and 232 under assessment. In the last year there has been a significant increase in those registered and under assessment. This increase is in some ways to be expected given the growing recognition of the benefits and status the programme brings.

In particular, the creation of the Registrar's role has served to remind forces of the ongoing commitment of the ACPO Homicide Working Group and others to making this the beginning, rather than the end of professionalising investigation at SIO level, so complacency around this work is overtly discouraged.

Numerically, the National SIO Database figures look quite impressive and, overall do demonstrate considerable achievement to date and a continuing drive for greater compliance across the majority of forces. It does, however, fail to highlight the less compliant forces, struggling to reach a reasonable standard for a number of reasons, and this is where much of my work will be focussed in 2010.

6 Current Status

So, five years on, how are we actually doing? Not surprisingly, the degree of compliance varies considerably from force to force. Some forces have been very active in the commitment and resources put in place to support the programme. This has had demonstrable results in high levels of compliance, with well structured and clearly communicated strategies and policies. This in turn has improved resilience and capacity, not least because of the need for robust succession planning that naturally flows from strong compliance and vice-versa. It has also had a beneficial effect on the morale of senior staff, as development is not ad-hoc or based on individual bias or circumstance. The majority of forces fall into the middle ground, that is they are achieving satisfactory compliance but require some support from time-to-time, but are otherwise progressing well. At the lower end of the scale however, a very small number of forces have poor compliance, in some cases leaving them with no SIOs registered at PIP Level 3. This is for a variety of reasons, but in the majority of cases will be easily and quickly rectified. One of my priorities this year will be to engage more robustly with these forces, seeking this time to address the issues at Chief Officer level where necessary.

7 Challenges to Success

If we exclude some of the more widely cited reasons for non-compliance, such as resource constraints or competing demands, then what are the real challenges to success in those forces that are not yet fully compliant? At all levels, success hinges on the commitment of those in influential positions to drive the programme forward. If the programme is not fully supported at ACPO level, then the likelihood is, regardless of the best intentions of Heads of Crime and other senior detectives, the programme will falter. There is in some forces, a distinct resistance to change, both in how SIOs are selected, and, in some cases the necessity to re-evaluate the efficiency and effectiveness of their major crime structures, making changes where necessary. In these forces, it is likely that succession planning is weak and capacity and resilience suffers as a result. In the majority of such forces, beneficial changes could be accomplished with minimum disruption or cost that would offer significant benefits almost immediately.

The 'evidence requirement' that sets out the level of investigative expertise SIOs must evidence in order to become 'Registered' is also frequently cited as being an excluding factor, particularly for those forces experiencing low numbers of homicide. It is accepted that this creates a specific problem not experienced by the larger, metropolitan forces, but there is still ample opportunity in all forces to achieve a steady progression of SIOs through to full registration. This can work providing forces have the appropriate support structures in place and the flexibility of deployment to enable those candidates needing to fill evidence 'gaps' to have the opportunity to 'SIO' a homicide (or other major crime) when that opportunity arises. As stated earlier, the work to further support weaker forces is a priority, and the ACPO Homicide Working Group, together with other professionals will ceaselessly endeavour to influence better compliance in specific forces and nationally.

On the other hand, success can take many forms, but converse to the forces blaming the rigidity of the programme, or its failure to cater for their particular circumstances, some forces have taken stock of their current structures, and long-term capacity around their ability to effectively manage major crime. Some of these forces have taken the bold step of embarking on formal collaboration with neighbouring forces. Where forces have amalgamated their major crime functions[3], this has had demonstrable benefits in terms of their approach to, and compliance with the SIODP, but more importantly it has strengthened their capacity and resilience. This is not to suggest that amalgamation is the panacea for all the problems facing some forces, but in the right circumstances it makes good operational and business sense and should at least be formally considered.

[3] Hertfordshire and Bedfordshire and Norfolk and Suffolk.

CPD compliance could also prove to be a risk factor. It is too early to say, but the consequences of a force failing to properly support and measure their SIOs compliance in this respect could be significant. I have, however, found that the vast majority of registered SIOs, having worked hard to achieve registration are keen to maintain it. They will, I am sure, endeavour to comply with the CPD requirement with or without the assistance of their force, though the latter is not an ideal situation, and is another area where work is in progress to address these issues.

8 The Future

An integral part of the original PIP concept was the need to have a level above SIO PIP Level 3, that is, a PIP Level 4 – Senior Investigator. The purpose of this role is to lead critical, complex and protracted Category A investigations. The programme is being designed to ensure those charged with managing an investigation which is, by definition, highly complex, have the necessary skills and knowledge to perform the role. One of the entry level criteria to PIP Level 4 will be registration at PIP Level 3, therefore, individuals will already be competent SIOs. PIP Level 4 will, however, demand much more of those entering this small national cadre. They will have not only the experience and knowledge of investigating multi-faceted complex and high profile cases, but the skills, experience and natural ability to straddle the wider strategic issues, giving sound advice and guidance across the operational and political spectrum. Selection, training and maintenance of competence, given the lower frequency of deployment, will be significant challenges to address. However, with PIP Levels 1, 2 and 3 now fully implemented, the work at PIP Level 4 has progressed steadily and is now well advanced. A small team of dedicated serving and retired senior detectives working under the auspices of the NPIA, along with other professionals, are currently building the structures to select, train and deploy these individuals. Their work is guided and monitored by the ACPO Homicide Working Group, and the programme should begin implementation towards the end of 2010, marking another milestone in the professionalising of investigation.

This article provides an accurate representation of the PIP Level 3 programme at this time, and yes, there is still much work to do. But I do not believe that anyone expected a national programme as significant as this to be flawless within the current timescale. I am, however, reassured by the continuing commitment and dedication of those ultimately responsible for delivering and ensuring the programme's increasing compliance nationally.

The programme has been forged and tempered to make it robust, defensible and fit for purpose for the foreseeable future, and I am sure that compliance with the PIP Level 3 policy will continue to strengthen in all forces, making them better equipped to deal with any eventuality, and will be further supported by the implementation of the Senior Investigator (PIP Level 4) role in the near future.

Operation Coveyville: Double no body murder investigation

Detective Inspector Stephen McCabe
Metropolitan Police Service

Abstract

This article details Operation Coveyville, the investigation into the murders of Ms Xiao Mei Guo, who sold counterfeit DVDs, and Ms Bonnie Barrett, a sex worker. Both women plied their respective trades on the streets of Whitechapel, East London where they came into contact with Derek Brown and were subsequently murdered at his home address. Their bodies have never been recovered and the motive for the killings remains unclear. The lessons learned from this double no body murder investigation are outlined.

The author Detective Inspector (DI) Stephen McCabe was the case officer and latterly the Investigating Officer (IO) for Operation Coveyville. DI McCabe has served with the Metropolitan Police Service (MPS) for twenty-two years. The majority of his police service has been as a detective, working extensively on murder and serious crime investigations. He has a depth of knowledge and experience in all crime areas within the police service.

Contents

All correspondence should be addressed to:
Steve.McCabe@met.pnn.police.uk

1 Background: Relevance of unrelated previous investigation

Prior to the commencement of Operation Coveyville, the Major Incident Team (MIT) investigated an unrelated murder of Xiong Zhang, who was an illegal immigrant from China, earning his living selling counterfeit DVDs (Operation Castle Point). During a robbery of DVDs from Xiong on 19 July 2007 in Barking, East London, he received serious head injuries, from which he died several days later. His wife was immediately concerned that he was missing but was reluctant to report him as such, and he died without his family being aware. This case remains unsolved.

The relevance of Operation Castle Point to Operation Coveyville is that the MIT developed a good working relationship with the Southall Monitoring Group (SMG), who monitor police performance and provide support to victims of crime. The SMG focuses particularly on helping minority communities and those with immigration issues. Xiong's family enlisted the help of the SMG to represent their interests during the enquiry.

A critical issue raised by the SMG during Operation Castle Point was the considerable unreported criminal violence being perpetrated against Chinese DVD sellers. Those who were victims of crimes such as robbery, and their friends or family members also in the UK, were fearful of being deported and therefore crime allegations were not encouraged, or a significant delay in reporting would occur.

During the course of Operation Castle Point, the SMG raised their concerns with the MIT about a missing Chinese female DVD seller named Xiao Mei Guo.

2 Commencement of Operation Coveyville

Xiao Mei Guo had gone missing on the 29 August 2007. Her associates had reported her missing to the police on the 4 September 2007 and this had been graded as a 'medium risk' missing person enquiry. On the 14 September 2007 Xiao Mei's husband, Jin Guo, was released from prison (for counterfeit DVD offences) and contacted the SMG expressing great concern about the disappearance of his wife.

The MIT were contacted by the SMG on the 21 September 2007 advising that Xiao Mei's missing person status should be raised to 'high risk'.

Figure 1 Image of Xiao Mei Guo

Xiao Mei Guo was twenty-nine years of age, and had been married to Jin Guo for over ten years. She was the mother of two young boys who were residing in China. She had travelled illegally to the UK with her husband, assisted by a criminal gang, just over twelve months earlier. Both Xiao Mei and Jin made a living by selling counterfeit DVDs and lived in a local address with a number of other Chinese DVD sellers. Her life was relatively stable, and she had an established routine, always selling DVDs from outside Whitechapel tube station.

From the point of SMG referral on the 21 September 2007, the MIT became involved in an advisory capacity to the local CID, who at this stage were dealing with the matter as a high risk missing person inquiry. Primacy remained with the local CID, however, practical assistance was given in the form of initiating the incident room and ensuring appropriate resources were in place.

2.1 Initial investigation

As a result of MIT involvement the following key lines of enquiry were completed in an attempt to establish how or why Xiao Mei may have disappeared:

- A search of Xiao Mei's home address;
- Detailed analysis of her mobile phone usage;

- Liaison with immigration services, which established that she was not in detention;
- Interrogation of MPS intelligence and the PNC database to establish if she had come to notice;
- Contact with Transport For London for information regarding usage of her Oyster card;
- Speaking with her associates to determine any possible reasons for her disappearance.

These enquiries went far beyond the investigative efforts that had been made by the local CID up to this point.

Over the weekend of 29 and 30 September 2007, advice was sought from an NPIA Behavioural Investigative Adviser (BIA). The purpose was to explore possible risks and the scenarios which may account for Xiao Mei's disappearance either voluntarily or against her will. The report prepared by the NPIA BIA concluded that she was either dead or that she was still alive but being held against her will. The report encompassed a media strategy aimed at reaching out to the possible offender(s). The advice provided by the BIA contributed to the transfer of investigative primacy for the missing person enquiry to the Homicide and Serious Crime Command on 2 October 2007.

2.2 Analysis of Xiao Mei's movements

Analysis of Xiao Mei's mobile phone records showed that her phone had been used in Whitechapel at 10:30 on the day of her disappearance, and then at 10.41 in the Rotherhithe area. During this later call, the last use of her phone, she had stated to an associate that she had travelled three stops on the tube with a customer who wished to try some DVDs.

Enquiries carried out with Transport For London revealed that an unregistered Oyster card had been topped up and used for a matching journey at these times, but no corresponding return trip was made.

Significantly, the recovery of CCTV footage from outside Whitechapel underground tube station showed Xiao Mei in the company of an unknown white male which supported the account provided by her associate that she was with a customer prior to entering the underground station.

3 Identification and arrest of Derek Brown

Identification of the male in the CCTV footage was critical to the enquiry. The images were released to the media but unfortunately they received little coverage and attention.

On the 6 October 2007, as enquiry team officers were revisiting sights of earlier witness appeals in the Rotherhithe area showing the CCTV images, a shop worker identified this unknown white male as currently being in the vicinity. Officers stopped the male and showed him the CCTV images. He identified himself as Derek Brown, whereupon he was arrested, initially on suspicion of abduction.

At the time of his arrest, Brown commented that he knew the area of Whitechapel as he frequently used prostitutes. This comment was noted as odd at the time by the officers who had arrested him.

3.1 Profile of Derek Brown

Derek Brown was forty-six years old and worked night shifts as a van driver. He was separated from his partner who lived in Kent with their three teenage children.

Figure 2 Image of Derek Brown

Socially, Brown was a loner who drank heavily. Research indicated that he regularly used the services of a number of sex workers who worked in the Whitechapel area.

In 1988, an allegation of rape against Brown by a sixteen year old female was not proceeded with. In 1989, he was sentenced to seven years for a rape which involved him forcing entry and subjecting the victim to a two hour assault during which she was raped and buggered. His prior offending history had involved numerous burglaries. Since serving his sentence for rape he had not come to police attention and was not a Registered Sex Offender.

4 Missing Persons or Double Murder?

Following his arrest, Brown admitted little in interview beyond that he was the person in the CCTV images. An initial search of his address, only a short distance from Rotherhithe station was instigated.

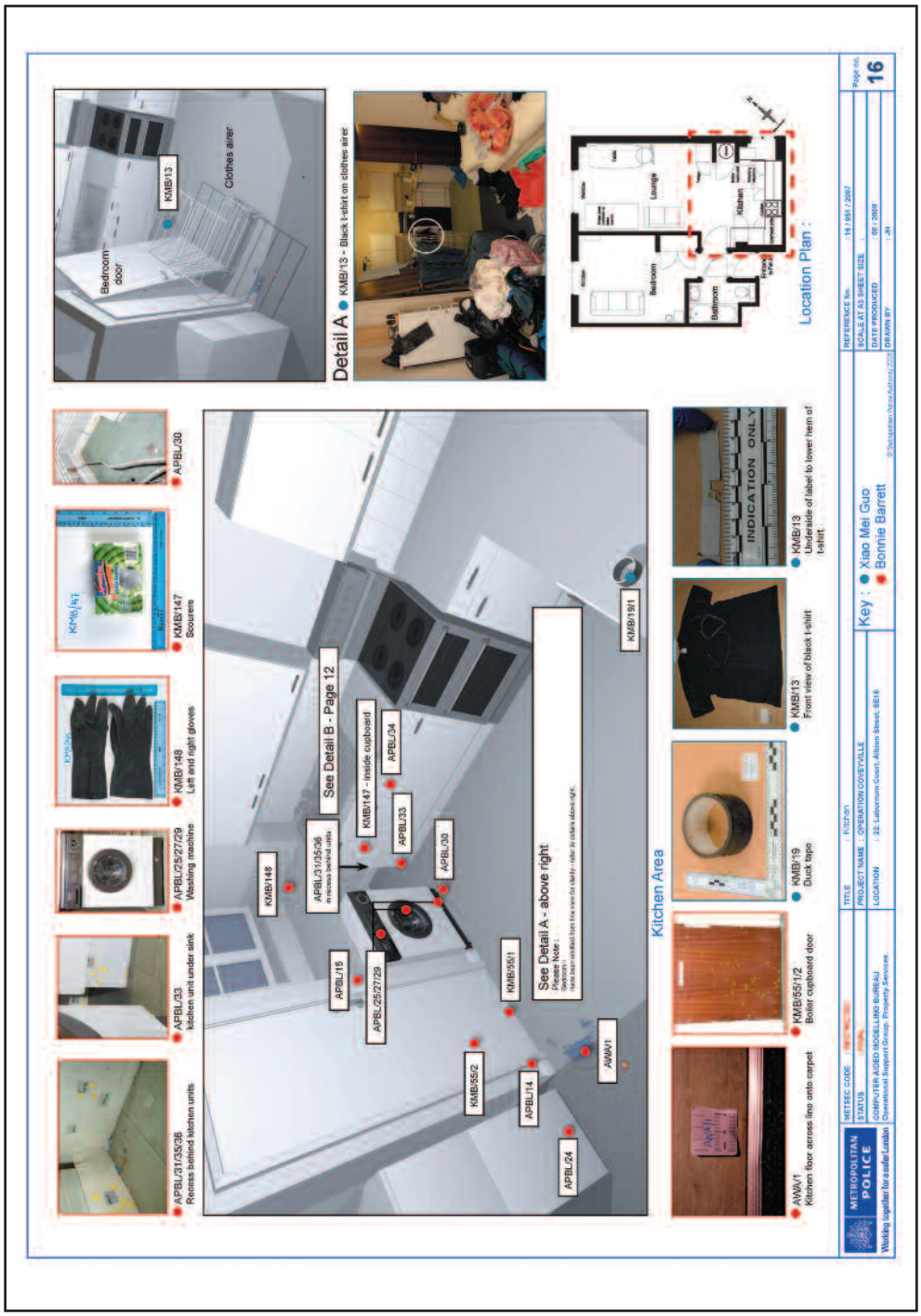
Initially, the investigation team were only looking for one victim, Xiao Mei, and at this stage the focus of the enquiry was to locate her. Brown's flat was initially searched by detectives with a negative result. It was not until a Crime Scene Manager (CSM) arrived on scene later that day, that blood staining was located.

The early forensic strategy aimed to establish whether Xiao Mei had been present within the flat. With significant areas of blood staining found which suggested more than one attack site, combined with evidence that a 'clean up' had taken place; a decision was made to widen the forensic strategy to consider what else may have occurred within the flat.

The scene search involved a detailed examination by CSMs and scientists from the MPS Evidence Recovery Unit (ERU). A number of enhancement techniques were undertaken, such as light sourcing, Luminol, 360 photography and Blood Pattern Analysis (BPA). During this lengthy scene examination, which took approximately three months in total, blood relating to another high-risk missing person, Ms Bonnie Barrett was identified. The BPA and subsequent Luminol examinations showed that Xiao Mei and Bonnie Barrett had not only been in the defendant's flat but had been subject to a brutal and sustained assault and that efforts had been made to cover this up by cleaning the premises.

Blood from both victims was found on numerous surfaces within the flat and at high and low levels on fixtures and fittings (including the ceiling). As neither of the victims had been located, the forensic evidence was vital for establishing what had happened to both females and this evidence would undoubtedly be vigorously cross examined at trial.

Figure 3 Forensic recovery in the kitchen of Brown's premises



4.1 Discovery of second victim

Bonnie Barrett was a twenty-four year old female who lived in Newham and worked on the streets of Whitechapel as a sex worker. She was a known drug user with a somewhat chaotic lifestyle. She had last been seen on 18 September 2007 in the Whitechapel area and had been reported missing on the 24 September 2007.

Figure 4 Image of Bonnie Barrett

She had gone missing before and this time her risk status had risen from 'low' to 'medium' and then 'high' as a result of a report that she had been seen being abducted, which was later found to be purely rumour. Despite her lifestyle, she had regular contact with friends and family, and her failure to access her benefits which had been paid to her on the 28 September 2007 was highly unusual.

As the investigation team's awareness of Bonnie's disappearance developed it was established that although Brown's comments on arrest were thought to be odd at the time, they were actually designed to provide him with a plausible reason for contact with Bonnie. Bonnie was his most recent victim and would appear to have been at the forefront of his mind.

4.2 Linking Brown to Xiao Mei Guo's murder

By the 9 October 2007 there was sufficient circumstantial evidence linking Brown to Xiao Mei on the day of her disappearance. By his own admissions he was with her as they entered the underground station. She alighted at Rotherhithe which is less than two minutes walk from his home address. There was no apparent previous association between them, therefore, suggesting no reasons why her blood would be in his flat.

House-to-house enquiries with neighbours revealed that sounds of a female screaming and whimpering had been heard coming from his flat on the day that Xiao Mei had gone missing. Brown was charged with her murder and after repeated requests he failed to divulge what he had done with her remains.

4.3 Linking Brown to Bonnie Barrett's murder

Whilst CCTV footage had shown a direct connection between Brown and Xiao Mei, no such link existed between him and Bonnie Barrett. Analysis of Brown's mobile phone usage indicated that he had been in the Whitechapel area on the evening of 18 September 2007 at 18:05 and then in the area around his home address by 19:30.

Financial transactions made by Brown on this day were also examined, and led to the recovery of CCTV footage which confirmed that he had indeed been in the Whitechapel area on that evening as late as 17:59.

A number of local sex workers confirmed that they knew him as a client, with several knowing his name and being able to identify his address. Several sex workers indicated that they believed Bonnie had a client called Derek who lived in Rotherhithe.

When collated and analysed as a whole, this intelligence provided a feasible link between Brown and Bonnie Barrett. In December 2007 the CPS agreed to charge Brown with her murder. Although it was a circumstantial case, the fact remained that he was in the area on the day she disappeared, significant traces of her blood had been found in his flat in various different rooms and there was a past association which did lend itself to Bonnie having unwittingly visited his flat.

4.4 Body disposal

In addition to the blood recovered from Brown's premises, a receipt was found showing that he had purchased items including cleaning products, paint, rubble sacks and a bow saw from B&Q. Significantly, Brown lived in a second floor one bedroom flat and therefore, had no apparent need for a bow saw or a significant quantity of heavy duty rubble sacks. These items seem to suggest they formed part of the clean-up and disposal kit.

Despite an extensive search, utilising many specialists, including direction from the NPIA National Search Advisor, the remains of Xiao Mei or Bonnie have not been recovered, nor has any of their property. Brown remains silent as to how he disposed of their bodies. Most notably, the saw, rubble sacks and large rucksack that he possessed have also never been recovered. Brown would cycle to and from work at night carrying a rucksack and it is possible that he dismembered his victims and disposed of them under the cover of darkness.

4.5 Proof of life enquiries

In order to obtain a successful prosecution against Brown, with no bodies found, the court needed to be first satisfied that Xiao Mei Guo and Bonnie Barrett were indeed dead. To prove that they were dead the investigation team first needed to demonstrate that they existed. As obvious as this sounds, evidence was obtained from family, friends and where possible independent sources, that both women had a routine lifestyle. It needed to be proved to the court that both existed and then at a point in time, they ceased to exist. The proof of life work undertaken was essential for illustrating this. However, the work undertaken had to be tailored to suit the circumstances and lifestyle of each of these vulnerable women. Consideration had to be given to their usual routines and the agencies they tended to interact with or come to the attention of.

Proof of life evidence in this investigation had its own 'achilles heel'. The suggestion could be made that these women had left of their own volition to seek a new life under an assumed name. Proof of life enquiries therefore had to focus on tracing their known identities and any aliases they were known to use.

In these particular circumstances, evidence was presented which demonstrated that neither victim had made any plans to disappear. Vital documents, cash and personal belongings which would have made their voluntary disappearance a viable and easier proposition had not been taken. This coupled with the lack of contact with friends and family which was entirely out of character for both women made this suggestion less likely. Obviously, the passage of time up to the trial and the lack of any contact with friends and family merely strengthened the evidence that both were dead.

5 Trial

The trial was heard at the Central Criminal Court in September 2008. Although the weight of forensic and circumstantial evidence against Brown was considerable, he provided no defence statement prior to the trial.

During the trial, among the things that he claimed were that Xiao Mei had been at his flat, but had then been attacked and abducted by Triad gang members and that Bonnie had been brought to his flat by an Australian Hell's Angel, over in the UK to attend the funeral of Gerry Tobin, and had left with him after they had sex.

It was clear that Brown had constructed these defences from disclosure served upon him and his instructing solicitors in the run up to the trial. All these issues had been investigated and eliminated by the investigation team.

The trial culminated in the jury returning after two hours and twenty minutes of deliberation with a unanimous verdict of guilty of both murders. Brown was sentenced to life imprisonment and a recommendation that he serve a minimum of thirty years.

5.1 Witness management

The management of witnesses during the build up to the trial required significant resources and was a key learning point. The key witnesses for Xiao Mei were in the main illegal entrants to the UK who were fearful of attending court or continuing to assist the prosecution. The SMG provided invaluable assistance in maintaining the confidence of these witnesses and ensuring that they attended the trial to give evidence.

The key witnesses for Bonnie were mainly sex workers with alcohol or drug addictions. Their chosen lifestyles posed particular issues around their reliability as witnesses. The investigation team engaged successfully with a number of outreach projects which interact with sex workers on a regular basis offering assistance, advice and shelter. Safe Exit was one such organisation which provided invaluable assistance in keeping the witnesses informed about the trial process and likely court attendance.

A contact sheet was initiated whereby Safe Exit staff would record each and every contact with the witness and the information they had given them regarding their requirement to attend court. This ran in tandem with police warnings.

The use of this contact sheet enabled the investigation team to demonstrate to the trial judge that when a particular witness failed to attend court that sufficient warnings had been given and that a witness summons could be served as soon as practicable. This system was invoked on a number of witnesses throughout the trial.

5.2 Motive

Brown has never revealed his motive for these murders. Research into his offending history revealed that there were two unreported sexual assaults and rape which he was responsible for since his release from prison in July 1994. What was apparent from these attacks and the matters for which he was previously arrested and convicted of, was that Brown's offences were sexually motivated and that he knew his victims, albeit to varying degrees. It is confirmed that he knew Bonnie and the suggestion, judging by Xiao Mei's acceptance of walking off with him, is that he previously knew her. It can only be speculated upon as to whether these killings were sexually motivated, it is more likely than not that they were.

What caused Brown to kill is also mere speculation, however, during the summer of 2007 Brown had failed in an attempt to move to Kent to be nearer to his children. This was a crushing blow to him. His children were the most important people in his life and it appears that he was being ever more distanced from them. After an argument with his ex-common law wife over this issue, Brown had told her: 'You'll hear of me!'

Great play was made of this comment at trial as within a month or two at most, Brown had killed Xiao Mei and Bonnie. The defence suggested that she had misheard Brown and that he had said 'You'll hear from me!' His ex wife was adamant that what she said is what she had heard.

Evidence suggests that Brown, frustrated with his life and the recent crushing disappointment of not being closer to his children sought notoriety as a way of striking back. He acted on his violent sexual urges and hatred of women.

6 Lessons Learned

Once Brown was identified the enquiry reverted to the tried and trusted policing methods of building a murder case. The significant difference was that the investigation focused on dealing with two murders and no bodies. The formula used in most murder enquiries was easily adapted to these most unique circumstances.

A number of lessons learned from this investigation are summarised below:

- Not all murders may be reported – Engagement with those on the periphery of society and representative groups is, therefore, vital for identifying potential murder victims. Considering Xiao Mei in particular, her community and the environment in which she lived, actively discouraged any involvement with society or support services. Her husband and friends took a significant risk in reporting her missing and bringing themselves to the attention of the authorities. The significance of their actions was not recognised initially. If it were not for the intervention of the SMG, vital CCTV evidence identifying Brown would have been lost and Xiao Mei and Bonnie's murders would have most probably remained undetected. Constructive engagement with organisations representing the vulnerable in society is therefore extremely important. Lines of communication developed between Operation Castle Point and the SMG is testament to this ethos.

- There is a need for a thorough initial response to missing person enquiries – Local policing units may lack the skills or resources to fully investigate. For example Xiao Mei Guo's home address had not been searched and the fact that Bonnie Barrett was a sex worker and had gone missing before seemed to influence the lack of progress. Some may comment that hindsight has allowed some of these conclusions to be drawn. However, there can be no substitute for a thorough investigation when presented with an unexplained disappearance. An investigative assessment needs to be made which is not constrained or influenced by assumptions based on stereotypical views of individuals or communities. It is crucial that assumptions are challenged and that there is an awareness of the possibility of homicide and a flexible case-by-case approach to proof of life enquiries.

- 'Offender Timelining' with NPIA assistance, is essential in cases such as this – The risk around unknown criminality by the perpetrator needs to be assessed. Brown was found to be a possible suspect for at least four other rapes.

- Organisational learning opportunities should be taken and good practice developed – The MPS has developed a central policy and guidance for the management of missing person enquiries (Operation Compass).

In the case of missing persons no matter what their lifestyle or vices may be, they all have a pattern to their existence; a routine that when significantly interrupted with no apparent reason needs to be taken most seriously and investigated thoroughly.

NABIS
NATIONAL BALLISTICS INTELLIGENCE SERVICE

UPDATE... UPDATE... UPDATE... UPDATE...

As the first anniversary of the official launch of NABIS approaches, we are constantly reviewing the information which will be of most use to our stakeholders, and how best to ensure that the intelligence available is disseminated and utilised to its full potential both locally and on a national basis.

The NABIS Intelligence Cell has undertaken a Baseline Assessment based upon the ballistic information developed at the three NABIS Forensic Hubs and the valuable intelligence that is on the NABIS database. We are also producing and disseminating meaningful, fast time intelligence products on a daily basis to Senior Investigating Officers, Force Intelligence Bureaus and Regional Intelligence Units.

Although NABIS has only been operational for a comparatively short period of time we are able to provide reliable information on the extent of gun crime in a manner that has never previously been available. By letting forces know the number of firearms that are currently actively being used by criminals in their force area we have provided intelligence that has allowed a focus to develop on 'the gun' rather than 'the criminal' which has resulted in significant recoveries of outstanding weapons.

The really exciting thing about NABIS is that as time moves on and the detail available on the database grows it will become increasingly more effective in allowing us to understand the true pattern behind firearm crime. It will allow us to identify armourers, tackle the supply chains and co-ordinate activity to reduce the number of firearms in circulation.

All of this, however, carries one important caveat; NABIS will only ever succeed if all police forces and law enforcement agencies take every opportunity to submit every single item of recovered ballistic material that fits the NABIS submission criteria to their local NABIS Hub, and ensures that the associated intelligence is entered on the database. It must be emphasised that the data the Intelligence Cell is producing and disseminating only relates to ballistic items that are submitted onto the NABIS database for NABIS forensic examination by the Hubs.

It is also important to ensure that where there is the potential to act upon intelligence, whether within a force, on a cross-border basis or nationally that the opportunity to do so is seized appropriately. NABIS will help to co-ordinate such activity but has no independent operational capability and the way that NABIS intelligence is managed and acted upon is vital to any effort to tackle gun crime.

At the moment there is considerable disparity between forces in relation to how effective they are at fully utilising NABIS and we ask you to consider if your force can improve in this respect and take positive action where necessary.

The Baseline Assessment has identified that there have been 389 links identified of which 335 are within forces and 44 between forces.

The Metropolitan Police has the highest number of identified links within force at 131, Greater Manchester Police and the West Midlands Police each have 63 and Merseyside Police have 60.

West Midlands Police has the highest incidence of firearms usage moving between forces with 18 incidents identified, followed by the Metropolitan Police (12), Greater Manchester Police (11) and Merseyside Police (10).

Included within the Baseline Assessment the Intelligence Cell has produced a summary of 'inferred weapons' identified from the Hub Linked reports.

Inferred weapons are created on the NABIS database to illustrate the presence of a firearm which has been identified from recovered ballistic material (projectiles and cartridge cases) but where the firearm is yet to be recovered.

For operational reasons we cannot disclose within this update the precise number of inferred firearms on the NABIS database which have been used in firearms incidents in England and Wales. However, a significant number of the inferred weapons discovered since NABIS went live have since been recovered. Those that remain outstanding are the focal point for pro-active investigative work.

The Metropolitan Police has the most number of inferred firearms used in criminality with West Midlands Police displaying the next highest recorded number.

The data in relation to inferred weapons has been analysed to provide a summary of firearm types used in criminality within forces and has been disseminated to each force in question.

NABIS Link reports show that there are wide differences between police forces in the types of firearms that they encounter being used in crime. For example, West Midlands Police and the Metropolitan Police experience a higher level usage of converted weapons, with a propensity towards converted Baikal pistols. Merseyside appear to have a dominance of original lethal purpose firearms ('real' as

opposed to converted or otherwise modified) used in criminality.

Of the inferred weapons identified that have been used in criminality in England and Wales the most popular is the Russian Baikal blank and irritant cartridge firing pistol which has been converted to discharge 9mm Short/.380 Auto bulleted pistol cartridges.

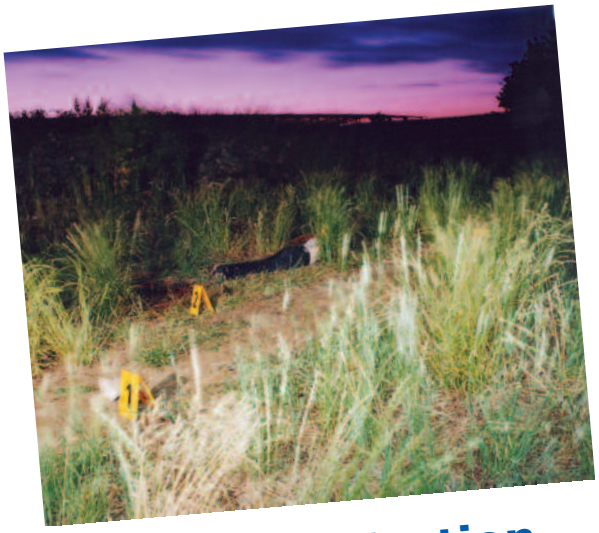
Converted Baikal pistols have been identified in the past as being produced in Lithuania, an operation subsequently closed down by the Lithuanian authorities a number of years ago. Recoveries of Baikals from this original conversion 'factory' continue to be made by police forces.

The Intelligence Cell data relating to Firearms Links within and between forces along with the Inferred Weapons Summary has been disseminated to the relevant Force Intelligence Bureaus.

Feedback already received has indicated that the data is well received and proving extremely useful.

The NABIS team can be contacted on
0845 113 5000 ext **7630 6204**
For further details see **www.nabis.police.uk**

NPIA
National Policing Improvement Agency



Body Identification

March 2009

Briefing Guide to Assist in Body Identification

Version 1.0

delivery

To obtain your copy, please contact:

The Specialist Operations Centre

0845 0005463

soc@npia.pnn.police.uk www.npia.police.uk/soc

OR

The Missing Persons Bureau

01256 602979

missingpersonsbureau@npia.pnn.police.uk

www.npia.police.uk/mpb

Risk Factors for Intra-familial Unlawful and Suspicious Child Deaths: A retrospective study of cases in London

Jenny Mayes, Alison Brown, Detective Chief Inspector Dave Marshall
Specialist Crime Directorate Child Abuse Investigation Command (SCD5) Metropolitan Police Service

Dr Martin A Weber, Professor Anthony Risdon, Professor Neil J Sebire
Department of Paediatric Histopathology, Great Ormond Street Hospital for Children and Institute of Child Health, London

Abstract

The prevention and detection of crime, the two main principles underlying all areas of safeguarding children, are brought together in this paper written by authors from multiple disciplines who have considerable experience of child homicide and suspicious deaths from their respective perspectives.

The paper details a retrospective review of 282 consecutive child deaths investigated by the Metropolitan Police Service (MPS) including suspicious (criminal activity-related deaths, including homicides) and non-suspicious child deaths to identify social, demographic and autopsy features significantly associated with suspicious or unnatural deaths.

The identification of risk factors in relation to child deaths can inform prevention initiatives to reduce the incidence of unlawful child deaths and the assessment of factors will initiate a more detailed investigation of the circumstances of a death to eliminate or confirm the possibility of any criminal offences linked to the sudden and unexpected death of a child.

The authors have endeavoured to advance what is sometimes referred to as the 'detective's gut instinct' based on their assimilation of psychological factors and anecdotal information by providing a research based list of factors, that whilst not exclusive to unlawful deaths, if present, may justify a more comprehensive examination of the circumstances surrounding a death.

This is entirely in keeping with Baroness Kennedy's statement that:

> Every child who dies deserves the right to have their sudden and unexplained death fully investigated in order that a cause of death can be identified, and homicide excluded.
>
> (*Kennedy, H,* 2004)

This paper assists by providing a research-based approach to guide the processes in both the prevention and detection of such offences.

The findings report 54 suspicious and 228 non-suspicious deaths, aged 0-192 months at death, had social and demographic features significantly associated with suspicious versus non-suspicious deaths, such as family history of previous violence to children, mental health issues, alcohol and drug abuse, and history of domestic abuse. Almost half (43 per cent) of the suspicious deaths involved children previously known to social services, and the family had previously come to police notice for domestic abuse in almost a quarter of cases (22 per cent). The accounts provided by parents or carers were more likely to be inconsistent and at autopsy, features of head injury, fractures, bruising, or a post-mortem interval longer than stated, were more common.

The importance of social risk factors for unnatural intra-familial child deaths cannot be overestimated. Future attempts to reduce these deaths should focus on the high-risk social groups identified from this research.

Jenny Mayes MSc is currently employed as an analyst within the Specialist Crime Directorate Homicide Command, Metropolitan Police Service (MPS). At the time of this research paper Jenny worked within the Child Abuse Investigation Command and was responsible for the analysis of intra-familial child homicides and suspicious deaths on which much of the research outlined in this paper is based. Prior to joining the MPS in 2001, she worked at a Liverpool University Psychology Department, the Office of National Statistics, the Health and Safety Executive and the NHS. She has a BA in Psychology/Sociology and an MSc in Applied Psychology.

Alison Brown BSc is currently an adviser on analysis to Abu Dhabi Police Force. At the time of this research paper she was the Strategic Higher Analyst responsible for the management of analysis within the specialist area of the Child Abuse Investigation

Command for the MPS. She has a degree in Applied Psychology and nine years experience in intelligence analysis within law enforcement.

Detective Chief Inspector (DCI) Dave Marshall MSc is a career detective with nearly thirty years police service. He currently manages the MPS, Specialist Crime Directorate, Child Abuse Investigation Command's Major Investigation Team, responsible for the investigation of all intra-familial child homicides and complex child abuse in London. In this role he has experience of over fifty child homicides and suspicious deaths over the last five years. He has an MSc in Forensic and Legal Psychology from the University of Leicester.

Dr Martin Weber is a Consultant Paediatric Pathologist at Great Ormond Street Hospital, London. He undertook his MD Thesis studying Post-mortem Examination of Sudden Unexpected Death in Infancy (SUDI) and has published several peer-reviewed papers in this field.

Professor Anthony Risdon is Emeritus Professor of Paediatric Pathology at Great Ormond Street Hospital, London. He is currently the only Home Office accredited fully trained Forensic Paediatric Pathologist in the UK. He has extensive experience in the post-mortem examination of natural and unnatural infant deaths and is a highly regarded expert in this area.

Professor Neil Sebire is currently Professor of Paediatric Pathology at Great Ormond Street Hospital, London. He has a research interest in understanding the causes of infant deaths and runs a research programme in this area. He has published over 350 scientific papers in scientific peer-reviewed journals.

Contents

All correspondence should be addressed to:
Professor Neil Sebire – sebirn@gosh.nhs.uk
Detective Chief Inspector Dave Marshall – Dave.Marshall@met.pnn.police.uk

1 Introduction

In the UK, sudden and unexpected child deaths are investigated on behalf of Her Majesty's Coroner (HMC) and, more recently, in London such deaths are also routinely investigated by the MPS. On the basis of the circumstances of death, clinical features and pathological findings, cases are broadly classified as suspicious or non-suspicious, according to whether the death is likely to be offence-related and may therefore result in criminal proceedings. Such deaths are, however, relatively uncommon in a given geographical area and there is limited published information available regarding specific details associated with suspicious, compared to natural, non-suspicious child deaths in the same well-defined population.

This paper reports the findings of an analysis of 282 consecutive cases from the London metropolitan area which have all been investigated by the MPS and had specialist post-mortem examinations performed according to a standard protocol. The aim of the study was to determine whether certain features are disproportionately associated with unnatural suspicious deaths. The findings are of potential benefit to the Police Service, paediatricians, pathologists and others involved in child protection work.

2 Methods

A retrospective review of two datasets derived from routine information collected by the MPS was conducted. First, data regarding deaths investigated as part of the MPS Specialist Crime Directorate Child Abuse Investigation Command (SCD5) intelligence and analysis of intra-familial suspicious deaths was collated (SUSP). The data used deaths that occurred between September 2002 and August 2007, covering all thirty-two London boroughs. For the purposes of this study, suspicious child deaths included those deemed probable unlawful killings (murder, manslaughter, infanticide and familial homicide), and those in which the final cause of death could not definitely be attributed to a specific criminal act but where there were aggravating criminal factors that either contributed to the death or represented a criminal offence in their own right. In all suspicious cases, further action was taken following the completion of the post-mortem examination, either criminal proceedings or involvement of other services. This dataset does not include children who died as a result of peer-on-peer murders, stranger murders, suicides or road traffic collisions, which are not within the SCD5 remit. Cases where there was an initial suggestion of possible suspicious death resulting in referral to the police, but where further investigation showed no grounds to suspect criminal wrongdoing, were excluded from the analysis.

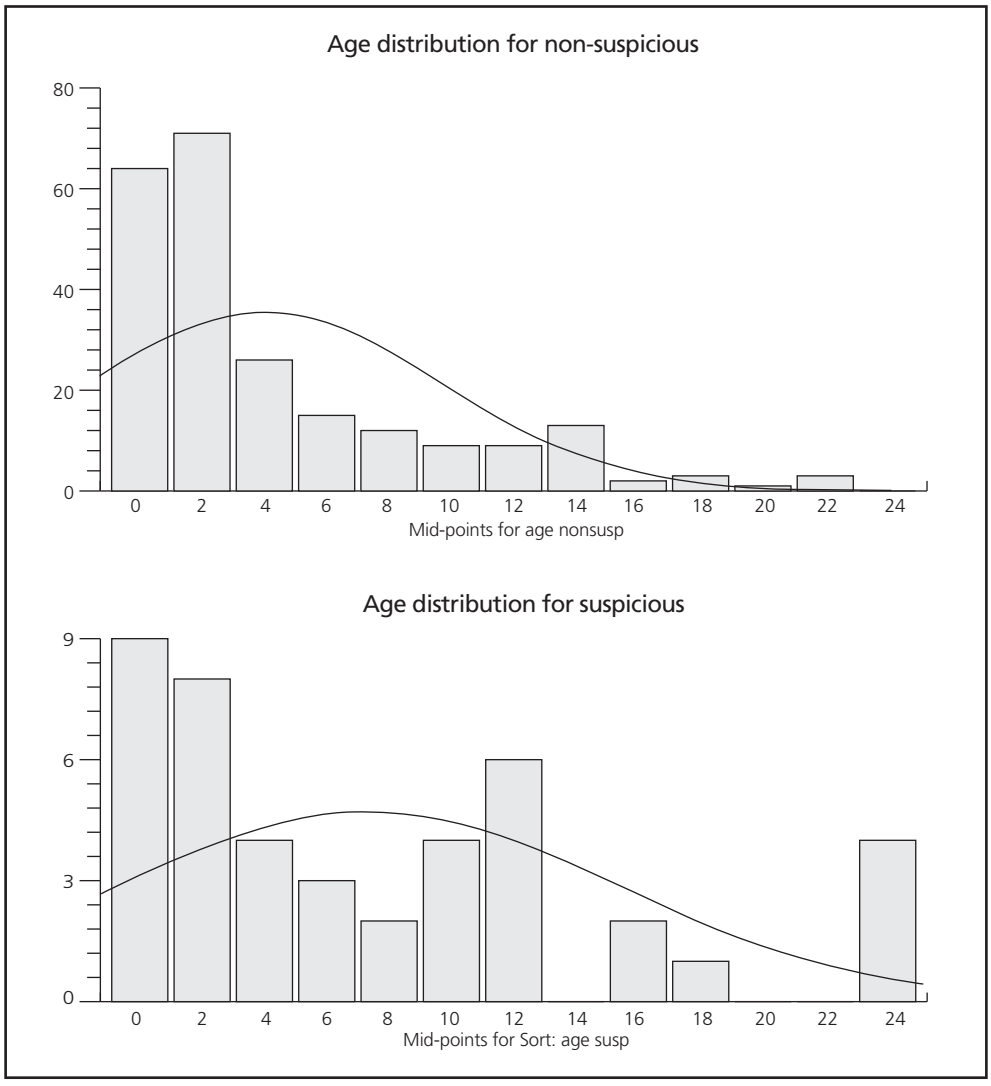
The second dataset consists of non-suspicious deaths of children under two years of age, investigated routinely as part of the MPS protocol 'Project Indigo' via form 90 (NONSUSP) covering the years 2005 to 2007; 2005 marked the inception of the wide introduction of this protocol. The non-suspicious deaths were also subdivided into those where a probable medical cause of death could be identified at post-mortem examination (medically explained) and the remainder where no definite identifiable cause of death could be determined but in which there were no features of unlawful death or other injury (unexplained). The majority of these deaths represent sudden unexpected infant deaths (SUDIs) or 'cot-deaths'.

Data was extracted after the cases were rendered non-identifiable by the MPS by removing personal data such as names, addresses and dates of birth. The use of the data for analysis and publication was approved by the MPS. The authors, external and internal, had full access to all of the data in the study (including statistical reports and tables) and take responsibility for the integrity of the data and the accuracy of the data analysis. The statistical significance of differences in the frequencies of findings between groups was examined using comparison of proportions and Mann-Whitney U tests, and odds ratios were calculated as appropriate.

3 Results

There were 54 suspicious deaths and 228 non-suspicious deaths during the study period. The overall age distribution of deaths was 0-192 (median 4) months. The age distributions of the deaths in each group are shown in Figure 1.

Figure 1 Age distributions of non-suspicious and suspicious child deaths for cases less than 24 months of age



The suspicious deaths included some children older than two years (median 10; range 0-192 months). However, further analysis was only conducted on cases involving children less than two years old so that direct comparisons could be made between the suspicious and non-suspicious group. The findings revealed that the suspicious death group were significantly older than the non-suspicious group (median 5.5; range 0-24 months) and (median 3; range 0-23 months) respectively (Z=2.2, P=0.03).

Of the 228 non-suspicious deaths of children under the age of two years, 113 (50 per cent) were categorised as 'medically explained', based on the finding of an acceptable probable medical cause of death at autopsy, the remainder being unexplained but without any features to suggest criminal activity or unnatural death. The causes of death for the 54 suspicious deaths are shown in Table 1.

Table 1 Categories of causes of suspicious child deaths

Suspicious deaths with aggravating factors	**Number**
Unascertained	11
Asthma	2
Probable stillbirth, not otherwise specified (NOS)	2
Prematurity and dehydration	1
Peri-natal hypoxia	1
Liver and kidney failure	1
Cervical fracture	1
Total	**19**
Homicides	
Head injury – Rotation Acceleration Deceleration Impact Injuries (RADI).	10
Head injury – other	8
Asphyxia	5
Abdominal injuries	3
Drug overdose	1
Spinal injury	1
Burns	1
Crush injury	1
Dehydration	1
Exposure	1
Limb injury	1
Other wounds	2
Total	**35**

In the suspicious category, death was categorised as 'unascertained' in eleven cases. There were features or circumstances indicating criminal-related activity associated with the death, but homicide or other direct cause of death could not be determined. These included two cases where the bodies of the victims were concealed for long periods of time in the suspect's house, which caused difficulty in establishing a definite cause of death at autopsy. In the remainder there were apparently inflicted injuries present that could not be demonstrated to have directly caused the death. This is analogous to the term 'unclassified' that *Krous et al* (2004) have used for sudden infant deaths that do not meet the criteria for a diagnosis of Sudden Infant Death Syndrome (SIDS) and for which an unnatural cause was possible.

Thirty-five cases were classified as homicides. Head injury was the most common mechanism of death, accounting for 18 cases (54 per cent). Over half of these (10/18; 55 per cent) had features of rotation, acceleration, deceleration impact injuries (RADI) (eg, shaking/impact injuries), with the presence of the pathological triad of subdural haemorrhages, brain swelling and retinal haemorrhage (*Harding et al,* 2004; *Leestma,* 2005; *Aryan et al,* 2005). Of the ten cases with RADI injuries, the median age was 6 months (range 1-16 months) and the majority (N=8; 80 per cent) were initially admitted to hospital alive. The history provided by the parents or carers was that the infant had either fallen, had a seizure or started spontaneously choking, before collapsing. Four of the deaths in this group also had other injuries including fractures of ribs, skull or long bones, and soft tissue bruising. The other fatal inflicted head injuries were caused by vehicle-associated trauma, being thrown from a height and assault with a weapon. In two of the cases, there were additional injuries present which would probably have been fatal had the victim not died from the head injury. Other causes of unnatural death included mechanical asphyxiation, including airway occlusion with plastic material, and multiple injuries due to physical assault, including abdominal trauma with mesenteric, duodenal and hepatic lacerations.

3.1 Social factors associated with suspicious and non-suspicious child deaths

Social factors associated with suspicious versus non-suspicious deaths are shown in Table 2 and Figure 2.

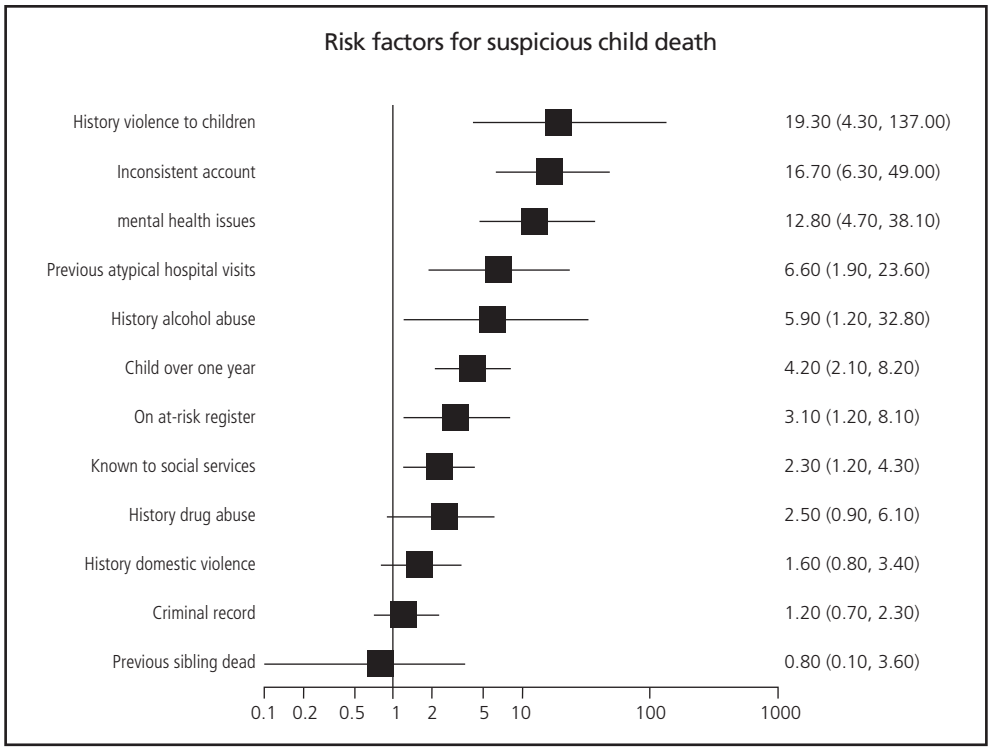
Table 2 Social risk factors for suspicious and non-suspicious child deaths

Risk factor	Medically Explained (N;%)	All non-suspicious (N;%) 228	All suspicious (N;%) 54	Statistics (OR, P) Suspicious versus non-suspicious
History of violence to children	1; 1%	2; 1%	8; 15%	19.3; P<0.0001*
Inconsistent accounts	2; 2%	6; 3%	17; 31%	16.7; P<0.0001*
Carer has known mental health issues	3; 3%	6; 3%	14; 26%	12.8; P<0.0001*
Prior atypical hospital visits	3; 3%	5; 2%	7; 13%	6.6; P<0.01*
History of alcohol abuse	1; 1%	3; 1%	4; 7%	5.9; P=0.03*
Over one year of age	22; 19%	30; 13%	21; 39%	4.2; P<0.001*
On child protection at-risk register[1]	5; 4%	12; 5%	8; 15%	3.1; P=0.03*
Known to social services[2]	18; 16%	55; 24%	23; 43%	2.3; P<0.01*
History of drug abuse	4; 3%	15; 7%	8; 15%	2.5; P=0.07
History of domestic abuse	16; 14%	34; 15%	12; 22%	1.6; P=0.21
Carer has criminal record	30; 26%	74; 32%	20; 37%	1.2; P=0.52
Previous sibling died	5; 4%	10; 4%	2; 4%	0.84; P=0.89

[1] For the purposes of this study, this includes cases in which the victim or another sibling is on, or was previously on, the child protection at-risk register.

[2] For the purposes of this study, known to social services includes cases currently or previously recorded as being referred to social services.

Figure 2 Social risk factors for suspicious versus non-suspicious paediatric deaths (Odds ratios with 95 per cent CI: Forest plot)



Overall, almost half (23/54; 43 per cent) of suspicious deaths involved children who were known to social services, 15 per cent were on the child protection at-risk register, and two (4 per cent) of the suspicious deaths had siblings who had also died unexpectedly. The child's family had previously come to police notice for domestic abuse in almost a quarter of cases (12/54; 22 per cent) including violence between parents or carers. In one case, the victim's mother was stabbed to death and the infant subsequently died of neglect and in another case, both mother and child were beaten.

In 26 per cent of cases (14/54) the parents or carers were recorded as having previous mental health issues, including one male suffering from depression, who killed the child in his care and then went on to commit suicide and one female suffering from post-natal depression who threw the infant in her care from a window. In seven cases, parents or carers attempted to commit suicide after the death of the child in their care was discovered, five of these directly after the murder at the crime scene; two of these individuals died.

3.2 Autopsy features in suspicious and non-suspicious child deaths

Features identified at autopsy in suspicious versus non-suspicious child deaths are shown in Table 3 and Figure 3.

Table 3 Findings at autopsy in suspicious and non-suspicious child deaths

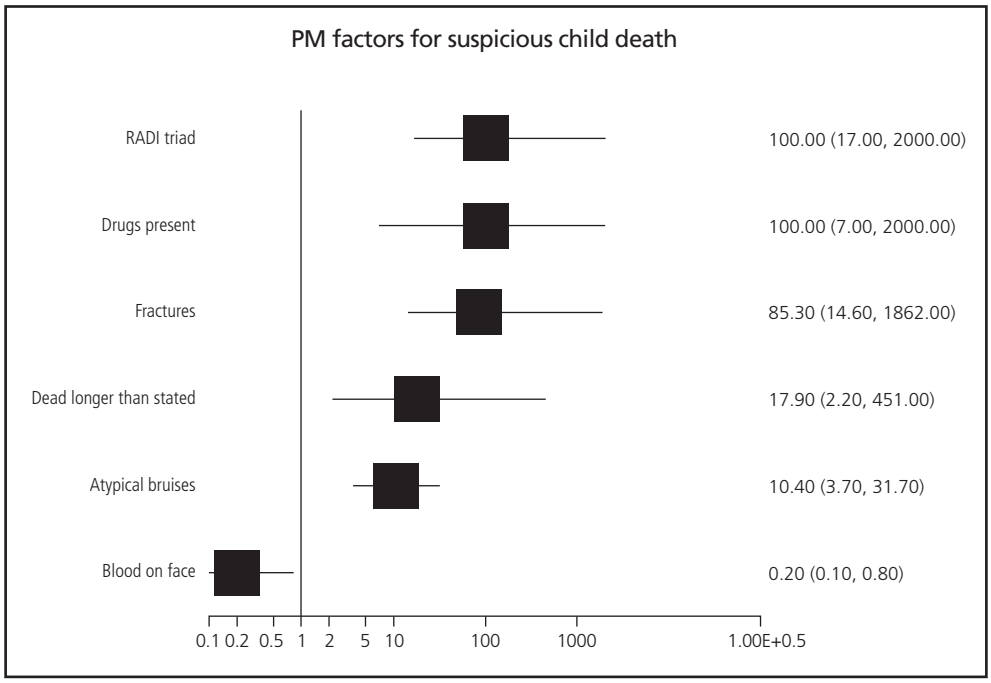
Risk factor	Medically Explained (N;%)	All non-suspicious (N;%) 228	All suspicious (N;%) 54	Statistics (OR, P) Suspicious versus non-suspicious
RADI triad	0; 0%	0; 0%	13; 24%	>100; P<0.0001
Drugs identified	0; 0%	0; 0%	6; 11%	>100; P<0.0001
Fractures	1; 1%	1; 0%	15; 28%	89.8; P<0.0001
Dead longer than stated	1; 1%	1; 0%	4; 7%	17.9; P<0.01
Atypical bruises	4; 3%	6; 3%	12; 22%	10.6; P<0.0001
Blood on face	6; 5%	33; 14%	2; 4%	0.2; P=0.02

The following features were found to be significantly associated with suspicious deaths:

- Presence of features of the RADI triad;
- Toxicological detection of drugs of abuse;
- Presence of fractures;
- Bruising at unusual sites (eg, torso);
- Post-mortem features indicating that the interval since death was significantly longer than stated by parents or carers.

Conversely, the presence of blood on the face was strongly associated with non-suspicious deaths.

Figure 3 Post-mortem examination risk factors for suspicious versus non-suspicious paediatric deaths (Odds ratios with 95 per cent CI: Forest plot)



4 Discussion

The findings of this study demonstrate that there are specific demographic and post-mortem features which are significantly associated with suspicious compared to non-suspicious child deaths. In particular, suspicious child deaths were often associated with significant social issues for parents or carers, such as previous history of violence to children, mental health issues, alcohol and or drug abuse, or domestic abuse. In many cases, these factors were known prior to the death, with two to three times the number of children already being known to social services or on the at-risk register in the suspicious death group.

The association of social factors and suspicious child deaths has been previously reported (*Christoffel et al,* 1983; *Hargrave and Warner,* 1992; *Vanamo et al,* 2001; *Romain et al,* 2003). However, the continuing excess of deaths in those known to be at-risk, raises concerns about the efficacy of social service intervention in this setting. In addition, certain features identifiable at autopsy were also highly associated with suspicious child deaths, such as presence of the RADI triad, identification of drugs of abuse, fractures, bruising at unusual sites and indications of a significantly longer interval since death than stated.

The rate of child homicide varies somewhat geographically, for example 1 in 100,000 children in Sweden and 3 per 100,000 in the USA, (*Somander and Rammer,* 1991; *Collins and Nichols,* 1999) with the vast majority being younger children (under the age of two years); most of these deaths reflect intra-familial violence by a parent, hence the rationale for the datasets used in the present study (*Blaser,* 1985; *Muscat,* 1988; *Somander and Rammer,* 1991; *Collins and Nichols,* 1999; *Merrick and Morad,* 2002; *Lyman et al,* 2003). The majority of these infant homicides occur in the home, the perpetrator most commonly being the father or step-father (*Fornes et al,* 1995; *Bennett et al,* 2006). It has been suggested that up to 10 per cent of child deaths may be suspicious (*Collins and Nichols,* 1999). In one study of all 361 paediatric deaths in a geographic region, about two thirds were due to trauma, 15 per cent due to SIDS and 10 per cent were suspicious (*Bowen and Marshall,* 1998). In another study of 360 deaths of children admitted to a Paediatric Intensive Care Unit (PICU), 45 (13 per cent) died of unnatural causes, of which about one fifth were due to deliberate injury (*Van Zaane et al,* 2004).

The cause of such unnatural deaths varies with the child's age. In infants, deaths are usually due to trauma, especially RADI type injuries, in toddlers and pre-school children, arson and beatings are more common and gunshot wounds and road traffic injuries become more common in later school years (*Christoffel et al,* 1983; *Hargrave and Warner,* 1992; *Vanamo et al,* 2001; *Romain et al,* 2003). Of the homicides in the present study, head injury was the most common mechanism of injury. This is consistent with previous data, suggesting that about half of paediatric homicides are due to head trauma, with around 25 per cent showing RADI type injuries (*Collins and Nichols,* 1999).

Adverse social circumstances are associated with all child deaths, not just suspicious deaths, including those due to natural causes and SIDS, indicating that many factors may act synergistically (*Fleming et al,* 2000). For example, suboptimal parental care or neglect may be complicated by superimposed infection, with the effects compounded by an unsafe sleeping environment. However, the association between social and demographic factors and suspicious child deaths has been particularly emphasised in several papers. Studies analysing routine mortality data including intentional and accidental paediatric deaths, demonstrate that suspicious deaths are more common in infants of young, single mothers with limited education and no prenatal care (*Winpisinger et al,* 1991; *Overpeck et al,* 1999; *Dolan et al,* 2003). In a study of cases of fatal child abuse in the USA, affected families were more likely divorced, separated, or single and fatal incidents were more frequent at the weekend and in the home, with the fatal event often being initiated by some other family disturbance (*Lucas et al,* 2002).

The data from the present study indicate that an inconsistent history of events provided by parents or carers is significantly more frequent in the suspicious death group and should therefore be regarded as one of the most important indicators of possible suspicious death. However, as with all the possible indicators they must be regarded as an indication or factor that merits further investigation. People react in different ways to death and may behave 'suspiciously' but after questioning, their rationale may provide an explanation which removes the suspicion and can negate an arrest (*Wate and Marshall,* 2009). This association is also consistent with data from a previous UK review of 81 children judged by the courts to have been killed by their parents, reporting that most of the children apparently died in the afternoon or evening, as opposed to during the night in most non-suspicious cases. Almost three quarters had previously presented with unexplained illnesses, including more than half who had been admitted to hospital within the previous month (*Meadow,* 1999).

In addition, it has been previously reported that the interval between injury and the onset of symptoms in suspicious deaths remains unknown in most cases due to inconsistencies in the history and lack of credibility of the parent or carer. The most common initial history provided in such suspicious cases is that the child had 'a fall' (*Collins and Nichols,* 1999). In many of the suspicious cases in the present study, it would have been obvious from the outset when the paramedics or police arrived at the scene or found the body, that a possible homicide had been committed. However, the cause of many of the deaths would have been less apparent and professionals may have initially been unsure whether some deaths were deliberate, accidental or as a result of natural causes. These would have been considered sufficiently suspicious to warrant further investigation.

This classification of deaths, as suspicious versus non-suspicious, is necessarily rather arbitrary, since it is based on death investigation by the Police Service to decide whether or not the death was likely to be related to a criminal act. The suspicious group will therefore include both definite cases, in which the perpetrators confessed to the act, and others in which the presumed perpetrators were either not identified or not prosecuted. This is a methodological issue common to all studies reporting suspicious child deaths. However, since the aim of this study was to identify features surrounding paediatric deaths that should precipitate further police investigation, rather than to provide definitive indicators of homicide, this distinction is less relevant. Nevertheless, since the methodology of this study has allowed the calculation of odds ratios for specific features in the same population and geographical area investigated by the same investigation teams, it will be apparent that some features of both the circumstances of death and the autopsy findings are so strongly associated with suspicious death, they should automatically raise the possibility of unnatural death in the future.

The importance of parent or carer psychiatric illness increasing the risk of suspicious deaths has been highlighted by this study, with an odds ratio of more than ten when a parent or carer had a known psychiatric history. Previous research has also indicated a similar increased risk with parental psychiatric disorder, such a history being present in around one quarter to one third of all child homicides (*Dolan et al,* 2003; *Webb et al,* 2007; *Liem and Koenraadt,* 2008).

Furthermore, in many previously reported cases, fathers killed their children in reaction to acute family stresses including threatened separation or divorce (*Liem and Koenraadt,* 2008). Similarly, a history of previous violence to children was the single greatest risk factor for suspicious deaths in this study, being present in around 15 per cent of cases and associated with a twenty-fold increase in risk. In a previous report of 64 child homicides, more than half of the perpetrators had a criminal record and previous violence to children was noted in about a third of these (*Dolan et al,* 2003).

The issue of previous child death as a risk factor for subsequent suspicious paediatric death has caused controversy in recent years (*Carpenter et al,* 2005). In the present study, a history of previous sibling death was no more common in the suspicious than the non-suspicious groups. This is consistent with a previous report of 46 second intra-familial child deaths, in which the majority was thought to be due to natural causes, with about 15 per cent of repeat deaths due to suspicious causes (*Carpenter et al,* 2005). Although insufficient data is available, in the opinion of the authors, it is likely, that a previous child death is relevant if there is parent or carer psychiatric history or history of violence to children, but not if such deaths were due to non-suspicious circumstances.

5 Conclusion

In summary, this study has demonstrated that suspicious compared with non-suspicious child deaths, are significantly associated with parent or carer history of previous violence to children, psychiatric illness, previous atypical hospital admissions, alcohol abuse and the child being known to social services or on the at-risk register. The accounts provided by parents or carers are more likely to be inconsistent and at autopsy there may be features of head injury, fractures, bruising, or evidence of a longer post-mortem interval than stated. This study has calculated the odds ratios for such risk factors and provides further evidence for the development of protocols for the Police Service and health care professionals for triaging such child deaths. The importance of social risk factors cannot be overestimated, and future attempts to prevent unnatural child deaths should focus on the high risk groups identified in this study.

References

Aryan, H.E., Ghosheh, F.R., Jandial, R. and Levy M.L. (2005) Retinal hemorrhage and pediatric brain injury: etiology and review of the literature. *Journal of Clinical Neuroscience,* 12, 624-31. San Diego, USA: University of California.

Bennett, M.D., Hall, J., Frazier, L., Patel, N., Barker, L. and Shaw, K. (2006) Homicide of children aged 0-4 years, 2003-04: results from the National Violent Death Reporting System. *Injury Prevention,* 12, 39-43. UK: BMJ Publishing Group.

Blaser, M.J. (1985) Epidemiologic characteristics of child homicides in Atlanta, 1970-1980. *Pediatrician,* 12, 63-67. USA.

Bowen, K.A. and Marshall, W.N. (1998) Pediatric death certification. *Archives of Pediatric and Adolescent Medicine,* 152, 852-54. Tuscon, USA: University of Arizona College of Medicine and Steele Memorial Children's Research Center.

Carpenter, R.G., Waite, A., Coombs, R.C., Daman-Willems, C., McKenzie, A., Huber, J. and Emery, J.L. (2005) Repeat sudden unexpected and unexplained infant deaths: natural or unnatural? *Lancet,* 365, 29-35. London: London School of Hygiene and Tropical Medicine.

Christoffel, K.K., Anzinger, N.K. and Amari, M. (1983) Homicide in childhood: Distinguishable patterns of risk related to developmental levels of victims. *American Journal of Forensic Medicine and Pathology,* 4, 129-37. USA.

Collins, K.A. and Nichols, C.A. (1999) A Decade of Pediatric Homicide: A Retrospective Study at the Medical University of South Carolina. *American Journal of Forensic Medicine and Pathology,* 20, 169-72. USA.

Dolan, M., Guly, O., Woods, P. and Fullam, R. (2003) Child homicide. *Medicine, Science and the Law,* 43, 153-69.

Fleming, P., Blair, P., Bacon, C. and Berry J. (2000) *Sudden Unexpected Deaths in Infancy. The Confidential Enquiry into Stillbirths and Deaths in Infancy, Sudden Unexpected Death in Infancy Studies 1993-1996.* TSO, London.

Fornes, P., Druilhe, L. and Lecomte, D. (1995) Childhood homicide in Paris, 1990-1993: a report of 81 cases. *Journal of Forensic Science,* 40, 201-204. Paris, France: Department of Forensic Sciences, University of Paris.

Harding, B., Risdon, R.A. and Krous, H.F. (2004) Shaken baby syndrome. *British Medical Journal,* 328, 720-21. London: BMJ.

Hargrave, D.R. and Warner, D.P. (1992) A study of child homicide over two decades. *Medicine, Science and the Law,* 32, 247-50. Leeds: Department of Forensic Medicine, St James's University Hospital.

Kennedy, H. (2004) *Sudden Unexpected Death in Infancy: A multi-agency protocol for care and investigation.* London: Royal College of Pathologists, Royal College of Paediatrics and Child Health.

Krous, H.F., Beckwith, J.B., Byard, R.W., Rognum, T.O., Bajanowski, T., Corey, T., Cutz, E., Hanzlick. R., Keens, T.G. and Mitchell. E.A. (2004) Sudden Infant Death Syndrome and Unclassified Sudden Infant Deaths: A Definitional and Diagnostic Approach. *Pediatrics* 114, 234-38. USA.

Leestma, J.E. (2005) Case Analysis of Brain-Injured Admittedly Shaken Infants: 54 Cases, 1969-2001. *The American Journal of Forensic Medicine and Pathology.* 26, 199-212. USA.

Liem, M. and Koenraadt, F. (2008) Filicide: a comparative study of maternal versus paternal child homicide. *Criminal Behaviour and Mental Health,* 18, 166-76. The Netherlands: Faculty of Law, Utrecht University.

Lucas, D.R., Wezner, K.C., Milner, J.S., McCanne, T.R., Harris, I.N., Monroe-Posey, C. and Nelson, J.P. (2002) Victim, perpetrator, family, and incident characteristics of infant and child homicide in the United States Air Force. *Child Abuse and Neglect,* 26, 167-86. Lincoln, USA: University of Nebraska.

Lyman, J.M., McGwin, G., Malone, D.E., Taylor, A.J., Brissie, R.M., Davis, G. and Rue, L.W. (2003) Epidemiology of child homicide in Jefferson County, Alabama. *Child Abuse and Neglect,* 27, 1063-73. Alabama, USA: University of Alabama.

Meadow, R. (1999) Unnatural sudden infant death. *Archives of Disease in Childhood,* 80, 7-14.

Merrick, J. and Morad, M. (2002) Children and homicide. *International Journal of Adolescent Medicine and Health,* 14, 245-47.

Muscat, J.E. (1988) Characteristics of childhood homicide in Ohio, 1974-84. *American Journal of Public Health,* 78, 822-24. New York, USA.

Overpeck, M.D., Brenner, R.A., Trumble, A.C., Smith, G.S., MacDorman, M.F. and Berendes, H.W. (1999) Infant injury deaths with unknown intent: what else do we know? *Injury Prevention,* 5, 272-75. Bethesda, USA: National Institutes of Child Health and Human Development.

Romain, N., Michaud, K., Horisberger, B., Brandt-Casadevall, C., Krompecher, T. and Mangin, P. (2003) Childhood homicide: a 1990-2000 retrospective study at the Institute of Legal Medicine in Lausanne, Switzerland. *Medicine, Science and the Law,* 43, 203-06. Lausanne, Switzerland: Institut Universitaire de Médecine Légale de Lausanne.

Somander, L.K. and Rammer, L.M. (1991) Intra- and extra-familial child homicide in Sweden 1971-1980. *Child Abuse and Neglect.* 15, 45-55. Sweden: Department of Forensic Medicine, Faculty of Health Sciences, University of Linköping.

Van Zaane, B.A., van Woensel, J.B., Teeuw, A.H., Maes, A. and Bos, A.P. (2004) Unnatural and unexplained death in a paediatric intensive-care unit, 1993-2002. *Nederlands Tijdschr Geneeskd,* 148, 1591-94. Amsterdam, The Netherlands: University of Amsterdam.

Vanamo, T., Kauppi, A., Karkola, K., Merikanto, J. and Räsänen, E. (2001) Intra-familial child homicide in Finland 1970-1994: incidence, causes of death and demographic characteristics. *Forensic Science International,* 117, 199-204. Finland: University of Kuopio.

Wate, R and Marshall, D (2009) Effective Investigation of Intra-familial Child Homicide and Suspicious Death, *The Journal of Homicide and Major Incident Investigation* 5(2), pp 17-38. London: NPIA.

Webb, R.T., Pickles, A.R., Appleby, L., Mortensen, P.B. and Abel, K.M. (2007) Death by unnatural causes during childhood and early adulthood in offspring of psychiatric inpatients. *Archives of General Psychiatry*, 64, 345-52. Manchester: Centre for Women's Mental Health Research and Biostatistics Group, University of Manchester

Winpisinger, K.A., Hopkins, R.S., Indian, R.W. and Hostetler, J.R. (1991) Risk factors for childhood homicides in Ohio: a birth certificate-based case-control study. *American Journal of Public Health*, 81, 1052-54. Columbus, USA: Ohio Department of Health, Bureau of Epidemiology and Toxicology.

Methods of Time Since Death Estimation within the Early Post-mortem Interval

Dr Benjamin Swift MB ChB MD FRCPath (Forensic) MFFLM
Consultant Home Office Registered Forensic Pathologist
Forensic Pathology Services

Abstract

This article outlines the various methods available to SIOs regarding estimation of time since death. The article has been compiled by Dr Swift, on behalf of the National Injuries Database, National Policing Improvement Agency (NPIA).

The methodology for estimating the time since death is not an exact science, however, the various methods employed can give some indication, supported by other circumstantial and scientific evidence, as to the approximate time since death. The article aims to better inform investigators of this complex area by summarising all the methods available that can be considered on a case-by-case basis.

Dr Swift qualified from the University of Leicester in 1998 (MB ChB). In 2005 he became a member of the Royal College of Pathologists by examination in Forensic Pathology (MRCPath(Forensic)) and became a Fellow of the Royal College of Pathologists in 2008 (FRCPath(Forensic)). In 2004 he was awarded a Doctorate in Medicine (MD) by thesis in Forensic Pathology by the University of Leicester. He is a Member of the Faculty of Forensic and Legal Medicine of the Royal College of Physicians of London (2007).

Following post-graduate training in surgical pathology within the University Hospitals of Leicester NHS Trust, Dr Swift commenced training in Forensic Pathology as a Specialist Registrar. He was later appointed as a Locum Consultant, also within Leicester. Following acceptance as a Home Office registered pathologist in early 2006, he joined the Forensic Pathology Services, Abingdon; He has since been made a Partner in this Group Practice, the largest in England and Wales and is engaged full-time in the practice of forensic pathology.

Dr Swift has published on pathology and forensic pathology, including papers in peer reviewed journals and chapters in textbooks and encyclopaedias. He lectures regularly to various agencies and organisations, and maintains membership of learned societies.

Along with colleagues he provides a suspicious death service primarily for East Anglia, and also provides support to the South East of England (including London and surrounding counties) and the Falkland Islands when required.

Dr Swift is widely consulted by both prosecution and defence throughout the UK and, on occasions, internationally on matters relating to Forensic Pathology. He regularly gives evidence in Crown court trials at the request of both prosecution and defence.

Contents

All correspondence should be addressed to:
Sonya Baylis, Head of National Injuries Database, NPIA – sonya.baylis@npia.pnn.police.uk
who will forward to Dr Swift for comment

1 Temperature Based Methods

Algor mortis (post-mortem cooling) requires a steady core body temperature prior to death, presumed to be approximately 37°C. The principal anatomical sites for taking readings include the brain, skin surface, nasal cavity, armpit, the rectum and specific internal organs (*Henssge et al,* 1995). Temperature based methods use the theoretical basis of Newton's law of cooling, which is that a body will dissipate its energy (heat) to its surrounding environment at an exponential rate. In fact, Newton's law is only applicable to inorganic spherical objects and not complex shapes, such as the human body. Because of this, published research has revealed that algor mortis studies fail to conform to the exponential decrease, producing a lag phase or plateau which results in a sigmoid-shaped curve. Though first described in 1868 the lag phase is still considered variable and unpredictable, lasting anywhere between half an hour to three hours (*Rainy,* 1868). This endogenous variation introduced a further unknown into any post-mortem interval (PMI) estimation (*Henssge et al,* 1995).

Attempts have been made to correct for differences in weight and external factors through published algorithms and nomograms, different for each method and anatomical site employed (*De Saram, Webster and Kathirgamatamby,* 1955; *Al-Alousi and Anderson,* 1986; *Al-Alousi et al,* 2001; *Al-Alousi et al,* 2002; *Hensgge,* 1988). The most frequently quoted nomogram, published for use with rectal temperatures, corrects for both the lag phase and for ambient temperature, though assumes a constant ambient temperature that rarely exists (*Henssge et al.,* 1995).

Infrared digital thermometers, rather than alcohol or mercury thermometers, have also been studied. The eardrum derives its blood supply from the internal carotid artery, thus, in life, infra-red measurements taken through the ear canal have been shown to reflect the core body temperature. Estimates for the time since death using ear readings have been provided up to sixteen hours post-mortem through the use of a single recorded measurement, used in collaboration with a standard algorithm (such as Henssge's brain nomogram) (*Rutty,* 2001a). Initial studies suggest there is also no lag phase associated with ear canal based estimations, (producing in a single exponential curve) (*Baccino et al,* 1996; *Rutty,* 2001a). Such estimations can, however, still be affected by factors such as head position and the presence of a cooling airstream (*Rutty,* 2001a).

In concluding, temperature based methods fail to account for the multiple variables that are experienced in true crime scenes, such as the effects of different items of clothing and the number of layers worn, the variety of ventilation or artificial heating experienced at scenes (under-floor heating, radiators working on daily cycles or constant) and even the physical position of the body. Submerged bodies and exposure to fires also alter core body temperatures.

2 Rigor Mortis

Muscular rigidity follows a period of flaccidity at death, commencing after three to six hours and lasting up to thirty-six hours, by which time it diminishes (*Knight,* 1996). The onset of rigor is considered predictable, occurring first within the jaw before demonstrable in the limbs in a descending and ordered fashion (*Shapiro,* 1954; *Gordon and Shapiro,* 1975). It could be assumed that rigor progresses in all muscles simultaneously after death and any apparent sequence of onset could be due to the difference in muscle volume at these sites, differences in temperature of each muscle and even the dynamic characteristics of each joint, for example, the wrist joint is inherently more mobile than the jaw (*Kobayashi et al,* 2001).

Any estimate for time since death based solely upon recognition of rigor status may be affected by the temperature of the environment, the degree of muscular activity prior to death and the age of the deceased (*Knight,* 1996); all of these factors are considered to alter the onset of rigor. Little useable progress has occurred in improving these rigor-based estimates, despite the claims of numerous publications.

3 Morphological Changes

In the absence of blood circulation, red blood cells settle under gravity within cutaneous (and visceral) blood vessels, therefore, livor mortis (hypostasis) develops. The spectrum of colouration is broad, depending not only on pre-mortem conditions but also on the time since death (*Knight,* 1996). Published studies that have used photometric measurement of livor claim to be able to provide a PMI estimate through quantitative analysis (*Kaatsch, Schmidtke and Nietsch,* 1994; *Bohnert, Weinmann and Pollak,* 1999). Similar work using a 'tri-stimulus colorimeter measuring system' was only able to estimate up to forty-eight hours PMI with confidence (*Vanezis and Trujillo,* 1996). Despite this, the onset of lividity, as well as its distribution, should be considered so variable that such methods may be unsuitable for the intense scrutiny of medico-legal trials, currently remaining within the realm of experimental trials.

Simple recognition of morphological changes (ie, how far decomposed) requires less specialist means, instead remaining heavily reliant upon the experience of the individual examining. The timing of decomposition is fraught with variations, many based upon unknown factors such as the health of the deceased prior to death, the effects of drugs or medications, the ambient environment (temperature and humidity), the extent of animal and/or insect activity and the degree of peri-mortem trauma (*Mann, Bass and Meadows,* 1990). As is often the case, the environment in which the deceased has laid forms the most important variable. Little human-based work has been published, compared to animal studies. Published work tends to originate from the Decay Research Facility in Knoxville, Tennessee (commonly known as the 'Body Farm'). The results from this small facility cannot be applied internationally, and may even vary within the same locality (*Haglund,* 2002; *Galloway,* 1997). In the absence of good quality, cadaver-based decomposition studies within the UK, caution is advised in attempting to provide an 'accurate' PMI estimation based solely upon descriptive changes.

Microscopic morphological methods have also been considered in the early post-mortem period. White blood cells stained using standard techniques (*Dokgoz et al,* 2001) show apparently recognisable degenerative changes by six hours at the earliest, with lymphocytes becoming altered after twenty-four hours. This technique appears limited up to 120 hours after death, however, these changes are subjective and thus open to inter-observer variation. This study should also be questioned because none of the tests were performed 'blind' to the PMI. Another microscopic technique applicable only to pre-menopausal women allows stimation of their menstrual cycle based upon the histological changes within the endometrium (*Schnabel, Neis and Btratzke,* 1997). This method is reliant upon a regular, uninterrupted menstrual cycle of known commencement and the absence of autolysis limiting recognition of the uterine phase.

4 Muscular Excitability

Professor Luigi Galvani's infamous studies on dead frogs in the 1780s first established the ability of muscle groups to contract under external electrical stimulation. The technique was subsequently refined resulting in numerous publications. By assessing the degree of contraction of specific muscle groups in response to electrical stimulation, it is considered possible to produce PMI estimates (*Henssge et al,* 1995; *Elmas et al,* 2001; *Querido and Phillips,* 2001). However, the equipment is very specialized and not widely available and the method involves subjective assessment making the estimates open to wide inter-observer variation.

5 Gastric Contents Emptying

By assuming that gastric clearing of ingested material occurs at a predictable rate produces methods of very limited results. The theory is that, if the time of the last meal eaten is known, the elapsed post-mealtime period might be estimated, and hence a time of death. However, these estimates have many confounding variables, being dependent upon individual variations in gastric emptying, the type of food ingested (eg, the fat content), the physiological and psychological status of the deceased prior to death (eg, degree of stress or fright), and the consumption of alcohol or drugs of abuse; all may alter the rate of digestion and, because of this, may result in marked and unpredictable variations. *Saukko and Knight* (2004) describe the technique as 'irrelevant' and explain how there is now almost a consensus that with extremely circumscribed exceptions, the method is too uncertain to have much validity.

The sole use of gastric contents analysis is to confirm that the contents match the constituents of a known last meal; it appears unable to provide an accurate time of death.

6 Ophthalmological Changes

The eye has been studied through tonometry, (the measurement of intraocular pressure which is of possible use only up to six hours after death), to direct ophthalmoscopic examination of retinal blood vessels. The latter requires the observer's recognising 'trucking', the situation in which the blood separates into distinct units (*Rutty,* 2001a). However, the latter has been noted within fifteen minutes of death, rendering it of extremely limited value (*Knight,* 1996; *Rutty,* 2001a).

Stimulation of the iris, either electrical or pharmaceutical, may result in persistent reflex contraction in the early post-mortem period; localised injection of adrenaline solutions may induce this reflex up to forty-six hours following clinical death (*Knight,* 1996). Assessment of the chemical constituents of the eye are considered below.

7 Vitreous Humor Analyses

Analysing the chemical constituents of the fluid within the eye dates back over four decades, and yet the results still remain subject to debate (*Henssge et al,* 1995; *Knight,* 1996; *Gong et al,* 2001; *Munoz et al,* 2001; *Bocaz-Beneventi et al,* 2002). The basis of the technique lies in the recognition that the eyeball forms a 'closed environment' separate to the rest of the body, but may still be influenced by ambient temperatures (*Knight,* 1996). The majority of published research relates to the changes in potassium concentration, suggesting that it increases as it leeches out of the intraocular cells, producing an exponential rise. However, this hypothesis is somewhat reliant on pre-mortem data, which may be limited given the great difficulty with which such biochemical information may be obtained from healthy living patients. Given the little that we know about ante-mortem vitreous concentrations, it has been suggested that significant inter-humoral differences may exist within the same individual, though one study of twenty-four individuals found this to occur significantly in only one case (*Tagliaro et al,* 2001). Also, the possibility of intra-humoral pathology producing spurious results also requires consideration during estimations, although *Mulla et al* (2005) would suggest that the likelihood of such errors are low (*Mulla, Massey and Kalra,* 2005). In the absence of large studies, the unknown currently exceed the known.

More recently published methods have become increasingly technical in an attempt to improve the predictive value of vitreous testing, including the creation of an artificial neural network in collaboration with capillary zone electrophoresis (*Bocaz-Beneventi et al,* 2002). A different study described the use of regression analysis in using potassium concentrations, suggesting a greater accuracy in PMI estimates may be produced by using the potassium concentration as the independent variable (rather than the dependent variable as used previously) (*Madea and Rödig,* 2006). The results are slightly improved (time of death estimates now being ±23 hours, rather than ±26 hours). A sample of 492 cases were analysed using the Loess procedure (a local regression analysis). Of those tested, 339 provided estimates outside of the true PMI, thus apparently proving the inaccuracy of the technique.

Additional analytical methods have investigated the concentrations of electrolytes such as zinc and nickel, though these were within an animal model; a lack of human-based follow up studies have prevented its forensic use to date (*Gong et al,* 2001). One study has shown a statistically significant association between time since death and the vitreal concentrations of specific amino-acids in fifty-eight bodies. Of those, the most significant was aspartate, glutamate and taurine (*Girela et al,* 2008). These initial results are encouraging, but larger follow-up studies are required.

Similar principles of electrolyte alterations have been assessed for both cerebrospinal fluid (CSF) and synovial fluid. Like vitreous humor, CSF and synovial fluid are considered closed environments, being from around the brain and joint spaces, respectively (*Henssge et al,* 1995; *Madea, Kreuser and Banaschak,* 2001). Alterations in potassium, glucose and lactate concentrations may progress in a similar manner to vitreous (*Henssge et al,* 1995), although subarachnoid haemorrhage following trauma would undoubtedly affect results. Synovial fluid-based methods may be of benefit in cases of severe trauma, heat-exposure or decomposition, which could result in the destruction of the integrity of the eyes or central nervous system. Also, on a practical basis, synovial fluid itself is more viscous and therefore more difficult to analyse (*Madea, Kreuser and Banaschak,* 2001).

8 Biochemical and Haematological Changes

Post-mortem blood samples are notoriously difficult to assess as the increasing loss of cellular integrity and the absence of energy-dependent trans-membranous transportation allows electrolytes and chemicals to redistribute. Extensive animal-based work assessing alterations in the serum potassium and sodium concentrations has been followed up in human cadavers, although external influences continue to affect its accuracy (*Querido,* 1990a; *Querido,* 1990b; *Querido,* 1991; *Singh et al,* 2002). Later work aimed to demonstrate a double logarithmic linear relationship between plasma chloride concentration and time since death, though numerous intrinsic and extrinsic factors appear to significantly alter these findings (*Singh et al,* 2003).

Novel biochemistry has aimed to identify volatile fatty acids and specific cations or anions (eg, the breakdown products leaking from a corpse) in surrounding soil as decomposition progresses (*Vass et al,* 1992; *Vass et al,* 2002). Vass' method involved the application of the principles of 'accumulated degree-days' (ADD), devised by entomologists to account for ambient temperature fluctuations (see **11 Entomological Methods**). Although initially impressive, the study fails to address the effect of altered pH, the difference in soil types, exposure to different conditions of burial, meteorological factors (such as temperature alterations, wind exposure or the presence of excess water) or the effects of insect and/or animal predation. As such the test remains experimental and only applicable to human remains within the soils of the University of Tennessee's Decay Research Facility. Additional research within this field is predicted, although this will be aimed at identifying the location of buried corpses, rather than PMI estimations.

9 Molecular Techniques

The molecular stability of calmodulin-binding proteins in rat skeletal muscle using autoradiography has been studied; similarly lung calmodulin content has also been measured by Immunoblot analyses (*Kang et al,* 2003). The results indicated a steady concentration of Ca2+/Calmodulin-dependent kinase II over a ninety-six hour timeframe, possibly indicating future use over very short PMIs, although further human work is required.

The results of cardiac troponin-I studies (a protein involved in the stimulation of muscle contraction) show a correlation between its degradation and the log of time elapsed since death (*Sabucedo and Furton,* 2003). When assessed against a standard reference material, it may provide a means of PMI estimation over periods of up to five days. This technique remains experimental in the absence of published follow-up studies.

Immunohistochemical staining for thyroglobulin (a thyroid gland protein) has shown a positive reaction up to thirteen days post-mortem, although this would be dependent upon the type of antibody used, the technical capabilities of the laboratory and the subjective opinion of the observer (*Wehner et al,* 2000).

10 DNA and Ultrastructural Changes

With the onset of cellular death, the ultrastructural components of cells begin to break down; deoxyribonucleic acid (DNA) and messenger RNA (mRNA) degenerates into discrete fragment lengths, their molecular weight altering over time. Assessment of DNA and denaturation could provide a method of early PMI assessment (*Perry,* 1988; *Boy, Bernitz and von Heerden,* 2003; *Lin et al,* 2000; *Cina,* 1994; *Liu,* 2000; *Chen and Chang,* 2002; *Inoue, Kimura and Tuji,* 2002). The use of flow cytometry to quantify this degradation has produced contradictory results when used with human splenic and dental pulp samples (*Cina,* 1994; *Boy, Bernitz and von Heerden,* 2003; *Di Nunno et al,* 2002).

Of potential importance is the suggestion that ultrastructural degradation does not appear to be individual specific. Like other methods, the rate appears dependent upon ambient temperature and humidity (*Perry et al,* 1988).

11 Entomological Methods

Bridging the transition between the early and late post-mortem periods, the study of insect life cycles may assist through two main approaches:

1. Recognition of the time-dependent maturation of Calliphoridae spp. (Blowfly) larvae, and;
2. The recognition of species succession over an inferred time frame (*Erzinçlioglu,* 2003; *Anderson and Cervenko,* 2002).

Blowflies, such as the green and bluebottle flies, have a predictable lifecycle. Likewise the faunal succession by additional species, such as beetles and spiders may assist. The time periods for these studies vary depending upon temperature, humidity, manner of death and even the presence or absence of narcotic drugs within the body. The use of ADD calculations assist by diminishing the effects of the temperature. It is considered that the product of the average daily ambient temperature against the number of days exposed will allow standardisation for the development of the same species in different temperatures.

12 Botanical Methods

Once the late post-mortem interval is entered, the dating of the post-mortem interval becomes even more difficult; there have been fewer methods published over the years that examine this. The use of plant growth includes palynology (the study of pollen) and botany, both of which can assist in forensic investigations (*Liggett and Swift,* 2003). This assumes the recognition of seasonal-specific pollen species adherent to articles of clothing or parts of the body, especially within interred remains. Rootlet infiltration of remains can similarly aid with perennial plants (counting of concentric annual growth rings), similar to the principle of dendrochronology (*Willey and Heilman,* 1987). However, growth ring sizes vary between same species plants and irregular growth may introduce eccentric rings, thus complicating assessments. During the creation of a 'shallow grave' rootlets may be exposed to light which inhibits plant growth, affecting assessment of plant in growth in concealed disposals (*Willey and Heilman,* 1987). The presence of annual plant growth with a corpse indicates only that the deceased was present before the start of that plant's growth season as, unlike perennial plants, they do not produce growth rings. Although many case studies have been cited where botanical studies have assisted criminal investigations, these methods rarely provide accurate answers; growth rings only indicate the minimal time since death, season or year of death (*Willey and Heilman,* 1987).

13 Conclusions

It remains debateable whether there is any single, reliable and accurate means of estimating the time since death during the early post-mortem interval, despite decades and even centuries in some cases of research. Published studies that have found statistically significant results are usually small scale, based on animal rather than human models and have not been followed up with larger scale studies. This prevents the use of any single method in forensic casework and, as such, the majority of methods of estimating the time since death should be considered carefully alongside the caveats that come with using such methods that have been outlined in this article.

Temperature-based studies have received the most attention and provide the more accurate estimate, although these still produce a broad timeframe. For example, using the most referenced methodology, Henssge's nomogram (ambient temperature below 23°C) the narrowest estimate range would be ±2.8hrs, the broadest ±7hrs (*Henssge*, 1988).

Although an element of caution should always be exercised with any method employed to estimate time of death these available methods should not be totally dismissed. If the relevant expert who is providing an opinion is managed and confines his or her conclusions only to their own area of expertise and other supporting circumstantial and scientific evidence is provided, for instance, evidence of last meal eaten, then an SIO could reasonably consider using any of these scientific methods for estimating time of death for their investigation. This article is aimed at providing SIOs with a greater appreciation of the variety of methods that may be available for estimating time since death and should be discussed with a pathologist who is involved with their case.

References

Al-Alousi, L.M., and Anderson, R.A. Microwave thermography in forensic medicine. *Police Surgeon.* 1986;30:30-42.

Al-Alousi, Anderson, R.A., Worster, D.M. and Land, D.V. Multiple-probe thermography for estimating the post-mortem interval: II. Practical versions of the Triple-Exponential Formulae (TEF) for estimating the time of death in the field. *Journal of Forensic Sciences.* 2001;46(2):323-327.

Al-Alousi, L.M., Anderson, R.A., Worster, D.M. and Land, D.V. Factors influencing the precision of estimating the post-mortem interval using the triple-exponential formulae (TEF). Part I. A study of the effects of body variables and covering of the torso on the post-mortem brain, liver and rectal cooling rates in 117 forensic cases. *Forensic Science International.* 2002;125(2-3):223-230.

Anderson, G.S. and Cervenka, V.J. Insects associated with the body: their uses and analyses. In, *Advances in Forensic Taphonomy: Method, Theory and Archaeological Perspectives,* Haglund, W.D. and Sorg, M.H.(Eds), pp174-200. CRC Press, Boca Raton 2002.

Baccino, E., de Saint Martin, L., Schuliar, Y., Guilloteau, P., Le Rhun, M., Morin, J.F. Leglise, D., and Amice, J. Outer ear temperature and time of death. *Forensic Science International.* 1996;83:133-146.

Bocaz-Beneventi, G., Tagliaro, F., Bortolotti, F., Manetto, G. and Havel, J. Capillary zone electrophoresis and artificial neural networks for estimation of the post-mortem interval (PMI) using electrolytes measurements in human vitreous humour. *International Journal of Legal Medicine.* 2002; 116(1):5-11.

Bohnert, M., Weinmann, W. and Pollak, S. Spectrophotometric evaluation of post-mortem lividity. *Forensic Science International.* 1999;99:149-158.

Boy, S.C., Bernitz, H. and van Heerden, W.F. Flow cytometric evaluation of postmortem pulp DNA degradation. *American Journal of Forensic Medicine and Pathology.* 2003;24(2):123-127.

Chen, Y.C. and Cheng, J.D. The relationship between postmortem degradation of bone marrow DNA in sternal bone and late post-mortem interval estimation. *Fa Yi Xue Za Zhi.* 2002;18(3):144-145.

Cina, S.J. Flow cytometric evaluation of DNA degradation: a predictor of postmortem interval? *American Journal of Forensic Medicine and Pathology*.1994;15(4):300-2.

De Saram, G., Webster, G. and Kathirgamatamby, N. Post-mortem temperature and the Time Since Death. *J. Crim.Law,* Criminology. 1955;1:562-577.

Di Nunno N., Costantinides F., Cina S.J., Rizzardi C., Di Nunno C. and Melato M.What is the best sample for determining the early post-mortem period by on-the-spot flow cytometry analysis? *Am J Forensic Med Pathol.* 2002;23(2):173-80.

Dokgoz, H., Arican, N. Elmas, I., and Fincanci, S.K. Comparison of morphological changes in white blood cells after death and in vitro storage of blood for the estimation of post-mortem interval. *Forensic Science International.* 2001;124(1):25-51.

Elmas, I., Baslo, B., Ertas, M. and Kaya, M. Analysis of gastrocnemius compound muscle action potential in rat after death: significance for the estimation of early post-mortem interval. *Forensic Science International.* 2001;116(2-3):125-132.

Erzinçlioglu, Z. Forensic Entomology. *Clinical Medicine.* 2003;3(1):74-76.

Galloway, A. The Process of Decomposition: A Model from the Arizona-Sonoran Desert. In Haglund, W. D. and Sorg, M. H. *Forensic Taphonomy: the post-mortem fate of human remains.* CRC Press, Boca Raton, USA. 1997: pp139-150.

Girela E, Villanueva E, Irigoyen P, Girela V, Hernández-Cueto C and Peinado JM. Free amino acid concentrations in vitreous humor and cerebrospinal fluid in relation to the cause of death and post-mortem interval. *J Forensic Sci.* 2008;53(3):p730-3

Gong, Z.Q., Xu, X.M., Zeng, X.B., Sun, Y.G. and Wand, D.W. Study on the relationship between PMI and the concentration of zinc and nickel in the vitreous humor of rabbit after death. *Fa Yi Xue Za Zhi.* 2001;17(3):129-131.

Gordon, I., Shapiro, H.A. *Forensic Medicine: A guide to principles.* Page 14. Churchill Livingstone, Edinburgh. 1975.

Haglund, W.D. and Sorg, M.H.(Eds) *Advances in Forensic Taphonomy: Method, Theory and Archaeological Perspectives.* CRC Press, Boca Raton. 2002.

Henssge, C. Death time estimation in case work. I:The rectal temperature time of death nomogram. *Forensic Science International.* 1988;38:209-236.

Henssge, C., Knight, B., Krompecher, T., Madea, B. and Nokes, L. *The Estimation of the Time Since Death in the Early Post-mortem Period.* Arnold Publishing, London. 1995.

Inoue, H., Kimura, A. and Tuji, T. Degradation profile of mRNA in a dead rat body: basic semi-quantification study. *Forensic Science International.* 2002;130(2-3):127-132.

Kaatsch HJ, Schmidtke E, and Nietsch W. Photometric measurement of pressure-induced blanching of livor mortis as an aid to estimating time of death. Application of a new system for quantifying pressure-induced blanching in lividity. *International Journal of Legal Medicine.* 1994;106(4):209-14.

Kang, S., Kassam, N., Gauthier, M.L. and O'Day, D.H. Post-mortem changes in calmodulin binding proteins in muscle and lung. *Forensic Science International.* 2003;131(2-3):140-7.

Knight, B. *Forensic Pathology.* Second Edition. Arnold Publishing, London. 1996.

Kobayashi, M., Ikegaya, H., Takase, I., Hatanaka, K., Sakurada, K., and Iwase, H. Development of rigor mortis is not affected by muscle volume. *Forensic Science International.* 2001;117:213-219.

Liao, Z., Yi, X., Zhang, Y., Peng, X. and Li, Q. Observations on rat's muscle at various post-mortem intervals by scanning electron microscopy. *Hua Xi Yi Ke Da Xue Xue Bao.* 1998;29(3):323-325.

Liggett, A. and Swift, B. Forensic webwatch – palynology, pedology and precipitation: environmental profiling in forensic science. *Journal of Clinical Forensic Medicine,* 2003;10(1):49-51

Lin, L.Q., Liu, L., Deng, W.N., Zhang, L., Liu, Y.L. and Liu, Y. An experimental study on the relationship between the estimation of early postmoretm interval and DNA content of liver cells in rats by image analysis. *Fa Yi Xue Za Zhi.* 2000;16(2):68-9, 127.

Liu, L. An experimental study on the relationship between early postmortem intervals and DNA content of spleen cells in rats by computerized image analysis. *Fa Yi Xue Za Zhi.* 2000;16(1):8-9, 63.

Madea, B., Kreuser, C. and Banaschak, S. Postmortem biochemical examination of synovial fluid – a preliminary study. *Forensic Science International.* 2001;118(1):29-35.

Madea B and Rödig A. Time of death dependent criteria in vitreous humor: accuracy of estimating the time since death. *Forensic Science International.* 2006;164(2-3):87-92.

Mann, R.W., Bass, W.M. and Meadows, L. Time Since Death and Decomposition of the Human Body: Variables and Observations in Case and Experimental Field Studies. *Journal of Forensic Sciences.* 1990;35(1):103-111.

Mulla A., Massey KL and Kalra J. Vitreous humor biochemical constituents: evaluation of between-eye differences. *Am J Forensic Med Pathol* 2005;26(2):146-9.

Munoz, J.I., Suarez-Penaranda, J.M., Otero, X.L., Rodriguez-Calvo, M.S., Costas, E., Miguens, X., and Concheiro, L. A new perspective in the estimation of the post-mortem interval (PMI) based on vitreous. *Journal of Forensic Science.* 2001;46(2):209-214.

Perry, W.L., Bass, W.M., Riggsby, W.S. and Sirotkin, K. The Autodegradation of Deoxyribonucleic Acid (DNA) in Human Rib Bone and Its Relationship to the Time Interval Since Death. *Journal of Forensic Sciences.* 1988;33(1):144-153.

Querido, D. Double logarithmic, linear relationship between plasma sodium/potassium concentration ratio and post-mortem interval during the 6-96h post-mortem period in rats. *Forensic Science International.* 1990a;44(2-3):125-134.

Querido, D. Linearization of the relationship between post-mortem plasma chloride concentration and post-mortem interval in rats. *Forensic Science International.*1990b;45(1-2):117-128.

Querido, D. In vitro loss of potassium from erythrocytes during the 0-108h post-mortem period in rats: relationship between potassium loss and post-mortem interval. *Forensic Science International.* 1991;51(1):111-123.

Querido D. and Phillips M.R. Estimation of post-mortem interval. Temperature-correction of extracellular abdominal impedance during the first 21 days of death. *Forensic Science International.* 2001. 15;116(2-3):133-8.

Rainy, H. On the cooling of dead bodies as indicating the length of time since death. *Glasg. Med. J.* 1868;1:323-330.

Rutty, G.N. *The use of temperatures recorded from the external auditory canal in the estimation of the time since death*. Medical Doctorate Thesis, University of Sheffield, 2001a.

Rutty, G.N.(Ed) *Essentials of Autopsy Practice.* Springer-Verlag, United Kingdom. 2001b.

Saukko, P. and Knight, B. Knight's Forensic Pathology. Third Edition. Arnold Publishing Ltd, 2004.

Sabucedo, A.J., Furton, K.G. Estimation of the postmortem interval using the protein marker cardiac Troponin I. *Forensic Science International.* 2003; 134(1):11-16.

Schnabel A, Neis P, Bratzke H. Cycles of the uterus mucous membranes and estimation of time of death. *International Journal of Legal Medicine*. 1997;110(1):31-2.

Shapiro, H.A. Medico-legal mythology, Some popular fallacies. *Journal of Forensic Medicine.* 1954;1:144-169.

Singh, D., Prashad, R., Parkash, C., Bansal., Y.S., Sharma, S.K. and Pandey, A.N. Linearization of the relationship between serum sodium, potassium concentration, their ratio and time since death in Chandigarh zone of north-west India. *Forensic Science International.* 2002;130(1):1-7.

Singh, D., Prashad, R., Parkash, C., Sharma, S.K., and Pandey, A.N. Double logarithmic, linear relationship between plasma chloride concentration and time since death in humans in Chandigarh Zone of North-West India. *Legal Medicine.* 2003;5:49-54.

Skinner, M. Planning the Archaeological Recovery of Evidence From Recent Mass Graves. *Forensic Science International.* 1987;34:267-287.

Tagliaro, F., Bortolotti, F., Manetto, G., Cittadini, F., Pascali, V.L. and Marigo, M. Potassium concentration differences in the vitreous humour from the two eyes revisited by microanalysis with capillary electrophoresis. *Journal of Chromatographic Analysis.* 2001;924(1-2):493-498.

Vanezis, P. and Trujillo, O. Evaluation of hypostasis using a colorimeter measuring system and its application to assessment of the post-mortem interval (time of death). *Forensic Science International.* 1996;78(1):19-28.

Vass, A.A., Bass, W.M., Wolt, J.D., Foss, J.E. and Ammons, J.T. Time Since Death Determinations of Human Cadavers Using Soil Solution. *Journal of Forensic Sciences.* 1992;37(5):1236-1253.

Vass, A.A., Barshick, S.A., Sega, G., Caton, J., Skeen, J.T., Love, J.C. and Synstelien, J.A. Decomposition chemistry of human remains: a new methodology for determining the post-mortem interval. *Journal of Forensic Sciences.* 2002;47(3):542-553.

Wang, X., Li, M., Liao, Z.G., Yi, X.F. and Peng, X.M. Experimental restiffening of rigor mortis. *Fa Yi Xue Za Zhi.* 2001;17(4):202-204.

Wehner F, Wehner HD, Schieffer MC, Subke J.Delimitation of the time of death by immunohistochemical detection of thyroglobulin. *Forensic Science International.* 2000;110(3):199-206.

Willey, P. and Heilman, A. Estimating Time Since Death Using Plant Roots and Stems. *Journal of Forensic Sciences.* 1987;32(5):1264-1270.

IT'S YOUR JOURNAL

YOUR CONTRIBUTION MATTERS

Be a part of ***The Journal of Homicide and Major Incident Investigation…***

Give us feedback on the articles in this issue.

Let us know what you would find useful in future issues…

…or even send us an article.

Contact the editorial team by email at homicide.journal@npia.pnn.police.uk

Relevant and Informative…

Launched in 2005 and published twice yearly, *The Journal of Homicide and Major Incident Investigation* contains ACPO guidance on investigating particular types and elements of homicide, good practice and case studies, together with academic research and legal discussion.

Useful…

So far, *The Journal of Homicide and Major Incident Investigation* has included articles on:

- Review of Undetected Historic Serious Crime: 'Why bother?';
- Media: A useful investigative tool;
- Focus on… Forensic Anthropology;
- The Human Tissue Act 2004: Implications for the Senior Investigating Officer.

We need you to contribute…

We are looking for articles that we can publish in forthcoming issues. You don't have to be an experienced writer; we can offer you **editorial support**.

- Have you worked on a case which may be of interest to other SIOs?
- Have you used a particular technique in an innovative and unusual way?
- Do you have specialist knowledge, of a type or aspect, of homicide investigations?
- Has good practice been identified in your force which would be of value to other forces?

THE JOURNAL OF
HOMICIDE AND MAJOR INCIDENT INVESTIGATION

Volume 6, Issue 1 – Spring 2010