

THE SIXTH K PRATHAP MEMORIAL LECTURE  
FORENSIC MEDICINE: THE CHANGING ROLES FOR THE CHALLENGES AHEAD

T.C. CHAO. MBBS. DMJ, FRCPath, FRCPA. FCAP. FCLM

*Senior Forensic Pathologist and Director, Institute of Science and Forensic Medicine, Outram Road, Singapore 0316.*

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President of the Malaysian Society of Pathologists, Professor Looi Lai-Meng, honoured guests, colleagues, ladies and gentlemen.

I am extremely honoured to have been invited to deliver the Sixth K. Prathap Memorial Lecture. It is difficult to follow in the footsteps of Dr. Prathap who had contributed much to the teaching and training of Pathology in Malaysia. I shall attempt to describe the development of Forensic Medicine in Singapore.

The word 'forensic' derives from the Latin word *forensis*, 'a public market or forum,' with *forum* being the Roman law court. Therefore, Forensic Medicine is the application of medical knowledge in the interpretation and establishment of facts in the law courts. It is also variously known as Medical Jurisprudence, Juridical Medicine, Medico-legal Practice and, in the United States of America, Legal Medicine.

Medicine and Law have been interlinked since ancient times, the earliest medico-legalist being the priest who was both law giver and healer. The oldest known law code — that of Hammurabi, King of Babylon at around 2200 B.C. — contained legislation of medical practice and the rights and duties of medical men. It provided controls on medical and surgical practice, dealt with medical malpractice, and clearly set out the civil and criminal liability of the physician.

In Egypt, too, laws were laid down for the practice of medicine and stab wounds, for example, were defined in the seventeenth century B.C. Hippocrates of Greece (460 — 355 B.C.) discussed the lethality of wounds. Subsequently, the Hippocratic Oath became the foundation of medical ethics.

In Rome, medico-legal interest dated from 600 B.C., from the time of Numa Pompilius. The bodies of women who had died in confinement had to be immediately opened to save the babies; this was the beginning of the Caesarean section. When Julius Caesar (100 — 44 B.C.) was murdered, his body was examined by Antistius, a physician, who found that only one of his twenty-three wounds was fatal. It had entered the chest between the first and second ribs.

In the Transitional Period around 1100, the Assizes of Jerusalem formulated a code of laws which, *inter alia*, required examination of the corpses of murder victims and reports to be made.

In 1209, Pope Innocent III of Italy appointed doctors to the courts to determine the nature of wounds' — the equivalent of today's forensic pathologists. In China, although forensic medicine was practiced since the Warring States (475 — 221 B.C.), it was not until 1247 that it became well-known to the forensic world through the book 'Hsi Yuan Lu' or 'Washing Away of Wrongs.' It was written by the great medical examiner/coroner Song Ci of the Southern Song Dynasty and is reputed to be far ahead of any similar work in existence at that time.'

In the 17th century, Paulus Zacchias of Italy wrote the acclaimed works called 'Questiones Medico-legales' or 'Medico-legal Questions.' It was first published in seven volumes in Rome between 1621 and 1635 and two additional volumes were published in Amsterdam in 1666. They dealt with a variety of subjects in legal medicine, public health and pastoral medicine. Other works on wounds appeared from Germany and France, and the first medico-legal journal was published in Berlin in 1782.

Development of Forensic Medicine in the United Kingdom and United States continued apace and, after the Second World War, Forensic Medicine rapidly developed into a medical specialty.

In Singapore, forensic medicine did not emerge as a specialty until 1969 although it had always been taught to medical students. Since then, however, it has had an important role in the practice of medicine and law.<sup>3</sup>

Forensic Medicine includes Forensic Pathology and Clinical Forensic Medicine. It involves examination of both the living and the dead.

In dealing with the dead, the traditional role has been to investigate into the cause of death and, if unnatural, to ascertain whether it is due to accident, suicide or murder. The forensic pathologist functions as a medical detective, and features prominently in testimony in the law courts. Thus, the basic function of Forensic Medicine is to assist in the administration of justice. From post-mortem examination and scene investigations, it is often possible to reconstruct the course of events leading to death. This is useful for police investigations and subsequent prosecution in the law courts. Murders disguised as suicides or accidents are exposed and the perpetrators brought to book. Lies are countermanded and the truth upheld.

However, Forensic Medicine has since evolved and assumed further responsibilities. A series of deaths from the same cause, whether natural or not, may need investigation to uncover the cause and to propose preventive action. When several National Service men died from heat stroke, the cause was determined to be disseminated intravascular clotting due to the formation of microthrombi in the organs. Predisposing factors were the weather during training, inadequacy of preparation, poor physical condition of the servicemen and inappropriate initial treatment given to the victims. When these factors were resolved, there was no further death from heat stroke.

Deaths from myocarditis probably of viral origin were also investigated. Victims were young people in otherwise good health who presented with acute abdomen or hysterical behaviour, and who were sent to surgical and psychiatric units. They had had, in common, influenza or a flu-like attack about two weeks before. They were not fully well but suffered from a low-grade fever and collapsed during exertion. The acute abdomen was found to be due to mesenteric lymphadenitis and the hysterical behaviour to hypoxia to the brain. When the results of investigation were published and the appropriate precautions taken, fatalities were reduced.

In the 1970s, there was a series of deaths from carbon monoxide poisoning. They happened in hotel or rented rooms with an attached bathroom, and the gas water heater in the bathroom on. The rooms were air-conditioned with closed ventilation. There was no gas leak but the common factor was the same brand of heater used. Laboratory testing showed that due to faulty design of the burning chamber, excessive carbon monoxide was produced. The heater was withdrawn from the market and rules and regulations on ventilation and the proper use of gas heaters were introduced. No similar death has since occurred.

Another source of carbon monoxide poisoning was from car exhaust fumes. In 1984, two couples were found unconscious in parked cars with their engines on to operate the air conditioning. Of these four victims, only a woman survived. They were clandestine love affairs, with the victims resting after sex with the air-conditioning on for comfort. In one car, there was a broken tail light just above the exhaust and, in the other, a hole in the front bulkhead. These allowed carbon monoxide from the engines to seep into the passenger compartments. The findings were published for public education but, alas, memories were short and another incident occurred 5 years later.

The toxic content of a Chinese medical product was revealed from the sudden death of a 28-year-old woman who collapsed at a bus stop. Autopsy showed hyperkeratosis on the skin of her hands and legs. The brain and liver had high concentrations of arsenic. The victim was asthmatic and was taking home-made pills from a Chinese physician who still possessed such pills in a raid on his shop. The pills contained arsenic in levels far exceeding the permitted safety limit. Legislations were amended to tighten regulations on the import and manufacture of medicinal products containing toxic substances.

In analysing deaths from home, traffic, industrial and sporting accidents, the causative factors found are publicized through the mass media, publications and talks for public education.

When a mass disaster occurs, Forensic Medicine plays an important part in the management and disposal of the dead. In some cases, it can assist in finding the cause(s). In October 1988, an explosion occurred after the lunch break on the tanker 'Spyros which'

had been docked in Singapore for repairs. A flash fire followed, killing 76 persons and wounding another 76. Confusion at the incident resulted in varied and unreliable eye witnesses' accounts. The autopsy findings revealed different groups of injuries. Some bodies were severely burnt, others less burnt while one group died of suffocation and carbon monoxide poisoning without any burn. This suggested that positioning of the different work groups would be important to the investigation. Matching the positions of the work groups with the severity of injuries, the path of the fire was plotted. This led to the bulkhead separating the fuel tank and the deck where the repair work was being done. Investigations showed that vapour from the fuel tank was explosive, quite unlike that expected from bunker or fuel oil, but rather similar to that from crude oil which was the cargo. An U-tube **connection** was found between the cargo and fuel tanks. Further, the log book of the tanker showed that, despite its age, it was very fuel efficient and the evaporation rate of the cargo was exceptionally high. It was then realized that the crude oil cargo had been siphoned off as bunker oil. On the day of explosion, a worker had used a flame torch to loosen some rusted nuts of the drip tray covering the vent from the fuel tank. Sparks dropped into the tank ignited the explosive vapour and caused the disaster. It was the autopsy findings, scene investigation and careful reconstruction of events that helped solved the case.

Another role for Forensic Medicine is to serve in various governmental committees dealing with medico-legal matters. This includes advising on legislation relating to medicine such as on matters pertaining to autopsy and human organ transplantation, drunken driving, use of seat belts and other like matters. It is also an important component of the Quality Assurance Committee to ensure good medical standards by investigating complaints against doctors and nurses, looking into medical mishaps and, through **Coroner's** inquiries, to enquire into possible criminal negligence in the deaths of patients.

The clinical part of Forensic Medicine deals with the examination of living patients in cases of assault, poisoning, drunken driving, rape, etc. and the provision of medico-legal advice and opinion on these cases. This aspect of Forensic Medicine will be further developed in Singapore to satisfy the needs of the Police and the Attorney General's Chambers.

Forensic expertise is also required by neighbouring countries. In October 1988, a series of deaths from food poisoning occurred in the state of Perak, Malaysia. Initially, the cause of poisoning was not known, but the source was suspected to be from eating 'Loh Shee Fun' noodles. A team comprising a Forensic Pathologist, a Paediatrician and two Public Health officials was sent to help in the investigation. Autopsy was performed on two victims and tissues brought back for analysis. Aflatoxin was found in the tissues by the Liverpool School of Tropical Hygiene, and boric acid in urine samples. Histopathology showed massive liver necrosis with steatosis, bile ductal and ductular metaplasia with acute cholangitis. The kidneys showed proximal tubular necrosis with vacuolation and eosinophilic and red cell casts in the collecting tubules. The glomeruli were normal. These changes were seen in nearly all the victims. Epidemiological study showed that the 13 children that died all ate 'Loh Shee Fun' from one manufacturer in Kampar. The conclusion was that they died from a combination of boric acid and aflatoxin poisoning.' Once again, Forensic Medicine had helped solve a mystery.

Another problem currently being investigated is the Sudden Unexpected Death of Thai workers in Singapore. The first occurred in 1982 and, to-date, 228 have died. They were all construction workers and 80% of them came from the Northeastern part of Thailand. The average age was 34 years. They were previously healthy and died suddenly, mostly within five minutes, either during low physical activity like chatting, watching a game or sleeping. None had died at work. Death

during sleep fell into two patterns. In one, they went to sleep and did not wake up the next morning. The other was more dramatic. They groaned or shouted in their sleep, had difficulty breathing, clenched their fists and urinated. Post-mortem examination showed lung haemorrhages with some evidence of myocarditis or pneumonitis. Toxicology and virology findings were negative. Such deaths also occurred in Northeastern Thailand and is known as 'Lai Tai' or 'Floating Death! This phenomenon also occurred among Thai workers elsewhere in the world. In Singapore, it was found that about 7% of the victims had similar deaths occurring among family members. In Singapore, all the victims were males although a few females have been reported from Thailand. A joint **Singapore-Thai** team has been established to investigate this matter and it is hoped that a solution can be **found**.<sup>5</sup>

Teaching is also an important function of Forensic Medicine. Besides medical undergraduates who receive regular lectures and tutorials, lectures on medico-legal topics are given to postgraduates, nurses, in-service doctors and general practitioners. The police need practical instructions on scene investigations and the collection of evidence, and the military on wounds and injuries.

What of the **future?** With advancement in technology, Forensic Medicine can further sharpen its investigative skills. DNA profiling is useful in individualising a person and immunohistochemistry can help identify cellular origin and specific toxins. Immunochemical studies on the livers of the Perak poisoning victims showed that

regenerative hepatocytes following injury of fetal hepatocytes have an immunophenotype of bile duct epithelium, that is, cytoskeletal phenotype of **AE1/AE3**, CK19 and CAM5.2.

Forensic Medicine therefore plays an important role in the investigation of death, be it natural or unnatural. The investigation, if carefully and meticulously carried out, will help ascertain the truth. This will not only assist the law courts in the administration of justice but also benefit the profession, community and society. It is a dynamic field, never static, and uses all the advanced technologies to meet the challenges ahead.

Thank you, ladies and gentlemen.

#### REFERENCES.

1. Camps FE, ed. The history of legal medicine. In: **Gradwohl's** Legal Medicine, Third Edition. Bristol: John Wright & Sons, 1976: 1-13.
2. Jia JT, **Cameron JM**, Wang X. A brief history of forensic medicine in China. *The Criminologist* 1988; 2: 67-85.
3. Chao TC. Forensic Medicine in Singapore. *Am J Forensic Med Pathol*, 1988; 9: 179-81.
4. Chao TC. Mass poisoning in Perak, Malaysia or Tale of the Nine Emperor Gods and rat tail noodles. Paper at the 12th Meeting of the International Association of Forensic Sciences, Adelaide, Australia, 24-30 October **1990**.
5. Report of the Singapore Task Force on Investigations of deaths of Thai workers in Singapore, July 1990.