Standards Employed to Determine Time of Death

The following material was edited by Jeff Kercheval and obtained from:

VICAP International Symposium
Quantico, Virginia, June 19 - 23, 1988
AAFS New York Meeting
New York, NY, February 17 - 22, 1997
material presented by:
Patricia J. McFeeley, M.D.
Chief Medical Investigator
State of New Mexico
Albuquerque, New Mexico

Armed Forces Institute of Pathology
George Washington University
Forensic Pathology Course (editor's notes)

"Sptiz and Fisher's Medicolegal Investigation of Death-Guidelines for the Application of Pathology to Crime Investigation, 3rd Edition"
Edited by:
Werner U. Spitz

The crime scene investigator should be familiar with the following concepts for effective evaluation of a crime scene involving deceased victims.

EARLY STAGES OF DECOMPOSITION:

RIGOR MORTIS:

Muscular relaxation immediately after death is followed by the gradual onset of rigidity without shortening of the muscle. This is caused by the conversion of glycogen into lactic acid. The conversion of glycogen into lactic acid is attributed to metabolization of muscle for a short time after somatic death, or from products built up during the death event. As the pH decreases, there is a physical change in the muscle protoplasm. There is a cross-linking of actin and myosin by the presence of excess lactic acid.

Perception of rigor is more rapid in the smaller muscles, however, all muscles are affected at a similar rate. The rigor is more evident in the short, smaller muscles earlier than in the longer, larger muscles.

Because this is a chemical process, heat accelerates and cold decelerated the process. Acidosis, uremia or other medical conditions promoting a lowered pH accelerate the process.

Rigor is typically quantitated by “mild”, “early”, “moderate”, “and “complete” as a descriptive statement of degree of change. This is totally subjective and two observers may have different interpretations. Usually, perceived stiffness in motion of a joint is “mild”, difficulty requiring force to move a joint is “moderate”, and having to use great force is “complete” rigor.

Once the physical change of the muscle is forced, that degree of change will not reoccur, so that if someone has broken the rigor, it will not reform to completion. If only partial rigor is present, some rigor will continue to form.

Some conditions which affect rigor mortis include:

- temperature
- illness
- activity before death
- physical conditions where the body are found

MECHANISM	ONSET	MANIFESTED	MAXIMUM	DISAPPEARS
Physical change	Immediate	1 - 6 hours	6 - 24 hours	12 - 36 hours

LIVOR MORTIS:

Livor mortis is the settling of blood to the dependant parts of the body. When cardiac activity stops, the hydrostatic pressure of the liquid blood causes it to settle to the lowest points within the body (depending on body position) and distend the dependant capillary bed. The color of the dependant part will depend on skin pigmentation and any additional compounds which may be present within the blood (i.e. carbon monoxide, etc.). The areas where the blood has settled will generally be dark blue or purple in color.

Livor begins at or very soon after death since it is a function of cardiac activity. However,

stasis can occur to some extent in shock and some degree can be present even while the person is technically alive.

MECHANISM	ONSET	MANIFESTED	MAXIMUM	DISAPPEARS
Settling	Immediate	2 - 4 hours	8 - 12 hours	----------

Livor will not usually develop where there is pressure from clothing or objects. Therefore, important information regarding whether a victim was clothed for a period of time after death or if body position was changed can be gained from a careful inspection of the livor's distribution. Generally, time can best be supported from observation of livor and comparison with the accelerating or decelerating factors affecting that particular scene.

TARDEAU'S SPOTS/PETECHIAL HEMORRHAGES:

Accumulated blood which has settled in an area may cause capillaries in a small area to rupture so that circular or rounded areas of skin hemorrhage occur. These areas may range from pinpoint in size to 4 - 5 mm or larger in diameter. Tardeau spots usually refer to the larger petechia.

Small pin point spots which are usually observed within the sclera (white portion) of the eyes and on the face may be suggestive of asphyxia.

ALGOR MORTIS:

Algor mortis refers to cooling of the body. Postmortem body temperature declines progressively until it reaches the ambient temperature. The metabolism of the body generates heat which is regulated to a narrow range. If the body cools at a uniform rate, then the rate of temperature decrease could be used to accurately determine the time of death. However, the body temperature is a narrow range, not a fixed temperature. Activity, illness, decomposition, infection and absorption of heat can maintain or raise body temperature after death. The body cools by radiation (transfer of heat to the surrounding air by infrared rays), convection (transfer of heat through moving air currents) and conduction (transfer of heat by direct contact with another object). Therefore, many factors may influence the rate of heat loss. Careful consideration of the scene, clothing, victim size, activity and physical factors must be considered in interpreting cooling rate. The Glaister equation is one formula used for determining the approximate time period since death based on body temperature.

$$\frac{98.4\% - \text{measured rectal temperature}}{1.5} = \text{approximate hours since death}$$

Temperature has to be considered in light of all the scene data. For example, a deceased person who has been in a closed car all day with the sun shining on the car who is observed at night could not be expected to cool in a regular manner. In fact, an individual in this situation may well have a body temperature above "normal". Several individuals who have studied the effects of body cooling suggest that the rate is not constant, but rather more heat is lost during the first few hours, then as the body begins to reach ambient temperature, the rate of heat loss slows.

OCULAR CHANGES:

Time of Death Determination's....continued

DESCRIPTION	EYES OPEN	EYES CLOSED
Corneal film	minutes	several hours
Scleral discoloration "tachy noir"	minutes to several hours	----------
Corneal cloudiness	2 hours or less	12 - 24 hours
Corneal opacity	----------	3rd post-mortem day
Exophthalmos (Bulging)	with gas formation	with gas formation
Endophthalmos (Retraction)	with advanced decomposition	with advanced decomposition

FOOD IN STOMACH: (This information can be gained at autopsy)

SIZE OF MEAL	TIME IN STOMACH (starts to empty within 10 minutes)
Light	1 _ - 2 hours
Medium	3 - 4 hours
Heavy	4 - 6 hours

Variations:

Liquid is digested faster than semi-solid food, which is digested fasted than solid food.

Emotional state may also influence the rate of stomach emptying. Psychogenic pylorspasm prevents stomach emptying for several hours. Hyper motility may cause diarrhea.

VITREOUS POTASSIUM:

The body maintains an increased concentration of potassium in the intracellular fluid. This increase is 2- to 40 times the concentration of potassium within the plasma. This high concentration requires a balance between the electrical charges inside and outside the cell membrane and is maintained in this relatively high concentration be active metabolic forces that "pump" the electrolytes selectively across the membrane. A return to equilibrium occurs after death at a steady rate because the pumping mechanism is no longer active and the cell wall becomes a semi-permeable membrane that allows the potassium to leak through the membrane to approach equilibrium. The leak is at a steady rate because of the mechanical limits of the membrane. This steady rate provides a built-in clock that allows a projection back to the time of death. An ideal sample, protected from most trauma is the vitreous fluid of the eye. Calculations are most accurate when samples are obtained within 12 hours after death.

One formula developed for estimating the time of death based on a uniform potassium leak rate of 0.14 mEq/L/hr. is:

$$(7.14 \times K^{+} \text{ concentration}) - 39.1 = \text{hours since death}$$

Soon after this data was published the formula was found to be inapplicable for some locations and/or situations. It is suggested that your medical examiner determine the rate for your specific location.

Time of Death Determination's....continued

Postmortem Tissue Changes:

Decomposition: Involves two major components. These components are:

Autolysis: The process by which digestive enzymes within the body cells break down carbohydrates and proteins. Autolysis usually starts in the pancreas.

Putrefaction: The major component of decomposition which is due to bacterial activity. Characteristics of putrefaction include:

1) Gas formation and bloating
2) Green discoloration of abdomen
3) Marbling along blood vessels-a brown black discoloration in blood vessels caused by hydrogen sulfide gas
4) Blisters and skin slippage
5) Loss of hair and nails

Mummification: Drying of the body or its parts with "leather-like" changes. Mummification is characteristically seen on the tips of the fingers and nose. It can occur in as little as 1 - 2 days.

Skeletonization: Characterized by removal of soft tissue. Occurs largely as a result of insects and animals.

Adipocere: Formation of a waxy substance due to the hydrogenation of body fat. A moist, anaerobic environment is required for the formation of adipocere.

EXTENSIVELY DECOMPOSED/SKELETONIZED REMAINS:

Should be treated as any other scene involving careful examination and documentation of the scene, collection of evidence, etc.

The best approach is to plan ahead. Another day at this stage will probably not change the scene significantly, but could make the final conclusions better.

Use the services of a forensic anthropologist if possible.

The weathering of bones depends considerably on:

Buried or not buried
Climate
Moisture
Elevation
Terrain
Protection
Insect / animal / human intervention

Check weather bureaus for rainfall, temperatures, etc.

INSECT INFESTATION (FAUNA):

Time of Death Determination's....continued

INSECT INFESTATION	MINIMUM POSTMORTEM INTERVAL
Body lice	Outlive host by 3 - 6 days
Blow flies	May deposit ova before or at death -larva (maggot) - hatch within 18 - 24 hrs. -pupae/casings + week
Insects/Arthropods	In temperatures greater that 40o F. -Highly dependant of locale, temperature, season -Collect samples in preservative (85% alcohol) and take to an entomologist -Collect soil sample from around body (within 2 feet)

PLANT LIFE (FLORA):

1) Grass/plants beneath an object wilt, turn yellow or brown and dies. The rate depends on type of plant, season, climate, etc.
2) Seasonal plants or remnants may help indicate a range of time.
3) Collect dead and drying grasses, twigs, flowers, etc. and take to a local botanist.

METHODS FOR THE ESTIMATION OF TIME OF DEATH...SUMMARY

Rate: Method: Estimation by evaluating the presence/absence of an indicator in a deceased in conjunction with the known behavior of such indicators.

Concurrence Method: Estimation by evaluating events which happen at or near the time of death, or offer information suggesting a time period for the death event.

Time of Death Determination's....continued

METHOD TYPE	INDICATOR
Rate Method	Rate of drying or discoloration of blood pools
Rate Method	Rigor Mortis
Rate Method	Livor Mortis
Rate Method	Algor Mortis
Rate Method	Decomposition
Rate Method	Flora (plants) around body
Rate Method	Fauna (insects) around body
Concurrence Method	Time of last known meal
Concurrence Method	Stopping of watch (due to trauma / damage)

EVIDENCE FOR ESTIMATION OF TIME OF DEATH:

1) Corporal Evidence: In the body

2) Environmental & Associated Evidence: In the vicinity and general surroundings

3) Anamnestic Evidence: Based on the decedent's ordinary habits and daily activities

Time of Death Determination's....continued

CORPORAL EVIDENCE	ENVIRONMENTAL & ASSOCIATED EVIDENCE	ANAMNESTIC EVIDENCE
Stage of decomposition of internal organs vs. exterior of body	Uncollected mail / newspapers	Usual activities
soot in airway (fire / smoke inhalation)	Lights on or off	Walking & sleeping patterns
Evidence if medical conditions	Alarm clock set	Eating habits, times, types of food
Alcohol / drug levels	Food on stove / in refrigerator	Appointments
Beard / nails / hair	Type of clothing day / night indoors / outdoors seasonal condition of clothing (mold / leached dyes, etc.	Answered / unanswered correspondences
	Presence of sale slips or receipts in clothing	
	Animals / pets in house	

Editor's Note: Material obtained from Dr. McFeeley's presentations was used with her permission