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Activities of the Unit for Forensic Chemistry and Toxicology of the Swiss Society of Legal Medicine

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Abstract. In Switzerland, analytical toxicology and chemistry in the Forensic Medicine are scientifically organized around the Swiss Society of Legal Medicine. These specialized fields of activity in service analyses, development and research are mainly concentrated within the six laboratories of the actual university's institutes dedicated for Legal Medicine in Basel, Bern, Geneva, Lausanne, St. Gallen, and Zürich. Forensic chemistry and toxicology are routinely dealing with the latest developments in analytical chemistry, using mainly very selective methods relying on tandem instrumental techniques like GC/MS or LC/MS in order to provide analytical results with the level of quality requested by the Justice.

The Unit for Forensic Chemistry and Toxicology is part of the Swiss Society of Legal Medicine. This scientific society can be divided into various specialities including so far: Forensic Pathology and Odontology, Forensic Haemogenetics and Forensic Chemistry and Toxicology.

In our Country, the activities in this specialized field of analytical toxicology for forensic purposes are quite particular due to the responsibilities given to each Canton's authorities in term of Justice. Thus, each Canton has its own organization and refers to a specific laboratory. Our members, chemists, biochemists, biologists or pharmacists, and laboratory technicians can be classified belonging for the largest majority to three kind of institutions:

- Laboratories linked to Universities, mainly within the Faculties of medicine,
- laboratories attached to the Departments of Justice or Health, and,
- private laboratories.

After their studies at the university, chemists or other diplomées from related disciplines have no practical experience at all in the detection of poisons in various samples including biological matrices. They might have acquired only very limited theoretical knowledge about what are forensic chemistry and toxicology made from as these branches are not part of the actual programme of studies. Indeed, most of the 'information' may have been gathered from unreliable sources like criminal books and newspapers by private readings.

Complet post-graduate formation is thus mandatory. This can be achieved only at specialized forensic toxicology laboratories within a minimum of one year full time training. Mastering the most advanced techniques of samples preparation, purification procedures, derivatization, separation and finally characterization of the detected molecules are just the basis. Additional experiences in pharmacokinetic and training in the interpretation of the results are mandatory as well as experience in reporting to tribunal's courts. Practical experience is in this context invaluable. Understandingly, leading positions for implementing internationally recog-

nized quality standards and continuous education and training pertain to the six laboratories of the Institutes of Legal Medicine. These are located in Basel, Bern, Geneva, Lausanne, St. Gallen, and Zürich.

Our Unit's 54 members meet 2 to 3 times a year and hold their annual scientific meeting together with the Swiss Society of Legal Medicine, during Summer times. The actual elected coordinator of our section is Dr. *Thomas Briellmann*, head of the Toxicology Laboratory at the Institute of Legal Medicine in Basel, to whom any interested person can write. Our Unit is divided into four groups, each member of the Unit can take part to more than one group's discussions. These are today:

- toxicology, including driving under the influence of drugs: 38 members (Dr. *C. Staub*, IML, Geneva)
- analysis of drugs of abuse or 'powders': 25 members (Dr. *W. Bernhard*, IRM, Bern)
- alcohol and driving : 25 members (Dr. med. *D. Castelli*, Lab. Bioanalytico, Lugano)
- heads of the 'official forensic toxicology laboratories': 6 members (PD Dr. *L. Rivier*, IUML, Lausanne)

This last group has recently been involved in the redaction of a consensus report for 'Guidelines for the analysis of drugs of abuse' published in a special issue of *LaboLife* 1997, the official publication of the Swiss Union of Laboratory Medicine.

At the international level, our members maintain close and continuous connections with many colleagues from all over the world, specially through the scientific meetings organized annually by the main scientific societies namely:

- The International Association of Forensic Toxicologists (TIAFT, Dr. *L. Rivier* is the regional representative). Interesting details on its activities can be obtained through the following web address: <http://www.cbft.unipd.it/tiaft/>
- The 'Gesellschaft für Toxikologische und Forensische Chemie' (GFTCh, represented in our Country by Dr. *T. Briellmann*), in Germany,
- the Society of Forensic Toxicology (SOFT) in the USA, and,
- the 'Société Française de Toxicologie Analytique' (SFTA, represented in our Country by Dr. *C. Giroud*, IUML, Lausanne) in France.

In 1996, Dr. *W. Bernhard* from IRM, Bern has organized a very successful TIAFT Congress in Interlaken and Dr. *P. Iten* from IRM, Zürich was participating in the organization of the annual Congress of the 'Deutsche Gesellschaft

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für Rechtsmedizin' which was held in Zürich.

We have been also very active in these different societies, presenting many scientific papers and posters at each annual meeting and when several critical recommendations for good laboratory practice in specific fields of application have been prepared. The latest of these recommendations deals with the detection of illicit drugs in urine in the European Union with special attention to the workplace and has been published in the TIAFT Bulletin Vol. 27, No. 2, 1997. Some of our members' laboratories are in the process of obtaining the ISO Guide 25 Accreditation.

At a national level, we are organizing for our own use and at regular intervals since several years Quality Controls drawn specifically to fit the needs of our field of expertise. As commercially available solutions are most of the time not available, or they do not satisfy our specific requirements, we have produced ourselves the necessary samples which behave as close as possible to the real life specimens. In order to cope with the most objective approach of this very important issue, we collaborate with the Swiss Centre for the Quality Controls in Geneva (Dr. A. Déom, Director).

What Are We Daily Dealing with?

The Forensic Chemistry and Toxicology's group deals with all matters pertaining to the organization, standardization and qualification of poisoning analyses related to the exercise of the Justice. Both inert and biological materials are looked for the presence of particular compounds which might explain the behavior or status of a certain individual. The variety of analytes is large, the quantity and quality of available material may be very limited (especially from putrefied, mummified, or severely burned bodies), the artefacts encountered may be significant, the requirements for proof of identify of the detected compounds are very high, and the results of the analyses may have far-reaching consequences, sometimes pertaining to other than the individual from whom the specimens were obtained. The forensic analyst must be prepared to defend his data in Court, and withstand vigorous cross-examination. Internationally recognized quality standards are thus required. This is why this need of the forensic analyst to satisfy legal processes sharply distinguishes them to the clinical toxicologists.

The *forensic chemists* will mainly deal with the analyses of drug of abuse exhibits taken by the Police or at Customs. Toxins in general, explosives and fire accelerants are also often encountered. After determining the quality of the drug (including adulterants like Paracetamol, Caffeine and Procaine, and diluents like sugars, *e.g.*), the exact amount of drug of abuse, as stated in the Swiss law should be accurately determined. From these figures, differentiation between a simple consumer and a trafficker can be well set. New designers' drugs have requested additional analytical skills and gave more importance to the role of these specialists in health services. Most often the pills sold in the black market contain substances quite different from what it is believed, and if present, the quantity of the active substance might be quite variable. Natural products as plants are also considered and, *e.g.*, *Cannabis sativa* L. plantations can be clearly classified between the fiber and the drug types. Finally, clandestine laboratories might be search for illegal activities by the characterization of residues from previous synthesis' processes.

The *forensic toxicologist* will analyze biological specimens (body fluids, tissues, *etc.*) for xenobiotics and other compounds which might have impregnated a person and modified his or her behavior or health. The range of substances to be detected is very large indeed as we estimated that more than 60 000 different toxic chemicals known to the chemists can be taken into account. Practically, any medicine, drugs, drugs of abuse, poisons and toxins should be looked after. Heavy metals and some ions are also part of the usual screening if the history of the case does require so.

Both forensic scientists have had specific five years training after their university classes and they should be able to use and maintain functional, state-of-the-art equipments. Not only they must be able to interpret their results, but they must be competent to defend these data if cross-examined. Upon written application, candidates can apply for the specific title of 'Forensic Chemist and Toxicologist' to the 'Swiss Society for Legal Medicine'.

Specific Analytical Approach and Methodology

Maintenance of a closed chain-of-custody is of up-most importance from the time of sample collection to the entrance of the specimen into the laboratory. The

samples should be properly obtained, placed in appropriate containers, sealed, signed and dated. Storage is organized to keep degradation as low as possible (usually at -20°).

Qualitative techniques should be as simple as possible divided between two different approaches: screening and confirmation. Immuno-assays, TLC, GC, HPLC and GC-MS have been used alone or in combination in order to cover an as wide as possible range of substances. For confirmation, mass spectrometry (GC-MS, GC-MS/MS and, more recently LC-MS and LC-MS/MS) is the golden standard. Specific libraries of reference mass spectra are available, the use of which, together with computerized search aids give a very powerful analytical approach.

Quantification techniques are generally made with an instrumentation different from the ones used for qualitative analyses. GC, HPLC and GC-MS using stable isotope internal standard are most often used.

Finally, the validation of these procedures are only obtained after publications of all methods used in scientifically peers reviewed and internationally reputed journals as *J. Anal. Toxicol.*; *Forensic Sci. Int.*; *Int. J. Legal Med.*; *J. Forensic Sci. Med. Sci. and the Law*; *e.g.* Neither our group nor the Swiss Society of Legal Medicine are publishing any scientific journal or newsletters by their own. Thus, original and most advanced technologies are generally known internationally and can be used only after careful validation.

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