



## Death as a Process: Early Postmortem Changes Observed in the Agonal Stage of Terminal Patients

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### Abstract

**Introduction:** Agony can be defined as the preceding stage to death, in those situations where life is gradually extinguished. So that, agony is characterized by the cese of the vital functions. From the moment of death and throughout the decomposition process, a series of observable postmortem changes occur in the corpse. Early postmortem changes are rigor mortis, livor mortis, algor mortis and cornea drying.

**Aim:** The aim of the present observational study is to monitor the clinical signs presented during agony and to determine those that are considered as early postmortem changes.

**Material and methods:** Signs monitoring and data registration were carried out during 4 months at the Intensive Care Unit of Hospital of Blanes (Girona, Spain), 21 patients were daily evaluated during their stay at the hospital until the moment of their death. The inclusion criteria for the individuals enrolled in the study were: i) Being diagnosed of a terminal disease and ii) Being at the end of life period. The evaluated signs were: Pallor and cyanosis, body temperature, lividities, rigidity, apnea, oral secretions, anuria, eye dehydration.

**Results:** General pallor was registered in 14 patients, 5 patients presented cyanosis. 12 patients presented rigidity in the cervical region, 5 patients presented rigidity in upper extremity and 8 individuals presented rigidity in the lower extremity; Lividities in upper extremities could be observed in 5 patients, and 7 patients presented lividities in lower extremities. Eye dryness was observed in 10 patients. All those signs are considered postmortem changes.

**Conclusion:** This article highlights the concept of death as a process. And it should be taken into account either by healthcare professionals dealing with the living, in their late stage of life, and also by forensic scientist dealing with the dead.

### Keywords

Early postmortem changes, Agony, Terminal patients

## Introduction

When cardiac or espiratory arrest occurs, brain function ceases within seconds as a result of the collapse of cerebral blood pressure and consequent cortical ischaemia. Within minutes, this loss of brain function becomes irreversible. Cellular death follows the ischaemia and anoxia inevitably consequent up on cardiac or espiratory failure, but different tissues die at different rates, the cerebral cortex being vulnerable to only a few minutes' anoxia, where as connective tissues and even muscle survive for many hours, even days after the cessation of the circulation [1].

In those situations where life is gradually extinguished, agony is the preceding stage to death. So that,

agony corresponds to the transitional stage between life and death, and it's characterized by the cese of the vital functions [2].

When death occurs, certain changes can be observed in the body, those postmortem changes take place in a

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predictable sequence, and that permits to classify those changes in different stages of decomposition. But although the stages sequence is predictable in most of the cases, the time of duration of each stage is significantly variable based on the individual circumstances as well as the environment conditions.

Early postmortem changes are rigor mortis, livor mortis, algor mortis and cornea drying.

Rigor mortis is defined as postmortem muscle contraction owing to locking of actin-myosin filaments because of decreased ATP synthesis [3]. Rigor mortis involves involuntary and voluntary muscles, leading those to joint stiffening. An initial flaccidity occurs, and then it onsets in the jaws, progressing to the upper extremities and then to the lower extremities. Rigor mortis persist for a variable period of time and then, it lessens and finally disappears as denaturation of actin-myosin linkages occurring in early decomposition. The disappearance will follow the same pattern as the onset [4].

Livor mortis occurs when the circulation ceases, as arterial propulsion and venous return then fail to keep blood moving through the capillary bed, and the associated small afferent and efferent vessels. Gravity then acts upon the now stagnant blood and pulls it down to the lowest accessible areas [1]. Lividity first becomes apparent from 20 minutes to 4 hours after death, being discoloration is at maximum intensity from 3 to 16 h. At fixation, lividity does not shift with a change of body position [4].

Algor mortis or body heat loss can occur by four mechanisms: Evaporation, radiation, conduction and convection [5]. The body temperature will decrease according to the environment.

Another early postmortem change is the “tache noir”, often observed in cadavers which the eyes remain open and the exposed part of the cornea dries, leaving a red-orange to black discoloration [6].

The postmortem changes useful for estimating time since death span from different processes: Physical (like body cooling and hypostasis); metabolic (supravital reactions); physico-chemical (rigor mortis); bacterial (putrefaction); autolysis (loss of selective membrane permeability, diffusion) and insect activity [7].

Different physical methods have been utilized to estimate the PMI. Electrical conductivity changes have been proposed in the literature in relation to PMI, establishing a positive relationship between the time after death and electrical conductivity [8]. Postmortem eye changes might be an important means to determine the PMI, different studies have explored relationship between the elapsed time after death and the opacity development of

the corneal and non-corneal regions [9-11].

Electrical conductivity changes have been proposed in the literature in relation to PMI, establishing a positive relationship between the time after death and electrical conductivity [8].

Numerous methods have been proposed for the determination of the time since death mainly by chemical means, like the measure of volatile fatty acids in the soil solution, as well as the analysis of amino acids, neurotransmitters and decompositional by-products, leading to the development of the new field in PMI estimation called thanatochemistry. Respect to molecular biology approaches, RNA appears as very promising target for the estimation of PMI [7].

Moreover, new growing field towards PMI estimation is the study of bacterial community changes during body decomposition. Understanding bacterial decomposition of the human body may be critical in determining time since death or Postmortem Interval (PMI), and potentially may have a significant impact on forensic investigations [12].

The aim of the present study is to evaluate the clinical signs that take place during agony and to determine those that are considered as early postmortem changes.

## Material and Methods

In order to evaluate the early postmortem changes that were observable in the agonal stage of the patients, signs observation and data registration were carried out during 4 months at the Intensive Care Unit of Hospital of Blanes (Girona, Spain), 21 patients were daily evaluated during their stay at the hospital until the moment of their death. Of the total of 21 individuals included in the study 9 were men and 13 were females, aged from 47 to 96-years-old.

The diagnosed disease are classified in oncological disease, cardiac, pulmonary, renal, and one femur fracture; 16 patients received oxygenotherapy. All patients received medication to release pain, consisting in subcutaneous clorur mòrfic, midazolam, butilescopolamina and haloperidol.

Morphic chloride is an opiate analgesic, indicated by sedation. Its undesirable side effects are nausea, vomiting, oral dryness, respiratory depression and urinary retention. The prescribed dose may vary depending on the pain that the patient shows and ranges between 10 mg every 4 h and 5 mg every 6 h, with a rescue dose if needed. There are various guidelines and pumps of continuous perfusion, depending on the need of the individual. Midazolam is an anxiolytic, hypnotic and amnesic medication indicated for sedation that is usually admin-

istered subcutaneously. The most frequent side effects are hypotension, respiratory depression, drowsiness and muscle weakness. The prescribed dosage usually is 2.5 mg subcutaneous every 6 h, with a rescue dose if needed. Butilescopolamine has an abrasive action of both salivary and bronchial secretions. Its side effects are oral dryness, tachycardia, urinary retention and hypotension. Haloperidol is an antipsychotic medication used for agitation and anxiety. Among its side effects are dystonia, hypotension, fever, drowsiness, urinary retention, dry mouth and blurred vision [13].

The inclusion criteria for the individuals enrolled in the study were: Being diagnosed of a terminal disease and being at the end of life period. The evaluated signs were: Pallor and cyanosis, cooling, lividities, rigidity, apnea, oral secretions, eye dehydration. A study chart was used to register the evaluated signs observations. The observations were carried out in a daily basis, from the patients income at the hospital until their death.

## Results

Body temperature, general pallor, cyanosis, rigidity, lividities, apnea, oral secretions, edema, eye dryness and anuria were monitored and registered for the patients included in the study.

### General pallor and cyanosis

General pallor was registered in 14 patients, 5 patients presented cyanosis and 2 patients did not present pallor nor cyanosis; These two cases that didn't present pallor

nor cyanosis corresponded to individuals with heart disease.

### Body temperature

Regarding body temperature, 5 patients showed axillary temperature above 37.5 °C and 14 patients presented temperature under 37.5 °C, temperature was not registered in 2 cases. Of these individuals with a temperature above 37.5 °C, 4 of them suffered from oncological condition and 1 of them suffered from infectious disease.

### Rigidity

12 patients presented rigidity in the cervical region, 5 patients presented rigidity in upper extremity and 8 individuals presented rigidity in the lower extremity.

### Lividities

Lividities in upper extremities could be observed in 5 patients, and 7 patients presented lividities in lower extremities.

### Apnea

Apnea was registered in 13 patients, 16 from the 21 observad patients received oxygen therapy.

### Edema

Edema could be observed in 6 patients out of 21.

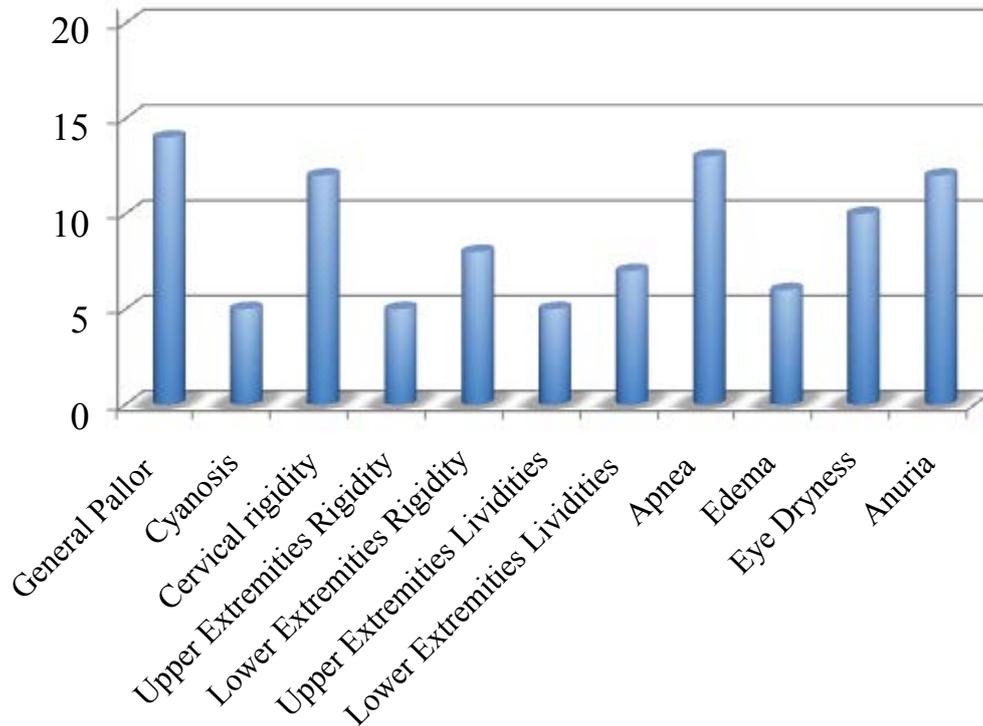
### Oral secretions

5 individuals presented oral secretions. It is import-

**Table 1:** The signes observed and considered as early postmortem changes.

Patient	Sex	Age	Pathology	Pallor	Rigidity	Lividities	Eye Dryness	Cyanosis
1	F	84	Alzheimer's Disease	X	X	-	X	-
2	F	87	Renal Insufficiency	X	-	-	X	X
3	F	90	Pulmonary Infiltration	X	-	X	X	-
4	M	88	Urinary Tract Infection	X	X	-	X	-
5	F	88	Respiratory Infection	X	X	-	X	X
6	F	77	Respiratory Infection	X	X	-	-	-
7	M	96	Respiratory Infection	-	X	X	X	X
8	M	88	Prostatic Cancer	-	X	-	X	-
9	F	47	Cervix Cancer	X	-	-	-	-
10	F	62	Lung Cancer	X	X	-	-	X
11	M	79	Cardiac Infection	-	-	X	X	-
12	M	74	Pancreatic Cancer	X	-	X	-	-
13	F	95	Breast Cancer	X	X	X	X	X
14	F	50	Pancreatic Cancer	X	-	-	X	-
15	M	83	Prostatic Cancer	X	X	-	-	-
16	F	82	Respiratory Infection	-	-	-	-	-
17	F	95	Respiratory Infection	X	X	-	-	-
18	M	95	Cardiac Infection	X	X	X	-	-
19	F	87	Cardiac Infection	X	-	-	X	-
20	M	85	Cardiac Infection	-	-	-	-	-
21	M	77	Respiratory Infection	-	-	-	X	-

X: Sign Observed; - : Sign not observed.



**Figure 1:** Signs observed in the patients studied.

ant to note that this variable may not be reliable since oral hygiene is carried out daily, followed by personal hygiene either by healthcare professionals or by the patient's family.

### Eye dryness

Eye dryness was observed in 10 patients.

### Anuria

12 individuals presented anuria, while 9 were able to micturate spontaneously.

Table 1 resumes the observation of those observed signs considered as postmortem changes, which are pallor, cyanosis, rigidity, lividities and eye dryness.

Figure 1 represents all signs observed, except oral secretions that were excluded from the results, due to the daily oral hygiene can be considered as an altering factor in the study.

### Discussion

End-of-life individuals included in the study presented pallor, cervical rigidity, cooling, corneal dehydration and lividities at lower extremities. All those signs are considered postmortem changes [1,4,5].

It has been previously described that slight hypostasis has been described in living individuals dying from a prolonged illness and terminal circulatory failure [14], which is consistent with our results. Nevertheless, oth-

er postmortem changes evaluated in that study such as haven't been considered in alive patients. Since the patients received hygienic measures daily at hospital, insect oviposition could not be evaluated.

There is a broad consensus among international policy statements that care provided at end-of-life should be different from care provided during other periods of life [15], so that health care professionals must take in account the signs observed in that study as indicated or of the agonal stage.

### Conclusions

This article highlights the concept of death as a process. And it should be taken into account either by healthcare professionals dealing with the living, in their late stage of life, and also by forensic scientist dealing with the dead.

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