

## Postmortem Interval – the “Third Rail” of Death Investigation

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“So, how long has this guy been down?” How many times have you heard that question, whether at a scene or in the autopsy room? Aside from “why would you ever want to do this work?” it may be the most frequent question that we encounter, and is surely the most troubling. Sadly, despite medical advances at almost every level, from high-tech scanners to submicroscopic DNA, determination of postmortem interval has not particularly changed since the early days of forensic pathology. In fact, our forbears such as Sir Sydney Smith or Sir Bernard Spilsbury were probably more confident regarding this issue than we are; they didn’t know just how much they didn’t know.

Are scientific tools available to help with this vexing problem? A number of attempts have been made to produce reproducible formulae to aid in postmortem interval determination. Measurement of potassium in the vitreous humor was popular; we now know that the ratio of potassium to time since death is neither linear nor reliable. Still promoted in some circles is body temperature measurement, whether convenient (tympanic membrane, axilla), embarrassing (rectal), or even dangerous (liver) at the scene. Is postmortem temperature helpful? Only if we know the antemortem temperature and the cooling rate, which of course, we do not know. Still, attempts were made, from the Moritz formula ( $(98.6^{\circ}\text{F} - \text{rectal temperature})/1.5 = \text{hours since death}$ ) to Simpson’s “under average environmental conditions, the clothed body will cool in air at the rate of two and one-half degrees an hour for the first six hours and averages a loss of one and one-half to two degrees per hour for the first twelve.” Despite the scientific aura about these formulae, they are inaccurate at best, misleading at worst. The problem – too many variables. Several dozen factors impinge on antemortem temperature, postmortem cooling rate, or both, rendering a single temperature, or even a series of temperatures, useless for determining postmortem interval.

Are the “usual” early postmortem changes helpful? We might consider corneal opacity and the “mortises” – livor mortis, rigor mortis, and algor mortis (postmortem cooling). Corneal changes are variable, and depend mostly on whether the lids are closed or not. Livor mortis, or the settling of blood after death due to gravity, depends on time but also on position, and is most helpful in determining whether or not a body has been moved. Similar reasoning applies to rigor mortis, the postmortem stiffening of muscles. For both livor and rigor mortis, the usual rule of thumb (appearance within two to four hours after death, complete within six to twelve hours) is highly inaccurate. Consider, for example, that both changes can be put “on hold” by simply refrigerating the body.

As the postmortem interval lengthens, late changes intrude and may include decomposition in all of its wonderful stages, insect colonization, animal feeding, mummification, adipocere formation, and so forth, depending on location and access.

Insect succession, for example, may be useful in determining season and or location of death. Decomposition may be hastened by illness or inappropriately advanced in an anatomic region by injury. For sure, though, the longer the time since death, the wider the possible time interval becomes for estimation purposes.

Perhaps modern science might bring us aid. A survey of the current literature regarding postmortem interval reveals many anecdotal reports and few series, many focusing on what does not work. The best science appears to have developed within the meat packing industry. After all, autolysis and decomposition to us represent tenderization or product loss to them, and interesting research has been produced examining, for example, skeletal muscle tensile strength and its relationship to time since death (or slaughter, in this case). Other work focuses on "protein clocks," the postmortem degradation of various proteins. Unfortunately, of course, such a system might be quite reliable in the hospital morgue but much less so in the woods or a flooded basement.

Caution, then, is highly recommended whenever approaching the "how long down" question with which we started. An estimate of postmortem interval, whether offered in the field or at autopsy, will always represent just that – a best estimate based on the usually fragmentary evidence at hand. Except in the case of reliably witnessed death, accuracy with respect to time since death may be approached but will never be reached except by luck or accident. Given our current state of knowledge, "I don't know" might be the best (and certainly safest) answer.