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FOUNDING EDITOR'S NOTE

PERSPECTIVES IN RESUSCITATION

Problems fundamental to resuscitation may be classified into three groups. First there is the process of dying, its definition and physiology. Secondly, there are biochemical triggers and jammed locks of dying and death. Thirdly, there is the optimal microenvironment of the central nervous system which ensures movement towards complete recovery.

WHAT IS DEATH?

The lawyers and legislatures would like reanimatologists to name the moment at which it would be agreed that murder would not be committed if the respirator were switched off. However, as I have frequently indicated, death means different things to different people. The classical signs of this event have been known to general practitioners from more than a century. However, the transplant surgeon would like to know when the cerebral cortex and brain stem are no longer functioning and will never regain spontaneous function. They would like to know this before the profound coma damages organs they wish to excise for the benefit of recipients. We may regard the acceptance by most members of the medical and nursing professions of the idea that irreversible damage to brain and brain stem represent an admission that further medical endeavors will not benefit the patient as an important advance in thinking which has occurred since the birth of "Resuscitation" in 1972.

However, the present acceptance of this fact should not discourage research which may result in change of our views on the irreversibility of this state. The sight of patients in "irreversible" coma should spur us on to examine, early on, the physiology and biochemistry to see if we could detect those changes which cause coma, with a view to opposing their genesis. Dr. Robert White made some important observations on improvement in cerebral functioning resulting from cooling. Other measures, such as long term oxygen, raising blood pressure, physiotherapy, long-term analeptics and electrical stimulation require more intensive testing. One should not simply accept the general view that "irreversible" coma is irreversible.

TRIGGERS OF DEATH

The biochemical triggers of dying and irreversibility of death are other holy grails upon whose trials we should set out. Initially, these will have to

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be pursued in animal experiments. The simpler techniques to be used involve chemical analysis of samples of body fluids.

It has been known since the time of Crile that acidosis is a very significant accompaniment of dying. It cannot be the primary trigger, since patients and animals can recover from short periods of severe acidosis. In the future, the following non-invasive, non-destructive techniques may prove more useful. Nuclear magnetic resonance of phosphates in the intact tissues, reflectance spectrophotometry of proteins in skin and cornea, transcutaneous measurements of oxygen and carbon dioxide, and infrared emission from dying tissue. I think it is a reasonable suggestion that the relatively little research on the biochemistry and biology of dying has included too many projects in which research workers have believed that one could study the process of dying by fixing or homogenizing tissue. I think this represents an attempt to study the behaviour of the horse after it has used its wit to leave the unbolted stable.

Death due to hypoxia or drowning is extraordinarily rapid. As one examines a recently-drowned patient with their extreme pallor, one cannot miss the extraordinary rapidity with which life has been extinguished. Since death always goes through a stage of hypoxia, it would be useful to try to define more precisely the relationship of the reversible hypoxia to that resulting in death itself. Siesjo and his collaborators in Lund have provided great insights into the biochemistry of hypoxia. Certainly his complex biochemical analytical procedures are likely to detect fundamental clues to this process.

IMPORTANCE OF MICROCIRCULATION

One knows that organs taken from the recently dead patient or animal can function perfectly well in recipient if the perfusion is sufficiently good. Dr. Robert White's pioneer work on keeping isolated brains viable underlies the importance of the circulation. We may therefore conclude that the essential difficulty in reviving an organ, patient or animal, is to revive the microcirculation. That is, the task is to ensure an oxygen supply to the blood vessels, before they are presumed to have suffered oedema or micro-thrombi—whichever be their fate. I know from personal experience with animals that frequently when one examines the tissues after an unsuccessful attempt at resuscitation, one sees a large number of petechial haemorrhages in the tissues. This indicates that the perfusion pressure has been too much for the wall of the capillaries, but too little to oxygenate the tissues. Such an observation poses the question as to what is the nature of the biochemical lesion which damages the capillary walls. Is there any way of preventing it? Another implied question is why cells become impermeable to oxygen soon after death in vivo when subsequent oxygenation in vitro can revive their function. The low Po_2, high Po_2, high potassium ion and high hydrogen ion concentrations in the immediate milieu in the cells can be reversed in vitro. Such changes are difficult to effect in vivo. The fact that a heart can be taken

out of a dead animal and perfused in a Langendorff apparatus and can then contract, also indicates that after death the extracellular fluid inhibits cardiac contraction. The microenvironment of the cell is of great importance.

The useful therapeutic conclusions of these observations is that one should attempt to perfuse the brain, the heart and the kidney, at least, as soon as possible in the early stages of resuscitation.

AREAS NEEDING RESEARCH

Finally, it might be useful to list a few areas where active research may be expected to yield positive results in the near future.

(A) Patients with cerebral thrombosis often have partial or complete recovery of cerebral function. The temporary nature of their neurologic deficit has been attributed to resolution of cerebral oedema, opening of anastomotic channels, and functional plasticity of neuronal tissue. Careful clinical trials to test each of these explanations are needed.

(B) The mechanism of plasticity of the brain which allows relative functional sparing in the face of extensive histologic damage needs elucidation.

(C) The correlation between pathological and functional lesions, be it in the coronary arteries and myocardium or cerebral vasculature and central nervous system is not complete. Its relationship would merit further intensive study.

(D) Current views on cerebral structure based on classical histology and electron microscopy may be inadequate and may represent a stumbling block in our understanding the mechanism of cerebral oedema, hypoxia and brain death. A radical revision of the current view is shortly to be published (Hillman, H. Cellular Structure of the Mammalian Nervous System. M.T.P. Press Ltd., Lancaster, U.K.).

(E) Abdominal pressure to aid in resuscitation, a technique dating back to Crile in the early 20th century, needs comprehensive clinical evaluation.

I have attempted to identify a few of the outstanding problems of resuscitation and possible approaches to their solution in the future.

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