Chapter 4

DISCUSSION

4.1 Identification of Contact Gunshot Entrance Wounds

In contact gunshot wounds, the face of the muzzle of the weapon is held against the surface of the target at the time of discharge. The muzzle may be held in such a way that it merely touches the surface, or it may be pressed hard against it. In the latter case, the surface may be indented by the muzzle, thus creating a seal between the muzzle and skin at the time of discharge. These types of wounds are known as *hard contact wounds*.

In hard contact wounds, the material exiting from the muzzle when the weapon is fired (that is, flames, gas from the burning propellant, soot, primer residue, metallic particles stripped form the bullet, and vaporised metal from the bullet and cartridge case[4]), is propelled into the wound and the edges of skin around the defect become seared by the flame and hot gases, as well as blackened by the soot deposition ***(Figure 4.1***, as well as ***Figure 3.3 a))***.

Figure 4.1: *A picture of a contact entrance wound exhibiting seared edges and soot deposition around the defect.*

Sometimes the entire bulk of matter escaping from the muzzle is driven underneath the skin, so that no evidence of a contact entry can be detected macroscopically. Here, contact entry can usually be identified during autopsy by observing soot and unburned powder particles in the underlying wound tract or deposited on the underlying structures.

Muzzle imprints ***(Figure 4.2)*** are oftentimes seen in hard contact wounds. When a seal is created between the muzzle and the skin, the gaseous matter is injected under the skin and this causes the skin to bulge outward toward the muzzle. The skin is forcibly pressed against the face of the muzzle and an impression of the muzzle is left in the skin in the form of abrasions and bruising, revealing the size and shape of the anterior aspect of the weapon.[41] This serves as unmistakable evidence of a contact gunshot wound.

Figure 4.2: A muzzle imprint left by a handgun pressed against the skin. Note the impression of the recoil guide rod at the inferior aspect of the wound.

Thali et al.[41] (2002) recorded the importance of these muzzle imprints. Despite being valuable proof of a contact gunshot entry, it can also facilitate the reconstruction of the event by providing information as to which type of weapon was used and how it was held at the time of discharge. They added that – in addition to the skin pressing against

the muzzle – the following factors (alone or combined) are responsible for the creation of a muzzle imprint:

- Direct pressure from the weapon pressed against the skin
- Reflexive, compensative muscular reaction by the shooter which forces the muzzle into the wound
- The effect of mobile firearm parts
- The suction effect of the muzzle after discharge[41]

Where a weapon is discharged over an area where skin overlies bone (as can be seen in the head, where skin overlies the skull), an entrance wound with a stellate or cruciform appearance can oftentimes be seen (Refer to ***Figure 3.3***). This is created by the emerging gasses becoming trapped between the skin and the underlying bony structure and causing the skin to bulge or balloon outward. When the stretching during this time exceeds the elasticity of the skin, it will tear and the tears will run outward from the defect, producing the star-shaped or cruciform appearance.

In addition to the fact that contact entries may not always exhibit a muzzle imprint or a stellate-shaped wound, entrance wounds may also not always be perfectly round, regular defects. Depending on various factors, such as the type and calibre of weapon, the position of the weapon against the surface, and other circumstances surrounding the event, defects may be large and irregular without soot deposition or searing of the wound edges. In these cases, the pathologist performing the autopsy may employ alternative methods of distinguishing the wound as one created at contact range.

Histologically, the entrance wound will exhibit the presence of black gunpowder in the wound tract or on and within the adjacent skin cells. Chemically, the presence of carbon monoxide from the muzzle gas can be detected in the wounds. However, this should be executed and interpreted with care, as carbon monoxide has been detected in wounds at a muzzle-target distance of 30 cm^4, which renders its ability to distinguish contact wounds uncertain.

In a singular incident, an autopsy was performed on a gunshot victim with strong suspicion of suicide, but the case was excluded from the study. The entrance wound was located in the right temporal area (entrance wound located by examination of the inward bevelling of the skull at point of entry), but *no* soot deposition, blackening or searing could be detected in the skin, the underlying bony structures, or tissues along the wound tract. The victim had been admitted to hospital and the wounds treated, but absolutely *no description of the wounds was entered into the victim's hospital files.* Although entries were made pertaining to which wound was the entry, no description of the wounds' appearance, the presence of soot or smoke, the size, etc., were given.

Any potential wound features characteristic of contact entrances were destroyed in the process of cleansing and medical treatment, and therefore, no deduction regarding the range of discharge could be done based on the appearance of the entry wound. Although contact discharge was suspected, no official mention of this could be made in the autopsy report and the case was consequently excluded from the present study.

This example highlights the importance of meticulous observation and documentation of gunshot wounds in hospital emergency units. Apfelbaum et al.[42] (1998) found that this is a neglected area in emergency medicine which could potentially have significant medico-legal and forensic implications.

In South Africa, subpoenas may take up to two years to be issued. If an emergency physician is called upon to act as factual witness in describing gunshot wounds after a lengthy period, thorough and comprehensive medical files may be the only source of recall for the physician.

The head was found to be the preferred site of entry in suicidal gunshot deaths, comprising 89,2 percent of the entire caseload. The right temporal area was found to be the site of choice in 45,8 percent of all suspected suicide cases, followed by the mouth with 19,2 percent of the cases ***(Table 3.1)***. These results correlate well with previously published research.[8, 9, 34, 43] The 8 cases of known or strongly suspected homicide, showed

5 cases with entrance wounds to the head (2 in the left temporal region, and one each in the vertex, forehead, and left fronto-parietal area), two with entries in the area of the precordium, and one in the abdomen. This arrangement of homicidal entrance sites also correlates well with forensic literature.[9]

In the accidental shooting death, the victim (security guard) placed his weapon underneath his jacket, which he used as a pillow. He fell asleep and the firearm discharged accidentally, creating a contact gunshot wound medially in the posterior aspect of the neck.

Three case of multiple gunshot wounds strongly suspected of being suicide, were identified. The weapons (a .22 calibre rifle and two 9mm pistols) were held against the inferior aspect of the mandible at initial discharge. Immediate incapacitation did not occur after the first shots, and the victims remained in a state of alertness where the firearms could be redirected and second shots fired into the right temporal regions (two cases) and the precordium, which then proved fatal.

Multiple suicidal gunshot wounds are not an infrequent occurrence and may cause problems in distinguishing manner of death. The inexperienced and ignorant believe that a gunshot wound to the head must cause immediate death, and therefore, if a victim is found with more than one firearm wound, manner of death *must* be homicide. This is an inaccurate notion.

Incidents of multiple suicidal gunshot wounds have been reported in forensic literature.[44, 45, 46] In fact, Karger et al.[44] (1997) reported that of 138 firearm suicides, 11 people who committed the act, fired two or more shots to the body. This means that of all the cases he studied, approximately 8 percent of cases exhibited multiple gunshot wounds.

Immediate incapacitation in such cases depends on some physiological effects, which basically involves tissue disruption, which reduces the functioning ability of the

central nervous system. The two main mechanisms to achieve this include direct disruption of brain tissue or indirect elimination of the central nervous system by cerebral hypoxemia from hemorrhage.[44] The instances where the initial shot was fired into the inferior aspect of the jaw, seemed to have only affected the facial structures. This enabled subsequent physical activity to bring about a second, fatal shot.

4.2 Detection of Weapons: The Dilemma

The detection and acquisition of firearms employed in contact gunshot events proved to be a great challenge. Standard operating procedure in most parts of the United States of America provides that all weapons and apparent suicides notes are taken into custody at the death scenes which appear to be suicide.[11] These firearms are then submitted to the relevant forensic science laboratory of the area. The same holds true for weapons discovered on scenes of homicidal and accidental shootings.

The author has found that – in South Africa – *no official protocol exists for the correct handling of weapons* discovered on scenes of firearm fatalities. This creates immense problems for those involved in the analysis of firearms.[47, 48] *Unofficial* protocol dictates that weapons be confiscated by members of the Criminal Record Centre (CRC) for gunshot residue testing (GSR-testing), photography, and fingerprinting. When these duties have been completed, the weapons are then to be securely conveyed to the ballistics laboratory of the FSL in Pretoria where it is then entered into the ballistics register before the relevant ballistic examinations and tests are to be performed. Due to the immense caseload of firearm-related crimes in this country, the ballistics laboratory may suffer a certain degree of backlogged cases. However, even in these circumstances, entrance into the laboratory's system may take no more than approximately four days.[47]

The most important of the evaluations performed in the ballistic laboratory is said to be the Integrated Ballistics Identification System (IBIS).

IBIS is a computerised system much like its fingerprinting counterpart, AFIS (Automated Fingerprint Identification System). All images obtained from microscopic examinations of bullets and cartridges (fired from a particular gun) are stored on the system's database and immediately compared to that of all other ammunition in the system. This enables the forensic scientist to determine whether that particular firearm had been employed in other crimes.

When all ballistic tests have been completed, the firearms are scheduled to be returned to the appropriate branch of the SAPS. No biological analyses of any kind are routinely performed on these weapons. (In fact, upon interviewing most of the investigating officers, the author came across some serious scepticism concerning the Biology Unit's "business" with firearms.)

Admittance of firearms into the register (SAP13) at the appropriate police stations requires entry of relevant information regarding the weapon into a logbook and storage of the weapon in a secure chamber under lock and key. The steps taken to release the firearms depend largely on the type of crime it was associated with at the time of seizure. In the case of weapons employed in suicidal and some accidental deaths, the relevant family members and insurance companies are contacted to retrieve the guns from the police station directly. Where a service pistol was employed in a suicide act, it is usually assigned to the relevant commanding officer of the station, who then generally orders the weapon to be cleaned.

Unfortunately, as discovered through the course of the present study, this *proposed* standard operating procedure is not only disregarded in a very high rate of firearm fatalities (creating a highly inadequate chain of evidence), but is also not nearly sufficient enough to procure thorough and comprehensive analyses of the weapons in different laboratories.

Of the 123 cases of contact gunshot wounds identified at the medico-legal laboratory in Pretoria, only 92 of the weapons utilised in these cases could be identified by the relevant investigating officers.

When the police are called to a scene of a firearm fatality, the officers processing the scene are those on call for that period in time. These officers, however, are rarely assigned as investigating officers to the cases of those death scenes they examined. Instead, the dockets regarding each case are accumulated and evenly distributed among the police officers of that specific station, who will then act as investigating officers to the assigned cases.

These investigators rely heavily on the documentation of the police officer who examined that particular crime scene. Notes, photographs, affidavits, and an array of additional information are present in the case files and serve as platform for the successful investigation of the death. *All* necessary data must be entered into the files in a clear and meticulous manner. However, case files are not always thorough and vital information is sometimes omitted. This could have disastrous consequences on an investigation. Consider, for instance, the case of suspected suicide where the investigating officer was contacted to obtain vital information concerning the circumstances of the case, but was unable to attest to the presence or absence of a suicide note, as this information was not mentioned in the docket.

Inadequate chains of evidence may cause the evidence to be deemed inadmissible by the Court, as its integrity cannot be proven. Incomplete documentation may create an insufficient chain of evidence.

Perhaps one of the greatest problems in a shooting death investigation and maintenance of chain of evidence, is the miscommunication between officers from the different agencies on death scenes, which may lead to *unfamiliarity with the location of the particular firearm.* The path of the firearm should be clearly stated in the case files and chain of custody closely monitored. However, this is not done and the consequences thereof can be potentially disastrous if exposed in Court.

In approximately 29 cases, the investigating officers informed the author that the relevant weapons had been conveyed to the ballistics laboratory at the FSL, whether via the CRC photographers, or by members of the SAPS on the scene. However, on contacting the ballistics laboratory to confirm the location of the weapons, it was discovered that none of the firearms had been entered into the ballistics register. In other words, according to the ballistic laboratory, the firearms were not in their possession. Contacting the CRC also yielded no information as to their locality. Approximately 5 of these weapons have been discovered as having been entered into SAP13, but never delivered to the FSL for analyses. By the time that this study came to an end, these weapons were yet to be delivered to the FSL, despite insistence that they be delivered immediately.

Case Study

In one particular case of an apparent suicidal shooting, the investigating officer delivered the relevant firearm to the FSL, but the gun was never located within the Forensic Laboratory itself. Packaged in an envelope, addressed to Sergeant Massyn at the Biology Unit, the weapon was supposed to reach the appropriate station for biological analysis, but Sergeant Massyn never received the package and it is believed that the handlers of this envelope *supposed* erroneous addressing and delivered the weapon to its "rightful" place: ballistics.[49] However, the weapons were still missing by the end of this study and it can only be hoped that the firearm will turn up eventually.

In 5 cases (with one mutual investigating officer), the author was informed by the relevant officer that the firearms in question were transported to the ballistic laboratory. However, the weapons were not entered into the ballistic system. After extensive researching, the firearms were "discovered" in the SAP13 register of the particular police station. The investigating officer was never informed that the members of the CRC obtained GSR test samples *on the scenes* and never confiscated the firearms for

photographing and fingerprinting. The weapons were therefore also not *en route* to the ballistic laboratory. During the course of the study, the investigating officer in charge of the cases quit the Police Service and it seemed to be unclear as to whom the substituting investigator was. Weapon transport could therefore not be organised.

Another 15 firearms to be analysed during the study were stationed at the specific SAP13, but were never delivered to the biology unit at the FSL. Some cases were identified at the very start of the research, but the firearms used are still outstanding. Scientifically, this creates immense problems, since time delay between detection and analysis of the firearms may influence the rate of detection of blood spatter on the outside and on the inside of the weapons. Backspatter on firearms undergo drying and may dislodge from the interior or exterior surface of the firearm during transportation or manipulation[50], which may then influence scientific authenticity of results. By the termination of the study, these firearms were still outstanding.

The author could not locate the remaining 24 weapons by the end of this study. The apparent absence of these weapons at any of the three sites included in the unofficial protocol of weapon handling raises some serious questions as to the validity of this proposed "protocol". If the firearms could not be found in these localities (CRC, FSL, and SAP13), where are they?

The lack of proper protocol on the handling of weapons causes great confusion among law enforcement personnel, forensic investigators, and researchers alike. When interviewing different members of the police service as well as forensic laboratory staff, it becomes painfully clear that very little consistency exists in the idea of proper firearm-related crime scene protocol in South Africa.

In the South African legal system, it is the duty of the Court to determine the manner of death with the aid of the investigating officer, the forensic pathologist, and any additional forensic investigators. However, it is oftentimes found that police officials on a scene (especially in suicidal gunshot deaths) unofficially decide manner of death and

investigate the scene as such. Whether this is done out of a desire to lessen the burden of the investigator, or to ease the suffering of the family and friends, this is utterly erroneous procedure. Investigation of a scene, and ultimately the entire case, should not be performed with the objective of proving a specific manner of death, but rather the pursuit of truth.

Case Study

In one case of suspected suicide, a young woman and her husband was sitting in the lounge of their home, watching television. According to the husband, he left the house to purchase take-away dinner, and – on his return – found his wife still seated in front of the television, but with a gunshot entrance wound to her head and a firearm lying on the floor next to her chair. The woman had indeed presented with a contact gunshot wound to the right temporal area. On contacting the relevant investigating officer (who ironically was also present on the scene), suicide was immediately accepted as mode of death (as it was "quite obvious that it was a suicide") and the weapon was returned to the husband on the scene.

Disturbingly, no previous history of suicidal ideation, depression, marital problems, financial difficulty and other problems frequently encountered in suicide victims, were known to have been present in the victim's life. Forensiometric analysis would have questioned the position and location of the woman's body on the scene, as suicide in a chair and in front of the television is quite rare. The only indications of suicide were the presence of the weapon on the scene, the entrance wound and the husband's testimony. Though manner of death may quite possibly be one of suicide, it will be extremely dangerous to create a president where all such cases are handled with a complete lack of meticulous investigation. How easy would it be to kill and get away with it just by staging a suicide!

In the South African criminal legal system the State prosecutes the accused/defendant for an alleged crime. Here - as opposed to civil law suites - the *burden of proof* rests upon the State to prove the defendant's guilt "beyond any reasonable doubt". In other words, the judge must be completely sure of every aspect of the case against the defendant.[50]

Considering the questionable decorum of weapon handling in this country and the resultant inability to prove the path and precise localities of a firearm throughout an investigation, would one not expect some shadow of doubt concerning the chain of evidence? What affect would the exposure of the inadequate chain of custody in shooting incidences have on the justice system? If an experienced defence attorney would come to know of the lack of thorough analyses on *all firearms*, together with the poor protocols, we might see many cases thrown out of Court on technical errors. This would cause endless frustration, which could have been prevented if formal protocols and training had been involved from the start of investigations.

When comparing the number of weapons obtained for analysis with those in previous international research, it becomes doubtful whether the results possess any statistical value. Furthermore, with such doubtful circumstances surrounding the analyses, one should consider if scientific examination and subsequent interpretation are at all conceivable.

4.3 Analysis and Results

Age, sex and race

The mean age of the suicide victims in the present study (36,1 years) is slightly lower than in studies performed by Kohlmeier et al.[34] (42,6 years) and Burnett and Collins[24] (39 years).

White South Africans constituted 58,5% of all shooting victims, while Black South Africans constituted only 36,6% of victims. In this country, the Black ethnic group form by far the greatest part of South Africa's racial composition with 78% of all citizens being Black and 10% being White (Reference: www.statssa.gov.za). Considering this, it is clear that those from the White ethnic group exhibit an exceptionally high frequency of firearm-related suicides when compared to those from the Black ethnic group. Blacks, however, show the greatest number of overall suicides (that is, suicide by any method.)[1, 2]

The male to female ratio of victims also correlate well with previous research.[24, 34]

Anatomical Site of Entrance Wounds

The head was the preferred site of entrance, with 89,2% of entries occurring in this area. This correlates well with previous studies.[8, 18, 43]

Weapon Analysis

Since *no* biological examinations of weapons have been done at the Forensic Science Laboratory prior to this study, novel investigative methods had to be employed by scientists at the Biology Unit. Experimental procedures employed by MacDonnell and Brooks[12] (1977) were chosen as suitable methodology to fulfil the objectives of this study. (However, precise measurements of blood penetration into the barrels – as was done by MacDonnell and Brooks – fell beyond the scope of this study.)

Although Benzidine was not the initial choice of presumptive test-substance for detecting blood inside the barrels of the weapons, it was at last accepted as medium because of the high incidence of false positives obtained by the alternative, luminol.

In the United States of America, as well as in the United Kingdom, the use of other presumptive tests for blood, like phenolphthalein and leucomalachite green (LMG) is well documented.[11, 38] However, these substances are not utilised in South Africa.[47] Luminol, a liquid that - when in contact with minute quantities of blood - induces chemical luminescence when viewed in darkness or near darkness, is the primary

substance used for presumptive blood tests in the South African forensic investigation system.[47] However, due to the great time delay between identification of cases and the delivery of weapons to the Biology Unit, the risk of false positive reactions obtained when luminol reacts with rust and other material in the barrels of the weapons, was too great and the decision was made to employ *benzidine* instead.[49]

The substance Benzidine, utilises the peroxidase-like activity of heme to produce a blue/purple colour as end product.[38]

Benzidine is used as a *presumptive test* for blood and exhibits identical sensitivity and specificity to tetra-methylbenzidine (a homologous substance most often mentioned in forensic literature as presumptive blood test).[38] Milton[38] (1991) compared the sensitivity and specificity of the latter with that of other agents used as presumptive tests for blood, such as phenolphthalein (the most frequently used chemical in blood detection in the United States of America), orthotolidine solutions and leucomalachite green.[38]

He found the phenolphthalein to be the best single test for blood, having both the greatest sensitivity and specificity, but – as already mentioned – this agent is not currently being used in the Police Forensic service.[47]

The tetra-methylbenzidine (together with orthotolidine) was the most sensitive test of the group analysed in the study. Bearing in mind that tetra-methylbenzidine and benzidine are indistinguishable with respect to the produced results, it can be assumed that benzidine will possess a sensitivity similar to that of tetra-methylbenzidine, namely one part in 10,000 to 200,000.[38]

The increased need for a high level of specificity and sensitivity of the presumptive tests are clear and for many years benzidine was the substance of choice. It is one of the most sensitive presumptive tests for blood[38] and – since its discovery – has been considered reliable for the generic diagnosis of bloodstains.[52] That is, until its carcinogenic effects were realised.

Benzidine ***(Figure 4.3)*** and its salts are considered dangerous carcinogens in man (especially in long-term occupational exposure) causing an increased incidence of especially bladder cancer.[52] Consequently, it has been declared a hazardous substance and its utilisation in the forensic domain has suffered since the late seventies. However, in South Africa it is only recently that the use of benzidine has been prohibited. It is therefore highly advisable that analysis employing the benzidine dye be done in a well-ventilated area, using latex gloves for skin protection.

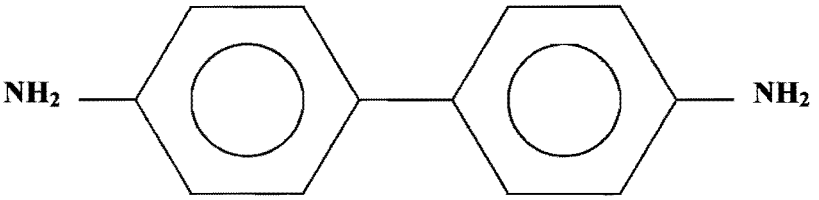

Figure 4.3: The chemical structure of benzidine.[52]

The existence of substances able to induce false positive results when using benzidine as presumptive test for blood is well known and documented.[38, 52] Plant peroxidases are known to create false positive reactions.

To obtain reliable sensitivity, a maximum of 10 seconds should be allowed for the colour reaction to occur.[38] In high blood concentrations the development of the colour will occur within 5 seconds. If the colour develops after 20 seconds, interference colour might have been produced or a false-positive result might have been obtained. The interpretation of the results of this test was highly dependent on the expertise and experience of the scientist performing the experiment, method of preparation and the blood concentrations on the surface being tested.

Of the 24 percent of weapons actually received and analysed, only 40 percent (12 firearms) possessed blood on the external surface of the weapon. This *does not correlate* with previous research.[10, 11, 35] Reports on the drawn back effect have documented blood on the outside of the same weapons in 64 to 90 percent of all firearms, independent of

type and calibre of the weapons. These numbers are significantly higher than that of the present study. Such a low rate of blood persistence on the exterior surface of a firearm used in a contact gunshot event is rare. Of special note is the low rate of blood persistence (27 %) on the outside of 9 mm pistols as compared to those in previous international studies (83 %).[10, 11, 35]

Unfortunately, due to the extremely low number of firearms delivered for analysis, statistical interpretations should be done with caution.

The low frequency of blood found on the outside of the weapons is symptomatic of a highly troublesome occurrence in the handling of weapons in this country. Handguns found on the scenes of fatal shootings are oftentimes found with a relatively large amount of blood on the external surface. It has been known to occur that – after photographing the weapons on scenes – they are sometimes picked up and wiped, to rid the weapon of the majority of blood.[47] The general fear of HIV / AIDS and other blood borne diseases so common in South Africa seem to warrant this action, but unfortunately it destroys any chance of successful scientific analysis of the weapons.

The frequency of blood back spatter on the inside of the barrels (70%) in this study seems to correlate with those of previous studies.[10, 11] Stone[35] (1992) recorded a persistence of blood on the inside of firearms in 47 to 74 percent of all weapons, dependent on the type and calibre. Once more, statistical interpretations of the results generated by the present study should be done with caution.

Weapons of greater calibre, for instance .38 Special revolvers and rifles, seem to possess greater blood retaining ability. This correlates well with previous research.[10, 11] No correlation of significance seems to exist between the anatomical location of entrance wounds and the number of weapons with positive tests for blood on the inside of the barrels. (All entrance sites occurring more than twice exhibited a statistical chance of retaining blood between 66 to 75 percent of the time.) In addition, no significant correlation seems to exist between the presence of hair or clothing as intermediate targets,

and the frequency of blood in and on the firearms. However, the small number of firearms analysed precludes proper determination of correlation between the above-mentioned factors and back spatter.

The conditions in some of the SAP13 registers are also cause for concern as to the validity of results produced during the study. It has been reported that some weapons – especially those of large calibre, like rifles and shotguns – are not placed in protective covering, such as paper or plastic envelopes or bags when entered into SAP13.[47, 48] Consequently, an extremely high risk of contamination exists in some of these registers, adding to decreased scientific validity of the study.

It is important to keep in mind that the above-mentioned practices are not born from laziness or ignorance on the part of the police officers. No proper protocol is in place to support the actions of those investigating shooting fatalities. No laws exist dictating the delivery of the firearms to the FSL for biological analysis. In fact, the advantages of biological analysis are unknown to most investigating officers. The burden should perhaps fall on those of us that understand and appreciate its significance, to push for the formation of novel criteria for the collection and analysis of weapons.

4.4 Recommendations

In a country where the incidence of unnatural deaths are of the highest in the world, it becomes essential to establish highly effective protocol for all aspects of an investigation, so that it will enhance the competency level of our police force and not take away from it. It should start at the very top.

The Court should be adamant about admission of evidence produced by strict adherence to scientific procedures and a completely intact chain of custody. It should insist on only allowing evidence that was detected, collected, analysed and interpreted by experts in the field without confounding factors.

The creation of standard operating procedure for fatal shooting incidents should be implemented as soon as possible and it should be strictly adhered to. Deciding on the manner of death on the scene should be avoided and all physical evidence collected according to the standard operating procedure.

Laboratory procedures regarding the biological assessment of firearms must be implemented and upgraded to international standards and novel chemicals, such as phenolphthalein, should be incorporated into the array of investigative tools. Proper systems, whether computer or manual, should be upgraded and adhered to so as to prevent the creation of great backlog.

Crime scene management must involve the primary entrance of forensic scientists. This will allow for detection and collection of evidence before it is contaminated or destroyed. The scientific handling of firearms on the scene is of great concern and a much greater respect for the scientific and biological value must be given to the weapons. Since the biological analysis of weapons do not pose a major risk for destruction of evidence such as fingerprints, it is perhaps essential that biological analysis occur prior to fingerprinting, and certainly prior to ballistic tests.