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Tolerance of the Profoundly Hypothermic Dog to Complete Circulatory Standstill.* (25363)

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Introduction of a clinical method of inducing and reverting hypothermia(1) has made determination of safe limits of complete circulatory standstill at 10°C or lower of practical importance. Experiments outlined below represent our efforts to define these safe limits.

Methods. Healthy mongrel dogs were anesthetized with intravenous sodium pentobarbital. Extracorporeal circulation and hypothermia were carried out by a pump-oxygenator-heat-exchanger device already described (1). Just before perfusion, 28-30 mg/kg of quinidine hydrochloride was given intravenously. The mid-esophageal temperature, as measured by a thermistor, was rapidly reduced to between 5°C and 9°C. At this point circulatory standstill was permitted by stopping the pump. Temperature drifts during cessation of circulation were prevented by external application of ice. The chest was opened only when electrical defibrillation of the heart was needed.

Experimental design. The period of complete circulatory standstill and the number of dogs in each period were as follows: 30 min., 2 dogs; 60 min., 12 dogs; 90 min., 6 dogs; 120 min., 2 dogs; 180 min., 2 dogs. Surviving animals were followed for at least 7 days and observed closely for central nervous system changes.

Results. The 14 dogs in the 30-minute and 60-minute groups all survived 7 days or longer and were completely normal. In the 90-minute group, 4 survived and were normal; but 2 of the survivors developed ventricular fibrillation that had to be corrected by electrical defibrillation. The remaining 2 in this group, as well as the 4 dogs in the 120-minute and 180-minute groups, died from irreversible ventricular fibrillation that developed in the rewarming period.

Discussion. Temperatures below 10°C induced and reverted with an extracorporeal system, permit 60 minutes of safe complete circulatory standstill in dogs. Periods of 90 minutes are less well tolerated, as shown by occurrence of ventricular fibrillation. This arrhythmia was irreversibe in 4 dogs in circulatory standstill for more than 90 minutes, as well as the 2 in the 90-minute group. Development of ventricular fibrillation may indicate that rate of metaboism in the heart, even though greatly reduced by the cold and the asystole, is still sufficient to cause irreversible changes if oxygen deprivation is continued beyond 60 minutes.

Summary. Periods of 60 minutes of complete circulatory standstill were tolerated in 10 dogs at temperatures of 10°C or lower.

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