Thermographic Study of Postmortem Cooling of the Human Head: A Preliminary Report

Ahmed Khallaf, M.B. and Brian L. Rosser, Ph.D.

• **Infrared imaging was used to evaluate the postmortem cooling of the human head during the first 15 hours after death. Warm and cool features on the head and face were selected and their patterns of cooling were recorded and then compared. Three main findings are highlighted: First, the complexity of the cooling process as a whole and the need for a more detailed thermologic model of head cooling; second, the definite difference in the pattern of cooling between the upper and lower part of the head; third, the consistency of the cooling pattern of the lower part of the head in all bodies evaluated in this small pilot study. In conclusion, computerized infrared thermography may be of significant value in forensic medicine and possibly in the study of heat balance of the head in living persons.**

The dynamics of heat production, transfer, and loss from the head in living human beings is a complex process in which physiologic mechanisms are continuously in action. Because the present study deals only with heat loss from the cadaver, physiologic factors do not apply, yet the temperature distribution between different areas of the skin, let alone between core and skin, may be of great significance in clinical and forensic medicine.[1] The main aim of this study was to look at the more fundamental thermologic changes that occur during the postmortem cooling process. These changes have a possible application in forensic medicine.

Even passive cooling of the head is a complex process because of the variety of anatomical organs and their corresponding thermal characteristics, ie, brain, skull, muscle, bones, sinuses, sense organs, fat, hair, and skin. This complex anatomy may eventually necessitate the construction of a quantitative or semi-quantitative model of the human head to aid in the understanding of heat transfer from the core to the scalp and facial skin, where the temperature is detected and measured by thermography.

Almost all previous forensic pathology investigations[2] of postmortem head cooling have been restricted to only a few temperature reference points that were measured by thermometers, thermocouples, probes, or microwave thermography.[3] In contrast, infrared thermography permits more detailed study, with an unlimited number of reference points or zones that can be used as temperature references. Because the images are magnetically stored and easily retrieved and reprocessed, additional points or references can be selected for further analysis. Another advantage of infrared thermography is that it is noninvasive and thus has ethical advantages as a method of investigation.

This paper presents results that were obtained during study of postmortem cooling of the head; specifically, it demonstrates differences in cooling rates between various selected features. This study lays the foundation for utilizing these and other difference in a more complete, pattern-based study of postmortem cooling of the head. It also demonstrates the large-scale differences in the cooling rates of upper and lower parts of the head.

Materials and Methods

Of eight cases studied, five were investigated in detail. These five cases form the basis for this paper. The general physical characteristics and cause of death, if available, are shown in Table 1. Characteristics of the head and face, as well as general observations, are described in Table 2. Table 3 provides information on date and time of death, temperature (if available) at time of death, start time of recording after death, and the total time of recording.

The equipment consisted of an Inframetrics Model 600 infrared scanning system, the necessary controls, and a monitor. A VHS videotape system was connected to the IR system and images were recorded on tape, which included a date and time stamp and the temperature range. The temperature range was manually set at 10C when the body was warm, and at 5C when the body had cooled significantly. The limits of the range were adjusted downward as cooling progressed. Thus good temperature resolution was maintained throughout the entire time a body was under study.

In all cases, the shrouded body was placed in the supine position and the head, except for case 5, was raised on a solid rubber block to an angle of about 45 degrees. This angle was used to obtain a good "half profile" view of the head and face within the permitted angle of tilt of the scanner and its liquid nitrogen vacuum dewar. The effect of this elevation on the pattern of heat loss in the lower part of the head is discussed later. For case 5, the choice of a slightly different viewing angle removed the necessity for raising the head.

A mercury thermometer, positioned about 6" from

From the Department of Mathematics and Computer Science, Polytechnic of Wales, Pontypridd, Mid Glamorgan, UK.

© American Academy of Thermology