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Forensic Medicine¹

There has always been a relationship between medicine and law. Statutes governing the liability of the physician were included in the ancient code of Hammurabi and in Roman Law. The law makers always attached a real importance to medicine in connection with basic rules pertaining to paternity, life and death, and medical evidence. Minimal and maximal duration of pregnancy was fixed in Roman Law.

There was no need for a special branch of law concerned with medicine except for legislation on the practice of medicine. The relationship between the physician and patient was contained in the general context of the medical contract and physician liability was judged accordingly. As long as the practice of medicine was guided by the physician's personal and sole concern for his patient and the basic principles of the Hippocratic Oath were adhered to, there were no major social problems.

A profound and generalized change occurred shortly after the Second World War and the practice of medicine is no longer carried out by the family doctor making house calls but more and more by groups and teams of physicians working in the technical complex of a hospital. The new developments in hospital care have made serious illness very expensive, so much so as to have been labeled "catastrophic". The cost of hospitalization has increased in the United States from a few dollars a day to astronomical figures of over \$100 a day, and similar increases have been experienced in other countries. To provide for this in nearly every country health and hospital services are being provided. In the United States, this is accomplished by voluntary hospital insurance for the individual or the group and more recently for the elderly through Medicare and for the indigent through Medicaid. The cost of maintaining a large hospital is enormous and many economic, social, ethical, and judicial problems have arisen in connection with the administration of health services that were not dreamed of when the family doctor took care of his practice in his office and in the patient's home at all hours of the day and night.

Medicine to a certain extent has become depersonalized even though it is more abundantly available. The patient often goes to a doctor and not to the same doctor. The impersonal and complex nature of medical care has resulted in an increasing number of liability and malpractice claims which has become very costly.

In the scientific field there have also been problems that have arisen in connection with the donation of tissues or an organ from a live donor into a recipient who is in need of such a transplant. Although blood for transfusion has been obtained from live donors for many years with little possibility of harm to the donor and only occasional risk for the donee, the transplantation of one of a paired organ like the kidney from a live donor does provide a risk for him. The transplantation of single organs like the heart, lungs or liver must be from an individual so recently dead as not to have exhausted the variable

¹ Excerpts from an address in response to presentation of the Honorary Degree of Doctor of Law to Dr. Milton Helpern by the Faculty of Law, University of Ghent, Belgium, February 1970.

viability of the intact organs to be transplanted. Problems arise when an organ is taken from a dead body. Death must be pronounced when there is irreversible cessation of life but before the relative short period of viability of the organs to be used is exhausted. There must be clearly demonstrable criteria of clinical death, the pronouncement of which must be the responsibility of one or more physicians not involved in any way with the transplantation procedure on the donor. The uniform anatomical gift act, now enacted into a law in more than 40 of the United States does provide for a donor over the age of 18 willing his organs during his lifetime to be used in the event of his death. In the absence of a will, the donation may be made by the next of kin in a decreasing scale of categories including friends who provide for burial of the deceased. The act also provides that the time of death be determined by one or two physicians not participating in the surgery. It also has a provision that when an official postmortem examination has to be carried out, that such a situation would have a prior claim before the donation could be effected. It has been generally recognized that victims of homicide should not be used as a source of donor organs for transplantation because of the possibility of prejudicing the prosecution or defense of the accused. This has been ignored in a few instances and has complicated the trials, the defense claiming that the removal of the live heart and other organs was an indication that the deceased was not in fact dead and the cause of death was in question because the autopsy on the victim was not complete!

It is extremely interesting that what formerly was a very simple problem, the recognition and pronouncement of death, usually made easy and certain by the inevitable progression of the signs of death, subjects of academic or purely medicolegal interest and only known to the non-medical public from their reading of detective stories, is now a topic of pressing scientific, medical, social, and juridical concern. From time immemorial, death was considered to have taken place when consciousness and natural respiration ceased. The dying person was pronounced dead when he ceased to breathe or "took his last breath". The heart and pulse were not considered although the passage of time and the signs of death usually made death evident and no longer apparent. One might comment that obvious brain death either traumatic or natural now coupled with the sophisticated use of the EEG and absence of spontaneous respiration are the main criteria for the pronouncement of death, not too unlike the ancient criteria by which death was first recognized by the most ordinary non-medical people in ancient times.

In connection with the pronouncement of death, there cannot be a hiatus between medical death and juridical death. The physician cannot decide for ulterior purposes that medical death occurred at a time different from juridical death. If the times of death do not coincide, there is the untenable situation of the possibility of killing a medically dead person or of a medically dead person remaining eligible for inheritance in a case of survivorship arising out of a double traumatic death in a common accident. The physician cannot pronounce his patient dead medically and alive for legal purposes. Such an action would violate the basic rules of inheritance, paternity, and survivorship. Problems pertaining to life and death may be essentially medical but have implications beyond medicine.

Forensic medicine utilizes the disciplines of all branches of medicine and related basic biological sciences and is concerned with legal problems and questions involving all of them. The clarification and solution of these problems and the correct answers to the medicolegal questions are of paramount importance in the administration of justice, both civil and criminal, and also for the public health and well-being of the community.

One of the most important of these medical disciplines with forensic applications is pathology. This is the science which deals with abnormal structural alterations and their recognition in the cells, tissues, and organs of the body—and in some cases the lack of

such recognizable alterations produced by disease or traumatic injury, or by combination of disease and injury. Medicolegal or forensic pathology is not only concerned with causation, but also with acceleration and aggravation of pre-existing abnormal states, either of natural or traumatic origin. In contrast to the broad medical activities of official departments of legal medicine in most countries throughout the world, in the United States as in Great Britain, such official medicolegal inquiries are almost exclusively concerned with the investigation and determination of the cause of sudden, unexpected, suspicious, and violent death, and also with some of the aspects of forensic psychiatry, mainly the valuation of mental disease requiring legal commitment in mental hospitals and, also, questions of mental competence and legal "insanity."

A knowledge of forensic pathology is, therefore, absolutely essential for the medical investigator and medical examiner officially designated for this responsibility, if such investigations into fatalities are to be properly and meaningfully carried out. The forensic pathologist must be trained for his position and understand his responsibilities and the purpose of his investigations if the needs of the community and the ends of justice are to be properly served. He must develop the necessary skills and be available to apply his knowledge without delay. He must appreciate the need for additional examinations and, even when the answer appears evident in a particular case, he must anticipate that other questions may arise later that might make it necessary—apart from merely determining the cause of death—to carry out microscopic studies on the tissues and have toxicologic, bacteriologic, and serologic examinations performed. The pathologist who is not experienced in forensic cases is too often limited in his outlook. He allows himself to stop when he finds the obvious, often failing to manifest that curiosity which could have led him to a complete investigation, revealing the actual facts that would provide the true answers, or, at least, additional equally important information for the subsequent development of the case.

In contrast to the hospital pathologist who is not pressed for the solution of the problem of the cause of death, or the determination of findings of legal significance, and who can, in a sense, isolate himself while carrying out his studies and postpone the announcement of his findings and conclusions, the forensic pathologist cannot delay his investigation or postpone his impressions until every phase of the work has been completed. There is an urgency in this work necessitating an active attitude. The forensic pathologist may be said to work in the "market place" and not in the "ivory tower." This does not imply that the work can be crudely and incompletely performed, but rather that significant findings must be reported promptly to appropriate agencies for investigation and indicated action, which action might be too late if the pathologist were to withhold all information until he had completed every aspect of his work on the case.

When the findings of the forensic pathologist indicate or suggest the continuing existence of a hazard to the public health or to human life, it is his responsibility to take positive action by immediately alerting those agencies concerned with such information so that they may initiate corrective measures. Failure to recognize promptly fatalities from carbon monoxide poisoning or, in a diagnosed case, failure to appreciate the possibility of a continuing hazard in the home or in industry that could result in additional poisonings, is an example indicative of a lack of awareness or indifference on the part of the pathologist.

Suspected or evident death from criminal abortion or other forms of criminal, accidental, or suicidal violence, require prompt notification to the law enforcement authorities. Death from infectious or contagious diseases requires verification and notification to the health department officials. Deaths from evident or suspected malpractice require investigation into the circumstances.

The recognition of suspicious injuries in the young infant as manifestations of the battered or abused child syndrome and the prompt reporting of such findings to protective child welfare agencies, as well as to the police, now required by Statute, is an essential medical responsibility which must not be evaded if the courts are to provide effective protection for the helpless child against such assaults.

Insensitive attending physicians, and in fatal cases, inert pathologists, have failed either to recognize the characteristics as indicative or suspicious of a pattern of human assault, often repetitive over a period of time, or to report such findings to the proper authorities. This inaction on the part of physicians has been rationalized by a fear of a law suit brought against them by an accused parent or guardian who is suspect. Such fears on the part of physicians and pathologists are unfounded, for all that they would be doing is reporting a suspicious situation for investigation with regard to an injured or neglected infant. They would not be acting in an accusatory capacity anymore than is done when evidence of homicide is revealed or confirmed at autopsy. The physician reports his findings as suspicious or indicative of assault or neglect and the investigating arms of the law then proceed. He does not and should not accuse anyone of a possible crime.

If the correct determination of the cause of a death and meaningful evaluation of the findings are to be accomplished, the postmortem examination must include an autopsy. The findings of the latter are occasionally sufficiently clear to permit an accurate reconstruction of the circumstances which, when subsequently investigated, are found to correspond precisely to what the autopsy findings indicated they would be. The more experienced and alert the pathologist, the more apt he is to appreciate the meaning of the findings in bizarre or subtle cases, the hazardous urgency of the situation they represent, and the necessity of promptly instituting a potentially life-saving investigation. The forensic pathologist must act with dispatch in reporting such cases if additional fatalities are to be avoided.

I shall describe such a case in which the striking characteristic appearance of the horizontally sectioned surface of the interior of the brain provided all the necessary information of the cause of death, the reconstruction of the preceding circumstances and the prompt correction of a dangerous hazard to life.

I was asked to examine a brain which had been removed during the routine performance of an autopsy. Death had occurred in a hospital to which the deceased, a middle-aged woman, was admitted in coma and where she died forty-eight hours later. On admission there was a suspicion of barbiturate poisoning, but despite the fact that the admission urine was reported to contain barbiturates, the clinical manifestations and changing neurological signs had made this diagnosis unlikely. The death was reported because of the initial coma, suspicion of barbiturate poisoning, and the many other etiological possibilities.

The pathologist performing the autopsy, sectioned the brain by cutting it horizontally into two approximately equal halves. The cut surfaces revealed a combination of findings which should have been immediately recognized as a delayed effect of carbon monoxide poisoning. The technical terminology is not so important as the fact that such damage is a characteristic finding in deaths from delayed carbon monoxide poisoning. There were also numerous small pin-point sized hemorrhages throughout the white matter of the brain, important as a finding to the experienced pathologist.

The appearance of the brain indicated that death had resulted from carbon monoxide poisoning, with survival for a period of time in coma which was known to have been at least forty-eight hours, the duration of the deceased's stay in the hospital. The appearance of the brain provided additional information. The small, pin-point sized hemorrhages in the brain were indicative of a type of carbon monoxide poisoning in which the exposure

must have taken place over a long period of time. This meant that the victim was exposed to a relatively low concentration of carbon monoxide in the atmosphere—on the order of about one thousand parts per million. In the event that death occurs after a period of survival in coma following exposure to a high concentration (for example, 10000 ppm) of carbon monoxide, the brain usually reveals characteristic changes, but in such cases the small hemorrhages are absent. Thus, these small hemorrhages combined with the more usual changes in the brain, indicate to the trained forensic pathologist a particular set of circumstances of exposure.

The important thing when a situation such as this presents itself is that the pathologist do something about it. What would have happened if this case were autopsied in a hospital where the conventional procedure is to place the whole brain in formalin solution to harden for a period of weeks prior to sectioning by the neuropathologist? Carbon monoxide poisoning was not suspected during the patient's stay in the hospital, and the changes in the brain were not evident on the surface, and only revealed when the brain was sectioned. It would have been very embarrassing indeed if several other cases of carbon monoxide poisoning occurred from the exposure to the same hazard which had not yet been discovered or suspected, while the brain of the deceased was slowly fixing in formalin for subsequent pathological examination. When an unsuspected fatal case of carbon monoxide poisoning is discovered at autopsy, it should immediately suggest the presence of a continuing hazard in the deceased's home or wherever he happened to be found.

In the case just described, the Health Department was immediately notified of our suspicion that the source of carbon monoxide in this fatal poisoning, based on the findings in the brain, was a defectively operating gas flame refrigerator. Such an appliance which is operating defectively may discharge sufficient carbon monoxide in the atmosphere of the room to produce a concentration of about 1000 ppm. This may cause fatal poisoning after a relatively prolonged exposure. This is specially apt to occur when the gas refrigerator is in a small unventilated apartment. It was on such an assumption that the death was reported for investigation.

Within an hour the inspectors telephoned to say that they had been to the apartment in which this woman had been found unconscious and had checked the refrigerator which was of the gas flame type. They reported that it was operating defectively and actually producing and discharging carbon monoxide into the air of the room in sufficient amount to produce a concentration on the order of 1000 ppm. Fortunately, the apartment had not been occupied by anyone else. The carbon monoxide in such cases is produced by the incomplete combustion of the fuel gas. The raw gas now used for fuel is of the natural type and does not contain carbon monoxide as a constituent.

A person remaining in such an environment for a short time would not be poisoned. It takes quite a while—several hours of exposure—to build up a concentration sufficient to produce coma. In many of these incidents, individuals have been slightly poisoned to the point of developing a headache or becoming nauseated and vomiting. Curiously, in cases in which these people have sought medical advice for their symptoms, carbon monoxide poisoning is rarely suspected or diagnosed. This type of poisoning usually goes undiagnosed despite the progressive symptoms and the opportunity physicians have to make the diagnosis. The "labeled" case which was encountered in former years when a person in a suicidal attempt turned on the raw gas containing carbon monoxide, presented no problems in diagnosis.

Today, in cases like the one described, where gradual accumulation of carbon monoxide produced headache as a first symptom, the individual approaches the physician who

is likely to treat him with aspirin alone or even with penicillin if he mistakes the carbon monoxide poisoning for sinusitis. The patient may go home and then be re-exposed, breathing in enough carbon monoxide to become nauseated, and to vomit. When these complaints are referred to the doctor, he may mistake them as manifestations of food poisoning.

The alert physician has an opportunity to make the diagnosis and effect a "cure." If he does not make the diagnosis, the patient will return home and may eventually breathe in enough carbon monoxide to be poisoned to the point of unconsciousness and then death. It is then left up to the medical examiner and forensic pathologist to recognize what has happened and to make the diagnosis. If the pathologist does not recognize the cause of death, or if he does, but fails to have the hazardous source of carbon monoxide corrected, more deaths from the same or similar sources are apt to occur.

In the case just described, the deceased was a woman in her fifties who had been found unconscious in her apartment. Two days before she had told her sister that she was going to enter the hospital for a varicose vein operation. The sister noticed that she was frightened about the impending operation and seemed depressed. On the day she was supposed to have entered the hospital, her sister called the hospital and learned that she had not done so. The sister tried to get in touch with her but was unsuccessful. Two days later, not having received an answer to her calls, she asked the superintendent to let her into the apartment where she found her sister lying unconscious on the sofa. She hastily concluded that she had taken an overdose of sleeping tablets. This conclusion was based on the knowledge that her sister was depressed and possessed sleeping tablets recently prescribed for her.

The hospital staff remained unaware of the fact that this was a case of carbon monoxide poisoning. This woman had other unfamiliar manifestations of acute carbon monoxide poisoning, but these were also misinterpreted. Carbon monoxide poisoning was never suspected during life. It is a type of poisoning in which the first opportunity for diagnosis may rest with the pathologist. If he does recognize what has happened he can save a great many lives, provided he takes the initiative to report his findings and conclusions to the proper agencies for action.

When the inspectors checked the gas flame refrigerator in the apartment in this fatal incident and found it defective, they also went through the entire apartment house and discovered seventeen other similar refrigerators as defective and dangerous as the one in the apartment of the deceased. Fortunately, in these other apartments the windows had been kept open, allowing enough ventilation to keep the concentration of carbon monoxide below a dangerous level.

This case described is an example of how changes in a single organ in the dead body enable a pathologist to determine the cause of death, reconstruct the likely circumstances and initiate effective action to eliminate an existing dangerous hazard to the lives of others.

Unfortunately, it is not always that easy, for there are times when a body and all its organs can be examined most thoroughly and the findings can be easily demonstrated, but what is needed to give them meaning will not be learned from the autopsy alone. This information can only be obtained by effective communication. The search for such information is often neglected. Pathologists and other physicians are frequently too reserved, too reluctant to leave the laboratory and talk to ordinary people. The forensic pathologist, working as a medical examiner, cannot hold himself aloof. One never knows from what sources the most revealing information will be obtained. The autopsy may disclose important and conspicuous findings but does not always provide complete information for the clarification and interpretation of a death. Investigation may supply this sig-

nificant data from the most unexpected sources to provide the missing link which gives continuity and meaning to all the other findings.

It is appropriate here to describe another case to illustrate how important it is to obtain information about a case apart from that derived from the autopsy.

The deceased was a person who had been admitted to a ward of a large hospital, on a Monday morning, in coma. He had been found unconscious at home and taken to the hospital where he survived for a period of eight days. There was evidence of scattered small superficial injuries but without any characteristic pattern. The cause of his continuous coma was never diagnosed in the hospital. After his death, eight days later, because of the possibility of traumatic injury based on some crusted abrasions on the face and chest, the death was properly reported to the Medical Examiner's Office where an autopsy was routinely performed. It revealed a large hemorrhage in the left side of the brain within the temporal lobe extending backward from the posterior border of the fissure of Sylvius. A careful search was made for a ruptured aneurysm on the left middle cerebral artery as a possible source of this hemorrhage, but none was found. Another finding was a thin layer of fresh pus beneath the meningeal covering on the under surface of the brain. The combination of a large fairly fresh cerebral hemorrhage complicated by this type of acute meningitis is unusual and suggested the possibility of a relationship to some other cause not apparent in the autopsy. Careful examination of the top of the head and skull did not reveal any small stab wound such as can be produced by an ice pick or other pointed weapon. There were these two conspicuous findings in the brain. Meningitis alone could have caused death; the brain hemorrhage could also have caused it. How was this case resolved?

While I was filling out the certificate of death and not too happy at my inability to relate the findings in the brain and determine their origin, the clerk asked a pathologist who had been assisting with the autopsy, what had been found. He replied that he had found meningitis and a cerebral hemorrhage. Whereupon, the clerk remarked in a somewhat surprised tone that the cousin of the deceased who had come to identify the body, and who had been waiting in the office for two hours while the autopsy was in progress, had told her that the deceased had been stabbed in the eye with a screw driver by his girlfriend. The clerk when asked why she had not given me this information replied that she had assumed that this would be evident in the autopsy. Her attitude was not unusual, for there are many people who are of the impression that an autopsy is a systematic procedure which, when completely performed, invariably provides all the answers. This is not so. The autopsy may reveal grossly conspicuous abnormal findings more than sufficient to provide a cause of death, but the information which clarifies the situation may come from the strangest unexpected source. A good example of this is provided by the cousin who came that day primarily to identify the body. If she had not been spoken to, the traumatic and homicidal character of this case might never have been solved. The cousin told the following story:

She had seen the deceased on the Saturday prior to the Monday morning when he was taken to the hospital. At that time he was conscious, appeared intoxicated and was wearing a surgical dressing on his left eye. When she asked him what had happened, he replied that his girl friend had "poked" him in the upper eye lid with a screw driver during a quarrel.

When the wound was inflicted, no one, including the deceased, appreciated how deeply the weapon had penetrated. The wound was not immediately disabling. The victim visited an emergency clinic and was instructed to return to the eye clinic the following Monday morning. It was after the visit to the clinic, where a patch had been placed on his eye,

that the deceased met his cousin, the informant, and told her what had happened. He then returned home. On Monday morning he was found unconscious without the dressing on his eyelid, and the cousin was not available to explain what had occurred. He was taken to the same hospital whose clinic he had previously visited. On admission his name was spelled differently and the hospital, being a large one, was not aware of his visit to the clinic two days before for an injured eyelid which went unrecognized and undiagnosed during his survival period of eight days in coma. When death occurred a total of ten days after the injury, the small puncture wound in the fold of the upper eyelid had healed over almost completely and the scar which remained was inconspicuous.

Naturally, we were chagrined, after the autopsy, to learn for the first time about the stab wound from the deceased's cousin, and immediately went back to the body to re-examine the area in question. What had been overlooked up to this point then became evident. There was the almost completely healed scar in the upper eyelid, not evident until the lid was pulled down, and as innocent in appearance as any of the other small scars on the body.

Examination of the orbit disclosed that the eyeball had not been injured and the skull was not fractured. The weapon had travelled in a backward direction above the eyeball and then through a small natural fissure in the bone in the back of the orbit, and passed into the cranial cavity where it had come in contact with the surface of the brain. Initially, slight damage here was subsequently complicated by a large hemorrhage into the brain substance that was delayed in its development, the end of the weapon at the same time having introduced the infection that caused the meningitis. It is correct to say that this type of traumatic injury happens not infrequently and there are some individuals who survive such injury without incapacitation.

In this case, the deceased had no immediate disability and might have survived without diagnosis if the delayed cerebral hemorrhage and complicating meningitis had not developed. When the injury was received, the damage was slight and complications did not develop immediately. The victim was not rendered unconscious or otherwise incapacitated. Neither he nor the doctors in the clinic suspected how far this small screw driver had penetrated. On admission to the hospital, two days after the stabbing, the eye patch was no longer in place. There was no suspicion of a stab wound in that location and the eye did not reveal changes which would cause one to suspect a penetrating wound of such depth and seriousness. Thus, the case with obvious findings at autopsy, with the meningitis or the cerebral hemorrhage sufficiently severe to have caused death, was only clarified by a witness who came to identify the body. Without this information, the traumatic and homicidal nature of the findings in the brain would not have been determined.