Science and Justice 57 (2017) 63–71

Contents lists available at ScienceDirect

Science and Justice

journal homepage: www.elsevier.com/locate/scijus

The United Kingdom and Ireland Association of Forensic Toxicologists; establishing best practice for professional training & development in forensic toxicology

Simon Cosbey [a,*], Simon Elliott [b], Sue Paterson [c]

[a] NIVHA Laboratory Services Ltd., Northern Ireland Science Park, Belfast BT3 9DT, UK
[b] Alere Forensics, Malvern Hills Science Park, Geraldine Road, Malvern WR14 3SZ, UK
[c] Toxicology Unit, Imperial College London, London, W6 8RP, UK

ARTICLE INFO

Article history:
Received 15 July 2016
Received in revised form 4 October 2016
Accepted 8 October 2016

Keywords:
Forensic toxicology
Training
Development
Best practice

ABSTRACT

The current status of forensic toxicology in the United Kingdom is discussed with an emphasis on professional training and development. Best practice is proposed using a blend of modular foundation knowledge training, continuing professional development, academic study, research & development and ongoing analytical practice. The need for establishing a professional career structure is also discussed along with a suggested example of a suitable model.

The issues discussed in this paper are intended to provoke discussion within the forensic toxicology community, industry regulators and other government bodies responsible for the administration of justice.

1. Introduction and background

In many jurisdictions, the structure of forensic science has remained largely unchanged, despite rapid growth and demand in recent years. The primary function of most laboratories is casework production, often with insufficient resourcing being directed towards research, innovation and professional development. The emphasis on production, corporate governance and accountability is often imbalanced by lack of scientific focus, control and regulation – with potentially serious consequences for public service and the administration of justice.

Although initiatives to strengthen the forensic sciences have been taking place in a number of countries, the situation in the United States and United Kingdom are discussed below.

1.1. United States

In the United States, the prestigious National Academy of Sciences was commissioned by Congress to conduct a study on forensic science. Their comprehensive report, 'Strengthening Forensic Science in the United States – a path forward' was finally published in 2009 [1].

Most of the recommendations within this comprehensive report were concerned with improving the science, with specific emphasis placed on foundational research, mandatory accreditation of laboratories and mandatory certification of scientists tied in with a mandatory code of ethics. The report also called for the creation of a new independent federal agency to oversee and regulate the practices of forensic sciences and to ensure the development of rigorous research to determine the capabilities and limits of forensic science.

One response to this report, published by a diverse group of academics, lawyers and practicing forensic scientists [2], emphasised the need for the development of a 'research culture' within forensic sciences.

Although particular attention was directed towards the questionable scientific foundation in pattern identification disciplines such as fingerprints, firearms, tool-marks & handwriting, the same recommendations are likely to be applicable across the spectrum of scientific disciplines. Although forensic toxicology should also be considered one of the forensic science disciplines, it has been fortunate to have successfully developed its own voluntary standards for practice (both laboratories and scientists) through the American Board of Forensic Toxicology (ABFT).

More recently (2013) the United States Government created a National Commission on Forensic Science, which was tasked with taking the National Academy's broad recommendations, and turn them into

* Corresponding author.
E-mail addresses: simon.cosbey@icloud.com (S. Cosbey), simon.elliott@alere.com (S. Elliott), s.paterson@imperial.ac.uk (S. Paterson).

http://dx.doi.org/10.1016/j.scijus.2016.10.003
1355-0306/

actions. The commission was chaired by James Cole, Deputy Attorney General and Patrick Gallagher, NIST Director.

A review of current events and activities relating to these initiatives has been published [3]. Although the review is directed towards forensic DNA practice, the first portion of the article provides an excellent review of forensic science initiatives in general.

1.2. United Kingdom

In the United Kingdom, forensic science has undergone many changes over the past decade in particular. For many years the primary provider of forensic services in the UK was the (government owned) Forensic Science Service (FSS). This organisation was closed in March 2012, and the work, assets and staff were transferred elsewhere. The decision to close the FSS has generally been heavily criticised throughout the forensic science community and this view was reflected in a report (July 2013) of the House of Commons Science & Technology Committee [4]. In this report, great concern was expressed about the future of forensic science in the UK within an unstable market, particularly in the area of research.

The report concluded that, in the absence of a strategic commitment to forensic science, the UK Government runs the risk of continuing the pattern of short-sighted decision making that led to the demise of the FSS and the creation of an unstable market. It recommended that a number of matters should be addressed, including R&D funding and assurance of quality standards. It also recommended that the role of the Forensic Regulator should be enhanced and underpinned by statute.

This paper reviews the current status of forensic toxicology and discusses a number of measures that could be undertaken to enhance the overall quality of the services provided. The responsibility however for implementing, managing and financing the initiatives outlined are beyond the control of a professional association and individual practitioners alone. It seems unlikely that the implementation of a successful, centrally managed system and its associated costs could be achieved without mandatory central regulation and public funding. An expansion of the Forensic Regulators Office and obligatory funding by the Department of Justice could be the means by which minimum standards could be assured.

2. Forensic toxicology - background

Forensic toxicology is a well-defined specialism relying heavily on a strong scientific foundation. It differs from many other areas of forensic science and requires particular attention due to the following needs:

High capital expenditure (analytical instrumentation) due to the diverse and challenging nature of analyses undertaken and the recent availability of 'super-instruments' such as those based on high-resolution mass spectrometry.

Technical expertise, requiring specialised training and on-going professional development.

Interpretative skills developed with experience and utilising continually developing sources of information for evidence-based practice

Continual analytical method development, validation and adoption of new techniques and practices.

Practitioner experience, requiring on-going staff development (both in analysis and case reporting) - an appropriate staff career development/progression pathway within forensic toxicology would be desirable.

Although forensic toxicology laboratories are often incorporated into general forensic science laboratories, they are often established within forensic medical institutes or university departments. Such circumstances can be highly beneficial due to their close proximity to an academic environment.

Those toxicology laboratories, which are incorporated into general forensic science organisations, are often regarded as an expensive quirk, on the periphery of mainstream forensic disciplines.

2.1. UKIAFT

United Kingdom & Ireland Association of Forensic Toxicologists (UKIAFT) is a professional association for forensic toxicologists in the United Kingdom and Ireland and was originally formed to provide a forum for practicing forensic toxicologists. It developed from a group of toxicologists representing the major providers of forensic toxicology services within the UK and Ireland and works in conjunction with other toxicology professional groups such as LTG (formerly the London Toxicology Group) and SOFT (Society of Forensic Toxicologists) and other associated groups such as the Royal College of Pathologists. Meetings are held regularly to share knowledge, discuss the development of new analytical techniques and advocate a high level of professionalism among its members.

Following the appointment of a Regulator of Forensic Sciences by the UK Government in 2008, practitioners representing the main providers decided that it was time to form a professional association of practicing forensic toxicologists with the aim of developing and supporting agreed national professional standards of practice and education in forensic toxicology. The first Annual General Meeting (AGM) of the UKIAFT was held at Glasgow University in September 2010 in association with a 2-day scientific conference meeting. Membership of UKIAFT is open to all practicing or trainee forensic toxicologists carrying out work in England, Scotland, Wales, Ireland (North and South) and the Channel Islands.

UKIAFT Laboratory Guidelines have already been published [5] and are available on the association's website (www.ukiaft.co.uk). Alcohol Technical Defence Guidelines have also been published on the website.

It is now considered appropriate that recommendations for professional development and training in forensic toxicology should now be issued for discussion; the general principles outlined in this paper have been reviewed by UKIAFT membership as the basis for establishing and controlling best practice in forensic toxicology.

3. Professionalism

There have been many definitions of the term 'profession'. It has been defined as 'a disciplined group of individuals who adhere to ethical standards, uphold themselves to, and are accepted by the public as possessing special knowledge and skills' [6].

This body of knowledge and expertise is usually based on a foundation of academic research, education and training at a high level. As a consequence, practitioners within a profession are supported in fulfilling their responsibility of providing the best service to the public.

The term 'profession' refers to the area of study and work while the term 'professional body' refers to the organisation that regulates the profession.

While professional bodies are organisations to which its members refer for licensing matters, professional advice and guidance, professional associations (such as UKIAFT) exist as a cooperative group available to set standards for practice and advocate high standards of professionalism among its members.

Professionalism is usually associated with academia, research, knowledge, continuing professional development (CPD), training, certification & licensing, self-policing, self-governance, maintenance of standards, advice & guidelines, public safety, altruism, best practice, experience and codes of ethics.

Behaviours associated with members of a profession include responsibility, accountability, public duty, professional autonomy & independence, corporate trust, professional interaction with others, adherence to ethical standards, professional identity.

There are also accepted traits, which a profession should have, and these have been outlined with reference to the Nursing Profession as an example [7]. Activities should involve:

functioning at a high intellectual level

a high level of individual responsibility & accountability
a specialised body of knowledge
learning in institutions of higher education
adhering to a code of ethics providing guidance within professional practice
a high degree of autonomy & independence of practice
a strong professional identity, commitment to the profession and to professional development
demonstration of competence and possession of a legally recognised license to practice.

There is no doubt that forensic toxicology (and indeed many other areas within forensic science) could score highly within the above framework.

The establishment of a sound professional framework should be seen as the basis for ensuring the highest possible standards of quality are maintained.

The development of consistent and appropriate training structures, continuing professional development, guidelines for practice, empowerment of individual responsibility and professional licensing should all be welcomed.

Indeed if the industry regulator held statutory authority, the input from a professional association should help fulfill the necessary obligations.

4. Career development

The establishment of a suitable tiered and progressive professional career structure would underpin forensic toxicology practice. Such a structure would help enable forensic toxicology to thrive and develop. To enable this development, organisations may wish to support such a structure; the acceptance of such a concept would greatly enhance overall quality and public confidence in the service.

Research, method development, scientific direction & leadership, training, professional development, mentoring, networking should be incorporated at all stages of the structure.

It would be expected that progression between levels within such a professional career structure would involve a formal assessment of competence. This is likely to involve formal review and a demonstration (through experience, professional development and training) of higher levels of competence and professional worth.

The elevation to higher levels should be reflected in a higher level of status and remuneration.

4.1. Succession planning

The continuing development of individuals should also be used as a tool to fulfill corporate succession planning needs. Although the creation of an unbalanced top-heavy structure should be avoided, some flexibility regarding grading 'quotas' should be acceptable in order to ensure that skill gaps are minimised when staff move on or retire. Laboratories should not find themselves in a position where serious skill gaps compromise the quality of their work.

4.2. Knowledge & skills retention

The retention of professional skills and knowledge within the specialism should form part of corporate governance policy; enabling staff to develop their careers within their chosen area of expertise will prevent dilution of these skills. This would result in a highly motivated workforce, comprising a mix of practitioners at various stages of their development. This dynamic mixture of experience, skills and knowledge would provide the perfect foundation for a thriving, successful operation.

4.3. Career structure

Although a potential career structure model, based on the above principles is outlined in Fig. 1a & 1b and is discussed below, further refinement of this structure would be expected. UKIAFT (as a professional association) could act as a focus for any refinement with input from practitioners, employers and industry regulators.

It should also be emphasised that corporate management and administrative function must also be allowed to thrive; indeed ultimate success can only be the result of close cooperation between management and professional strands.

Although higher levels within the professional structure will incorporate management and leadership functions, primary roles at all levels should have a strong science element; this needs to be complemented with a suitable and parallel management/administrative structure – outside the scope of this discussion.

5. Career structure - suggested model

A suggested model for a suitable professional career structure is outlined in Fig. 1a and b. It is based on five career levels (bands); progression to higher levels should involve a combination of on-the-job experience, scientific competence & achievement, management & leadership ability, teaching & research within forensic toxicology. Short-circuiting of the pathway (as a substitute for good corporate planning) should not be acceptable and should be regarded as a quality risk.

There should preferably be incremental remuneration associated with each band to reflect the progressive nature of the personal development required within each band. Such an incremental range would be particularly important for the main career band (Level 4 in this model) to prevent career stagnation within an environment of ongoing professional development and increasing professional worth.

Although expected time durations within each stage have been suggested, progressive incremental development and responsibility undertaken should reflect an individual's speed of development. The suggested model does not consider in-house human resource initiatives that may be in place, including the need to blend professional progression with in-house performance expectations.

'Fast-tracking' of suitable individuals could be accommodated within the structure, but this should not be adopted for reasons of corporate convenience; barriers between levels should be respected and progression to the higher level should be supported by suitable assessment, increasing responsibility and evidence of competence.

Fig. 1a describes the suggested career structure for Reporting Forensic Toxicologists (Levels 1–5). However, after completion of Levels 1 and 2, those individuals with particular aptitude and desire to pursue an analytical toxicology career should have an alternative pathway parallel to the reporting scientist route, as described in Fig. 1b.

The time spent within each band may be extended indefinitely for individuals wishing to remain at a particular level. Many individuals who do not wish to take on extra responsibility may be content to work at their selected level, carrying out a valuable function with a high level of job satisfaction. For this reason, overlapping incremental pay progression within bands would be appropriate in order to reflect increasing experience and worth.

5.1. General comments

Although this structure could represent a sound basis for a suggested career structure, there are a number of related issues requiring further consideration.

The structure does not consider pure administrative and managerial function, which should be regarded as separate and complementary; management, administrative and scientific roles are all essential to the successful operation of a laboratory.

In order to progress to the higher levels in this structure, scientists will often carry out a court reporting function and this is reflected in the reporting pathway (Fig. 1a). Organisations may however wish to accommodate those scientists whose court responsibilities

a

Level 1 – Foundation

Description: this level should be regarded as the main entry-level stage for scientists anticipating a career in forensic toxicology. This stage primarily represents a laboratory-based initial training period allowing the trainee to carry out routine laboratory work and gain some relevant experience in analytical toxicology. It also provides the opportunity to assess this area of work as a future career path.

Entry Requirement: Minimum Honours degree level in a relevant science subject. Preference for entry can be given to appropriate and desirable prior educational course structure such as modules in analytical chemistry, toxicology, forensic science or relevant post-graduate study. Preferred undergraduate science courses could include pharmacy, pharmacology, biochemistry, chemistry, etc. Non-graduate entry is also acceptable for individuals wishing to pursue a suitable workplace-based programme of study.

Primary Operational Role: Routine analytical toxicology laboratory work - under supervision.

Expected Duration: 1+ year

Main Training Thrust: Analytical toxicology - theory & practice. Supported by relevant training courses, mentorship and relevant in-house training modules.

Level 3 – Forensic Toxicologist (Reporting)

Description: this level should be regarded as the main training stage for scientists furthering their career in forensic toxicology casework reporting. Although there may be a defined proportion of time spent in the laboratory environment, scientists working within this stage would be expected to undergo training & development in the interpretative aspects of forensic toxicology and be able to carry out limited and defined court reporting duties for certain case types. It is suggested that initial case types could be non-suspicious post-mortem toxicology, drug and alcohol driving followed by a period of consolidation and review. Progression to more complex case types (e.g. drug facilitated crime, suspicious deaths/homicides, alcohol technical defence, poisoning, etc) should be made with supervision and competency assessment. This would also be expected to include competency to peer review the work of others.

Entry Requirement: Completion of Level 2 and satisfactory assessment for entry into Level 3. Entry to this level should not normally be possible without completion of Level 2.

Primary Operational Role: Continuing interpretative development, training in report writing and defined case reporting.

Expected Duration: 4+ years

Main Training Thrust: Interpretative aspects of forensic toxicology, court reporting training and progressive case reporting.

Level 2 –Scientist (Analytical Toxicology)

Description: this level should be regarded as the main laboratory training stage for scientists wishing to purse a career in forensic toxicology. This is primarily a laboratory based training stage although additional responsibilities within the laboratory environment should be encouraged. It would be expected that trainees at this stage become actively involved in non-routine analytical toxicology, method & instrument development.

Entry Requirement: Completion of Level 1 and satisfactory assessment for entry into Level 2. Entry to this level should not normally be possible without completion of Level 1. Non-graduates entering at foundation level would be expected to have completed their degree.

Primary Operational Role: Analytical toxicology laboratory work including areas of additional responsibility such as instrument maintenance, method & instrument development, and some line management responsibilities.

Expected Duration: 1+ year

Main Training Thrust: Analytical toxicology, further theory & practice – supported by relevant training courses, mentorship and relevant in-house training modules.

Level 4 – Senior Forensic Toxicologist (Reporting)

Description: this level should mainly be regarded as the main aspirational career level for competent court reporting scientists. Individuals working within this band should have already developed a broad knowledge base in forensic toxicology enabling them to:

- contribute significantly to the reporting operation of the laboratory
- be able to carry out preliminary case assessments, advise clients on casework strategy, carry out casework interpretative assessment and case reporting with peer review responsibilities for most casework types and circumstances.
- contribute significantly to a mentoring and training programme for others
- actively support the laboratory quality management system, with responsibilities as appropriate

Although there will be a significant proportion of time spent in case reporting and related activities, it would also be expected that scientists within this level should continue to develop their practice by experience and continuing professional development. This increase in experience and professionalism should be reflected in incremental pay progression.

Entry Requirement: Completion of Level 3 and satisfactory assessment for entry into Level 4. Entry to this level should not normally be possible without completion of Level 3.

Primary Operational Role: Case reporting (including client advice, casework direction, peer review). Continuing interpretative and scientific development. Mentorship and training of others.

Expected Duration: ongoing

Main Training Thrust: Ongoing professional forensic toxicology practice and case reporting - supported by relevant training courses, mentorship and relevant in-house training modules.

Level 5 – Consultant Forensic Toxicologist (Reporting)

Description: this level should mainly be regarded as the top band for highly competent and experienced court reporting scientists. Consultants must be able to take responsibility for wide ranging issues at both sectional and corporate levels within the organisation. They would be the main source of advice, and be actively involved in, corporate and strategic decisions involving their specialism. They will have been able to demonstrate an impressive track record in research, scientific development, leadership, innovation and professional development within their specialism and have a core involvement in the training and development of others. They will likely have contributed to forensic toxicology on a national or international level and be comfortable with contributing appropriately at this level. They will have developed an extensive knowledge base in forensic toxicology enabling them to:

- contribute significantly to the management and/or operation of the toxicology service at both sectional and corporate levels, within the overall management structure.
- act in a consultative capacity for forensic toxicology issues within a corporate management environment
- act in a client consultative capacity.
- play a prominent role in the staff mentoring and training programme
- act as the main quality focus for forensic toxicology within the organisation with responsibility for leading, driving and defining current reporting practice.

It would also be expected that scientists within this level should continue to develop their practice by experience and continual professional development.

Entry Requirement: Completion of Level 4 and satisfactory assessment for entry into Level 5. Entry to this level should not normally be possible without completion of Level 4 and extensive experience and achievement within forensic toxicology. Entry to this level should not be regarded as routine progression and should be reserved for individuals who can demonstrate high achievement in their practice. It should not be for individuals involved in non-operational corporate management.

Primary Operational Role: Advanced case reporting (including client advice, casework direction, peer review). Forensic toxicology guidance, management and leadership. Organising training and development and mentorship. Quality focus for forensic toxicology with direct involvement in the quality management system.

Expected Minimum Duration: ongoing

Fig. 1. (a) – suggested career structure for forensic toxicology (Reporting) b – suggested career structure for forensic toxicology analyst.

b

Level 1 – Foundation

Description: this level should be regarded as the main entry-level stage for scientists anticipating a career in forensic toxicology. This stage primarily represents a laboratory-based initial training period allowing the trainee to carry out routine laboratory work and gain some relevant experience in analytical toxicology. It also provides the opportunity to assess this area of work as a future career path.

Entry Requirement: Minimum Honours degree level in a relevant science subject. Preference for entry can be given to appropriate and desirable prior educational course structure such as modules in analytical chemistry, toxicology, forensic science or relevant post-graduate study. Preferred undergraduate science courses could include pharmacy, pharmacology, biochemistry, chemistry, etc. Non-graduate entry is also acceptable for individuals wishing to pursue a suitable workplace-based programme of study.

Primary Operational Role: Routine analytical toxicology laboratory work, under supervision.

Expected Duration: 1+ year

Main Training Thrust: Analytical toxicology - theory & practice. Supported by relevant training courses, mentorship and relevant in-house training modules.

Level 2 –Scientist (Analytical Toxicology)

Description: this level should be regarded as the main laboratory training stage for scientists wishing to purse a career in forensic toxicology. This is still primarily a laboratory based training stage although additional responsibilities within the laboratory environment should be encouraged. It would be expected that trainees at this stage become actively involved in non-routine analytical toxicology, method & instrument development.

Entry Requirement: Completion of Level 1 and satisfactory assessment for entry into Level 2. Entry to this level should not normally be possible without completion of Level 1. Non-graduates entering at foundation level would be expected to have completed their degree.

Primary Operational Role: Analytical toxicology laboratory work including areas of additional responsibility such as routine instrument maintenance, assist in method & instrument development, and support the quality management system as appropriate.

Expected Duration: 1+ year

Main Training Thrust: Analytical toxicology, further theory & practice – supported by relevant training courses, mentorship and relevant in-house training modules.

Level 3 – Forensic Analyst/Practitioner (Analytical Toxicology)

Description: this level should be regarded as the main training stage for scientists furthering their career in analytical forensic toxicology. Scientists working at this Level would be expected to contribute significantly to method development, analytical science and training of junior members of staff. They would also be expected to undergo further training & development in instrumental techniques, methods and emerging technologies.

Entry Requirement: Completion of Level 2 and satisfactory assessment for entry into Level 3. Entry to this level should not normally be possible without completion of Level 2.

Primary Operational Role: Primary analytical toxicology laboratory work with additional training responsibilities and method development/validation supporting the quality system. Individuals would be expected to be able to troubleshoot equipment issues.

Expected Duration: 4+ years

Main Training Thrust: Advanced analytical toxicology practice – supported by relevant training courses, mentorship and relevant in-house training modules. Relevant training of accreditation/quality standards and procedures, where appropriate.

Level 4 – Senior Forensic Analyst/Practitioner (Analytical Toxicology)

Description: this level should mainly be regarded as the main aspirational career level for competent analytical toxicologists. Individuals working within this band should have already developed a broad knowledge base in analytical forensic toxicology enabling them to:

contribute significantly to the management and/or operation of the laboratory, with supervisory responsibilities

be able to carry out a wide range of analytical procedures and methods, with an overall awareness of casework investigation and have significant knowledge of instrumentation and servicing process

contribute significantly to a mentoring and training programme for others

actively support the laboratory quality management system, with responsibilities for quality assurance, etc as appropriate

It would be expected that scientists within this level should continue to develop their practice by experience and continuing professional development. This increase in experience and professionalism should be reflected in incremental pay progression.

Entry Requirement: Completion of Level 3 and satisfactory assessment for entry into Level 4. Entry to this level should not normally be possible without completion of Level 3.

Primary Operational Role: Advanced analytical toxicology practice. Analytical toxicology laboratory guidance, supervision and leadership. Continuing analytical scientific development. Mentorship and training of others.

Expected Duration: ongoing

Main Training Thrust: Ongoing professional analytical toxicology practice – supported by relevant training courses, mentorship and relevant in-house training modules.

Level 5 – Lead Forensic Analyst/Practitioner (Analytical Toxicology)

Description: this level should mainly be regarded as the top band for highly competent and experienced analytical toxicologists. Lead scientists must be able to take responsibility for wide ranging issues at both sectional and corporate levels within the organisation. They would be the main source of advice, and be actively involved in, corporate and strategic decisions involving their specialism. They will have been able to demonstrate an impressive track record in research, scientific development, leadership, innovation and professional development within their specialism and have a core involvement in the training and development of others. They will likely have contributed to forensic toxicology on a national or international level and be comfortable with contributing appropriately at this level. They will have developed an extensive knowledge base in forensic analytical toxicology enabling them to:

- contribute significantly to the management and/or operation of the laboratory at both sectional and corporate levels where appropriate and within the overall laboratory management structure.
- play a prominent role in the staff mentoring and training programme
- act as the main quality focus for forensic analytical toxicology within the organisation with responsibility for leading, driving and defining current analytical practice.

It would also be expected that scientists within this level should continue to develop their practice by experience and continual professional development.

Entry Requirement: Completion of Level 4 and satisfactory assessment for entry into Level 5. Entry to this level should not normally be possible without completion of Level 4 and extensive experience and achievement within forensic toxicology. Entry to this level should not be regarded as routine progression and should be reserved for individuals who can demonstrate high achievement in their practice. It should not be for individuals involved in non-operational corporate management.

Primary Operational Role: Advanced analytical toxicology practice. Analytical toxicology guidance, management and leadership. Organising training and development and mentorship. Quality focus for forensic analytical toxicology with direct involvement in the laboratory quality management system (e.g. authorization of standard operating procedures and validation documentation, actively assist management with assessment visits, etc).

Expected Minimum Duration: ongoing

Fig. 1 (*continued*).

are minimal but fulfill professional progression requirements in other areas such as research, technical expertise and innovation. This pathway is outlined in Fig. 1b.

Pay banding ranges should ideally complement career structure. The general principles of elevated remuneration reflecting higher levels of responsibility and expertise should be adhered to.

The incorporation of professional licensing and registration into the structure could also be considered, with Level 4 being the most likely band within which this could be incorporated. Licensing would help provide assurance of professional standards, particularly important within a legal environment.

The potential role of an appropriate professional qualification in forensic toxicology should be considered, analogous to the fellowship of the American Board of Forensic Toxicology. This is based on a more professionally orientated course of study, in comparison with the typical PhD approach in the UK, where the entrant to forensic toxicology may have had no exposure to the subject during training.

6. Training & development

To complement a professional career structure, a suitable system of ongoing training and development is essential. This may be represented by several parallel strands of activity, within a structured pathway of development. These strands are as follows:

(a) Modular Foundation Knowledge Training
(b) CPD
(c) Analytical Practice
(d) Research, Development & Academic Study

No proposal is being made regarding the funding for training and development initiatives, their regulation and assessment. Such matters lie outside the scope of this document but may be part of future debate regarding the overall regulation of forensic science in the UK & Ireland.

Forensic Toxicology Types: The suggested schemes for training and development outlined in this paper are directed towards traditional post-mortem forensic toxicology. There are of course other branches of the discipline which fall outside this general scope (eg human and animal sports toxicology, clinical toxicology, workplace and drug control toxicology) and consequently adjustments would need to be made to training provision in these areas.

6.1. (a) Modular foundation knowledge training

A series of theory training modules should form the basis of forensic toxicology foundational knowledge and represent an essential base for future career development and professional practice. These modules can be delivered within a relatively short time span, possibly at an early stage within the professional development programme.

This body of foundation knowledge should however be amplified and updated on an ongoing basis through a CPD programme (see below).

The content of these foundation modules should reflect basic principles of forensic toxicology, analytical techniques, interpretative information, quality assurance and report production. They should be updated regularly to reflect the continually changing nature of forensic

MODULE NO.	MODULE TITLE – Alcohol Foundation Training
Road Traffic Law & the Drinking Driver	
1	Evolution of Legislation, Statutory Limits & Breath Testing Provision
2	Road Traffic Legislation
3	Some Relevant Case Law
Production of Alcohol & Alcoholic Drinks	
4	General Principles & Background
5	Fermentation, Distillation & Nature of Alcoholic Drinks
Analytical	
6	Analytical History. Modern Headspace GC Analysis
7	Sample Collection & Storage
8	Isopropanol, Acetone & Other Volatiles
9	Analytical Procedures
10	Statistical Treatment of Alcohol Results
11	Quality – Assurance & Control in the Laboratory
Pharmacology	
12	Alcohol in the Body – **Absorption**
13	Alcohol in the Body - **Distribution.** Relationship between Alcohol Concentrations in Blood, Plasma, Vitreous, Urine, Breath. Choice of Specimens for Analysis.
14	Alcohol in the Body - **Elimination** Metabolism including use of minor metabolites in alcohol intake assessment (eg. EtG, FAEE, EtS, PEth), Alcohol Back Calculations
15	Alcohol Technical Defence
Breath Testing	
16	Fundamentals of Breath Testing for Alcohol
17	Breath Test Devices and Practical Considerations
Interpretation	
18	Alcohol Effects, Driving Impairment
19	Analytical Considerations & Post Mortem Effects
Case Strategy & Reporting	
20	Customer requirements, initial case assessment & analytical strategy. Assessment of results, production of written report.

Fig. 2. Modular structure for forensic alcohol foundation training. The structure represents suggested content that could be applicable in many forensic institutions but should be adapted appropriately.

toxicology practice and should include current thinking, latest research and relevant issues of interest.

Training could be provided in-house using current members of staff, through expert consultancy services or recognised forensic toxicology training programmes.

The establishment of a central regulatory framework would be a useful focal point for the development of standardised and accredited training packages.

Consideration could also be given to the development of the modules within an appropriate international teaching and accreditation framework, possibly at Masters Degree level; an online approach may be particularly beneficial.

A suggested structure and content for the training modules is provided as a guide (Figs. 2 and 3); individual organisations may wish to modify the content and overall coverage to suit their own business needs, including offering a series of advanced knowledge modules to appropriate staff. Organisations should also offer training & support for those individuals wishing to pursue management roles and responsibilities; support should be available for staff to enroll in part-time management courses at Masters Degree level.

Each module within a programme should incorporate an outline of the module content, knowledge requirement, relevant literature, references, key papers and presentation material. The module collection should be focused within a training manual.

MODULE NO.	MODULE TITLE - Toxicology Foundation Training
Introduction & Background	
1	Introduction to Toxicology, Drugs & Society
Pharmacology & Chemistry	
2	General Principles & Drug Pharmacology
3	The Nervous System
Analytical Toxicology (1) – Analytical Techniques	
4	Sample Preparation & Extraction
5	Immunoassays
6	Gas Chromatography (GC)
7	GCMS
8	HPLC and u-HPLC
9	LCMS
10	High Resolution Mass Spectrometry, HR-LCMS, HR-GCMS
11	Other Analytical Techniques & Emerging Technology
Analytical Toxicology (2) – Laboratory Operations	
12	Laboratory Reagents & Reference Standards
13	Samples - Collection & Storage
14	Batched Analysis, Calibration & QC Strategies
15	Method Development, Validation Strategies
16	Analytical Strategies
17	Quantitative Analysis, Measurement & Uncertainty
18	Quality – Assurance & Control in the Laboratory
General Toxicology & Interpretation – Introduction*	
19	Pre-analytical Considerations: Sampling Sites, Sample Storage, Drug Stability
20	Post-mortem Redistribution
21	Drug Tolerance & Dependence
22	Drug Interactions
23	Impaired Driving & Behavioural Toxicology
24	Drug Facilitated Sexual Assault
25	Sources of Information & Reference. Drug Concentration Databases, Drug Interaction Information, Published Case Studies
26	Drugs in Oral Fluid
27	Drugs in Hair
28	Paediatric Toxicology, Drugs in the Elderly
29	Pharmacogenomics
Case Strategy & Reporting	
30	Results – getting it all together. Case history, pathology, witness reports, half-life, drug persistence,

Fig. 3. Modular structure for forensic toxicology foundation training. The structure represents suggested content that could be applicable in many forensic institutions but should be adapted appropriately.

	analytical detectability, metabolite ratios, kidney/liver function, drug interactions, tolerance, sample storage issues
31	Customer requirements, initial case assessment & analytical strategy. Assessment of results, production of written report.
Individual Drug Groups**	
(a)	Chemistry
(b)	Isolation & Analysis
(c)	Pharmacology, therapeutics & mechanism of action
(d)	Effects (psychoactive & physiological) & Duration of action
(e)	Effects on Driving
(f)	Interpretation – Blood concentrations, drug interactions, tolerance
(g)	Case Reports

**** It is likely that more advanced treatment of interpretative modules will be provided at later stages in training & development.***

*****Consideration should be given to each of the common drug groups encountered in forensic toxicology casework. The extent of this coverage will depend upon casework types encountered within each organisation and should be tailored accordingly.***

Fig. 3 (*continued*).

Attendance at a modular training session should be followed up with a suitable assessment exercise, either in terms of a written examination or related project work.

In this paper, forensic alcohol has been considered as a separate series of modules. Because alcohol is usually considered a sub-set of forensic toxicology, organisations may decide to blend these modules, as they deem appropriate.

6.2. (b) CPD - continuing professional development

A good foundation of knowledge, experience and research should be complemented with an ongoing programme of continuing professional development, ensuring that fresh thinking, new techniques and research information is continually added to the body of knowledge already gained. Such development will help both the individual and their organisation to thrive. CPD should not be viewed as a hindrance or onerous task, but rather a mechanism to demonstrate a continued good understanding of forensic toxicology; CPD is applicable to professional members of UKIAFT.

Some professional organisations manage CPD within a predefined structure of scored activities. These include:

- Conference attendance
- Conference debriefs
- In-house courses
- External training courses and seminars
- Networking meetings
- Literature research and information sharing
- Research and publication activity

In addition to the above activities, particular emphasis should also be given to the updating and dissemination of knowledge, the foundation of which will already have been delivered within the modular training programme (see previous section).

Although the preparation and delivery of update sessions could be carried out by external experts/consultants, the use of existing staff specialising in particular fields within the organisation should be encouraged.

Resourcing - in order to support the time requirements and cost of CPD, there must be appropriate corporate support, although sharing of costs (between the individual practitioners and the organisation) should be considered, reflecting its mutually beneficial nature. Although the extent of employer support however will always be subject to limitation by financial pressure, the importance of CPD must be emphasised to ensure the expertise of staff is not undermined by changes in analytical techniques and practice.

CPD can be also be drawn from analytical practice.

6.3. (c) Analytical practice

Analytical practice, including instrumental analysis, forms the bedrock of forensic toxicology and is central to it. Without quality analytical systems, managed and run by experienced, competent and enthusiastic staff, there can be no service. Although relatively junior staff can carry out some of the routine analytical work, the involvement of more senior staff at higher career levels is essential. The senior staff can provide supervision, mentoring, innovation, direction and training. Establishing a dynamic mixture of people, at different levels should be considered essential. The skill range within a team should be considered a dynamic entity with continuous evolution of staff at all levels, including cross-training.

Staff feeding into the bottom of the pathway will fuel the dynamic mix and provide the basis for satisfying professional needs and controlled succession planning. This fluidity should also be supported with a suitable career development pathway where the increasing worth of staff can be rewarded by actual and earned progression.

Staff at all levels should have some involvement in analytical work, although senior experienced or reporting staff would not usually be expected to carry out routine laboratory work. They are however likely to have greater involvement in the direction, supervision and mentoring of analytical staff.

In general, the case reporting function should not be completely isolated from the analytical function; they are inextricably linked and should be considered as an integrated entity in terms of overall management. The principles of career development, CPD and research should apply to all aspects of forensic toxicology.

6.4. (d) Research, development and academic study

In order to maintain a high level of analytical excellence, an ongoing programme of research and development should be actively managed. This can be used to enhance the services provided to customers and to contribute information and data to the wider profession. Forensic toxicology relies heavily on the publication and dissemination of information (eg. casework data, method development and validation) to other practitioners.

Method Development - development of existing technology and the introduction of new methods and analytical instruments can usually be effectively carried out in-house using existing staff, perhaps with some consultancy assistance. Maximum benefit can be gained if this work forms part of staff development schemes with consequent professional development and publishing opportunities.

Contribution to Professional Knowledge - research and subsequent publication of findings and presentation at meetings should be encouraged and supported. The sharing of scientific research with other practitioners is an essential contribution to the forensic community - most practitioners use database information and published case reports for interpretation purposes.

Academic Links - the availability of an active research and teaching function within an academic institution will complement the operational function of a forensic toxicology service provider. Pure research, leading to academic qualifications within a university or similar institution can have direct benefits for the operational side and should be encouraged. This type of arrangement can bring enormous benefits to both organisations, because;

useful and relevant research work is delivered at minimal cost,

students have the advantage of working alongside operational scientists

future employees can often be identified and retained within forensic toxicology.

If such an intimate relationship cannot exist for reasons of governance, steps should be taken by operational laboratories to build a close and symbiotic relationship with local academic institutions.

Higher Degrees & Professional Qualifications - opportunities for further development should also be encouraged. Although not necessarily an essential criterion for promotion, such achievement would be expected to contribute significantly to overall prospects for career development. Consideration should also be given to the potential role of appropriate training and qualifications provided by the Royal College of Pathology (www.rcpath.org).

Professional Relationships - close relationships with other professionals such as pharmacologists, pathologists, biochemists and clinicians should be established, as analytical results often need to be considered in conjunction with clinical history and accompanying disease findings.

7. Conclusion

In this paper, the need for a multi-element professional structure to support forensic toxicology practice is discussed. This includes a suggested career development structure and an ongoing programme of training and development. This may be managed within a number of parallel strands incorporating foundational modular knowledge training, CPD, ongoing practice, research and academic study.

To enhance the programme, academic links should be established.

The discussion generated and principles outlined in this paper should help in the future development of systems for enhancing best practice within forensic toxicology. Currently it would be difficult however to establish a system capable of administering a central comprehensive regulatory framework for registration, training & development. Consequently, the involvement of Government, other related professional groups and the Office of the UK Forensic Regulator should be regarded as essential for the further development of the initiatives outlined.

Acknowledgements

The authors would like to acknowledge the consultative input provided by the membership of the United Kingdom and Ireland Association of Forensic Toxicologists (UKIAFT) during the preparation of this paper.

References

[1] National Academy Of Sciences, Strengthening Forensic Science in the United States: A Path Forward, National Academies Press, Washington, 2009 ISBN: 0-309-13131-6.
[2] J.L. Mnookin, et al., The Need For a Research Culture in the Forensic Sciences, UCLA Law Review, 2011 725–779.
[3] J.M. Butler, U.S. initiatives to strengthen forensic science & international standards in forensic DNA, Forensic Sci. Int. Genet. 18 (2015) 4–20 (Available online open access http://dx.doi.org/10.1016/j.fsigen.2015.06.008).
[4] House of Commons Science & Technology Committee, Forensic Science. Second Report of Session 2013–14, Volume 1, 26 July 2013 HC610.
[5] G.A.A. Cooper, S. Paterson, M.D. Osselton, The United Kingdom & Ireland Association of forensic toxicologists. Forensic toxicology laboratory guidelines, Sci. Justice 50 (2010) 166–176.
[6] Professional Standards Councils, Australia, http://www.psc.gov.au/what-is-a-profession (accessed 01.11.15).
[7] J.T. Catalano, Contemporary Professional Nursing, Chapter 1, F A Davis Company, Philadelphia, 1996.