The Toxicology Laboratory—Perspectives

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The scope of activities and services offered by the toxicology laboratory is influenced by a number of societal and scientific vectors which change from one decade to another. The factors that mold or determine the activities of this arena are varied and frequently poorly defined, but generally they fall into three broad groups or categories: (1) the demand or need for services; (2) the technology or equipment available; and (3) the support or payment for services rendered (figure 1).

The interplay and influence of these factors on the composition and activities of the toxicology laboratory are demonstrated by its development and progress during the past 40 years, i.e., from 1947 to its current status in 1987. Forty years ago, there was a focus or emphasis on forensic problems and public health which encompassed the area of poisonings and alcoholism as well as the investigation of the public or unexpected death. At that time, technology was limited, the "Cadillac" of laboratory instrumentation being the Beckman DU quartz spectrophotometer, while clinical laboratories were grappling with the issues of accuracy and precision of tests or procedures, as exemplified by the Belk-Sunderman survey which was published in the *American Journal of Clinical Pathology* during that year.¹ In general, the hospital or independent clinical laboratory ignored involvement with toxicology or medical/legal work, although many were able and willing to perform blood alcohol levels when requested. Quantitative blood levels of drugs were in the state of development and the procedures for the detection of poisons frequently consisted only of qualitative or "spot" tests. Payment for toxicology services, other than the blood alcohol test, was either low or non-existent since much of the work was done in governmental and university research laboratories or, in the case of medical/legal work, in the laboratories of a relatively few large medical examiner systems.

An example of the state of toxicology at that time can be illustrated by the approach to marijuana testing which focused on identification of the weed in a cigarette rather than identifying mari-
juana hydrocannabinol or its metabolites in the serum or urine of the user. An acceptable medical/legal approach is exemplified by that used in the conviction of a soldier who was found to have some marijuana cigarettes in his possession; the chain of custody for the legal credibility of the specimen or evidence was similar to that in use today. However, the toxicology evidence presented was the identification of the marijuana weed as outlined in the brochure or manual entitled *Marijuana: Its Identification* as published by the U.S. Treasury Department, Bureau of Narcotics, in 1938. The gross and microscopic characteristics of the leaf were identified (figure 2), and the confirmatory chemical or validation test, which was acceptable in court, was the application of a few drops of dilute hydrochloric acid to the surface of a dried leaflet. A positive result was an effervescence owing to a spherical cystolith of calcium carbonate at the base.

**Figure 2.** Dried marijuana leaflet (x 17). Taken from Marijuana: Its Identification, U.S. Treasury Dept., Bureau of Narcotics, 1938.
of a nonglandular hair that gave a characteristic warty appearance under low power magnification (figure 3). This relatively infrequent exercise 40 years ago can be contrasted to the frequently used current identification of marijuana use which focuses on its metabolites in the urine of the patient rather than identification of the parent plant. With an increasing interest in personal health and surveillance programs associated with the drug culture of the post-Vietnam era as well as the concern of industry for productivity and employee welfare, a large segment of today’s toxicology laboratory is devoted to marijuana and drug testing in addition to monitoring levels of a variety of therapeutic agents and drugs. The technology explosion in methodology and equipment, i.e., chromatographic techniques, radioimmunoassays, immunochemical procedures, mass spectrometry, etc., not only allows the detection, with great specificity, of drugs and their metabolic by-products but also measures their concentration. This exemplifies and validates the theme of a frequently cited quote from Lord Kelvin: “When you can measure what you are speaking about and express it in numbers, you know something about it; when you cannot express it in numbers, your knowledge is of meager and unsatisfactory kind.”

The advances in quality control and quality assurance in the clinical and toxicology laboratory are not only due to the scientific and professional leadership of the laboratory scientist and clinical pathologist but also have been stimulated by industry who has long recognized that quality control is an absolute necessity for its continued existence. An example of this phenomenon is a personal experience with a puzzled oil company executive in the early 1960’s who

Figure 3. Cystolith hairs on marijuana leaflet (×111). Taken from Marijuana: Its Identification, U.S. Treasury Dept., Bureau of Narcotics, 1938.
pointed out that his company repeated many octane determinations on its batches of gasoline in order to establish a precise base for an economic advantage. On the other hand, the decision to operate on a friend of his who had a common duct stone was made on the basis of a single determination of the serum bilirubin in a series of tests whose results were plotted on a chart at the foot of the patient’s bed! Confirmatory testing and second opinions are responses to societal demands as well as the results of our own profession’s initiative.

Payment for services or support of the activities of the toxicology laboratory has been enhanced or assisted by governmental or third party and insurance payees, as well as industrial and business support of drug testing. Furthermore, the cost of these procedures has diminished markedly with automation and economy of scale in reference laboratories producing competition in the market place where pricing is a major consideration with the assumption, albeit occasionally false, that quality is at an acceptable and constant level among the competitors!

What does the future hold for the toxicology laboratory? It seems reasonably certain that it will respond to the demand or requests for tests of drugs or substances which are the concern of society and which can be measured or detected for a price that someone will pay or support. Changes in methodology and instrumentation continue to progress at a rapid rate, and one can anticipate that even greater sensitivity and more acceptable procedures may develop from such disciplines or techniques as positron emission tomography or, possibly, microprobe analysis. If, during the past 40 years, interest in the toxicology field has progressed from a focus on public death or public health to the current attention on personal health and surveillance, it can be anticipated that, in a society with a litigious orientation and an overwhelming interest in a risk-free life as well as expectations of longevity with quality of life, there will be an increasing emphasis on environmental issues.

Examples of these that would have an impact on the toxicology laboratory would be pesticides, industrial chemicals, air and water pollution in general, food additives and toxins, hydrocarbons and carcinogens, and heavy metal monitoring programs. Also there is the additional potential of the toxicology laboratory as a reference or confirmatory role for patient or self-monitoring drug or toxic substance programs. An example of what one may expect from society is exemplified by an editorial in a recent issue of the Mature Outlook Newsletter which, in focusing on items of interest for an aging population, discussed lead in tap water with a review of tests used to detect this environmental hazard as well as how to manage the same. The influence and demands of a vocal and enlarging geriatric population with its political and legislative impact should not be ignored in planning for the future. Also to be considered are changes in the interest of both health professionals and the public as discussed in “Ebbs and Flows in Medical Interest” which was published in the February 21, 1952 issue of the New England Journal of Medicine. In this classic paper, Dr. Henry A. Christian points out that about every decade or two there is a resurgence in interest of a medical issue or disease that has been dormant in recent years. Heavy metals may be an example of such a phenomenon since there was considerable interest in the environmental hazards of mercury in the medical literature of the early 1970’s. Subsequently, the protective effect of selenium on the toxicity of methylmercury in fish was identified with a loss of interest with mercury in food.

In summary, irrespective of the specific vectors and factors which will influ-
ence the direction that the toxicology laboratory moves in the future, the scope of activities and services offered by this segment of the clinical laboratory will be the interplay and result of societal demand, technological advances and fiscal support or payment in a manner similar to its evolution and development during the past 40 years.

References


