Letter

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The study of forensic toxicology should not be neglected in Japanese universities

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Summary **Forensic toxicology is aimed at identifying the relationship between drugs or poison and the cause of death or crime. In the authors' toxicology laboratory at Chiba University, the authors analyze almost every body for drugs and poisons. A simple inspection kit was used in an attempt to ascertain drug abuse. A mass spectrometer is used to perform highly accurate screening. When a poison is detected, quantitative analyses are required. A recent topic of interest is new psychoactive substances (NPS). Although NPS-related deaths may be decreasing, use of NPS as a cause of death is difficult to ascertain. Forensic institutes have recently begun to perform drug and poison tests on corpses. However, this approach presents several problems, as are discussed here. The hope is that highly accurate analyses of drugs and poisons will be performed throughout the country.**

Keywords: Forensic toxicology, new psychoactive substances, forensic institutes

1. Introduction

Forensic toxicology is aimed at identifying the relationship between drugs or poison and the cause of death or crime using screening and quantitative analyses of various substances such as drugs, poisons, and alcohol in the blood, urine, saliva, other bodily fluids, or hair of a corpse. In the past, many pharmacy schools gave forensic chemistry lectures and they conducted education and research on drugs and poisons. Only a few colleges have such lectures, but they are returning at some schools of pharmacology. Thus, forensic toxicology is usually restricted to departments of legal medicine in universities. In Japan, many departments of legal medicine study deceased individuals, including analyses of drugs and poisons in the blood and other bodily fluids. Institutes of forensic medicine in foreign countries analyze use of alcohol and antihypnotic substances in living subjects, and some departments of legal medicine in Japan deal with clinical forensic medicine.

Toxicology examines the effects of drugs or poison on the functions of living individuals, and a drug that may be useful at treating an illness may be harmful if ingested at high doses. Such toxicity can directly or indirectly cause death, and death can occur due to accidents, homicides, suicides, or in various other ways. For example, mortality can occur due to ingestion of a fatal dose of an antihypnotic or due to an aneurysm in a cerebral blood vessel. A small quantity of a drug may result in increased blood pressure and cause disruption of an arterial aneurysm, resulting in a subarachnoid hemorrhage.

In Chiba Prefecture, approximately 52,000 people die every year, and approximately 400 bodies are autopsied. The autopsy rate is 0.7%, which is much lower than that in other advanced countries and regions. Based on these statistics, deaths are not thoroughly investigated in Japan. Although the authors' toxicology laboratory performs few autopsies, all bodies except those in skeleton form (from which bodily fluid samples cannot be obtained) are analyzed for drugs and poisons. The substances analyzed include alcohol, carbon monoxide, narcotics such as opium, antihypnotics,

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cannabis, psychotropic drugs, cyanide, various legal drugs including prescription medicines, and a new type of drug known as new psychoactive substances (NPS). In Japan, NPS are referred to as "dangerous drugs."

2. The current state of the study of forensic toxicology in the authors' laboratory

2.1. *Equipment for analysis*

Initially, a simple inspection kit known as "Triage" was used in an attempt to ascertain whether there is evidence of drug abuse in blood or urine samples. This kit can be used to screen for several classes of drugs such as phencyclidine, amphetamines, methamphetamines, barbiturates, benzodiazepines, cocaine, THC-COOH, tricyclic antidepressants, and opiates. Drug abuse can be detected within 15 min. However, this kit has a rather low level of reliability and it tests only for common drugs, so it is unable to facilitate a more thorough investigation.

A mass spectrometer is used at Chiba University to perform highly accurate drug and poison screening. Gas chromatography-mass spectrometry (GC/MS), liquid chromatography-tandem mass spectrometry (LC/MS/MS), and liquid chromatography quadrupole time-of-flight mass spectrometry (LC/QTOFMS) are performed to analyze substances that are specified in software libraries or other substances such as NPS. When a poison is detected, quantitative analyses are required. If a certain substance is detected, a quantitative analysis is required, and the fatal dose of the drug should be determined in order to examine the relationship between the drug and mortality. Quantitative analyses are performed at the authors' laboratory using the techniques mentioned above.

2.2. *Postmortem changes*

The results of quantitative analyses differ in living and dead subjects due to postmortem changes. For example, ethanol is produced posthumously depending on the individual's condition. In instances of fatal accidents while driving where ethanol is detected, drunk driving cannot be directly inferred as the cause of the accident. However, such misjudgments have been made in the past. Tricyclic antidepressants and selective serotonin reuptake inhibitors are known to easily alter the blood ethanol concentrations. Additionally, increases and decreases in blood sugar levels hamper efforts to ascertain the blood sugar level before death. Various parameters are estimated in living individuals in an attempt to determine the cause of death.

2.3. *NPS*

A recent topic of interest is "dangerous drugs" (NPS). The authors have encountered several cases involving NPS.

Since March 2013, many drugs with similar chemical structures have been classified as NPS, and the police and other government agencies have begun to monitor their use (*1*). The possession and use of NPS as well as their production, distribution, and sales of NPS have been prohibited since April 2014 (*2*). Although purchasing NPS in a store is difficult, NPS may be sold underground as antihypnotics. As a result of strict controls, NPS-related deaths may decrease, but use of NPS as a cause of death is difficult to ascertain. The structures of NPS are changing constantly, and even the name of the drug can be determined, a standard sample of the drug may not be available in a timely manner.

3. Current issues related to the study of forensic toxicology in Japan

Differences between forensic institutes and departments of legal medicine Forensic institutes within every prefectural police department have recently obtained equipment such as mass chromatograph spectrometers and they are testing for drugs and poisons. In addition, similar examinations are performed by the National Institute of Health Sciences, the health bureau in every prefecture, and the Narcotics Division of the Ministry of Health, Labor, and Welfare. Drug tests are performed by a department of legal medicine to investigate the cause of death, while other institutes test for drugs to investigate crimes that are directly or indirectly related to drugs. Despite their reputation, forensic institutes do not perform academic studies but instead perform practical tasks. As an example, police and narcotics agents may investigate whether an antihypnotic is consumed or not, determine whether the person was involved in a criminal act, investigate the sale of the drug, and try to ascertain the method of production, distribution, possession, and use of the antihypnotic. However, death investigations by departments of legal medicine examine antihypnotics, measure the quantity of amphetamines and other ingredients, and determine the cause of death. The dangers of antihypnotics should be publicized and the use of these substances should be halted. The aims of a forensic institute are to investigate crime and facilitate the prosecution of criminals, while the aims of a department of legal medicine are to determine the cause and manner of death and prevent its recurrence.

Recently, forensic institutes have begun testing corpses for drugs and poisons. The police consider these tests to be less expensive than the tests conducted by the departments of legal medicine at universities. However, two problems may arise. The first is the objectivity of the decision reached. The police investigate a crime and forensic institutes test for drugs and poison during a criminal investigation. To prove that a murder has

occurred, for example, an objective determination of that fact is indispensable for the court. Therefore, there is considerable debate as to whether forensic institutes under police supervision are capable of making such determinations. A second problem is that police may determine whether an individual's death was associated with illegal activity based on use of a simple inspection kit. If police determine that a death is not related to a crime, they may not perform the required tests. As a result, important cases in terms of public safety may be overlooked. Moreover, the crime itself may be overlooked.

Further research into forensic toxicology is currently underway. Methods of drug testing and testing rates differ among university laboratories. In addition, employing technicians and scientists to analyze drugs and poisons is an expensive proposition. The hope is that highly accurate analyses of drugs and poisons will be performed throughout the country.

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