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Sudden Death in Cold Water and Ventricular Arrhythmia

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ABSTRACT: We describe a case in which a young man collapsed with no pulse but continuing respiration immediately after a cold swim that lasted only a few seconds; death ensued despite attempts at resuscitation. We also describe an experiment in which ventricular ectopic beats were precipitated by facial immersion during trunk immersion.

KEYWORDS: pathology and biology, cardiovascular system, death, ventricular fibrillation, "dry drowning"

Sudden death after a person enters cold water is usually attributed, though without direct evidence, to laryngeal spasm or to reflex vagal arrest of the heart. We now describe a case of sudden death that cannot be readily explained except by ventricular fibrillation, and we also describe ventricular ectopic beats produced by mild cooling of the body surface.

Case History and Pathology

An army cadet, aged 18, passed as fit at a medical examination two weeks previously, was sunbathing beside a swimming pool containing water at approximately 16°C. He was a good swimmer and had swum in this pool without difficulty earlier that day. He dived into the pool, swam 15 m across it, climbed out, turned, and suddenly fell to the ground unconscious. He was then seen to be breathing but was blue in the face and no pulse could be felt. External cardiac massage and artificial respiration were started within a few minutes by two trained people who happened to be present and were continued according to normal practice for about 20 min without effect. Postmortem examination the next day showed no abnormality of the coronary arteries, heart, lungs, or central nervous system. The airways were normal apart from a dental brace and mucus that might have collected after the collapse.

Experimentally Produced Ventricular Arrhythmia

During experiments to measure heat exchanges in water, made with full safety precautions, a healthy male volunteer, aged 20, was immersed to the neck in water at 29°C. After 1½ min, heart rate had increased from 61 to 67/min, in sinus rhythm. Water at 29°C was

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then sprayed over the head to simulate partial immersion of the head without preventing breathing; the heart rate slowed to 52/min, and 9 s after the spray was started ventricular ectopic beats appeared. The arrhythmia continued for 25 s, when the heart returned to normal rhythm at 56/min. Figure 1 shows these changes. The subject was unaware of the arrhythmia and reported little discomfort or shivering. The same subject developed a similar ventricular arrhythmia when a spray of water was applied to the head in a second, similar immersion in colder water at 26°C.

Discussion

It would be difficult to explain the swimmer's sudden death just *after* having left the water in any way other than by ventricular fibrillation. Neither laryngeal spasm nor other forms of airway obstruction would have produced very sudden collapse with continued breathing and no pulse. Reflex vagal arrest of the heart would be unlikely to have continued after the start of cardiac massage. Sudden immersion up to the neck often induces ventricular ectopic beats, sometimes multifocal in origin [1], associated with reflex sympathetic stimulation of the heart and increased arterial pressure [2]. Sinus bradycardia can be induced reflexly [3,4] by cooling of the head; it precipitated a ventricular arrhythmia in the present study during cooling of the trunk insufficient to produce an arrhythmia on its own. It presumably did so by causing increased diastolic dilatation of ventricles that were already under reflex stimulation by adrenergic nerves. The dental brace in the death we describe might possibly have caused further reflex cardiac slowing through pharyngeal irritation.

These observations together therefore suggest that cooling of the trunk, particularly if the head is cooled as well, can occasionally induce sudden death from ventricular fibrillation in susceptible individuals. Recognition of this as a cause of the relatively rare cases of very sudden collapse in cold water, which usually occur while the victim is still immersed [5], might permit resuscitation by continuation of cardiac massage and ventilation until the victim is transferred to a hospital with facilities for defibrillation.

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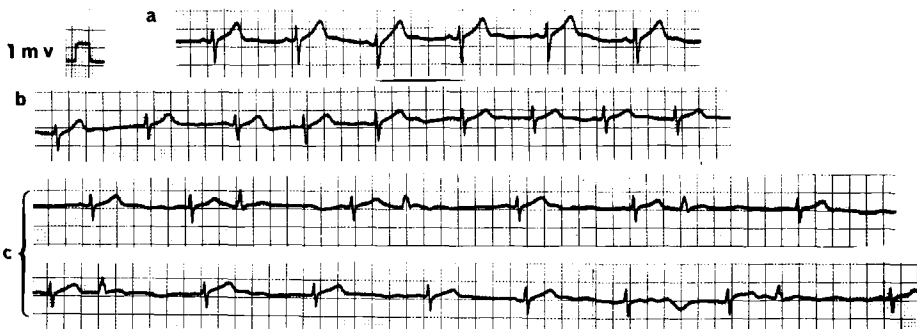


FIG. 1—Electrocardiogram (lead fifth left intercostal space in the midclavicular line, to right shoulder) (a) in air, (b) 1/2 min after immersion to neck in 29°C water, and (c) 9 s after starting to cool head. Vertical lines indicate intervals of 0.2 s.

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