

SPECIAL ARTICLES

THE ROLE OF THE CLINICAL CHEMISTRY LABORATORY PHYSICIAN IN HEALTH CARE DELIVERY

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Introduction

Chemistry

Chemistry is the science of matter and the changes it can undergo. The world of chemistry therefore embraces everything material around us. Chemistry is the centre of science. In one direction lies physics and how the principles of chemistry are based on the behaviour of atoms and molecules. In the other direction lies biology and the contributions being made by chemists to an understanding of that most awesome property of matter, life. Traditionally the field of chemistry has been organized into three branches:

- **Organic Chemistry**, the study of the compounds of carbon
 - **Inorganic Chemistry**, the study of all other elements and their compounds.
 - **Physical Chemistry**, the study and application of the principles of chemistry to physical phenomena.
- But modern chemistry is now more than test tubes and beakers. New regions of study have developed as information has been acquired in specialized areas or as a result of the use of particular techniques. We therefore nowadays speak of:

- **Analytical Chemistry**, the study of techniques for identifying substances and measuring their quantities.
- **Biochemistry**, the study of chemical compounds, reactions and other processes in living systems.
- **Chemical Engineering**, the study and design of industrial chemistry processes, including fabrication of manufacturing plants and their operation.
- **Computational Chemistry**, the study of the computation of molecular properties.
- **Medicinal Chemistry**, the study and application of chemical principles to the development of pharmaceuticals

- **Theoretical Chemistry**, the study of molecular structure and property in terms of mathematical models.
- **Molecular Biology**, the study of the chemical and physical bases of biological function and diversity, especially in relation to genes and proteins.

Various interdisciplinary branches of knowledge with roots in chemistry have arisen, including:

- **Materials Science**, the study of the chemical structure and composition of materials.
- **Nanotechnology**, the study of matter at the nanometer level where structures consisting of small numbers of atoms can be manipulated.
- **Environmental (“green”) Chemistry**, the economical utilization and renewal of resources coupled with hazardous waste reduction and concern for the environment.
- **Clinical Chemistry**, clinical chemistry, chemical pathology, clinical biochemistry, pathological biochemistry, molecular medicine and molecular diagnostics are all names for the same subject, that is, that branch of laboratory medicine in which chemical and biochemical methods are applied to the study and treatment of disease.

Already, some teaching hospitals abroad, particularly in Scandinavia, have merged clinical chemistry with clinical pharmacology into single departments. This makes sense, because they both deal with how the body handles molecules, either internally generated (for example, glucose) or administered as drugs (for example insulin). Besides, clinical chemistry and chemical pharmacology use the same types of equipment.

Laboratory Medicine

The Royal College of Pathologists of UK, in describing the place of laboratory medicine in health delivery defines laboratory medicine as “the science behind the cure”. Clinicians draw heavily on the resources of the medical laboratory, as no clinician can tell the level of blood glucose in a diabetic under treatment until it has been measured, and whether a “pale” patient is anaemic or not can only be determined after measurement of the patient’s haemoglobin level (B-Hb).

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The practitioner of clinical chemistry (laboratory physician) must be thoroughly schooled in science and equipped with knowledge in chemistry in general and biochemistry and molecular biology in particular. The laboratory physician as a hospital consultant should be engaged in the care of patients in emergency medicine and intensive care as well as patients in “ordinary” wards, special clinics (eg diabetic/metabolic clinics, dialysis units, toxicology), paediatric and neonatal units.

Metrology

Metrology is a new science, the science of measurement. Measurements are of crucial importance in metrology. In the 1950's the International Organization for Standardization (ISO) through its various committees and related organizations, such as the International Union of Pure and Applied Chemistry (IUPAC) decided to try and devise a simple, common system of metric units to replace the plethora of units then in force and simultaneously standardize the symbols used in scientific literature.

The resultant SI system (Système Internationale) consists of the basic units, supplementary units, derived units and the decimal multiples and sub-multiples of these units formed by the use of prefixes. The logical strength of the SI lies in the basic six units, from which practically all units in clinical chemistry and medicine can be derived by multiplication or division of the basic units.

Measurement	Name of Unit	Symbol
Length	metre	m
Mass	kilogramme	kg
Time	second	s
Electric current	ampere	a
Temperature	degree kelvin	°K
Amount of substance	mole	mol

The metre was originally defined as the distance, under standard conditions, between two marks engraved on a platinum/iridium bar at Sèvres in France, but in 1960 it was redefined in terms of a specific wavelength of light (1650763.73 wavelengths) in a vacuum emitted from a lamp containing ⁸⁶Kr and operating under well reproducible conditions.

The kilogramme was the mass of a platinum/iridium alloy prototype kept in France.

The unit of time was based on the frequency of emission of light from a caesium atom excited under closely standardized conditions.

The Kelvin scale of temperature was defined by the decision to fix the thermodynamic temperature of the

triple point of water at exactly 273.15 °K; the triple point of water being the point at which ice, liquid water and water vapour co-exist in a stable equilibrium.

The ampere was based on the force measured in newtons between parallel conductors 1meter apart in a vacuum.

The mole was the amount of substance containing as many elementary units as there are atoms in 0.012kilogram of ¹²C

The elementary units could be an atom, molecule, ion, radical, electron, photon or a specified mixture of such entities.

The IFCC and AFCC

The International Federation of Clinical Chemistry (IFCC) was formed primarily to make recommendations regarding standardization - the use of reference materials as calibrators and use of reference methods in analytical work in clinical chemistry. The IFCC and the International Committee for standardization in Haematology (ICSH) have made recommendations on the derivation and use of reference values. A few years ago, the African Federation of Clinical Chemistry (AFCC), the African chapter of the IFCC, was formed with a clinical pharmacologist, Prof. Vanessa Steenkamp of the University of Pretoria, South Africa, as its first president.

Quality Assurance

Quality assurance is always at the heart of the laboratory physician leading a medical laboratory, especially in the setting of a teaching hospital, as the laboratory physician is acutely aware of the fact that an erroneous result reported from the laboratory can easily lead to wrong treatment or even death of the patient. This involves daily batch-wise control of the analytical work (“internal quality control”) and less frequently (once every quarter of the year), the external quality control system.

The recommended external quality control system is the WHO collaboration Centre, UK NEQAS, Birmingham Quality, P.O BOX 3909 Birmingham B152UE, U.K. Hundreds of laboratories all over the world take part in it and it provides opportunities for pitting one's laboratory's performance against those of some of the world's best laboratories. For each analysis the laboratory 's result is compared with the target value and specimen percentage bias and accuracy index calculated. Persistently poor performers are given advice about what to do to achieve better results.

Reporting of results

A WHO/IFCC-standardized system of reporting results, with reference limits beside them for ease of interpretation, is recommended.

There should be space on the report for comments from the laboratory, eg. that the specimen was haemolyzed, lipaemic or insufficient, or that the laboratory requests another specimen for confirmation of an unexpected result.

Concluding remarks

An academically as well as professionally qualified consultant laboratory physician is indispensable in the setting of a teaching hospital. He or she is the only one of the laboratory staff qualified to solve clinical problems at the laboratory - clinical interface. A teaching hospital (in any part of the world) that operates without a medically qualified consultant chemical pathologist is rendering substandard service.

Unfortunately, as far as chemical pathology is concerned there are only two such persons in the whole

of Ghana, whilst the projected needs of the country for the next five years is at least 10 medically qualified consultant chemical pathologists. Of the two medical consultants, only one is currently in active service, at Komfo Anokye Teaching Hospital (KATH) in Kumasi. This information is given to the Ministry of Health and the Ghana College of Physicians and Surgeons in the hope that in the apportioning human resources (including sponsorship of residents) to the various sectors of the health service, due priority is given to Laboratory Medicine in general and Chemical Pathology in particular.

