

Figure 11-3. The official death certificate lists the cause and sometimes the mechanism of death.

The Commonwealth of Massachusetts
STANDARD CERTIFICATE OF DEATH
REGISTRY OF VITAL RECORDS AND STATISTICS

DECEASED: NAME FIRST MIDDLE LAST
Esther Victoria Lawson

PLACE OF DEATH (City/Town) COUNTY OF DEATH
Salem Essex

PLACE OF DEATH (Check only one)
 HOSPITAL
 Home EPO (Outbreak) DCA
 OTHER: Nursing Home Residence Other (Specify)

WAS DECEDENT OF HISPANIC ORIGIN?
 (If yes, Specify Puerto Rican, Dominican, Cuban, etc.)
 NO YES

RACE (If of White, Black, American, or Other)
white

DATE OF BIRTH (Mo., Day, Yr.)
July 15 18

AGE - Last Birthday
 UNDER 1 YEAR: MONTHS : DAYS
 UNDER 1 DAY: HOURS : MINS

Susan Van Eppen

A forensic pathologist's report may indicate the cause and mechanisms of death in a single statement (as do some death certificates, Figure 11-3). For example, someone killed in a car accident may be said to have died from "massive trauma to the body leading to pulmonary arrest." Trauma to the body is the cause of death; respiratory arrest is the mechanism of death.

TIME OF DEATH

During an autopsy, the forensic examiner wants to determine when the person died. By establishing the time of death, a suspect may be proved innocent simply because he or she was not in the same place as the victim at the time of death. On the other hand, the suspect may remain a person of interest if he or she was in the same area at the time a person died. Many factors are used to approximate the time of death. These factors are discussed in more detail in the following sections.

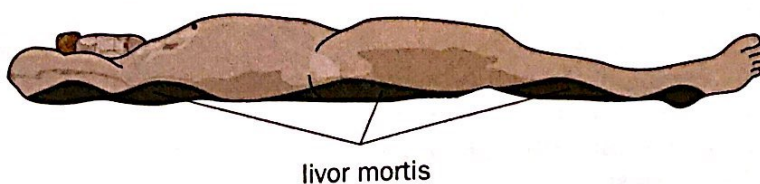
LIVOR MORTIS

Livor mortis means, roughly, death color. As a body begins to decompose, blood seeps down through the tissues and settles into the lower parts of the body. The red blood cells begin to break down, spilling their contents. Hemoglobin, the substance in red blood cells that carries oxygen and gives blood its red color, turns purple when it spills out of the cells. This purplish color is visible on parts of the skin wherever the blood pools. The process of livor mortis takes time.

Pooling of blood in the body, known as *lividity*, provides a clue as to how long the person has been dead. Lividity first begins about two hours after death. The discoloration becomes permanent after eight hours. If death occurred between two and eight hours, lividity will be present, but if the skin is pressed, the color will disappear. After eight hours, if the skin is pressed, the lividity will remain. The ambient temperature at which a person dies impacts the time it takes for lividity to set in. If the corpse is left outside on a hot, summer day, livor mortis takes place at a faster rate. If the body is left in a cool room, livor mortis is slower. This is why it is so important to record the environmental conditions surrounding a dead body. The extent of livor mortis is also affected by anything impeding the flow of blood, such as tight wristwatches or belts.

Besides providing an approximate time of death, livor mortis can provide other important clues. Because gravity pulls the blood toward the ground, lividity can reveal the position of a corpse during the first eight hours (Figure 11-4). If the corpse were face down in a flat position, blood would pool along the face, chest, abdomen, and portions of the arms and legs close to the floor. If the corpse were positioned on its back, blood would

Figure 11-4. The location of livor mortis can reveal the position of the body during the first eight hours after death.



pool along the back, the buttocks, head, and the parts of the arms and legs close to the floor. If the corpse were wedged in a standing position, the blood would collect in the lower legs and feet and the lower arms and hands.

Lividity also can reveal if a body has been moved. For example, if the person

died sitting in a chair, lividity would appear on the back of the thighs, buttocks, and the bottom of the feet. If the corpse were then moved so that the body was lying face down on the floor, lividity would also be found on the face, chest, abdomen, and front surface of the legs. Dual lividity could occur if the body was kept in one position two hours after death and then moved to a second position before the lividity became permanent. This is not uncommon if a murder victim is killed in one place and then transported somewhere else.

RIGOR MORTIS

Have you ever seen a dead animal in the road? Were all four of its legs stiff and sticking straight up in the air (Figure 11-5)? If the animal was still there a few days later, you may have noticed that the animal was no longer stiff. **Rigor mortis** means, roughly, death stiffness. It is temporary and can be very useful in determining the time of death.

Rigor mortis starts within two hours after death. The stiffness starts in the head and gradually works its way down to the legs. After 12 hours, the body is at its most rigid state. The stiffness gradually disappears after 36 hours. Sometimes, depending on body weight and temperature in the area, rigor may remain for 48 hours. If a body shows no visible rigor, it has probably been dead less than two hours or more than 48 hours. If a body is very rigid, then the body has been dead for about 12 hours. If the body exhibits rigor only in the face and neck, then rigor has just started, and the time of death is just over two hours. If there is some rigor throughout the body, but a lack of rigor in the face, then the body is likely to be losing rigor, and the death occurred more than 15 hours ago.

The stiffness occurs because the skeletal muscles are unable to relax and remain contracted and hard. In life, the flexing and relaxing of muscles happens as the muscle fibers slide back and forth. Whenever muscles contract, they release calcium. In healthy, live muscles, the calcium molecules are removed from the cells. This requires energy, and for cells to get energy, they need oxygen. After death without circulation, oxygen flow to the cells ceases, and calcium accumulates in the muscle tissue. In the presence of the extra calcium, the muscle fibers remain in the contracted, rigid position (Figure 11-6). Because the muscles control the movement of bones, the joints appear to be rigid as do the muscles. The muscles eventually begin to relax as the cells and muscle fibers begin to dissolve by autolysis.

Many factors affect when rigor mortis sets in and how long it lasts. When trying to estimate the time of death, these factors need to be taken into account:

1. **Ambient temperature.** The cooler the body, the slower the onset of rigor. The warmer the body, the onset of rigor is faster because chemical reactions happen more quickly at higher temperatures.



If a body needs to be transported when rigor is at its peak, it might be necessary to break bones to change the position of the body.

Figure 11-5. During the first 48 hours of death, the skeletal muscles are stiff—a condition known as rigor mortis.



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Figure 11-6. Live muscle fibers slide back and forth; in the first 48 hours of death, the muscle fibers become locked in a flexed position.

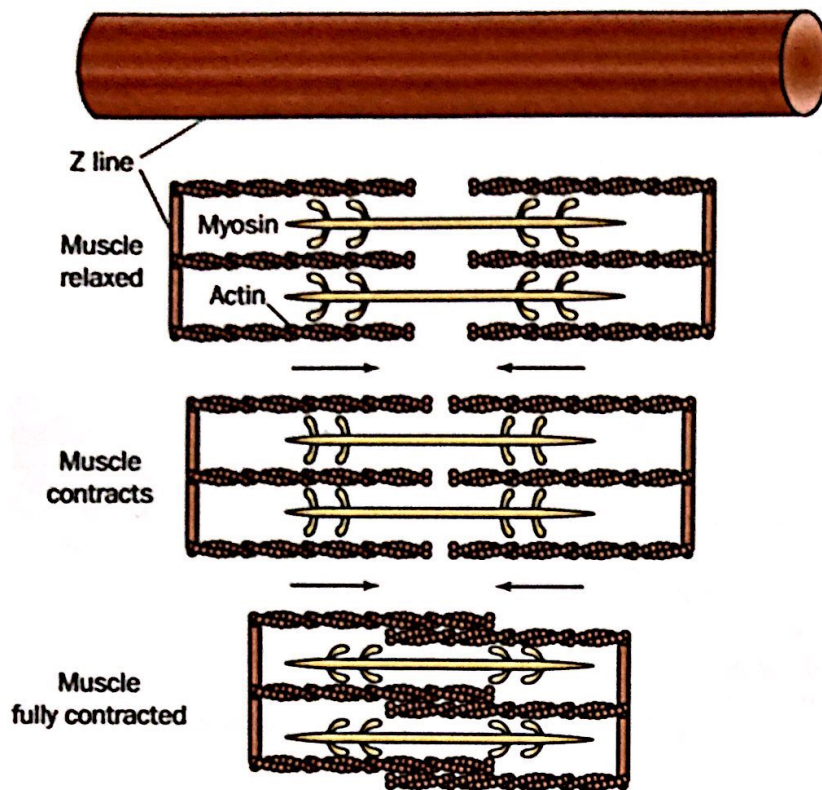


Figure 11-7. Body weight and physical activity affect the timing of rigor mortis.



Figure 11-8. Progression of rigor mortis.

Time After Death	Event	Appearance	Circumstances
2 to 6 hours	Rigor begins	Body becomes stiff and stiffness moves down body.	Stiffness begins with the eyelids and jaw muscles after about two hours, then center of body stiffens, then arms and legs.
12 hours	Rigor complete	Peak rigor is exhibited.	Entire body is rigid.
15 to 36 hours	Slow loss of rigor	Loss of rigor in small muscles first followed by larger muscles	Rigor lost first in head and neck and last in bigger leg muscles.
36 to 48 hours	Rigor totally disappears	Muscles become relaxed.	Many variables may extend rigor beyond the normal 36 hours.

2. *A person's weight.* Body fat stores extra oxygen and will slow down rigor mortis. A person with less oxygen stored in the body experiences rigor faster (Figure 11-7).
3. *The type of clothing.* Because clothing helps keep a body warm, the presence of clothes accelerates rigor mortis. A naked body cools faster, which slows down the onset of rigor mortis.
4. *Illness.* If a person dies with a fever, the body temperature will be higher, and rigor mortis will set in faster. If a person experiences hypothermia, the onset of rigor will be slower.
5. *Level of physical activity shortly before death.* If a person was exercising or struggling before death, then rigor will progress faster. This is true for several reasons, including the fact that exercise increases body temperature and decreases oxygen availability to the cells in the body and increases lactic acid levels.
6. *Sun exposure.* A body exposed to direct sunlight will be warmer, and rigor mortis would occur faster.

Because so many variables can affect how fast rigor mortis progresses, a precise time of death cannot be determined, it can only be estimated. However, when rigor mortis is combined with other factors, a more accurate time of death can be established (Figures 11-8 and 11-9).

Figure 11-9. Factors Affecting Rigor Mortis.

Factors Affecting Rigor	Event	Effect	Circumstances
Temperature	Cold temperature	Inhibits rigor	Slower onset and slower progression of rigor
	Warm temperature	Accelerates rigor	Faster onset and faster progression of rigor
Activity before death	Aerobic exercise	Accelerates rigor	Lack of oxygen to muscle, the build up of lactic acid, and higher body temperature accelerates rigor
	Sleep	Slows rigor	Muscles fully oxygenated will exhibit rigor more slowly
Body weight	Obese	Slows rigor	Fat stores oxygen
	Thin	Accelerates rigor	Body loses oxygen quickly and body heats faster

ALGOR MORTIS

Algor mortis means, roughly, death heat and describes the temperature loss in a corpse. When a person is alive, the body maintains a constant temperature. To keep our temperature within a normal range, many parts of our body work together, including the circulatory, respiratory, and nervous systems. In death, the body no longer generates heat and begins to cool down.

To take a corpse's temperature, forensic investigators insert a thermometer into the liver. Having a standard location for taking body temperature ensures that investigators can compare their results.

How fast a corpse loses heat has been measured, and investigators can determine how long ago death occurred by its temperature. Approximately one hour after death, the body cools at a rate of 0.78°C (1.4°F) per hour. After the first 12 hours, the body loses about 0.39°C (0.7°F) per hour until the body reaches the same temperature as the surroundings. This is just an estimate and will vary depending on surrounding temperature and conditions. In cooler environments, the body will lose heat faster than in hotter environments. If it is windy, heat loss will occur faster. The surrounding air temperature and other environmental factors are noted when a body is found, because the environment will affect the rate at which the body loses heat. The excess body fat and the presence of clothing will slow down heat loss. Time of death determined by body temperature calculations is always expressed as a range of time because it cannot be calculated exactly; however, a rule of thumb is to expect a heat loss of approximately 1 degree F per hour.

STOMACH AND INTESTINAL CONTENTS

Medical examiners help determine the time of death by studying the corpse's stomach contents. In general, it takes four to six hours for the stomach to empty its contents into the small intestine and another 12 hours for the food to leave the small intestine (Figure 11-10). It takes approximately 24 hours from when a meal was eaten until all undigested food is released from the large intestines. From this, it can be concluded that:

1. If undigested stomach contents are present, then death occurred zero to two hours after the last meal.