Combating drunken driving

Questioning the validity of blood alcohol concentration analysis

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The reliability and accuracy of blood alcohol concentration results presented in South African courts in respect of possible driving under the influence (DUI) cases, have in recent years been subjected to intense scrutiny and severe criticism. Research has shown that multiple factors may negatively affect the reliability of results obtained from the analysis of such samples – including inappropriate or non-standardised sample management. In particular, long delays between sample acquisition and analysis may compromise the validity of results. Such delays may also negatively affect the outcome of both criminal and civil legal proceedings in possible DUI cases. A retrospective descriptive study was conducted on records from the Pretoria Forensic Chemistry Laboratory (PFCL) regarding the relevant dates pertaining to blood samples from deceased persons that were received for analysis. The parameters included the dates of sample acquisition at medico-legal mortuaries, delays in submission of samples to the laboratory, and dates of actual analyses. In addition, the expiration dates of sample collection kits were recorded. Our results show that numerous expired kits were utilised and that there was an average delay of approximately five months between sample acquisition and laboratory analysis. This delay period varied greatly but appears to correlate with geographical distances of medico-legal mortuaries from the PFCL. In order to optimise and facilitate the administration of justice in both criminal and civil cases of alleged DUI, these shortcomings should be urgently addressed. It is argued that the implementation of prescribed measures and standard operating procedures in sample management, together with interventions such as accreditation of laboratories and improved resourcing of medico-legal and toxicology laboratories, is urgently required.

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In South Africa, criminal prosecutions of people driving while under the influence of alcohol (DUI) have in recent years received much attention. Defence attorneys often dispute the validity of the reported blood alcohol concentration (BAC) or breath alcohol concentration (BrAC) values of drivers accused of being under the influence of alcohol. Anecdotal evidence also suggests that insurance companies have become stricter in their approach to payouts in respect of damages suffered in cases where drivers may have been under the influence of alcohol, or where BAC values had exceeded the stipulated statutory limit.[1] In South Africa the specified legal limit for driving a motor vehicle is 0.05 g of ethyl alcohol per 100 ml of blood. Therefore, as little as 0.01 g per 100 ml increase in BAC value above the legal limit may result in criminal prosecution or the repudiation of an insurance claim for damages. Accordingly, defence attorneys in cases of criminal prosecution, or those litigating in respect of insurance claims, will often challenge the validity of reported BAC values on the basis that, for example, the sample may not have been properly obtained, was inappropriately stored or inaccurately analysed. In criminal cases the burden rests on the state or prosecution to show that the reported BAC value was accurate and a true reflection of the amount of alcohol in the blood of the driver at the time of the accident. The submission of reports prepared by experts in the employ of the state are deemed to be presumptive proof of the contents thereof, in terms of Section 212 of the Criminal Procedure Act. However, the defence or respondent may argue that there is a reasonable likelihood that the reported BAC value is not reliable, on the basis that a significant change in BAC value of the sample had set in since the time of the accident, or that the sample had not been properly analysed.

If the driver of a motor vehicle that has been involved in an accident is fatally injured, s/he will undergo a medico-legal autopsy, and in most cases a blood sample will be retained by the forensic medical practitioner in order to determine the BAC. The literature indicates that there are indeed a number of factors that may negatively affect the reliability of using such post-mortem blood samples for purposes of establishing the probable BAC at the time of the relevant incident. These include, for example, developments such as post-mortem autolysis and decomposition of the body, obtaining the blood sample from an inappropriate site in the body, use of inappropriate containers for sample collection and/or storage, contamination of samples, temperature variations during transit or storage of the sample, and undue delays in sample analysis.[2]

The failure to conduct timely analyses of blood samples may compromise DUI investigations and criminal prosecution, and may undermine the constitutional rights of accused individuals. Furthermore, it may result in long delays in settling disputes or claims for insurance pay-outs and in settling the estates of deceased individuals, potentially causing great financial hardship to dependants or beneficiaries. However, perhaps the greatest risk associated with delays in analysing blood samples lies in the fact that changes in the concentration of alcohol or drugs in such specimens may make the measured and/or reported values inaccurate and unreliable. The effects of long periods and variable conditions of storage on measured BAC have not been fully established, but many authors have warned against long retention periods of samples as this may cause substantial alterations (increase or decreases) in BAC.[3] Long delays in the analysis of biological fluid samples such as blood may result in sample degradation or alteration due to the thermolability of substances, actions of micro-organisms, evaporation and haemolysis.[4] Although specific steps may be taken in an attempt to minimise such risks, such as refrigeration of samples and the addition of chemical preservatives to the specimen, there is

no guarantee that these measures will prevent negative outcomes. The best approach would be to ensure that rapid and effective sample analysis takes place as soon as possible after acquisition. Multiple studies have shown that long retention of samples can result in variable results, even if samples are refrigerated or have been chemically preserved with substances such as sodium fluoride.[5] Clearly this could have profound effects on criminal and civil legal proceedings.

In 2015 it was reported that 44 526 DUI cases were withdrawn from South African courts in the 2012/2013 financial year, for a variety of reasons – but a substantial number of these related to inadequacies in the maintenance and operation of technical equipment (including breathalyser apparatus), inadequate or inappropriate sample retention and storage, as well as invalid sample analysis.[6]

Blood samples for alcohol analysis in post-mortem and DUI cases are submitted to the Forensic Chemistry Laboratories (FCL), which are run by the National Department of Health (NDoH). Until recently, there were only three such laboratories in South Africa, situated in Pretoria, Johannesburg and Cape Town. A fourth was opened in Durban in 2015. These laboratories receive large numbers of samples derived from fatal outcome cases (medico-legal autopsies), as well as from drivers stopped at roadblocks and accident scenes.

This study aimed to investigate sample management in respect of collection of blood and fluid samples during medico-legal post-mortem examinations, the subsequent storage periods before submission thereof to toxicology laboratories, and the time lapse from the collection of the sample to the analysis thereof. Our findings suggest that samples are being poorly managed and that it would be beneficial to introduce remedial and preventative measures in the form of prescribed protocols and procedures, in order to minimise risks associated with sample degradation, before analysis.

Materials and methods

A retrospective descriptive study was carried out on toxicology records from the database at the Pretoria Forensic Chemistry Laboratory (PFCL), pertaining to blood samples received for analysis from 55 medico-legal mortuaries in KwaZulu-Natal, Mpumalanga, Limpopo and northern Gauteng over a period of six consecutive months, from 1 July 2012 to 31 December 2012. All blood samples received by the PFCL were included in the study.

The following data and information were evaluated for each specimen: date of sample acquisition (i.e. date of autopsy), date of sample transfer to the PFCL, and date of sample analysis at the PFCL. In addition, the date of manufacture and the manufacturer's stipulated expiration date of the container kits for blood alcohol samples were recorded. A review was also undertaken of the geographic distribution of the mortuaries in each of the provinces, and their respective distances from the PFCL. Data were collected by the first author.

The data were entered into a Microsoft® Office Excel® 2007 spreadsheet and transferred to the IBM® SPSS® Statistics (IBM Corporation, Armonk, New York, US) program as well as the SAS/STAT® Software (SAS Institute Inc., Cary, North Carolina, US), and analysed in conjunction with a statistician. Approval to perform the study was obtained from the relevant authorities, including the head of the FCL and the Research Ethics Committee of the Faculty of Health Sciences at the University of Pretoria, prior to the commencement of the study.

Results

The PFCL received a total of 39 429 samples for 2012. These included 23 862 DUI samples,

5 968 post-mortem blood alcohol samples, 3 649 toxicology samples and 1 320 other samples (which include food and liquor samples). For the designated study period (1 July to 31 December 2012), a total of 3 010 post-mortem samples were received. Of these, 253 samples had to be excluded from the study due to incomplete paperwork (e.g. the date of the post-mortem was not completed on the collection form). A total of 2 757 samples were thus included in the study. Most of the study samples (43.2%, n=1 191) were received from KwaZulu-Natal, followed by northern Gauteng (30.1%, n = 831), Limpopo (14.9%, n = 410) and Mpumalanga (11.8%, n = 325).

Dates of sample acquisition and delivery

Table 1 indicates by province in which the mortuary is situated, the average number of days between sample collection and delivery to the PFCL, the average number of days between delivery at PFCL to analysis, and the total number of days from sample collection to analysis. From the data it appears that there were substantial variations between provinces in delays between collection and delivery, but that the period between receipt of sample and analysis was fairly constant for all samples, being approximately 102–118 days.

Grouping of mortuaries according to geographical distance from the PFCL

The 55 submitting mortuaries were further divided into eight groups according to their distance (divided into 100 km ranges) from the PFCL, as set out in Table 2. Mortuaries situated within 100 km of the laboratory (five mortuaries) handed in their samples within, on average, seven days of collection or autopsy (SD = 23.93). Of the 55 mortuaries, 38% (n = 21) delivered their samples to the laboratory, on average, within 30 days. Four (7%) mortuaries handed in their samples, on average, more than 120 days after sample collection (with one mortuary taking 587 days to submit the samples). It seemed clear that greater geographical separation from the PFCL resulted in longer delays in sample delivery, although it was also noted that smaller mortuaries (where fewer autopsies were performed) also tended to have longer delay periods before delivery of samples. In general, the closer the distance to the PFCL, the shorter the time between sample collection and delivery at the PFCL (Table 2).

Expiry dates on sample collection kits

The manufacturer of the blood alcohol collection kits has set an expiration date of two years after the date of production of the kit.

Table 1: Number of days between collection, delivery and analysis per province

Province	Mean number of days between collection and delivery date (m±SD)	Mean number of days between delivery and analysis (m±SD)	Mean number of days between collection and analysis (m±SD)
Northern Gauteng	5.17 ± 6.85	102.13 ± 34.17	107.42 ± 34.65
KwaZulu-Natal	93.06 ± 160.77	118.52 ± 35.35	213.32 ± 165.18
Limpopo	34.99 ± 43.44	102.38 ± 32.98	138.05 ± 58.37
Mpumalanga	43.69 ± 106.72	102.73 ± 30.23	147.52 ± 114.76
Combined averages	52.11 ± 119.31	109.12 ± 34.96	161.20 ± 126.85

Table 2: Mortuary grouping according to distance from Pretoria and the number of days between collection, delivery and analysis for each distance category

Distance from Pretoria FCL	Number of mortuaries	Mean number of days between collection and delivery date (m±SD)	Mean number of days between delivery and analysis (m±SD)	Mean number of days between collection and analysis (m±SD)
0–99 km	5 mortuaries (Northern Gauteng – 3, Mpumalanga – 2)	7.14 ± 23.93	102.45 ± 33.91	109.69 ± 40.94
100–199 km	8 mortuaries (Mpumalanga – 6; Limpopo – 2)	24.18 ± 80.18	97.20 ± 29.00	121.46 ± 85.36
200–299 km	11 mortuaries (Mpumalanga – 6; Limpopo – 5)	46.58 ± 93.72	110.00 ± 34.04	157.97 ± 107.60
300–399 km	7 mortuaries (Mpumalanga – 3, Limpopo – 3; KwaZulu-Natal – 1)	50.82 ± 45.43	90.63 ± 30.22	141.45 ± 50.82
400–499 km	10 mortuaries (KwaZulu-Natal – 6, Mpumalanga – 2; Limpopo – 2)	44.16 ± 35.40	101.50 ± 25.66	148.94 ± 46.61
500–599 km	2 mortuaries (KwaZulu-Natal)	61.73 ± 37.93	95.93 ± 27.55	158.43 ± 53.89
600–699 km	10 mortuaries (KwaZulu-Natal)	99.08 ± 168.47	120.56 ± 35.79	222.27 ± 172.77
700–799 km	2 mortuaries (KwaZulu-Natal)	40.27 ± 53.94	105.30 ± 28.02	146.01 ± 63.61

These dates are printed on the containers (Figure 1). In 197 (7%) of the 3 010 cases reviewed, no expiration date was stated or recorded in the records reviewed at the PFCL. In 688 (23%) cases, expired kits had been used to collect the blood sample, with most of these kits having expired nine years prior to sample collection (the rest of the expiration dates ranged from one to seven years prior to sample collection). In 305 (10%) cases kits were used that were valid at the time of sample collection but they had expired either before they were submitted to the PFCL or before they were analysed.

Figure 1: Manufacturing and expiration date as listed on a standard blood alcohol collection kit

Discussion

From the data collected in this study, it appears that there are at least three serious concerns in post-mortem blood alcohol sample management. These are: 1) the long delays in getting samples to the PFCL; 2) the long delays between receipt of sample and the analysis thereof; and 3) the use of expired kits for sample storage. To the best of our knowledge, this is the first study to clearly and definitively illustrate the delay between sample collection and analysis.

The study suggests that delays of between four and six months between sample collection (autopsy) and sample analysis are not unusual. Unfortunately, for a variety of reasons, a very large national backlog has developed in the analysis of all these samples. According to the NDoH, in November 2014 the country faced a backlog of 69 476 samples.[7] The PFCL receives post-mortem samples from medico-legal mortuaries in KwaZulu-Natal, Limpopo, Mpumalanga and the northern part of Gauteng, thus serving over half the country's population (approximately 27 million people).[8] While it will be important for future research to establish the extent to which such delays have an impact on the actual BAC at the time of autopsy (if at all), the preliminary conclusion is that the current system hampers rather than supports the prosecution of people suspected of DUI offences.

There are currently no prescribed minimum periods for the completion of sample analyses in South Africa. Internationally, accepted norms and procedures in respect of post-mortem sample acquisition and analysis have evolved in the forensic medical and scientific fields. Following standardised operational procedures (SOPs) and accrediting laboratories according to national and international standards will help to authoritatively validate results in DUI investigations. While a lack of such accreditation does not mean results produced in a laboratory are necessarily inaccurate or unreliable, accreditation does provide some measure of quality assurance. It is for this reason that appropriate quality controls and audit mechanisms should be put in place in respect of sample acquisition, storage and analysis.[9] Medical practitioners and scientists who render professional services in this domain, or who are called to testify as experts in legal proceedings, are obliged to divulge all relevant information that may have an impact on the validity of results, without regard for the interests of the parties involved. It is their duty to draw attention to conditions or developments that may lead to inaccurate analyses or results being served before the courts.

In addition to delays in processing time, the fact that 253 samples (8.4%) had to be excluded from the study due to incomplete paperwork is of further concern. It is worrying that in some cases the forensic medical practitioner and/or forensic officer responsible for completing the required information did not appreciate the importance of providing all pertinent information.

Our results indicate that in approximately a third of cases reviewed, expired kits were used to collect samples for blood alcohol analysis (with many kits having expired nine years prior to sample collection). These specially designed kits comprise a protective polystyrene box that houses a glass sample bottle containing sodium fluoride (preservative) and potassium oxalate (anticoagulant) with numbered tamper-proof seals to ensure the integrity of the sample during transit to the FCL. While our study could not determine why expired kits had been used, the potential for legal proceedings to be prejudiced or undermined by such use is obvious. Future research should seek to establish whether the use of expired kits does indeed compromise the integrity of the sample and whether the relatively short expiry period

specified by the manufacturer is an undue limitation in the use of such kits.

It seems clear to the authors that the results presented here represent the proverbial 'tip of the iceberg' as far as forensic toxicology results from state mortuaries and laboratories are concerned. These problems cannot be placed at the door of a single agency, service or group of individuals. Multiple, in-depth studies may be required to adequately identify the scale and nature of these problems. In the meantime, efforts should be made to fast-track the implementation of appropriate and valid preventative and remedial measures. These may include introducing prescribed SOPs regarding sample management (collection, storage, despatch, container validation, time limits for analysis, etc.), ensuring that there is greater decentralisation of forensic toxicology analytical services, accrediting laboratories and introducing effective laboratory information management systems (LIMS). And yet, such measures may come to nothing if there remains a shortage of trained analysts working in forensic toxicology, and if the management and resourcing of medico-legal mortuaries in South Africa are not improved.

From time to time, media reports suggest that police officers intentionally tamper with blood samples, for example by subjecting them to extreme heat in the boots of cars and microwave irradiation.[10] If true, the implementation of stricter protocols for the management and despatch of these samples might help to prevent such conduct.

In 2015 the government asked whether the legal limit for driving with alcohol in the blood should be lowered to a zero value. Based on our findings, a better way to address the problem of DUI may be to optimise the administration of existing legislation and ensure that there are fewer 'loopholes' – or valid defences – for culprits.[11]

It should be reiterated that this study addressed only the management of blood samples retained from deceased individuals: the results are not necessarily a reflection of the management of samples obtained from living drivers suspected of DUI. Separate studies will be required to shed more light in this regard. Furthermore, this study did not seek to identify all possible causes or reasons for delays in the delivery of samples to laboratories. Clearly, a multiplicity of factors may play a role, including, for example, the efficiency of mortuary management, whether use is made of shared transport services, and the decision to aggregate samples until adequate numbers are accumulated to 'justify' sample despatch. It would seem obvious that greater geographical distances would serve as a deterrent to immediate or rapid sample transfer (perhaps more so when bureaucratic restrictions for inter-provincial travel are considered).

Conclusion

Long delays in analysing blood samples collected at medico-legal mortuaries, as well as the use of expired containers for such samples, have the potential to seriously undermine the administration of justice in South Africa, as such shortcomings provide a basis upon which those who are indeed guilty of driving while intoxicated may escape successful prosecution. More structured studies are required to assess and address the problems related to forensic toxicology service delivery in South Africa. By doing so we may pre-empt the opportunistic defences sometimes presented on behalf of those who bring this scourge to our roads.

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Notes

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