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Fallacies in the Signs of Death

Philosophers of old and great men of medicine have recorded changes in the human body for thousands of years (circa 2600 B.C.). One of the better known references to postmortem decomposition is recorded in the Bible: It was Lazarus of Bethany, brother of Martha and Mary, who was one of the first "stinkers." Jesus said "Take ye away the stone." Martha said to Jesus, "Lord, by this time he stinketh for he hath been dead four days" (John 11:39).

Although the classic triad of death—*algor mortis*, *livor mortis*, and *rigor mortis*—is subject to unpredictable variations, the ever present time clock of decomposition is run by the conditions of the local environment. For example, a traveler crossing the desert, dying of thirst, dissipating his energy by trudging in the sand, collapses and dies. It naturally follows that the rays of the hot sun and the warm dry winds will virtually devour all body water until no semblance of moisture is left in the remaining carcass after a few days. Natural mummification will occur eventually unless the body is disturbed by predators. To speculate on the time of this unwitnessed death is foolhardy, as the passage of time in such an arid environment is of no importance.

By contrast, if a man is covered by an avalanche of snow near one of the frigid poles of the earth, his body will be well preserved indefinitely, unless or until it is disturbed. Here again, in the matter of an unwitnessed death, the passage of time is inconsequential.

On the other hand, if a man falls prey to wild animals in the jungle or in the pirana-infested waters of the Amazon, a river which yields no corpse, death is unwitnessed and the passage of time since death is trivial.

For those of us who do not dwell in such extremes of environment and zones of hazard, and have the responsibility of giving the date and time of death on certain documents (notably the death certificate, autopsy protocols, insurance forms, etc), an occasional review for the sole purpose of updating the significance of certain postmortem changes in light of our present social change is necessary [1].

As one among many medical examiners who must function daily in the maze of uncertainty about the time of death, it has been a constant revelation that the classic signs of death (SOD) are fickle beyond the imagination. To add further confusion to this issue, many authorities on this subject do not agree except within wide limits [2-11]. It is this total unreliability of such frivolous factors as the SOD that makes it unwise to use them in fixing the time of death.

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Experimental Results

In attempting to illustrate the vagaries in the SOD, it should be acknowledged that for each success there have been several reverses in photographing the good cases. The reasons are as follows.

1. Dead people are poor actors.
2. Seldom is one able to obtain a repeat performance for the photographer with the same vim as the first time.
3. Rigor mortis is elusive at times, and in the eyelids is not detectable.
4. Instant rigor occurs frequently, particularly after death following an emotional encounter, a fight, or flight on foot. To establish photographic proof, one must be fortunate and present at the scene to help preserve this feature by manipulation of position if necessary.
5. The very obese dead are difficult to handle. In the total absence of rigor, this group imposes an exercise in weight lifting. Other than the ability of the obese to retain body heat longer, photography of their inability to develop rigor must be aided by torsion of the extremities.

Algor Mortis

This is the first sign of death, formerly called "the chill of death" and logically so because body heat had been present for the entire life span until death.

In the past, many interested observers have attempted to formulate a scale adapted to the hourly rate of body cooling after death. In most accounts published in pertinent literature at home and abroad, the rate of body cooling is postulated under ordinary conditions, indoors and outdoors, at about 70°F. The consensus is that the average human body cools at a rate of 2½ to 3½°F for the first two or three hours, and then at a rate of 1°F/h until the body temperature approaches that of the environment.

Individual modifications of this rule have been published by many authorities in this field, based on varied experience and geographical locality. Ironically, no two authorities on this subject agree; however, all of them are correct, each in his own right.

It is obvious that the application of such a rule, regardless of how loosely applied, would leave anyone who uses it in a quandary. This same situation could be easily converted into a dilemma if one takes into consideration all of the factors which alter the temperature gradient, such as clothing, nudity, obesity, senility, weather conditions, and sundry other factors.

The virtual cooling period of Fiddes and Patten [12], is worthy of consideration, especially the disclosure that the rate of body cooling is fairly steady through 85 percent of the temperature gradient from 99°F downward. After that the rate of heat loss is erratic and should not be used in computing the postmortem interval.

Lyle et al [13], in their deep appreciation for the poor state of the art in this respect, pioneered a three-year study of the postmortem temperature gradient by use of a thermocouple introduced into the brain as immediately after death as practical. Although other anatomical sites were used for comparison, the brain proved to be the site of choice and gave the most reliable results. This was a decisive step in a scientific direction and the results of the study proved that, under controlled conditions, the postmortem time interval could be followed with accuracy.

Joseph and Schickele [14] made a thorough and comprehensive study of body heat and postmortem cooling. Based on the general law of energy transfer, this effort proved to be

an exercise in producing graphical illustrations with temperature curves under varied circumstances of environment derived from applied physics and mathematics.

Other important ancillary studies include the rise in potassium concentration in the vitreous humor as the postmortem interval increased, reported by Coe [15] and also Sturner and Gantner [16]. In spite of all of these studies, the passage of time and the personnel who could make use of them has shown that they are neither popular nor practical for one reason or another.

Livor Mortis

The second sign of death is also called the "darkening of death" because shortly after death, in from 20 min to 2 h usually, purple-red blotches begin to appear in the skin. This change is first apparent in the dependent portions of the body and represents stasis of blood, which is visible in dilated superficial skin vessels due to the forces of gravity.

Within the first three or four hours after death these livid blotches may be "blanched out" by pressure of the finger against the skin, only to return when the finger is removed. After a vague, undefined length of time when the blood hemolyzes and stains the surrounding tissues by diffusion, this maneuver cannot be repeated [17]. The forensic significance of this change in the stability of the lividity is that if the position of a dead body has been changed after death but before lividities are fixed, the finding of two different areas of distribution of livores, such as in front and behind, may serve as mute evidence that the body has been moved since death.

With the aid of attendants, I have ordered the change of position of dead bodies after 12, 18, and beyond 24 h, and have photographed shifting livores at each postmortem interval. It is possible that any prankster could unwittingly convert shifting livores into a joke on law enforcement investigators if this SOD is to be accepted on its face value.

The best use of livor mortis may be obtained from its reflexion of color changes resulting from the combination of hemoglobin with such substances as carbon monoxide, cyanide, nitrobenzene, potassium chlorate, and nitrates. Other than this array of color changes, the shifting about of livores with changes of body position after death is of little or no practical significance.

Rigor Mortis

This third sign of death, also called the "stiffening of death," is the best known of all SOD, having been frequently mentioned in earlier historical writings, later in mystery dramas, and currently used as the butt of many jokes. Although there is considerable disagreement between authorities about the onset and disappearance of rigor mortis, as with the other signs of death, rigor is the most deceiving sign of the triad; for example, rigor mortis may not develop at all in certain bodies.

This phenomenon seems to be a common occurrence in bodies of the extremely obese, although it occurs occasionally in the senile, bony, and emaciated. Exactly where the line is drawn is not clear, but in my observation it seldom develops in bodies weighing in the 300–500-lb range and beyond.

By contrast, in the discovery of a body frozen stiff due to cold, the presence of rigor mortis should not be assumed to exist in combination with cold because, in principle, this is chemically unsound. Rigor is catalyzed by heat and retarded by cold just as most chemical reactions are; hence, stiffness due to cold is one condition while rigor mortis is another.

The development of instant rigor following strenuous physical exercise and emotional exertion, is part and parcel to the physical laws operating in the chemistry of death. The onset of cadaveric spasm appears to obey the same laws that govern rigor mortis [18]. There still remains the poorly understood operation of the local factor, which accounts for the lifelike sustained rigor of a single muscle group.

It is the consensus that rigor mortis appears in various parts of the body in varying degrees of intensity until it is fully developed throughout. Many observers have described its *modus operandi* as beginning in the muscles of the face, jaws, and neck and moving progressively caudad over the arms, hands, chest, abdomen, and lower extremities. After remaining in this rigid state for up to twelve hours, rigor is said to disappear in the same order of appearance, head to foot.

This schema of operations is more apparent than real. Since the volume of muscle mass varies in different parts of the body, it is logical that if rigor mortis forms at all, it will form in every part of the body where there is muscle tissue. While the distribution of heat and the presence of enzymes, metabolites, and other necessary conditions in the tissues may vary from one anatomical region to the other, the chemical change causing rigor will be effective throughout the body in varying degrees according to the size of the muscle mass [19]. Thus, rigor mortis is probably more unreliable than the other two classic signs of death put together and should not be used in a court of law to fix the time of death.

Discussion

It should be acknowledged by all interested parties that there are few subjects in the field of medicine with more built-in frailties and uncertainties than the SOD. The longer the postmortem interval the more unreliable the timetable becomes, until finally the obvious question arises: Are these signs worthwhile in the first place? Or, are they just a necessary chapter in the textbooks of morbid anatomy?

In recent years residents training in pathology have been duly warned by their peers that the SOD are to be used with caution in fixing the time of death, and that accuracy is acquired through experience. After many years of personal experience and summarizing the opinion of others with similar experience, it would appear that use of the SOD constitutes a lesson never well learned.

Despite this existing state of age-old vague confusion, the public at large has accepted the SOD, both in fiction and in fact. In television murder mysteries depicting the body of the victim dead at the crime scene, the act showing the coroner giving the precise time of death to the minute is carried out to the utmost. This image leaves the viewers with the impression that the coroner or medical examiner is endowed with mystic powers comparable to a sixth sense, which is untrue.

Even today, in practice, the reliability placed on the SOD is put to a great test of strength when it involves the discovery of a murder victim, but it is put to an even greater test when attempting to place the suspect with an alibi at the scene of the crime at the time of death. It is obvious that such a conclusion based on the SOD is not only tricky, but in a court of law it is artificial.

Conclusion

The classic signs of death are the best we have and there is no hope that they will improve in the future. To most pathologists this treatise reveals no amazing discoveries. It does, however, assure the uninformed that nobody can fix the time of an unwitnessed death by use of its classic signs with any degree of certainty.

As one accustomed to the daily observation of this group of fickle postmortem changes, the forensic pathologist is in the best position to render an opinion on the time of death when provided with reliable facts. The forensic pathologist, however, should be immediately unshackled from any obligation to fix the time of death as part of an absolute medicolegal responsibility to do so.

It follows that in recording the date of death on official documents in instances of unwitnessed death, missing persons, and similar forms, the use of the SOD should be very loose and preferably not at all; no hour of day should be given since this is tantamount to falsification.

With due respect to the classic SOD and their permanent status in the annals of medicine, they have outlived their span of usefulness. Even among forensic pathologists who have occasion to use the triad daily, the subject is still barely alive and is seldom a topic of discussion.

I am not unaware of the likely criticism from some quarters as regards the condemnation of such a long-standing edifice in medical history; however, this was done as a first step in alleviating an age-old state of uncertainty.

Summary

No one can, with any degree of certainty, fix the time of death by the classic signs of death. Experienced observers have repeatedly publicized the fact that postmortem changes are variable and, at times, deceiving. Rigor mortis occurs immediately after death in some instances, while in others it does not form at all.

Further study of these signs makes it obvious that their use should be limited to a special set of circumstances and, above all, the forensic pathologist should be unshackled from any obligation to fix the time of death as part of an absolute medicolegal responsibility to do so.

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