

## A study of algor mortis in relation to cause and manner of death in hospitalised/non-hospitalised cases in tropical climate of central India

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### Abstract

**Introduction:** To understand the different aspects of average rate of cooling (ARC) in detail, is very important for understanding algor mortis in order to determine time since death in early post-mortem interval, as the classic triad of so-called thanatochronological data is constituted by algor mortis, rigor mortis and livor mortis. This paper is a humble trial to show some light and to detect any relation between average rate cooling of cadaver to cause and manner of death, and hospitalisation in tropical climate of central India.

**Materials and Methods:** A cross sectional study was carried out in department of Forensic Medicine & Toxicology, Gandhi Medical College, Bhopal. 173 cadavers were selected randomly which were brought for autopsy. After collecting routine data like age, gender, height, weight etc. following data were also collected – ambient room temperature, rectal temperature, cause of death, manner of death, and hospitalisation. Data were analysed using SPSS software.

**Conclusion:** The study found that cause of death, manner of death or hospitalisation has no effect on rate of cooling ( $p > 0.05$ ).

**Keywords:** Algor mortis, Average rate of cooling, Cause of death, Manner of death, Hospitalised/non-hospitalised, Cadaver.

### Introduction

Objective of post-mortem examination includes estimation of time since death (TSD). Algor mortis have been always an important method in determining the TSD along with other methods such as rigor mortis, livor mortis, biochemical changes in blood, serum, and cerebrospinal fluid etc. But so far no single method is capable of telling the TSD precisely. Algor mortis is cooling of the cadaver, which happens due to loss of heat from cadaver owing to difference of temperature between the cadaver and environment. So in order to that, temperature gradient gets established from core to surface of body, core being the hottest and surface the coolest. Heat dissipation from body to environment occurs at a certain rate, which is  $1.5^{\circ}\text{C}$  per hour in temperate climate and  $0.7^{\circ}\text{C}$  per hour in tropical climate,<sup>1</sup> which may be referred as average rate of cooling (ARC). TSD can be determined precisely on the basis of ARC. This paper aims its study at ARC in relation to cause of death, manner of death and hospitalisation. Various routes of temperature monitoring from dead body are—rectal, infra-hepatic, tympanic membrane, cribriform plate, out of which rectal route is the ideal route for measurement of core body temperature. Rectal temperature ranges from  $36.5^{\circ}\text{C}$  to  $37.5^{\circ}\text{C}$ .<sup>1</sup>

### Materials and Methods

A cross-sectional observational study was conducted at department of Forensic Medicine & Toxicology, Gandhi Medical College, Bhopal during the period of July, 2015 to August, 2016.

A total of 173 cadavers brought for medicolegal autopsy were randomly selected for this study. Those cases in which time of death is known and documented were included and those in which time of death is not known and the temperature at the time of death is either high or sub-normal were excluded. The post-mortem requisition form, along with the inquest papers, were received from the police. The cadavers were studied in the same condition in which they were brought. Minimal disturbances were done as far as possible with regard to clothings and coverings.

Exact time since death was recorded from hospital records and police documents. After noting the external appearance, the clothings were removed and rectal temperature was recorded in supine position, after spreading both legs apart exposing the perineal region. Laboratory thermometer of length 32 centimetres with a temperature range of  $0^{\circ}\text{C}$  to  $50^{\circ}\text{C}$  was inserted 10 centimetre deep in rectum of cadaver. The reading was noted two minutes after keeping the thermometer inside the rectum, then thermometer was taken out. Simultaneously ambient temperature was also recorded with ambient temperature thermometer. Further details such as age, gender, built, height, weight, actual time of death, time of reading of rectal temperature, cause of death, manner of death, hospitalised or non-hospitalised etc. are also noted from the documents and history. Average rate of cooling was calculated using the formula:

$$\text{ARC} = \sum \text{RC} / n$$

ARC – Average rate of cooling, RC – Rate of cooling of each cadaver, n – number of cadavers.

$$\text{RC} = (t - t^1) / \text{known TSD in hours}$$

t – Rectal temperature of cadaver at the time of death, t<sup>1</sup> – Rectal temperature at the time of autopsy. Data were analysed using SPSS software.

**Results**

In the present study total number of cases were n=173. Mean ARC was found to be 0.98 ± 0.7 °F/hour (Table 1). Males cool more rapidly than females. Extreme age groups have extreme average rate of cooling. ARC is inversely proportional to body mass index (BMI). It was observed that cooling was inversely proportional to environmental temperature, not against Newton’s law of cooling per se.

As determined by independent sample t-test mean ARC of hospitalized cases (1.13 ± 0.87 ° F/hour) were not significantly different from non-hospitalized cases (0.9 ± 0.58 °F/hour), t(89)=1.82, p = 0.07, 95%CI: -0.02, 0.47.

Mean ARC was maximum in myocardial infarction (1.16 ± 0.81 °F/hour), followed by drowning (1.08 ± 0.58 °F/hour), poisoning (1.03 ± 0.93 °F/hour), shock and haemorrhage (1 ± 0.72 °F/hour), asphyxia (0.89 ± 0.52 °F/hour), and electrocution (0.65 ± 0.36 °F/hour). There was statistically no significant difference between groups as determined by one-way ANOVA (F(5,167)= 0.68, p = 0.64).

Mean ARC is maximum in Natural deaths (1.16 ± 0.81 °F/hour) followed by accidental deaths (0.98 ± 0.69 °F/hour), suicidal deaths (0.95 ± 0.71 °F/hour), and homicidal deaths (0.8 ± 0.67 °F/hour) There was statistically no significant difference between groups as determined by one-way ANOVA (F(3,169)= 0.49, p = 0.69).

**Table 1: Frequency distribution and descriptive study of study population**

Study group	N	N%	Mean ± SD	Min.	Max.
Complete Sample	173	100	0.98 ± 0.7	-0.3	4.32
Hospitalisation					
Hospitalised	61	35.3	1.13 ± 0.87	-0.05	4.32
Non Hospitalised	112	64.7	0.9 ± 0.58	-0.3	2.7
Cause of Death					
Myocardial Infarction	14	8.1	1.16 ± 0.81	0.12	2.7
Drowning	6	3.5	1.08 ± 0.58	0.78	2.25
Poisoning	27	15.6	1.03 ± 0.93	-0.3	4.32
Shock & Haemorrhage	76	43.9	1 ± 0.72	-0.05	3.6
Asphyxia	44	25.4	0.89 ± 0.52	0.18	2.19
Electrodution	6	3.5	0.65 ± 0.36	0.09	0.96
Manner of Death					
Natural	14	8.1	1.16 ± 0.81	0.12	2.7
Accident	85	49.1	0.98 ± 0.69	-0.05	3.6
Suicide	67	38.7	0.95 ± 0.71	-0.3	4.32
Homicide	7	4	0.8 ± 0.67	0.08	2.1

**Discussion**

This cross-sectional study was conducted on 173 cadavers for estimation of time since death by the algor mortis in early post-mortem interval. In this study rectal temperature, height and weight were measured of those cadavers whose time of death was known. Average rate of cooling (ARC) was calculated and compared statistically on the basis of cause of death, manner of death, and hospitalisation.

Mean ARC of study population in the present study was 0.98 °F/hour or 0.5 °C/hour. Our results resembles to study conducted by Nanadkar S D et al (1994)<sup>2</sup> and Basu S K et al (1984).<sup>3</sup> In their study ARC was 0.43 °C/hour and 0.4 °C/hour respectively. A mild discrepancy was noted which may be due to warmer environmental temperature of Aurangabad region<sup>2</sup> in comparison to Bhopal region as Aurangabad is more close to equator.

Our results contrast with the results of Wilkie Burman (1847)<sup>4</sup> who reported ARC of 1.6 °F/hour since there study was in temperate climate. Robertson W G Aitchison (1925)<sup>4</sup> reported ARC in first 3 hours after death of 3.5 °F/hour in robust built and 4.5 °F/hour in emaciated person, in the next 3 hours ARC is 3 °F/hour common for both types of built. Keith Simpson (1965)<sup>5,6</sup> mentioned that ARC in first 6 hours is 2.5 °F/hour or 1.5-2 °F/hour in first 12 hours. Laxman J B (1979)<sup>7</sup> reported ARC to be 0.7-0.8 °F/hour. Spitz and Fishers (1993)<sup>8</sup> stated that ARC in 1<sup>st</sup> hour after death is 2-2.5 °F/hour and 1.5-2 °F/hour in 1<sup>st</sup> 12 hours and 1 °F/hour in next 12-18 hours. The above discrepancies for different temperature recording of different researchers may have come as a result of difference in environmental temperature from India, as most of the studies are done in temperate climate where average temperature of environment is low so rate of cooling will be more.

In the present study no difference in the rate of cooling was observed between hospitalised and non-hospitalised cases. No literature was found regarding comparison of ARC in hospitalised and not-hospitalised cases. Cases have been selected according to exclusion and inclusion criteria and those hospitalized cases were selected whose hospital stay is less than 3 days, which automatically excludes the infectious cases. So here it can be stated that environment temperature inside of the hospital may be cooler than the outside ambient temperature which resulted in higher rate of cooling in hospitalised cases.

In literature as mentioned by Gordon I, Shapiro H A and Berson S D (1988),<sup>9</sup> Mukherjee J B<sup>10</sup> in 1994 that in cases of shock and haemorrhage cooling is faster than other cases due to loss of blood as blood is warm in nature so if blood will be lost temperature will come down. In the present study ARC is maximum in deaths due to Myocardial Infarction. No literature has been found to correlate myocardial deaths to ARC. ARC in drowning cases was 2<sup>nd</sup> fastest cooling rate in the present study, which means that body cool down faster in water, in support to that Gordon I, Shapiro H A and Berson S D in 1988<sup>9</sup> mentioned that body cool down faster if submerged in water in comparison to air.

The present study found that manner of death has no effect on rate of cooling. Although in homicidal cases ARC was  $0.8 \pm 0.67$  °F/hour which may be due to loss of warmer blood in peri-mortem time, consequently which makes the cadaver to cool a lot sooner, as it is supported by Gordon I, Shapiro H A and Berson S D (1988),<sup>9</sup> Mukherjee J B<sup>10</sup> in 1994 who mentioned that in cases of shock and haemorrhage cooling is faster in comparison to other non-haemorrhagic shock cases.

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