HYPOXIA IN MAN

Induced Unconsciousness, with Reflex and Muscle Control, The Logical Approach to the Three Dimensional Study of Cellular, Cardiorespiratory and Cerebrospinal Hypoxia

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GENERAL ANAESTHESIA IN THE HUMAN BEING, AN ESSENTIAL DISCIPLINE FOR ALL PHYSICIANS

The multiplication of anaesthetic agents and techniques with the drift from a control by gases to a control by drugs, during the last three decades has had a double effect.

(1) It has segregated interest in anaesthesia to a restricted professional-technical group.

(2) It has sharply reduced the overall interest in anaesthesia among resident house officers who no longer are required to give anaesthetics, and who have no intention of becoming anaesthetists.

It is believed that this elimination of the house officer from a tour of duty in anaesthesia has been most unfortunate. Exclusion from this fundamental clinical routine has been predicated and apparently justified by a desire for an improved and safer field for surgery, aided and abetted by students and house officers who are not interested in serving as technicians or in becoming anaesthetists.

As the end in view was limited to anaesthesia and the technique looked upon as merely a convenience for the surgical service, the change has come easily.

However, the student, the resident and presently the general practitioner has suffered an irreparable loss. He is no longer familiar with the unconscious patient, and with the management of the abnormal physiology which accompanies or may precipitate unconsciousness. He is no longer sensitive to man—alive, the three dimensional view of form, function and time. Sensitiveness comes only when one is required to control this integration in unconscious man, the man in whom induced control has taken the place of voluntary or automatic control. If one is not responsible for, and obliged to direct the factor of timing, this third dimension is likely to be overlooked altogether.

Time operates by determining the instant, the degree and the duration of function. Its recognition allows the instantaneous freezing of the fluidity of function. It permits a precise diagnosis, or the application of a desirable act, as it were in functional transit. The effect of a gas or drug either progresses or retrogresses. It is never static.

Timing determines the correct instant of effect or action. Form and function may be taught, time must be experienced.

The factor of timing becomes apparent for example, in the variable hazard of retro-orbital block for intra-ocular surgery. Suppose morphine has been given and respiratory obstruction develops. The aspiration effect of the large vessels is reduced and blood dams back into the right ventricle. The veins of the systemic circulation, including those of the head and neck, become engorged; at this instant the swollen orbital veins present an enlarged area for trauma during injection for retro-orbital block.

ACCIDENT AND DISEASE

To become familiar with the phenomena of unconsciousness induced and controlled by anaesthetists, is to be at home with the phenomena of unconsciousness induced by accident and disease, i.e., drowning, foreign body obstruction, electrocution, carbon monoxide poisoning, cerebral haemorrhage, terminal poliomyelitis and drug poisoning. The sequence of depression,
rigidity and relaxation in anaesthesia is paralleled by the depression, spasticity and flaccidity of hypoxia. The physics of gas therapy and the mechanics of relief are identical.

The chief value of general anaesthesia for all physicians is, therefore, to provide a means of becoming acquainted with the abnormal physiology of the unconscious patient.

Given this incentive and objective the student may well become eager for opportunities to administer general anaesthetics. The anaesthetist will become intrigued by the broader view of unconsciousness from its many causes, and he will develop more respect for the integrity of normal physiology. He will become more conservative in subordinating these normal processes to depressive and lethal drugs. It will become clear that while increased demands upon normal function may fall within physiological limits, suppression of function may set off a chain reaction resulting in morbidity and mortality.

INTERDEPARTMENTAL CORRELATION

Interdepartmental correlation helps to break down barriers in the field of medical education. This does not mean, however, that specialists in one field or department should do independent research in another, i.e., the anaesthetist is not expected to carry on fundamental research in physiology independent of the authority, direction, and control of this department. Instead of assuming the role of pathfinder, the anaesthetist may well spend more time in the department of physiology as an advanced student. Interdepartmental correlation suggests that basic knowledge should be common knowledge. The physiologist and the pharmacologist should visit the operating room as frequently as the pathologist, preferably after a short course in operating room routine.

Familiarity with this three dimensional aspect of form function and timing will not only clarify the view when interference occurs through accident, or disease, but the indications presented by this superimposed pathology will be seen to carry with them clear indications for treatment.

The following suggestions are offered for the interdepartmental correlation of the problem of hypoxia, from its metabolic, cardiorespiratory and cerebrospinal point of view. A strong emphasis is placed on clinical opportunities to activate this academic information. The magnificent integration of the marvellous complexity of man—alive, should intrigue rather than discourage interest. After all so much time and effort has been devoted to becoming acquainted with the various systems and functions of the organism, that reasonable attention can certainly be devoted to a study of the total living man.

ACADEMIC INSTRUCTION

Undergraduate Interdepartmental Correlation.

Anatomy. The structures of the upper airway by postmortem sections and general orientation by peroral endoscopy are to be featured. Relations and measurements in adult and infant should be stressed. Emphasis would be placed upon the anatomical location of accessible blood vessels in the extremities, for purposes of transfusion, medication, intravenous anaesthesia and analgesia.

Physiology. A study of infant, child and adult physiology with special reference to muscle tone, reflexes and impaired function as these relate to anaesthesia, resuscitation and inhalation therapy, would be stressed as well as the relative resistance of infant and adult to medication and to progressive hypoxia.

Biochemistry. Demonstrations would be made covering the chemistry of tissues; metabolism; hormones; respiration; water-balance acid-base and functional tests, as these apply to hypoxia. The phenomena of histotoxic hypoxia and the biochemistry of methylene blue, cyanides and alcohol would be examined.

Chemistry and physics. A study would be made of the chemical make-up of anaesthetic and other therapeutic gases with special reference to their diffusion and elimination, as well as the physical behaviour of gases in relation to partial pressures, diffusion and explosive factors, as these may result in hypoxic manifestations.

Pharmacology. Laboratory work dealing with gases and drugs employed to control pain, to save life and to treat clinical disease would be considered. Therapeutic indices, allergy, reversibility of drugs, detoxification as related to hypoxia would be discussed.

Pathology. Lesions resulting from hypoxia in the cardiorespiratory and cerebrospinal systems
merit special consideration. Reference would be made to blood diseases that influence the action of anaesthetic drugs and gases, such as the anaemias, purpuras and leukaemias.

The pathological effects of the following should be taught:

1. Poison gases in civilian and battle hazards, toxic gases in industry (carbon monoxide, ammonia, carbon dioxide, hydrogen sulphide, hydrocyanic acid). Histotoxic hypoxia of alcohol and the sulphonamide drugs.

2. The action of drugs, i.e., hypnotics, narcotics, sedatives, analgesics, anaesthetics, as these appear in postmortem lesions.

3. Special reference could be made to the pathological lesions resulting from asphyxia of the newborn, suffocation and strangulation, as well as from tumours and foreign bodies in the airway. The pathology of terminal poliomyelitis can be discussed from the point of view of hypoxia. The microscopic anatomy of the respiratory tract may be studied with reference to gas exchange, inflammation, and regeneration following trauma, noting particularly granuloma of the vocal chords and tracheal mucosa trauma from endotracheal balloon pressures. The requirements of thoracic surgery in relation to gas pressure control, oxygenation, mediastinal shift, and the treatment of extensive tuberculosis and its complications, must be considered. Special attention would be given to traumatic or surgical collapse and shock, abdominal distention, hypoxic headache following encephalography, pulmonary oedema, pulmonary embolism, atelectasis, massive collapse of the lung, coronary embolus and to infections due to anaerobic organisms such as those of gas-gangrene and tetanus.

Medical jurisprudence. Death from hypoxia should be considered along with the coroners’ reports and the rulings relative to operating room deaths. National death returns as these refer to hypoxic accidents may be reviewed, and a survey made of hypoxic deaths occurring under the supervision of the university.

Medicine. Physical examination with reference to post-hypoxic accidents would be stressed. The treatment of disease of a cardiorespiratory, cerebrospinal and metabolic nature could be considered. The physical signs of death as these are determined by the absence of a heart-beat (cardiac arrest), by intracardiac needle, by alteration of the colour of the mucous membranes in the presence of oxygen administration and by retinal haemorrhages would be discussed.

Radiology. The interpretation of radiographs would be taught with reference to the pathology of the airway and the lung, mediastinal shift, malposition and tumours of the trachea, as well as acute infections of the airway.

CLINICAL INSTRUCTION

Interdepartmental Correlation for Resident House Officer and Practitioner. Instruction would feature opportunities to become familiar with the induction, maintenance and recovery from a simple nitrous oxide-oxygen ether anaesthesia; it would include dissertations on the prevention, recognition and treatment of postanaesthetic complications. The technical care of patients with certain diseases by oxygen or helium therapy employed by mask, catheter or tent should be detailed as well as the administrative supervision of technical assistants.

Obstetrics. Asphyxia neonatorum, its incidence, special histology and gross pathology should become familiar to the student. He would be taught to recognize the stages of progressive hypoxia, depression spasticity and flaccidity and their underlying pathology. The indications which this pathology presents for specific treatment would be clarified. Suitable equipment to meet these indications needs to be improvised. Post-treatment pathology would be carefully noted, i.e., reactions following laryngoscopy and intubation for terminal hypoxia.

Paediatrics. The incidence and form of hypoxia in the newborn, the infant and the child would be studied together with adequate emergency treatment.

Surgery. The hypoxia incidental to anaesthesia and surgery would be reviewed and demonstrated by the department of anaesthesia. Acquaintance with the three dimensional man would here be accomplished. Metabolic, cardiorespiratory and cerebrospinal hypoxia as it may be controlled by safe general anaesthesia would be featured. Every
case of general anaesthesia is material for a study of normal physiology. The reaction of normal physiology to pharmacological, physical, pathological and surgical factors incidental to operation would be demonstrated. The expert knowledge of the anaesthetist would be brought to bear to demonstrate without hazard to the patient, familiar and exceptional physiological reactions. The student will be expected to become acquainted with how to maintain the airway of the unconscious patient and adept in simple laryngoscopy in the unconscious relaxed patient; this is the open door to the knowledge of how to treat all types of emergency hypoxia.

**Extramural activities.** Hypoxia is by no means limited to operating room or ward emergencies. A modern resuscitation service must be provided not only within the hospital for the treatment of asphyxia neonatorum, drugs, narcotics, acute alcoholism, pulmonary complications, anaesthetic overdosage, pathological abnormalities, mechanical obstruction from foreign bodies in the airway and trachea, allergy, terminal poliomyelitis, polyneuritis, and facial diplegia; but in every ambulance servicing hypoxia accidents which occur in public places, for example, gases used industrially, i.e., carbon monoxide, refrigerants, chemical fumes, fumigation, submersion, firefighting, electrocution, strangulation, hanging, suffocation from soft materials and from external pressure of moving objects (e.g. automobiles, elevators, laundry machines), from collapse of buildings, from earthmounds, sand, coal, landslides in manholes and declivities. The student will understand that his work has a bearing on public health scarcely second to his hospital activity.

**Military.** Opportunities could be offered for contact with the medical departments of the army and navy as these departments reflect specialized hypoxic hazards.

Reference would be made to the effects of high altitude acceleration and deceleration hypoxia, as these are met in air forces. Submarine air conditioning, and escape techniques would be explained. Compression and decompression through the use of airlocks in the army and in industry would be described.

The student must be advised of his responsibility to instruct fire, police, industrial first aid and lay organizations in the emergency care of hypoxia.

**Conclusions**

While hypoxia cuts across the entire field of medicine, appearing both as a symptom and a cause of death, its urgency demands that it be immediately identified, segregated and treated as a potential fatality if the present national mortality rate of at least 50,000 a year is to be reduced.

The current practice of pointing out the danger of hypoxia in its many fields at irregular or at long intervals over the years of medical instruction, has failed to bring to a focus the tragic significance of the problem.

An early strong and sustained effort to effect permanent interdepartmental correlation respecting hypoxia is imperative. Because of the loss of lives involved in delay, the desire for unique institutional experimental approaches to the need may perhaps be sacrificed in favour of an immediate two-fold programme.

1. Academic interdepartmental correlation as suggested or in some modified form for undergraduates.
2. Clinical correlation calculated to activate this material for graduates.

(a) By sponsorship through a permanent committee representing surgery, obstetrics, paediatrics, internal medicine, anaesthesia, pathology, and military medicine.

(b) By familiarity with induced and controlled unconsciousness through the teaching of anaesthetists. A knowledge of the unconscious patient is the logical approach to the treatment of metabolic, cardiorespiratory and cerebrospinal hypoxia.