DEEP HYPOTHERMIA IN INTRACRANIAL SURGERY*
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In order to evaluate the effect of low body temperature in intracranial surgery, we have carried out 18 major brain operations under medium deep and deep† hypothermia. The series consisted of 14 cases of brain tumour and 4 cases of vascular malformation. This is a preliminary report on our experiences from a neurosurgical point of view. Problems bearing on the general effects of hypothermia lie beyond the scope of the present communication and will not be discussed in detail.

General hypothermia was introduced into practical medicine in 1939 by Smith and Fay,23,24 who used the method in the treatment of cancer. Fay11 was also the first to employ hypothermia as an adjuvant in neurosurgery. With a “cooling blanket” he lowered the body temperature of patients with head injuries and hyperthermia to about 33.0°C (91.4°F.).

In 1951 a different method for lowering the body temperature was introduced by Laborit and Huguenard14 under the name of hibernation artificielle. This method, in which a superficial hypothermia is induced mainly by means of different drugs (“lytic cocktail”), has been used in intracranial surgery by Lazorthes et al.15 and by Woringer et al.29

In 1950 Bigelow et al.4 and in 1951 Boerema et al.7 showed that at a body temperature of 20°C (68°F.) dogs can survive total occlusion of the circulation during any time up to 15 minutes without sequelae from cerebral hypoxia being demonstrable on restoration of normal body temperature. Bigelow et al.5 also found that oxygen consumption decreased almost linearly with lowering of the temperature, provided that shivering was prevented by the administration of appropriate anesthetics and arterial oxygen saturation was maintained at a high level, and that under these conditions a tissue oxygen deficit did not develop during the cooling period. It is on the basis of these fundamental experiments that hypothermia has been utilized for the last 3 years in cardiac surgery to permit intracardiac operations under visual control. Communications on these investigations have been published by Lewis et al.16 Swan et al.28 Bailey et al.2 and others.

Hemorrhage, increased intracranial pressure, acute brain swelling and local cerebral hypoxia still render many intracranial procedures hazardous.

† In this paper “deep” hypothermia is to be understood as 27.0°C. (80.6°F.) and below, “medium deep” as 27.1°C–32.0°C. (80.8°F–89.6°F.) and “superficial” as above 32.0°C. (89.6°F.).
These complications are responsible for most of the postoperative neurological sequelae and deaths, and are the main cause of most of the difficulties encountered in brain surgery.

Despite the advances made in methods of hemostasis, the prevention of hemorrhage during or after an operation is still an important problem for the neurosurgeon. The introduction of induced hypotension by ganglionic blocking agents in 1948 marked a great advance, especially in the surgery of vascular malformations. It has long been known that the blood pressure decreases with lowering of the body temperature, but the underlying mechanism appears to differ widely from that of hypotension induced by ganglionic blocking agents.

Studies on cerebral hemodynamics in man indicate that the fall in blood pressure in the cerebral arteries accompanying ganglionic block is compensated by a corresponding decrease in the peripheral resistance caused by vasodilatation, with the result that the cerebral blood flow is still sufficient for satisfactory oxygenation of the brain. Stone et al. found complete compensation at blood-pressure levels as low as 31 to 60 mm. Hg in 4 cases, but they pointed out that these results do not permit generalization, since many different factors, such as general anesthesia or arteriosclerosis of the cerebral arteries, might cause compensation to be incomplete. It seems reasonable to suggest that increased intracranial pressure may act similarly by deranging cerebrovascular dynamics. In hypothermia, on the other hand, the consumption of oxygen decreases simultaneously with the fall in blood pressure: oxygenation of the tissues is still satisfactory, despite low arterial pressure, peripheral vasoconstriction and diminished blood flow. In experiments on dogs Bigelow et al. found this to hold down to a temperature of 19.0°C. (66.2°F.) for up to 4 hours (blood pressure between 20 and 40 mm. Hg).

Clinical investigations of the side effects of induced hypotension show that this method involves certain risks of damage to the brain and other organs by hypoxia. By means of questionnaires to British anesthetists, Hampton and Little collected information about 21,000 cases in which hypotension had been induced by ganglionic blocking agents. There were 42 deaths (0.2 per cent), probably ascribable to the hypotension. Statistical evaluation suggested that 80 mm. Hg is a critical level, above which complications are infrequent. The incidence of cerebral hypoxia cannot be estimated from these series. Berg and Nilsson, using flicker fusion after administration of Evipan as a test of cerebral function, found values supposed to indicate diffuse cerebral injury in 12 of 29 patients operated upon extracranially under induced hypotension with blood pressures between 60 and 80 mm. Hg. As to deep hypothermia, no comparable investigations are available, but, as far as we know, no experimental or clinical data available show that hypothermia involves a risk of cerebral hypoxia (provided that ventilation is sufficient and shivering is prevented). Smith reviewed a number of patients with cancer treated with hypothermia. He found no signs of mental dis-