

Forensic Analysis in Toxicology

Forensic toxicology is a multi-disciplinary field combining toxicological principles, analytical chemistry and methods, analytical toxicology, clinical chemistry, pathology, pharmacology, investigative research, data collection and collation — and a certain amount of detective work. TCAS has extensive expertise in forensic toxicology with more than 28 years of conducting hands-on investigations.

Principles of Forensic Toxicology

The ultimate goal of forensic toxicology is to correctly establish or refute causation to *reasonable toxicological certainty*. Aside from assessing each piece of evidence on its own merits, the forensic toxicologist must rule out other possible factors before drawing conclusions. Thus, the nature and steps of a forensic investigation are primarily based on the circumstances and available facts pertaining to the case itself. However, every case is different and there is no guarantee that there will be sufficient toxicological evidence to provide a decisive opinion.

To produce scientifically credible reports and opinions, the expert forensic toxicologist must conduct his investigation and assessment pragmatically. Evidential factors may include medical records, symptoms, treatments, dosages, environmental conditions and events (sometimes over a period of many years), historical records, laboratory data, etc. In criminal investigations, crime scene evidence, police reports, witness statements, autopsy reports, postmortem interval and analytical toxicology reports all contribute to reconstructing events.

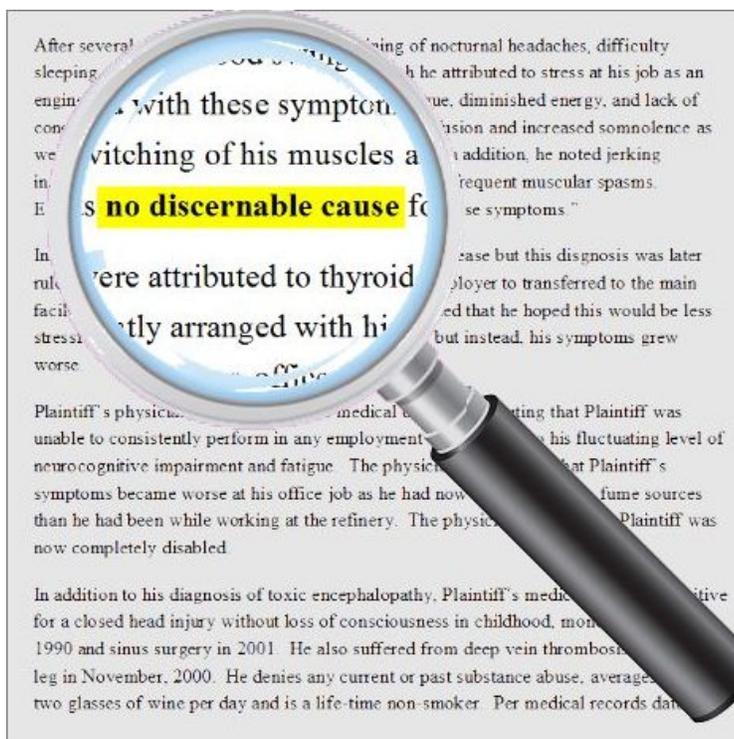
Although the forensic toxicologist goes where the evidence leads, he must be prepared to factually recount on demand all of the investigative steps taken to derive the reported results. This is a critical responsibility as a forensic investigation may or may not lead to a determination of causation.

Forensic Toxicology in Litigation

Toxicological opinion(s) presented as expert testimony can significantly impact the outcome of a case. Although the outcome of a forensic investigation is relevant to the parties involved, proving or disproving a case is a matter for legal counsel. The toxicologist can only offer opinions and evidence to assist and educate the judge and the jury.

Thus, accurate compilation and objective interpretation of investigative results are central to any responsible forensic toxicological assessment. When deposed and questioned by counsel, the expert toxicologist must be keenly aware of the obligations and responsibilities thus imposed:

- **Case Knowledge:** The toxicologist must be prepared to testify regarding the basic facts of the case and answer questions pertaining to circumstances. He may be questioned at great length on what might otherwise be presumed to be trivial matters. Thus, the toxicologist's testimony will only be regarded as credible if he possesses a working knowledge of case facts.
- **Qualifications and Integrity:** The toxicologist must stay within his area(s) of expertise, deferring non-toxicological matters to other experts and authorities.
- **Foundation of Opinions:** The toxicologist must be able to clearly and concisely communicate the generally-accepted method(s) that were used to conduct the investigation and/or arrive at opinions or conclusions. This may include explanations of any relevant studies or citations applicable to the investigation.
- **Degree of Certainty:** The toxicologist must define the degree of certainty of his conclusions. Toxicological opinions should be expressed as conclusions arrived at *within reasonable toxicological certainty*.



Forensic toxicology is an investigative process which may or may not lead to causation.^(a)

- **Credibility:** The toxicologist must expect that opposing counsel will attempt to refute or discredit his testimony and may even enter motions to exclude. In such instances, the toxicologist must be prepared to produce objective rebuttals supported by generally-accepted methods and peer-reviewed epidemiological studies and/or case evidence.
- **Ethical Coherency:** The toxicologist must be thorough without being redundant and complete without transgressing into unrelated areas. If confronted by difficult or misleading questions, he must respond with concise professionalism, integrity and dignity.

As previously stated, the impact of a well-constructed toxicological assessment in litigation can be instrumental in assisting the judge and jury in understanding the case evidence. A scientifically credible report can provide key information as to the contaminant(s) present in an individual as well as the dose of each substance and whether the levels are consistent with a therapeutic dosage and/or adverse health effects. When such results are presented as testimony with respect to a substance's potential effect on an individual's death, illness, or mental or physical impairment, these factors can have profound evidentiary impact. For example, the results of a blood analysis from a driver involved in an automobile accident can be used to determine if the individual was under the influence of drugs or alcohol.¹ Similarly, the amount of a substance in the blood can be compared to levels documented in generally-recognized, peer-reviewed studies to demonstrate or refute general or specific causation.

Compliance with Scientific Methodologies

Because the forensic toxicologist goes where the evidence leads, it is critical that the investigative procedure be based upon generally-accepted, peer-reviewed methods. The forensic toxicologist may be confronted with a massive volume of evidence which must be carefully analyzed, compiled and reduced to isolate relevant investigative components. In other cases, little or no physical evidence may exist. Thus, there are sometimes important investigative avenues to be explored. Although evidence may ultimately appear, the forensic toxicologist must sometimes develop opinion(s) from extrapolation of information. This may come from paper-based records, autopsy records, physician reports, company memos, police reports, first-hand accounts (in the form of sworn statements or deposition testimony), questionnaires, studies, specialized analyses of blood, tissue and/or environmental samples — in other words, every conceivable source of information.

To this end, it is extremely important to be thorough when assessing the available data, particularly where data quality is concerned. For example, quality control can be critically important for some substance measurements and the forensic toxicologist should do more than merely accept summarized laboratory results. All available raw laboratory data should be acquired and reviewed, particularly the actual GC/MS spectrometry analyses for such methodological factors as (a) mass ion fit, (b) retention time, (c) baseline noise and other analysis artifacts. Any or all of these data components can prove to be relevant to the overall toxicological assessment.

Summary

Although forensic evidence varies as widely as the cases themselves, the requirements imposed on the expert toxicologist are strict, particularly with respect to expert testimony. There can be no "gray" areas if the toxicologist's testimony is to be regarded as scientifically credible. In particular, there can be no "novel methods" used to present opinions or conclusions. Credible testimony must be presented in compliance with the Frye or federal Daubert standard:

"While courts will go a long way in admitting expert testimony deduced from a well-recognized scientific principle or discovery, the thing from which the deduction is made *must be sufficiently established to have gained general acceptance in the particular field in which it belongs.*"

Frye v. United States, 293 F. 1013, 1014 (DC Cir. 1923).²

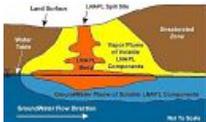
Forensic Toxicology Archives

The following archive illustrates some of the methods and investigative techniques *TCAS* employs to conduct forensic toxicological assessments. Toxic exposure studies provide descriptive and instructional information pertaining to some of the various toxic agents with which *TCAS* has been involved on numerous occasions. Toxicology case studies are impartial and objective summaries of toxicological matters in which *TCAS* was retained for the purpose of assessing health-based factors which, in some cases, led to a determination of causation. No names or identifying information have been provided due to privacy and legal considerations.



Toxic Exposure Studies: TCDD Dioxin Toxicology

TCAS has been involved in numerous cases involving TCDD exposures. We have had considerable experience in conducting toxicological risk assessments for TCDD, PCBs and other dioxin congeners. As part of our approach to presenting toxicological information in a manner that can be easily understood by a judge and jury, we have produced many demonstratives... [\(more\)](#)



Toxic Exposure Studies: Forensic Analysis of Light Non-Aqueous Phase Liquid (LNAPL)

For more than two decades, *TCAS* has been retained in cases involving LNAPLs. We have significant experience in establishing the source(s), age and characteristics of LNAPL. We have performed LNAPL risk assessments on behalf of individuals, private industry and government agencies such as the New York State DEC, New Jersey DEC and others . We have offered unbiased... [\(more\)](#)



Case Studies in Toxicology: Alcohol Intoxication Leads to Fatal Boating Accident

This case study summarizes the events leading up to and following a fatal boating accident on Florida's intracoastal waterway. It illustrates the role of back-extrapolation and weight-of-evidence (WOE) in an alcoholic impairment assessment and demonstrates how behavior and judgment on the part of the defendant can be considered as evidential in a toxicological analysis... [\(more\)](#)



Case Studies in Toxicology: Mold in Motor Home Causes Aspergilloma

This case study illustrates the role of toxicological weight-of-evidence (WOE) in a case involving exposure to mold inside a motor home. It also illustrates how analytical measurements and medical history can be considered as evidential in a toxicological analysis. Shortly after purchasing a new motor home, the owner noticed... [\(more\)](#)



Case Studies in Toxicology: Toxicological Assessment of Phosphoric Acid

This case study summarizes the events leading up to and following the filing of a lawsuit by a woman against her employer for an injury allegedly suffered as a consequence of a toxic exposure to a cleaning chemical. It illustrates the important role a toxicological assessment can play in litigation and demonstrates how inference and assumption can... [\(more\)](#)



Case Studies in Toxicology: Toxic Tort: Trichloroethylene in Residential Water Supply

This case study summarizes the events surrounding the filing of a lawsuit by residents against a company for allegedly contaminating the local water supply with trichloroethylene, a chemical used in industrial cleaning and degreasing. It further illustrates how exposure evidence, historical factors, a residential questionnaire and a toxicological risk... [\(more\)](#)

Case Studies in Toxicology: Cleaning Chemical Exposure

This case study recounts the circumstances surrounding a woman's claims that exposure to a chemical stripping agent caused burns, infection and damage to her immune system. The outcome illustrates the importance of validating claims against medical history and assessing toxicological factors according to peer-reviewed literature in order to establish reasonable... [\(more\)](#)



Case Studies in Toxicology: Postmortem Alcohol Formation in a Severely Burned Victim

In this case study, a passenger severely injured in a motor vehicle fire filed a lawsuit against the vehicle manufacturer. The case partially rested on whether or not the driver could be shown to have been intoxicated. The surprising outcome was based on a little known but well-documented fact concerning endogenous alcohol which can be created following... [\(more\)](#)



Case Studies in Toxicology: Hair Samples Yield Incorrect Cocaine Use Conclusion

This case study recounts the circumstances relating to a teacher faced with pending dismissal for alleged drug use based on erroneous interpretation of cocaine in hair test samples. This case illustrates the importance of applying a correct, peer-reviewed scientific methodology to laboratory analyses and interpreting the results in line with established... [\(more\)](#)



Case Studies in Toxicology: High-Level Petroleum Hydrocarbon Vapor Exposures Induce Toxic Encephalopathy

This case study demonstrates how causation can be demonstrated by weight-of-evidence (WOE) and how objective investigation of contributing factors can play a pivotal role in formulating an expert opinion to reasonable toxicological certainty. Toxic encephalopathy can be caused by repeated exposure to high-level refinery hydrocarbon vapors. A process engineer worked for seven... [\(more\)](#)



Case Studies in Toxicology: Fatal Accident Caused by Long-Term Drug Use?

This case study summarizes the events following the death of an elderly man involved in a motor vehicle accident and demonstrates how pharmacological factors and behavior on the part of the defendant can be considered as evidential in a toxicological analysis... [\(more\)](#)



Case Studies in Toxicology: Pesticide Exposure Leads to Sudden Death

This case study summarizes events relating to the death of a man with a history of seizure disorder who was fatally exposed to pesticides in his unventilated basement apartment. It illustrates the role of an impartial toxicological assessment in litigation involving pesticides... [\(more\)](#)



Case Studies in Toxicology: Polypharmacology Induces "Sleep Driving"

This case study illustrates the role of toxicological weight-of-evidence (WOE) in a motor vehicle accident case involving polypharmacology and antidepressants. It also illustrates how drug interactions can be considered evidential in a toxicological causation assessment. On the evening prior to a serious motor... [\(more\)](#)

Case Studies in Toxicology: Polycyclic Aromatic Hydrocarbons (PAHs) and Polychlorinated Biphenyls (PCBs) Create Residential Hazard



This case study reviews a residential contamination case involving local residents exposed to water contaminated with PAHs and PCBs flooding their properties. It illustrates the importance of applying generally-accepted, peer-reviewed toxicological assessment methods and the steps necessary to present scientifically credible findings in litigation.... [\(more\)](#)



Case Studies in Toxicology: Cass Lake: Mass Toxic Tort

This case study summarizes the events leading up to and following a widespread contamination case involving local residents and a company disclaiming responsibility for damages. It illustrates the role of weight-of-evidence (WOE) in a toxicological analysis and demonstrates how meticulous attention to detail can be a deciding factor in a complex assessment... [\(more\)](#)



Case Studies in Toxicology: Acute Marijuana Intoxication

This case study illustrates how circumstantial evidence can be misinterpreted and how drug-impaired judgment and behavior can be regarded as evidential in a toxicological causation assessment. A motorcyclist was fatally injured when he collided with a city bus in a business district... [\(more\)](#)

Notes and References

1. National Institute of Justice, "Forensic Toxicology," 2014
 2. University of Florida Levin College of Law, "Frye v. United States, 293 F. 1013, 1014," DC Cir. 1923
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Images

- a. TCAS demonstrative (redacted), graphical image © Copyright 2017, TCAS, LLC.
 - b. Thumbnail images from multiple sources as noted on referenced pages.
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A Message from Dr. William R. Sawyer Chief Toxicologist, TCAS, LLC



"Although forensic toxicology is a challenging discipline imposing many requirements on the expert toxicologist, an investigative spirit and quest for accuracy can sometimes uncover scientifically credible discoveries that can strongly impact a case."

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