

Chapter 7: Determining Time of Death

I. Time of Death & Body Changes

Significance of Time of Death

An accurate determination of the time of death eliminates some suspects & focuses attention on others. In order to make a best-guess estimate of a victim's time of death, the forensic pathologist relies on several changes that occur in a reliable, predictable pattern after death.

Measuring Body Temperature

Under ideal circumstances the corpse loses heat at a rate of 1.5C/hour until it reaches equilibrium with the surrounding air. Temperature is taken either rectally or from the liver.

The rate of a body's heat loss may vary depending on the following environmental circumstances:

- 1) Warm Air Temperatures: body loses heat more slowly.
- 2) Cool Air Temperature: body loses heat more quickly.

*After the body reaches the same temperature as its surroundings, this method can no longer be used to estimate time of death.

State of Rigor Mortis

Rigor Mortis: _____

Rigor mortis begins throughout the body at the same time, but the muscles become rigid at different rates in the following predictable pattern:

- 1) 2 hours after death, rigor mortis begins in the face & progresses downward to the lower regions of the body.
- 2) After 8-12 hours, the entire body is in a full state of rigor mortis, which last for about 18 hours.
- 3) After peak rigor mortis is reached, the process begins to reverse itself in the same order in which it appeared (head to toe).

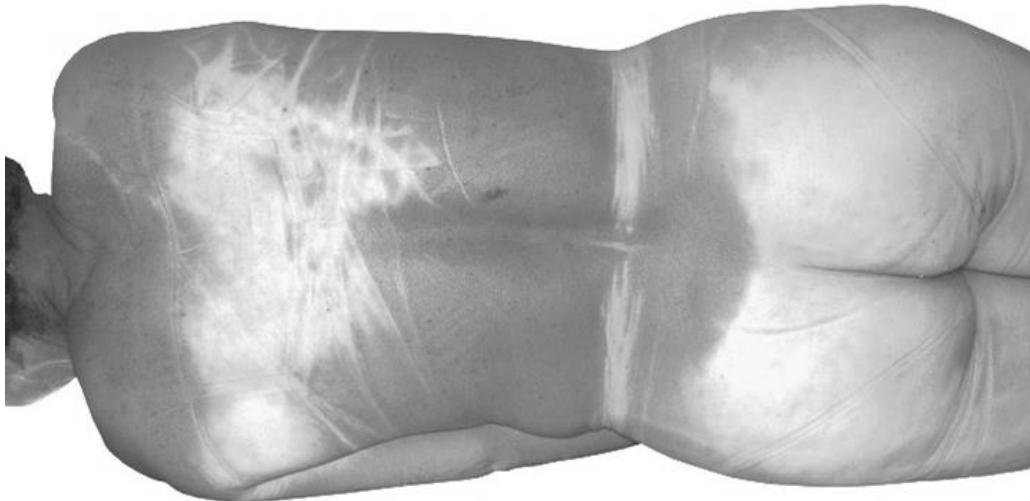
Rigor mortis is useful for determining the time of death during the first 36-48 hours after death under normal conditions. Can be very unreliable because heat quickens the process & cold temperatures slow it. Additionally, obese people may not develop rigor mortis at all, while in thin people it may develop rapidly.

Measuring Lividity

Lividity: _____

Lividity can be used to determine the time of death & whether the body was moved after death. As can be seen in figure 1, the any part of the body that presses against a firm surface appears pale & surrounded by the lividity.

Figure 1: Lividity Discoloration Patterns



Forensic pathologists can determine the approximate time of death by observing whether the lividity discoloration patterns have become fixed or not:

- 1) **2-6 Hours After Death**: discoloration of the skin due to lividity can be *shifted* by rolling the body into different positions.
- 2) **8+ Hours After Death**: lividity becomes **Fixed** such that *rolling the body into different positions will NOT alter the discoloration pattern*. This occurs because blood vessels begin to break down & the blood seeps into the surrounding tissues, permanently staining them.

The color of the lividity can also provide clues to the forensic pathologist regarding the manner of the victim's death:

- 1) **Red/Pink Lividity**: may be caused by carbon monoxide poisoning, cyanide poisoning, or exposure to cold temperatures after death.
- 2) **Purple Lividity**: caused from oxygen deprivation due to heart attack, shock, or asphyxia.

Observing Stomach Contents

The forensic pathologist uses the contents of the victim's stomach & intestines to help determine the time of death. If the pathologist observes an:

- 1) **Full Stomach**: if the stomach contains undigested food, then death likely occurred within an hour or two of the meal.
- 2) **Empty Stomach**: since the stomach takes 4-6 hours to empty following a meal, an empty stomach indicates that death must have occurred several hours after eating.
- 3) **Empty Small Intestine**: death occurred 24 hours after the victim's last meal.
- 4) **Empty Colon**: no food had been eaten 48-72 hours before death.

Insect Life Cycles

Insects are often attracted to, & lay eggs in the moist areas of a corpse such as the eyes, nose, mouth, armpit, groin, & open wounds. The stage of development of these insects when the corpse is found may offer clues as to the time of death (see figure 2).

Figure 2: Blowfly Life Cycle

It never takes these insects long to make their way to a decomposing body, and the first thing they do when they get there is lay eggs. This timeline is based on a constant temperature of 70 degrees.

DAY 1

Adult fly lays eggs on body.

DAY 2

Eggs hatch and larvae emerge.

DAYS 3-7

TWO WEEKS

Emergence of adult fly.

ACTUAL SIZE



Their measured life cycle allows **forensic entomologists** — bug specialists — to roughly calculate when a victim died based on the developmental stage of the blowflies when the body is discovered.

DAYS 8-9

Prepupation. Larva forms a hard, cocoonlike shell and begins developing adult features.

II. Determining the Rate of Decay

Methods of Breakdown

The decomposition of a body involves two distinct processes:

Autolysis: _____

Putrefaction: _____

Under normal circumstances (average temperatures above ground), putrefaction follows the following predictable sequence:

- 1) 36 hours after death, the abdomen takes on a greenish discoloration that spreads to the chest, neck, & head.
- 2) Bloating of body cavities begins due to the accumulation of gasses produced by bacteria.
- 3) The skin begins to marble, or form a weblike pattern of blood vessels.
- 4) Skin begins to blister & slip from the body as gasses continue to accumulate within body cavities.
- 5) Body turns a greenish-black color, & fluids of decomposition begin draining from the nose & mouth.

The breakdown of internal organs also occurs in a predictable pattern: Intestines → Liver → Lungs → Brain → Kidneys.

Reading Assignment

World of Forensic Science / Decomposition

The biological and chemical changes undergone by a body after death are known as decomposition. Decomposition is the continual process of gradual decay and disorganization of organic tissues and structures after death. Some tissues, such as bones, teeth, and hair, are more resistant to the action of microorganisms and other environmental factors and may last for centuries. Fossilized bones from animals and hominids, extinct millions of years ago, are studied today by paleontologists and anthropologists, thanks to such resilience.

Forensic medicine and forensic anthropology investigate the sequence and types of changes that affect decomposing bodies under different conditions and environments. A number of variables may affect both the rate and sequence of decomposition. Therefore, the estimation of time elapsed since death, known in forensics as the postmortem interval, takes into consideration the particular conditions associated with the decomposing body, such as temperature, level of humidity, and medium, such as exposure to preservatives, water, or soil.

For centuries, pigs were the animal model used to study both anatomy and the decomposition process due to their internal structural similarities to the human body. However, in 1980, the University of Tennessee at Knoxville began a research project on human decomposition with cadavers donated by the families of deceased persons or by the individuals who willed their bodies to science. In an area known as the Anthropological Research Facility, human bodies were laid to decompose in several different controlled conditions. These controlled experiments have significantly contributed to the better understanding of human decomposition and to new levels of accuracy of forensic reconstruction techniques, such as the circumstances of death, time and cause of death, and determination of age, race, and gender. The data collected from several types of experiments and the measurements of each skeleton are recorded in a computer data bank named ForDisc (Forensic Discrimination).

A general description of postmortem changes due to decomposition basically includes two stages of autolysis, and four stages of putrefaction, besides some conservative phenomena such as saponification or adipocere, natural mummification, calcification, etc. However, these latter events only occur in specific conditions. Autolysis consists of the fast and intense spontaneous self-destruction of tissues by the body enzymes present in the cells, without any bacterial interference. Once cells stop receiving nutrients and oxygen via blood circulation, they start anaerobic (without oxygen) "breathing", breaking ATP (adenosine tri-phosphate) into ADP (adenosine di-phosphate) to obtain energy. Anaerobic respiration lasts for a few hours, until all ATP reserves are exhausted. The anaerobic respiration induces the accumulation of lactic acid in cell tissues that disrupts cell function. Enzymes then collapse the cell nucleus and cell breakdown (necrosis) occurs.

Tissues rich in blood vessels (more dependent on oxygen and energy) are the first ones to suffer autolysis, whereas those poorly irrigated or deprived from blood vessels, like the ocular corneas, are not immediately affected by decomposition. Putrefaction (or breakdown by microorganisms) follows autolysis. With the exception of fetuses and newly born babies, the main source of these microorganisms in corpses is the right part of the large intestines. Microorganisms then invade the abdominal cavity, the chest, head, and limbs. The first visible signs of such activity are the greenish abdominal stains, accompanied by the initial odors of rotting flesh. The stains gradually expand to other parts of the body (thorax, head, and limbs) and change from light to dark green, then beginning to blacken. In people who have drowned, the greenish coloration starts on the face, progresses toward the thoracic area, and then to other parts, due to the position that drowned bodies assume in water, which facilitates putrefaction of the upper respiratory pathways first. In newly born infants, putrefaction agents (bacteria, fungi, etc.) invade the body through all cavities, especially through the respiratory pathways. The greenish stains appear in newly born babies first on the face, neck, and chest due to bacterial activity in the upper and lower respiratory pathways, and because their intestines are sterile. This phase of decomposition is known as the chromatic period.

Bacterial action destroys the structure of cells and soft tissues, releasing in the process body fluids in

internal cavities such as chest, abdomen, and oral tract. Anaerobic microorganisms produce methane, hydrogen sulphide, and other gases responsible for the increasing stench that surrounds rotting organic matter. As gases accumulate inside the body, it starts to swell, forcing more fluids from organs to internal cavities and blood to the periphery of the body. This phase of decomposition is called the gaseous period.

Subcutaneous (under the skin) blisters containing a mixture of plasma, hemoglobin, and gases appear and a marbled-like pattern spreads through the skin. The outer layers of the skin (epidermis) begin to detach from inner layers of the skin (dermis) as the gaseous period progresses. The subsequent phase involves the process of liquid putrefaction, in which the soft tissues are gradually dissolved. The body loses its shape as tissue mass decreases and the separation of skin layers is completed. During this liquefaction period, gases are released and a putrefied creamy substance covers the skeleton. The next phase is known as skeletonization, with the environmental elements (e.g., larvae, worms, and sometimes insects) separating the skeleton from ligaments, which causes the detachment of the skull, the mandible, and long bones, with bones eventually collapsing apart. Bones become increasingly fragile and lighter over the years, and acidic soils eventually dissolve them.

Adipocere (a waxy substance formed after death by fatty tissues) formation is not a universal phenomenon during decomposition. It is more common in remains of children, women, and overweight people, requiring both adipose (fatty) tissues and contact with humidity in the soil, or immersion in water, or the prevention of body water evaporation. Collective burial graves, where bodies are piled together, are also favorable to adipocere formation. Adipocere is very rare in remains of slim individuals because it results from the spontaneous chemical transformation of fatty tissues into a grayish-white waxy matter. Coroners have a special interest in adipocere because of its preservation properties of other tissues underneath. Adipocere-conserved body parts allow the performance of several forensic tests some months (and even years) after death. Examples are, the study of facial or neck lesions, toxicological tests, or the study of perforations caused by bullets.

Unborn fetuses that die between the sixth and the ninth months of pregnancy undergo a different process, known as maceration, due to prolonged exposure to the amniotic fluid. Fetal maceration external signs resemble in some ways those found in corpses immersed in water. However, the precise sequence of internal changes in fetal maceration is unique and offers three different well-defined phases or maceration degrees that allows the forensic determination of postmortem interval.

Questions Based on the Reading

Directions: All questions must be answered on a separate piece of loose-leaf. Please restate each question before recording your response.

- 1) Describe the difference between autolysis and putrefaction.
- 2) It is said that a human body can decompose into skeletal remains in only a couple of weeks if the conditions are right. What would those conditions be and how do those conditions contribute to such rapid decay?