Chapter 1

Introductory Chapter: Linkages Between Clinical and Forensic Toxicology

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Additional information is available at the end of the chapter

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1. Overview on interconnections between sciences and professionals in case of poisoning

Poisoning, whether acute or chronic, and whether accidental or deliberate, is one of the major causes of morbidity and mortality worldwide. International data gathered by the World Health Organization (WHO) suggest that at least an estimated over 100.000 people died worldwide from poisoning every year [1]. Of the factors contributing to this high loss of lives, is the misdiagnosing of poisoning due to lack of qualified personnel and lack of appropriate medical equipment for conducting relevant investigations.

Strictly speaking studying poisoning incidents, how they occur, their symptoms and signs, the toxic agents involved, the diagnosis and management thereof as well as the outcomes of treatment, is a multi-disciplinary endeavour that requires skills and competences in injury epidemiology, clinical and forensic, or analytical toxicology.

Although epidemiologists painstakingly work to study, describe, and quantify the determinants of both acute and chronic poisoning incidents, medical clinicians and clinical toxicologists, clinical pharmacists and nurses are the professionals who are confronted on a daily basis with cases of acute poisoning requiring their immediate attention to save or preserve the lives of victims of such incidents.

Clinicians, particularly, emergency and critical care doctors, ought to decide on the basis of symptoms and signs, often not unique to the incident, whether it is a case of acute poisoning or not. The history related by patients themselves, their relatives and or sometimes by paramedics or police personnel who brought the victim constitutes more often the main evidence clinicians may get about the circumstances of the acute poisoning incident. Understandably, where such history is lacking or incomplete, forensic toxicological assessment of the victim's specimen is another tool capable of providing clues to what may have happened [2].

In settings where published and widely publicized treatment guidelines exist, clinicians may have algorithms to guide their assessments and presumptions. In settings where such guidelines do not exist, the clinicians' instincts and experiences are the valuable tools for making a correct presumptive diagnosis and crafting a management care plan.

2. Importance of guidelines and algorithms in diagnosis and management of a poisoning incident

Several studies have reported the usefulness of treatment guidelines in general and for specific diseases notably epidemics such as HIV and noncommunicable diseases [3–6]. In summary, treatment guidelines and algorithms for management of specific diseases and conditions:

a. facilitate the choice of appropriate medicines and prescribing of correct doses;

b. provide guidance in establishing differential diagnosis;

c. speed the consultation process as clinicians are guided on what tests to perform and what to look for.

Unfortunately, with regard to poisoning incidents, national treatment guidelines of several countries have shortcomings as guidance and algorithms on specific poisoning agents are not presented there in [7]. It should be noted that the International Programme on Chemical Safety (IPCS) has published guidelines concerning the prevention and clinical management of poisoning including a manual on "Basic Analytical Toxicology" which provides practical guidance on clinical aspects and detailed monographs on tests to be conducted for specified chemicals [8].

3. Role of forensic toxicology and medical laboratory in the diagnosis and monitoring of treatment in case of a poisoning incident

Medical laboratory and forensic toxicological assessments are important in establishing the diagnosis and identifying the toxic agents involved in a poisoning incident, and possibly the doses ingested. In case of deliberate poisoning, suicide or para-suicide as well as in case of intoxication or criminal poisoning, the identification of the toxic agents help not only in the management of the victim but also in providing clues that may lead to the possible culprit [9, 10].

Although, medical laboratory testing plays a crucial role in the detection, diagnosis and treatment of disease in patients; and that laboratory tests help determine the presence of a disease and monitor the effectiveness of treatment; in case of poisoning, detecting biochemical parameters modified as a result of the effects of the toxic agent is an important contribution for the purposes of making a diagnosis. Classical cases include the determination of acetylcholinesterase in case of acute poisoning due to pesticides as well as the identification of toxins produced by bacteria involved in food poisoning incidents [11–13].

With regard to forensic or analytical toxicology, its role in the detection, identification, and quantification of drugs, chemicals, and other foreign compounds (xenobiotics) in biological and related specimens such as blood, saliva, hair, urine, etc., is of utmost importance in the diagnosis, treatment, prognosis, and prevention of poisoning. Sometimes, a forensic toxicological assessment is the only means by which objective evidence of the nature and magnitude of exposure to a particular toxic agent or a group of toxicants can be obtained [14].

4. Limitations of medical and forensic laboratory services

There are several obstacles and limitations with regard to the existence and operation of forensic laboratory services. In several countries, firstly, the lack of properly trained clinical and forensic toxicologists is the main obstacle to the establishment and use of forensic laboratory services. The competences required for a trained analytical toxicologist include a fundamental knowledge of principles of emergency medicine and intensive care, a good grasp of pharmacology and clinical toxicology as well as a practical mastery of clinical chemistry and basic laboratory operations, including aspects of medical laboratory health and safety. Secondly, the lack of appropriate funding for the training and establishment of such services further compound the problem. Thirdly, it is noteworthy that even where relevant clinical personnel such as clinical pharmacists exist, equipment needed to run the services are lacking. It should be noted that several types of equipment are required for providing analytical toxicological assessments, this include:

a. A carbon monoxide (CO)-Oximeter: normally very necessary for determining carboxyhaemoglobin and methaemoglobin measurements in case of a suspected incident by carbon monoxide [15].

b. Standard clinical chemistry analysers and assay kits: for use in determining basic biochemical parameters such as glucose, total bilirubin, ALT, AST, cholesterol, triglycerides, creatinine, urea, uric acid, fibrinogen, calcium and phosphorus, aminotransferases, etc [16].

c. Machines for UV-visible spectrophotometry, thin-layer chromatography (TLC), high performance liquid chromatography (HPLC), and gas chromatography-mass spectrometry (GC-MS), and possibly high performance liquid chromatography-tandem mass spectrometry (HPLC-MS-MS): for use in the identification and quantification of a wide variety of medicines, drugs, chemicals, and pollutants [17].

d. Machines for atomic absorption spectrophotometry or inductively coupled mass spectrometry (ICP-MS): for use for metals analysis [18].

5. Necessity for rapid methods in forensic toxicology

The need to treat the victim of acute poisoning as well as the need to apprehend the perpetrators of deliberate or criminal intoxication dictates the need for rapid methods for identifying

poisons involved in a poisoning incident. This is a subject of ongoing research and it requires massive investments particularly in developing countries where funding for research is scarce.

Moreover, some of the methods mentioned above such as GC, HPLC and TLC require the presence of reference chemicals to be used for the identification and quantitation of toxicants [19]. However, the availability and access to these references and other reagents pose several challenges particularly to developing countries that may not have sufficient funds to purchase these products [14].

For the above reasons, newer and simpler methods, techniques, equipments, and devices that are more affordable and easy to operate are urgently required to develop and establish forensic toxicology services in several developing countries.

6. Concluding remarks

Clinical toxicology and forensic toxicology share a mutually beneficial partnership; these two sciences support both the management of the patients who have been victims of poisoning; and the identification of the causative agent that may have inflicted toxicity, injury or death as a result of an acute accidental or deliberate poisoning incident. Several initiatives are required to develop and establish analytical toxicology services. These include educational interventions to train people with required competencies; and funding to establish and equip laboratories capable of assisting clinicians with meaningful findings to guide the management of victims of poisoning incidents.

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