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# Artificial Respiration

ALBERT S. BARBER, '65

## INTRODUCTION

Breathing is essential for life. An organism is able to survive only for a short time without oxygen. Active breathing provides the pulmonary ventilation required to supply oxygen to the cells of the body. Artificial respiration, if it produces satisfactory pulmonary ventilation, will maintain life in the absence of active respiration. Thus, artificial respiration becomes an emergency measure when breathing has stopped, or is severely impaired.

Under what circumstances does the emergency arise? Respiratory arrest or seriously impaired pulmonary ventilation may result from a number of causes. Frequently it is caused by obstruction of the airway due to external compression, e.g. strangulation, or to the aspiration of foreign bodies. Paralysis of respiration, leading to anoxia, may be associated with muscle paralysis e.g. in poliomyelitis, or with curare. A depression of the central nervous system by poisoning may result in apnea, e.g. due to an overdose of barbiturates or the inhalation of anesthetic vapor or gases. Electric shock can lead to apnea even though circulation may still be functioning. Trauma to the chest in the form of multiple rib fractures or a ruptured diaphragm may produce a severe impairment of active respiration, making artificial respiration necessary. Lack of oxygen itself, if it persists long enough, will produce depression of the central nervous system. Examples of this are drowning and suffocation, as well as poisoning with carbon monoxide.

If this condition of apnea is not reversed, it will lead to fatal anoxia. Artificial respiration, if properly executed before the onset of permanent anoxic damage, will result in the return of active respiration and the restoration of life.

## HISTORICAL DEVELOPMENT

Primitive man associated respiratory movements with life, and decreased movements with sleep. He observed that a sleeping person could be awakened by external stimuli, such as pain and noise. This led to the attempt to revive the dead by using similar stimuli. No doubt this application was sometimes successful and so it led to such treatments as placing live coals on the victim's chest or scorching him with a firebrand.

Perhaps the earliest account of mouth-to-mouth breathing is recorded in the Bible, where the story is told that Elisha revived the dead child of the Schanammite woman by stretching himself on the child, and placing his mouth on the mouth of the child. (II Kings iv 34.)

Since that time many accidental observations have been made about mouth-to-mouth resuscitation. Vesalius, a famous anatomist of the 16th century was at the point of losing his life because he dissected a man so soon after apparent death

that his heart began to beat again when Vesalius blew into his lungs.

In 1774, Dr. William Tossach, of Edinburgh reported how he revived a cold, grey, limp miner just rescued from a smoke-filled mine. No pulse was detectable. Tossach said "I applied my mouth close to his and blew my breath as strong as I could but, having neglected to stop his nostrils, all the air came out of them. Wherefore, taking hold of them with one hand and holding my other on his breast at the left pap, I blew again my breath as strong as I could, raising his chest fully with it. Immediately I felt six or seven very quick beats of the heart; his thorax continued to play and the pulse was felt soon after in the arteries." He continued his method and the victim recovered. (2)

Early in the 19th Century when the role of  $O_2$  and  $CO_2$  in metabolism was discovered, mouth-to-mouth breathing was abandoned because it was generally believed that expired air did not have a sufficient  $O_2$  content to be of value in

## —Artificial Respiration—

resuscitative measures. In its place, many external methods were successively devised, the best known being those of Silvester, Schafer and Holger Nielsen.

In recent years research has shown that these methods have only limited value because:

1. It is difficult to maintain an open airway.
2. It is impossible to tell if the victim is receiving pulmonary ventilation and the ventilation achieved is often inadequate. (8).
3. They require a special positioning of the victim as well as considerable training and skill of the rescuer.
4. They are exhausting for the rescuer.

Research has shown that the limitations inherent in external methods are overcome by mouth-to-mouth resuscitation. It is now recommended as the correct emergency procedure by most authorities. (1) The advantages of mouth-to-mouth breathing are:-

1. Adequate pulmonary ventilation is produced. (8)
2. Both hands are free and can help to maintain an open airway.
3. The effects of the method are evident by observing the movement of the victim's chest.
4. No great physical effort is required and artificial respiration can be maintained over a long period of time.
5. Since access only to the head of the victim is required, it can be performed in any position or situation, eg. while the victim is still in the water.

### METHOD

See enclosed Canadian Red Cross Society pamphlet.

### CONSIDERATIONS OF METHOD

#### Pulmonary Ventilation

The tidal volume of a normal adult is about 500 c.c. and with a deep breath a

volume of 1500 c.c. is easily obtained, which is sufficient for expired air resuscitation.

The normal composition of expired air is about 16% O<sub>2</sub> and 4% CO<sub>2</sub>. (6) This represents both the air expelled from the dead space, which is essentially atmospheric air, and the alveolar air which contains up to 5% CO<sub>2</sub> and from 12-18% O<sub>2</sub> depending on the person's oxygen consumption. (6)

Hyperventilation increases the physiological dead space, thus decreasing the CO<sub>2</sub> content and increasing the O<sub>2</sub> content of the expired air. In addition, the air first entering the alveoli of the victim will be the air from the dead space of the rescuer, while the alveolar air of the rescuer, for the most part, will fill the victim's dead space. There is ample evidence to show that an O<sub>2</sub> content of 18% is adequate to maintain life. The air reaching the alveoli of the victim from a hyperventilating rescuer would probably be even higher than 18%. In fact, Elam et al. have demonstrated that a normal oxygen saturation and an adequate CO<sub>2</sub> level can be maintained in the victim without difficulty by expired air resuscitation. (3, 4)

#### Airway

An adequate exchange of air depends on an open airway. Obstruction of the airway above the larynx is the most common cause of failure of any method of artificial respiration. (5) In expired air resuscitation, this type of obstruction is prevented because the hands are free to keep the head extended at the atlanto-occipital joint, as well as to keep the lower jaw pulled forward.

### CONSIDERATIONS OF APPLICATION OF METHOD

The response of a victim to artificial respiration decreases with the length of time of apnea. If artificial respiration is started immediately, there is an excellent chance of recovery. In a few minutes, how-

ever, a point is reached where recovery is not possible with even the best resuscitative measures because permanent anoxic damage has occurred. For example, the cells of the cerebral cortex can survive for only 8-13 minutes after cessation of respiration. (7) It is therefore of the utmost importance to start artificial respiration immediately. Some authorities recommend starting mouth-to-mouth breathing even before clearing the airway or draining water from the body of the victim. (1)

It is possible to evaluate the effect of mouth-to-mouth breathing by observing the victim's chest. When it rises, one can be sure that the victim is receiving adequate pulmonary ventilation. Further expansion of the chest is unnecessary and could lead to injury.

Artificial respiration should be continued at a rate of 12-20 breaths per minute until normal breathing is restored. In the case of a short period of anoxia, this may take only a few insufflations of air. After longer periods of anoxia, the restoration of active respiration may take a considerable period of time. If efforts during the first minute or two do not produce a change in the victim's color in spite of good chest movements with insufflations, or it becomes evident that there is no adequate circulation, one should use closed chest cardiac massage, especially if the time element appears to be in favor of the patient. A discussion of closed chest cardiac massage is beyond the scope of this article.

#### CONSIDERATION OF MECHANICAL DEVICES

As an emergency procedure, mouth-to-mouth breathing is as effective as mechanical or hand-operated respirators. It has the added advantage that it can be started immediately. If a mechanical device is available, and the rescuer is familiar with its operation, it can be used advantageously. The use of oxygen in a respirator does not necessarily make it more efficient.

It is recommended to use the method which supplies adequate pulmonary ventilation to the victim. If the method is changed, and cyanosis reappears, one should return to the former method.

In some cases the color of the victim will be restored, but spontaneous respiration will fail to return immediately. In this instance, a mechanical or a simple hand-operated device such as the Ambu resuscitator would be advantageous, if brought into play, since it would relieve the rescuer.

#### SUMMARY

1. The effects of respiratory arrest may be reversed by artificial respiration if applied before the onset of permanent anoxic damage.
2. The method most widely accepted and taught today is mouth-to-mouth breathing. It provides adequate pulmonary ventilation and enables the rescuer to maintain an open airway.
3. To be successful, artificial respiration must be started immediately.
4. If the victim's color does not improve in spite of adequate ventilation, closed chest cardiac massage should be used in addition to artificial respiration.
5. Mechanical devices may be used to advantage to supplement mouth-to-mouth breathing provided they continue to supply satisfactory pulmonary ventilation.

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# The Emergency Management Of Airway Obstruction

R. N. REDINGER, '62

## INTRODUCTION

It is imperative that an adequate airway be maintained for an individual to live. It is also true that airway obstruction takes precedence over any emergency and therefore must be remedied first. Even gross hemorrhage is not as dangerous as airway obstruction, since a human being can often survive with only a small blood volume. However he cannot tolerate a deficit of oxygen for more than three to five minutes at the most and often much less than this. If not death itself, irreversible damage to vital organs, i.e. the brain, may occur in a very short time.

Respiratory difficulties may arise in other ways as well, i.e. by depression of the respiratory centre or by peripheral mechanical changes involving the musculo-skeletal system. In these situations the problem usually is not as acute as in airway obstruction and often more time is available to correct the difficulty. However airway obstruction may be superimposed upon these difficulties, making the problem very urgent. In this case the patient cannot stand as much oxygen deficit since he has been on a low O<sub>2</sub> supply previously.

## THE DIFFERENTIAL DIAGNOSIS OF AIRWAY OBSTRUCTION

The most important factor to consider here is the *age* of the patient. It is readily seen that when comparing the infant, the child, the adult and the elderly individual, the causes of airway obstruction in each case may then take on distinctive characteristics. This is due to the activities, anatomy and/or physiology, and peculiar disease entities characteristic of each specific age group. Another factor that is very important is whether or not the patient is conscious.

Causes of airway obstruction may conveniently be discussed under the broad headings of pathophysiological causes, soft tissue changes and foreign bodies.

### Pathophysiological Causes

In the main the structures to be considered here are the tongue, epiglottis, and the less obvious larynx, trachea, and bronchial tubes. When a person becomes unconscious, e.g. coma or under anesthesia, the tongue may drop back into the throat,

the epiglottis then tends to cover the larynx and the vocal cords are drawn together—all of these occurrences causing some degree of airway obstruction. This may occur in any anesthetized patient but is often overlooked in the elderly person where coma may exist due to the prevalence of such diseases as cardiovascular accidents, heart failure and diabetes. Accompanying this is the frequent decrease of the cough reflex which allows accumulation of mucous secretions and aspiration of the same.

In the infant we have different problems to consider. Here the lumina of the various components of the respiratory tree are much smaller than later in life and since resistance to respiration is inversely proportional to the square of the diameter of the lumen, difficulties are more prone to occur. Superimposed on this is the weaker musculature and thoracic cage of the infant so that he is not as well equipped to cough up material that is causing obstruction. Convulsive seizures also may cause airway obstruction by allowing any of the above factors to come into play and such "fits" occur more frequently in the febrile young child and epileptic.

## Soft Tissue Damage

The pharynx, larynx, trachea and/or bronchi may be affected and give rise to airway obstruction. The majority of cases here are on an inflammatory basis with edema, hemorrhage and excess mucous secretion causing the obstruction. Other causes are allergy, trauma, neoplasm and psychological factors. Inflammation with edema, excess secretion and hemorrhage occur in a host of diseases. The infant and child are most severely affected because of the high incidence of these diseases and because of anatomical relationships (as explained before).

In the pharynx such diseases as severe and acute nasopharyngitis, Ludwig's angina, peritonsillar or retropharyngeal abscesses, erysipelas, and more rarely diphtheria and pemphigus may cause obstruction. This is usually only partial in nature but the associated occurrence of convulsive seizures may be enough to kill the child. A more dangerous and likely cause of airway obstruction in the very young occurs when the larynx, trachea or upper bronchi become severely congested. Acute edema of the larynx, tracheo-bronchitis and very rarely laryngeal diphtheria are to be dreaded and must be treated immediately or death may result.

Allergens or irritants may be inhaled and cause severe edema of the respiratory tree, particularly in the lower portion. This of course may occur in any age group with allergies perhaps more prevalent in the young and irritants in certain occupational groups. Trauma rarely may cause airway obstruction because of hemorrhage and tissue swelling. Blows to the "Adam's apple" or thyroid cartilage can cause very rapid death as a result of profuse and rapid hemorrhage of ruptured laryngeal blood vessels.

Even more rarely is neoplasm the cause of airway obstruction. A common offender is the benign polyp that lies above or below the vocal cords. It may lodge between the vocal cords on excessive inspir-

ation or expiration respectively, and then cannot be dislodged by coughing. Of course any malignant process such as carcinoma or sarcoma even as high as the lower pharynx can cause obstruction due to its size or by causing soft tissue damage and/or rupture of an invaded blood vessel with profuse bleeding. Needless to say, this group presents mainly later in life.

Even rarer causes of airway obstruction are the psychological ones such as angioneurotic edema. This may occur in any age group, being prevalent in a certain personality type.

## Foreign Bodies

These are perhaps the most obvious of all offenders to be considered in airway obstruction. The age groups affected most are once again the two extremes of the age scale.

The young experimenting child has a tendency to put anything he can grasp into his mouth. This gets caught up by the swallowing mechanism and since the latter is not as mature as in the adult, the object often gets into the wrong tube. Irritation on lodging in the respiratory tree causes local tissue swelling and mucus production. The lumen of the passage is small and the youngster's cough is weak due to his underdeveloped body structure. The end result is that the child is gasping for breath and turning blue. Some of the commoner objects swallowed are peanuts, hard candies, coins and feathers.

In the elderly, the problem of decreased cough reflex along with weakness allows the aspiration of accumulated mucus and vomitus. Food particles or pills often get into the lower respiratory passages. Even dentures have been known to cause obstruction.

In the general population the commonest example of a foreign body causing obstruction is the fish bone. This usually lodges higher up in the pharynx at the base of the tongue, in the tonsil or lingual

## *Airway Obstruction*

tonsil. The presenting problem most often is the pain and irritation, rather than the obstruction.

### EMERGENCY TREATMENT OF ACUTE AIRWAY OBSTRUCTION

The acute airway obstruction usually is found by the general practitioner in the home or at the office and he must be prepared to cope with the problem without the use of any complex devices. As always, but particularly in an emergency, it is important to have a preconceived plan of attack in mind and the essential instruments should be available.

The easiest way to relieve some airway obstructions, and this may be life saving, is to use gravity to clear an airway. By turning the patient on one side or putting him in the Trendelenberg position (the infant may be held upside down and patted on the back) secretions are allowed to drain and smaller foreign bodies such as chewing gum may be dislodged.

Equally as simple is the rule to make sure that the tongue is not causing obstruction. It can easily be pulled out and any obvious secretions or foreign bodies may be removed as far back as the finger can reach. By pulling the tongue out and pulling the chin forward while slightly hyperextending the head, the airway becomes a straighter tube and the epiglottis is lifted out of the way.

However if the above procedures have been of no avail, an attempt to pass a large bore tube nasally into the larynx may well alleviate obstruction, particularly if it is on the basis of pharyngeal swelling. A far more certain procedure is the insertion of an endotracheal tube. This, however, takes considerable skill and most physicians are not trained in handling one.

Again these procedures may not be possible, i.e., in the small child with a small lumen and excessive tissue edema. Next a large bore needle, No. 14 preferably, may be inserted through the crico-

thyroid ligament and if oxygen is available it may be administered via tubing connected to a syringe. This can prevent death and also prevents the necessity of doing a tracheostomy. It may be desired in small children.

As a last resort and never to be delayed if relief is immediately mandatory, a laryngotomy or cricothyroid stab may be performed. This is a very simple procedure and is done by feeling between the thyroid and cricoid cartilages anteriorly and then inserting a blade through the ligament between these two cartilages. The blade is then turned and a cannula inserted to provide an airway. The disadvantage of this procedure is the narrowness of the lumen at this level in the respiratory tree. Later the opening may have to be enlarged. A better procedure in the long run, although more difficult to perform, is the tracheostomy. With the head partially extended and without anesthetic an incision is made above the second and third tracheal rings in a vertical direction. If the operator is skilled a horizontal incision may be made between the above cartilages leaving a better cosmetic result afterwards. In performing the operation the isthmus of the thyroid gland will likely have to be cut through as well. No attempt should be made to control bleeding until the procedure is over and a tube of sufficient diameter and strength has been inserted several inches down into the trachea. The surrounding area may then be packed with sterile gauze with pressure controlling hemorrhage. Suction may be needed to clear the airway and artificial breathing by mouth-to-tube or even O<sub>2</sub> given if necessary and available. The patient is then easily transported to a centre where more elaborate and definitive treatment can be instituted.

The pros and cons of a high and low tracheostomy may be discussed as well. However if the incision is made any lower than over the 2nd and 3rd tracheal rings the danger of retraction below the sternum

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# The Emergency Treatment Of Cardiac Arrest

JAMES D. CURTIS, '64

## INTRODUCTION

The term "cardiac arrest" has a variety of definitions in the literature. In this discussion cardiac arrest implies cessation of heart action that is sudden, unexpected and possibly reversible. There are two types of arrest: asystole, which is the more common, and ventricular fibrillation. The method of restoration of the heart beat differs according to the type encountered.

When cardiac arrest occurs, the primary consideration is time. The brain is the organ most vulnerable to anoxia and can tolerate only 3-5 minutes of circulatory arrest without permanent damage. The heart ranks second to the brain in vulnerability and responds less readily to treatment if anoxia is prolonged. Immediate treatment is obviously essential.

Cardiac arrest may occur in the operating room where the equipment and personnel are available for resuscitation, or it may occur outside the hospital where such equipment is absent. The significant number of sudden deaths occurring outside the hospital warrants the development of resuscitative measures that can be applied on-the-spot.

## ETIOLOGY

Hosler<sup>7</sup> states "almost without exception, the cause of cardiac arrest resolves into lack of oxygen in the vital tissues", that is, the myocardium, and the central nervous system.

In the operating room, the arrest is usually related to the anesthetic agent. When anesthesia is too light, the vagal reflexes are not depressed and intubation, extubation, or tracheo-bronchial aspiration can cause inhibition of the heart. Prolonged tracheal aspiration alone can reduce the peripheral arterial oxygen saturation from 95-97% to 70-75%. Too high a concentration of the anesthetic agent or insufficient amounts of O<sub>2</sub> in the mixture will depress the respiratory and vasomotor centers of the medulla, the myocardium and other tissues.

The choice of the anesthetic and its careful administration are vitally important. Some anesthetics alter the conduction system and render the heart more susceptible to arrhythmias while almost all of them are cholinergic and sensitize the myocardium to vagal stimulation. A competent anesthetist will select carefully the type and concentration of the anesthetic indicated.

Some organic diseases predispose the patient to cardiac arrest, especially pathologic states of the heart, blood vessels or lungs. Anemia, hypovolemia, and hypercapnia may also be contributing factors. Certain drugs given pre-operatively cause overstimulation of the myocardium, others cause depression, and others are toxic. For example, morphine may depress the medullary centres.

Outside the hospital, cardiac arrest occurs most commonly in cases of drowning, electrocution, drug and gas poisoning, myocardial disease, severe trauma, severe hemorrhage and in the terminal stages of some acute diseases.

## DIAGNOSIS

In the operating room, the most reliable means of diagnosis is by continuous observation of the peripheral pulse, skin color, sweating, respiration, pupil size, and body temperature. Recently, the use of continuous monitors of E.C.G., E.E.G. and blood pressure in surgery has become increasingly common. They make possible not only an early diagnosis but the differentiation of asystole and ventricular fibrillation. However, the skill, knowledge, and judg-

ment of a competent and conscientious anesthetist cannot be replaced. The suspicion of the surgeon may be aroused by the absence of bleeding or cyanosed blood. He must check the diagnosis by palpation of the pulse in another area—the carotid or femoral arteries or the abdominal aorta.

Outside the operating room, diagnosis is made by examination of the pulse, blood pressure, skin color and by auscultation.

## TREATMENT

In recent years great interest has been aroused in cardio-respiratory resuscitation. Several procedures have been recommended. In each case, however, the immediate re-establishment of the oxygen system, that is, the circulation of the blood and the oxygenation of this blood, is of paramount importance. Once this has been accomplished, the urgency of the situation is over and restoration of the normal heart beat can be attempted.

Cardiac resuscitation is particularly indicated in those people with normal hearts, that is, those not suffering from intrinsic heart disease. It is not advised in patients in the terminal stage of a hopeless disease.

### 1. Cardiorespiratory Resuscitation Outside the Operating Room.

In cardiac arrest occurring outside the operating room, the most practical method of resuscitation is external cardiac compression combined with artificial respiration.

#### (a) *External Cardiac Compression*

External massage is carried out by placing the two hands, one on the other, on the lower third of the sternum and applying pressure with the arms extended and using the body weight. To allow cardiac filling, the hands are lifted off the chest wall, thereby allowing full recoil of the sternum and ribs. The intermittent compression and relaxation is repeated 60-80 times per minute.

Since the heart lies between the sternum anteriorly, the vertebral bodies posteriorly

and is restricted laterally by the pericardium and the inflated lungs, compression of the sternum squeezes the heart against the spinal column and blood is forced out of the heart. The ribs are fixed at either end but permit sufficient movement in the thoracic cavity in an unconscious person to reduce the A-P diameter by 3-4 cm.

#### (b) *Artificial Respiration*

The airway is cleared, if necessary, the head is fully hyperextended, and if it is available, a short tube is inserted to ensure a patent airway and to prevent obstruction by the lips or tongue. If such a tube is not available, direct mouth-to-mouth or mouth-to-nose respiration is used. The lungs should be inflated 10-20 times per minute.

#### (c) *Procedure*

The following steps should be followed in on-the-spot resuscitation:

1. Place the victim in a horizontal, supine position on a firm surface.
2. Clear the airway, place the head in a fully hyperextended position and apply artificial respiration.
3. After one minute, if no response is observed (improvement of color, constriction of the pupils, efforts to breathe and palpable pulse) thump the precordium sharply several times.
4. If still no pulse is felt begin external cardiac compression immediately.

If only one rescuer is present he should intermittently perform artificial respiration (six deep breaths) and external cardiac compression (for one minute). If two rescuers are present, each assumes one function. If three are present, the legs may be elevated to assist venous return. Resuscitation must be continued until the patient recovers or until help arrives. If the patient does not recover, steps must be taken to restore the heart beat, as described below.

### 2. Resuscitation in the Operating Room

The first step in resuscitation in the operating room is again restoration of

the oxygen system. Immediately upon diagnosis, the anesthetist administers 100% oxygen by a face mask or endotracheal tube and places the patient in a 15° Trendelenburg position. The surgeon confirms the diagnosis and quickly acts to restore the circulation.

If the abdomen is open, the heart is compressed against the anterior chest wall through the diaphragm. This is a very inefficient method of cardiac massage and only 10-15 seconds should be spent on this maneuver. If the abdomen is not open the precordium may be thumped two or three times. If a spontaneous rhythm does not appear, external cardiac compression is then carried out for 45 seconds. If no response is evident, thoracotomy must be performed.

Several different steps have been suggested preliminary to undertaking internal cardiac massage such as intra-arterial transfusion, drug injection, intra-cardiac puncture and the use of an electrical pacemaker. Hosler<sup>8</sup> suggests direct intra-arterial transfusion under pressure via the brachial or lower posterior tibial artery, but to set up this procedure requires a great deal of time. Sadove and Julian<sup>15</sup> have suggested a rapid intravenous injection of 1 mg. of atropine and 2-8 mg. of phenylephrine in 20 cc. of saline. These drugs block the vagal reflex and help correct the peripheral circulatory collapse. Keeley et al<sup>10</sup> advise intravenous administration of 0.2 cc. of neosynephrine with 1 mg. of atropine sulphate to counteract both cardiac standstill and ventricular fibrillation. Zoll et al<sup>18</sup> have recommended intra-cardiac injection of 0.1-0.3 ml. of 1:1000 adrenaline. The mechanical stimulation of the needle or the action of adrenaline may stimulate contractions. In addition, Zoll et al recommended the use of an electric pacemaker. Electrodes, smeared with conducting jelly are placed 5-8 cm. apart on the precordium and stimuli are given 60-100 times per minute. It has been found that this method is usually effective only in heart-block, in Stokes-Adams syndrome, and in certain phases of hypo-

thermia. It is never effective in ventricular fibrillation or prolonged anoxia.

It is to be emphasized that no more than one minute should be spent performing the above operations if the heart fails to beat. If the heart does not assume spontaneous rhythmicity in this time, a thoracotomy and internal cardiac massage must be performed. Asepsis should be ignored if the chest has not been prepared. The surgeon rapidly estimates the fourth or fifth intercostal spaces and incises from about 2 cm. lateral to the sternum, to avoid the internal mammary artery, to the mid-axillary line. The right hand is inserted into the chest cavity, pushes the lung posteriorly, and moves behind the heart. The fingers are placed along the border of the left ventricle and the thumb and thenar eminence around the lateral border of the right ventricle. Massage is commenced by lifting the heart upward, compressing it against the sternum and simultaneously squeezing. Blood is consciously forced out of the ventricles by deliberate but gentle action. Between each squeezing stroke a definite forceful opening of the hand must be made to simulate diastole thus allowing adequate filling. Massage should be carried on at a rate compatible with the filling of the ventricles—usually about 60 times per minute. With adequate massage the myocardium exhibits good color and tone and a systolic pressure of 70-120 mm. Hg is obtained.

Once artificial respiration has been applied and massage has been initiated, the crisis is over. The pulse and blood pressure are checked to determine the efficiency of the massage. If the circulation is found to be inadequate the pericardium is incised from the base to the apex and the bare heart is massaged. The costochondral junctions of the two adjacent ribs may now be cut for more room. Massage is then continued and a self-retaining rib retractor is introduced. In instances where the heart is large and the surgeon's hand is small, the difficulty in effecting adequate massage may be overcome by using both hands.

When satisfactory circulation is ensured, time can now be taken to inspect the heart. If spontaneous activity has returned, manual assistance of systole combined with calcium chloride and gluconate injections are recommended to strengthen contractions. If such activity has not returned the surgeon determines whether the heart is in asystole or ventricular fibrillation. The treatment is quite different.

### (a) *Cardiac asystole*

Intracardiac injection of 5-10 cc. of 10% calcium gluconate or chloride is recommended to restore myocardial function. Repeated injections may be necessary. If there is no response an intra-cardiac injection of adrenaline is indicated. Adrenaline is very effective but tends to increase irritability and can lead to ventricular fibrillation. Hearts with good tone may be given procaine amide (2-5 cc. of 1% solution) to reduce irritability. Other drugs mentioned in the literature are isopropyl-noradrenaline, noradrenaline, molar lactate, sodium bicarbonate and quinidine. Zoll et al recommended the direct application of a pacemaker at this point, but this is ineffective except in the particular instances mentioned. If these measures are unsuccessful, improper myocardial color and tone, inefficient massage, poor oxygenation of the blood and other extraneous factors are considered.

### (b) *Ventricular Fibrillation*

When the heart is in ventricular fibrillation, it has the appearance of a writhing bag of worms. Defibrillation by electrical means must be performed. It is essential that the heart muscle be in good condition when therapy is applied. The electrodes of the defibrillator are moistened with saline and applied firmly to the heart with as broad a surface of contact as possible. One electrode is placed near the apex. A voltage of 170-270, an amperage of 1.5 amps. and a duration of 0.1-0.3 seconds are used. During the shock the myocardial fibres are coordinated in a state of contraction. When the current is broken, the fibres relax together and it is hoped that

the A-V node will send down a stimulus resulting in a coordinated beat. Adjunctive drug therapy is indicated. Intra-cardiac injections of potassium chloride (10 meq.) procaine hydrochloride (5-15 ml. of 1% solution) or procaine amide (100 mg.) may be administered at intervals. If fibrillation resumes, another countershock and more drugs are given. If asystole follows defibrillation treatment is given as described above.

Cardiac asystole has been maintained manually for as long as eight hours before the restoration of the heart beat. However, after one hour if the pupils are dilated and fixed and massage fails to produce a blood pressure of 70 mm. Hg, further efforts are fruitless.

Once intrinsic rhythmicity has been attained, diligent and intelligent post-resuscitative care must be administered.

## CONCLUSION

Cardiac arrest occurs most commonly in surgical patients. The greatest hope for resuscitation is in this group. Outside the operating room, prognosis is poorer due to inadequate facilities and etiological factors.

Prophylaxis is the most intelligent method of dealing with cardiac arrest. It can occur, however, under the best conditions. Treatment must be immediate. Permanent brain damage will ensue if the brain is anoxic for more than 3-5 minutes.

The process of resuscitation is divided into two steps: (1) restoration of the oxygen system and (2) restoration of the heart beat. The emergency is over when the first step has been successfully completed. Time may be taken to restore the normal intrinsic rhythm. Surgeons must be adequately trained in the complete procedure and lay rescuers must be instructed in non-surgical cardiorespiratory resuscitation.

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# Foreign Objects in the Eye

D. TRENHOLME JONES, '63

## INTRODUCTION

*"The Light of the Body is the Eye" (Mathew 4:22)*

The eye is subject to frequent trauma from foreign objects, and, being the prime sensory organ of the body, deserves every attempt to maintain its normal function. Evolution has provided lids, lashes, tears and bony orbit as protection; when these fail, it is our duty to minimize damage and aid nature in her attempt at healing. The mechanism, diagnosis and treatment of foreign objects and their effect on extra-ocular and intra-ocular structures is the subject of this paper.

## EXTRA-OCULAR FOREIGN BODIES

### I. General Mechanism of Extra-Ocular Foreign Bodies

The most common accident encountered in ophthalmology is the retention of a foreign body on the surface of the eye. This frequently occurs in both domestic and industrial life and although often a trivial matter it is not always so. If the foreign material is not automatically removed by the tears it frequently incapacitates the patient so long as it remains, while the trauma involved by injudicious and awkward attempts at removal, or the introduction of infection may cause permanent damage to vision and even on occasion, loss of the eye.

Such foreign objects most frequently strike the cornea, but they may land upon the bulbar conjunctiva and remain on the surface epithelium or become deeply embedded in the tissues. Others are washed by the tears into the lower fornix, eventually finding their way to the inner canthus, and, on occasion, into the lacrimal passages. It is interesting to note that one infrequently diagnosed foreign object is a hair or cilia, hidden from view except for the minute portion projecting from the lacrimal punctum and causing continued corneal irritation. More frequently foreign bodies become lodged in the middle of the upper subtarsal sulcus, occasionally working their way into the recess of the fornix. These objects, although difficult to detect, often cause continued corneal irritation

and so give us an indication of their presence.

### II. Symptoms and Signs of Extra-Ocular Foreign Bodies

As the cornea is struck by a non-penetrating foreign body, there is a sharp burning pain and a reflex gush of tears. This is followed by a momentary blindness and spasm of the eyelids. As long as the foreign body remains, the symptoms of irritation persist, such that the patient frequently causes further abrasion and damage by continued rubbing of the injured eye. This is frequently seen in objects which become adherent to the palpebral conjunctiva. More deeply penetrating objects are frequently less irritating, due to the absence of pain fibres within the depth of the tissues, and may remain unnoticed until the corneal epithelium sloughs away. Such deeply penetrating objects frequently elicit uveal irritation which manifests itself in circumcorneal injection and miosis.

Multiple inert fragments of industrial dusts or other fine substances fail to give rise to acute symptoms. Such particles are generally washed away by the tears while others result in blepharo-conjunctivitis and corneal abrasions, accompanied by mild photophobia and lacrimation.

### III. Diagnosis of Extra-Ocular Foreign Bodies

The diagnosis of extra-ocular foreign bodies, although frequently obvious, is often complicated by the distress of the

patient resulting in photophobia and blepharospasm. The discovery of one particle does not preclude others, so that thorough examination of the eye is essential. The discussion of diagnosis and treatment will be limited to those procedures which are capable of being carried out in the general physician's office or the emergency room. The steps of diagnosis are summarized as follows:

a) *Thorough History*

b) *Visual Acuity*

This is necessary in establishing a diagnosis as well as ascertaining the severity of the injury. It is also important to record for medico-legal reasons.

c) *Examination*

This requires adequate focal illumination, preferably oblique. Adequate magnification is essential and in most cases can be supplied by a hand lens or ophthalmoscope. Only if local irritation prevents examination should a local anesthetic such as 0.5% Tetracaine be employed.

The examination must include the cornea and bulbar and palpebral conjunctiva. One should always evert the upper lid to examine the conjunctiva and fornix. A double eversion of the upper lid requires a local anesthetic. The inner canthus beneath the plica, and lacrimal punctum must not be overlooked.

d) *Staining*

If the foreign body is otherwise undetectable, a sterile *Fluorescein* stain is often of value. Most frequently, this reveals that a foreign body is not present and that the irritation is a result of corneal abrasion.

e) Slit lamps, ophthalmic loupes and gonioscopic lenses are instruments usually confined to the realm of the specialist.

#### IV. Treatment of Extra-Ocular Foreign Bodies

All procedures are to be carried out in aseptic conditions. Superficial particles are to be irrigated out with saline or removed with a wet cotton applicator. Embedded particles may be removed with a spud or

sharp sterile hypodermic needle after the application of a local anesthetic. Occasional superficial rust stains may be scraped off. If the object has deeply penetrated, the patient should be referred to an ophthalmologist. A local antibiotic or sulfonamide ointment should be applied to prevent infections. In selected cases mydriatics are to be used to prevent uveitis. A firm bandage is to be applied to the eye to splint the lids preventing movement and further corneal irritation. The patient is to be observed the following day to evaluate results of treatment and speed healing. Corneal epithelialization is usually completed in 36 hours.

#### V. Complications of Extra-Ocular Foreign Bodies

Retained Foreign Bodies such as glass, coal, plastic and the inert metals such as gold, exert little or no effect upon the tissues. These may be indefinitely retained by the cornea, once the initial irritation has subsided. Other metals cause chemical reactions within the tissues so that more extensive damage results. Such metals as lead, copper and iron leave a resultant stain and may have serious toxic effects. Retention of vegetable matter may result in serious inflammation with resultant reduction in vision. Animal matter produces a somewhat similar picture, producing irritative symptoms which are frequently further aggravated by the toxic effects of the animal tissue fluids.

Infection is by far the most dangerous complication. It may be introduced at the time of injury or become superimposed at a later date. Because of the severity of resultant infection, prophylactic use of local antibiotics is well justified.

Small breaks in the surface epithelium may lead to the development of ulcers, permanently affecting vision. Rupture of Bowman's membrane produces permanent corneal opacities. Traumatic implantation cysts are a rare occurrence.

Thus, we see that prompt and efficient treatment of foreign bodies is essential in

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reducing the immediate damage and later complications of the injury.

### INTRA-OCULAR FOREIGN BODIES

#### I. General Considerations

The retention of foreign bodies within the eye although not a common injury, is an important one. To a large extent, such injuries are industrial ones. Proper techniques and preventive measures such as safety goggles and machinery guards could do much to alleviate this problem.

The size, site, chemical nature and number of particles are all factors influencing the prognosis. Due to minute size and velocity, many penetrations are accompanied by little or no pain as opposed to the intense pain of surface extra-ocular foreign bodies. They may only have a transient stinging sensation such that the incident is hardly noticed.

#### II. Effects of Intra-Ocular Foreign Bodies

The vast majority of intra-ocular foreign objects perforate the cornea. Unless such wounds are extensive, they heal rapidly and without complications. Conjunctival and scleral wounds tend to become invisible while those of the cornea leave a permanent tract, although this may be difficult to detect. A perforation of the iris is often diagnostic evidence of a foreign body. Frequently, the foreign body, if retained in the lens, results in complete opacification and permanent cataracts. Once the object has cleared the lens, the momentum is usually sufficient to carry it through the vitreous into the retina and choroid although it may be retained in one of these. It occasionally carries on, perforating the ocular coats a second time to become embedded in the orbit.

Fortunately, the heat generated in the emission of particles coupled with their speed of transmission often renders them sterile. Infection is most apt to follow the introduction of stone or wood. The lens and vitreous form excellent culture media

with resultant pyogenic and gas gangrene infections. Despite vigorous antibiotic treatment such infection inevitably worsens the prognosis.

The reaction of eye tissues varies widely with the chemical composition of the foreign particle. Inert substances excite no tissue reaction and practically no mechanical block. In the anterior chamber, they tend to remain indefinitely inert while in the vitreous, degenerative changes may ultimately occur. Common examples of these are: glass, plastic, porcelain, the precious metals—gold, silver, platinum and tantalum. Also stone, rock, clay and coal produce minimal reaction.

Other metals produce various degrees of tissue response. Aluminium and zinc frequently elicit a local reaction while nickel and mercury produce a suppuration.

Iron and copper, which are frequently found in the eye, undergo electrolytic dissociation resulting in eventual degenerative changes. Iron causes siderosis as it combines with cellular proteins, thus killing the cells and resulting in their atrophy. This may be first detected by the appearance of rusty particles in the iris and lens. Secondary Glaucoma commonly follows. Copper, which is not protein bound, produces chalcosis, a milder reaction than siderosis. It produces a golden green sheen in the lens (Sunflower cataract). Degenerative changes seldom appear and vision may be unaltered although acute reactions do occur.

Wood and vegetable material most often produce infection although delayed granulomatous inflammation is also produced. Implantation cysts and sympathetic ophthalmia should be considered. Animal matter tends to be absorbed although epithelium may remain to produce intra-ocular cysts. Retained cilia (eyelashes) may be carried in by the penetrating foreign body or by the subsequent surgery. These may produce severe iridocyclitis.

### III. Diagnosis and Localization of Intra-Ocular Foreign Bodies

The diagnosis is often aided by a good history indicating the possibility of minute high velocity particles. Such particles most frequently arise while hammering. Any workman injured while hammering should be routinely x-rayed despite the absence of clinical signs. Thorough examination of the eye is similar to that for extra-ocular foreign bodies in which suitable light and magnification are essential to localize the point of entry. The anterior chamber and fundus should be examined with an ophthalmoscope for direct visualization of the object. Such an examination with a dilated pupil often accurately localizes the object.

Clinical signs of an intra-ocular foreign body may be minimal or absent. Decreased visual acuity, signs of corneal penetration, as well as blood or cells in the vitreous humor are all indicative. A hole in the iris or continued irritation following an ocular injury would suggest an intra-ocular foreign body and should be viewed with suspicion. The late development of mydriasis, 3 to 6 weeks after injury, indicates siderosis. Siderosis as well as chalcosis are direct evidence of the presence of iron or copper.

Special techniques have been developed for the detection and localization of such particles which can not be detected by the above. A slit lamp is invaluable, while a gonioscope and small magnet often locate otherwise undetectable objects. At the present time, localizing x-rays allow the skilled radiologist to locate and pin-point many foreign objects. The Berman metal locator can be used to detect and position metal objects located near one of the accessible areas of the eye ball.

### IV. Treatment

Treatment is similar to that of an extra-ocular foreign body with immediate removal of the object if possible. The less manipulation that is required, the better, as unskilled hands may further aggravate

the damage. The removal of foreign bodies is generally indicated except when the particle is inert, probably sterile, and when little damage has been done to vision. It is also contraindicated when the process of removal will inevitably destroy sight. Complicated procedures are in the realm of the eye surgeon and should be conducted in the proper operating theatre where suitable equipment is available. Giant electro-magnets are frequently used for the extraction of ferrous particles.

Initial treatment of intra-ocular foreign bodies includes the administration of anti-tetanus serum as well as the control of infection by local or parenteral antibiotics. Atropine should be instilled to dilate the eye and thus prevent uveitis. A soft pad should be placed over the eye and taped in place under moderate pressure to keep the injured eye at rest. The patient should be hospitalized where definitive treatment may be carried out. A constant awareness should be maintained for complications.

### V. Complications

Many of the complications of intra-ocular foreign bodies are similar to, but more severe than those of extra-ocular foreign bodies.

- a) Infection
- b) Intra-ocular hemorrhage
- c) Irreversible damage to ocular tissues, eg. cataracts
- d) Retinal detachment
- e) Sympathetic ophthalmitis
- f) Secondary complications due to retained material

### CONCLUSIONS

The high incidence of foreign objects in the eye necessitates a thorough understanding of the mechanism and effects of such trauma. The vast majority of such cases can be adequately diagnosed and treated by the practitioner in his office.

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However, the complication and severity of certain of these injuries necessitates the skill of the medical specialist as well as the facilities of a well-equipped ophthalmological clinic. Thus, a combination of factors is required if a maximum effort is to be made to preserve sight.

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"The excesses ow our youth are drafts upon our old age, payable with interest about thirty years after date."

Colton

"It is indeed a desirable thing to be well descended, but the glory belongs to our ancestors."

Plutarch

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"Everything that exceeds the bounds of moderation has an unstable foundation."

Seneca

"We may take fancy for a companion, but must follow reason as our guide."

Samuel Johnson

# Emergency Office Treatment Of Epistaxis

WILLIAM A. HOWE, '62

## INTRODUCTION

Epistaxis is a common complaint and if it persists can be quite distressing to the patient. Those cases presenting themselves to the Doctor make up only a small percentage of all nose bleeds for the majority are treated at home. Although very few nose bleeds ever result in exsanguination, large quantities of blood can be lost and vigorous treatment may be necessary.

The office treatment of Epistaxis will be discussed realizing that should these measures fail, as they occasionally do, the patient should then be sent to hospital for further management.

For a discussion of the etiology of Epistaxis which will not be dealt with in this article, the reader is referred to an article by Donald G. Nassr in the March 1960 issue of this Journal.

## PRELIMINARY TREATMENT

Although you can be sure any patient going to his doctor with a nose bleed has tried every home cure currently in vogue, it might be profitable to have the patient sit upright and compress his nostrils with thumb and forefinger while remaining very still and breathing through his mouth during the time it takes you to prepare for the examination. The upright position of the patient lowers the blood pressure at the site of hemorrhage and favors clotting. It is said, also, that 90% of the bleeding points can be compressed by pinching the nostrils. Should these measures alone stop the bleeding you should cauterize the area to prevent recurrence. The occasional patient will become quite anxious at the sight of his own blood and will be benefited by an initial dose of morphine which not only makes the examination easier but also lowers the blood pressure.

## EXAMINATION

Begin by cleansing clots from the nose by suction, and, if necessary, by irrigation with a small rubber ear syringe. Look first for bleeding from Kiesselbach's plexus of veins on the anterior inferior portion of the cartilaginous septum. If the bleed-

ing point is not discovered here, examine the ends of the inferior and middle turbinates. If the bleeding area still is not seen, shrink the entire nasal cavity with a spray and pledgets soaked in Pontocaine-ephedrine solution and look again.

## ACTIVE TREATMENT

### A. Local

When the bleeding point is seen, place a Pontocaine-ephedrine pledget firmly against it and hold for several minutes. Then, dry the area and cauterize with 50% trichloroacetic acid or, following cocaine application, electric cautery using a blunt electrode at a cherry-red heat. If the bleeding is anterior, a piece of fat salt pork may be cut to fit the cavity and inserted. Commercial intranasal tampons do not work as well as pork but are less expensive and more dignified. If the bleeding point is not readily accessible, the nasal cavity may be packed with oxidized cellulose or 1/4 inch selvedge gauze saturated in petrolatum or oil to prevent adherence to the mucous membrane. The absorbable oxycell or Gelfoam packs are particularly useful in a blood dyscrasia when the removal of a pack might start the bleeding again. However, these are of little use in hypertensive nosebleeds for they will not exert sufficient pressure on the bleeding

point and are difficult to remove should the need arise. The packing itself is tedious but not difficult. Pack the upper and posterior portion and then work downward and forward until the packing is complete. If the pack shows a tendency to come out, either put a cork of proper size in the nostril or put some tape across the nostril. If bleeding still continues, a posterior pack might be done as well as the anterior one. This, however, is done only for severe hemorrhage and might better be dealt with in hospital. To pack the posterior nares, pass a soft rubber catheter into the nostril and down into the pharynx where it may be grasped and brought out through the mouth. Through the oral end of this catheter is then tied a strong silk ligature. To the other end of this ligature, at a distance of some 12 inches is tied a pledget of gauze. On this is tied an additional 12 inches of silk ligature. The catheter and first silk ligature are then withdrawn from the nostril until the pledget is firmly pulled upwards into the posterior nares. The pledget of gauze may be held tightly in position by tying the silk ligature over another pledget at the anterior nares. A post nasal pack should be removed within 24 hours because of the danger of otitis media, but, if iodoform gauze is used, this complication can usually be avoided. A nasal pack should be removed in 24 to 40 hours, but, if profuse epistaxis recurs, both packs may be reinserted and left in for as long as four days. There is an inflatable post-nasal pack available on the market which is inserted into the anterior nares and inflated. Its advantages are the more even pressures that can be applied and the ease with which it can be placed, compared with the conventional pack.

### B. Systemic

When a patient on anticoagulant therapy has prolonged serious nosebleeds, the obvious course of action is to lessen the degree of anticoagulation. Protamine sulfate is an antagonist of heparin as well as an antithromboplastin agent. In the pres-

ence of heparin, however, there is a tendency to mutual inactivation, and, thus, it is used as an antidote. For the treatment of excessive anticoagulant-induced hypoprothrombinemia, as seen occasionally in dicoumarol therapy, Vitamin K or Mephyton is the drug of choice. Estrogens have been claimed by some to have dramatically arrested spontaneous hemorrhage. It is claimed that they control hemorrhage within an hour in most cases without disturbing endocrine function or causing toxic symptoms. However, their usefulness has not yet been fully established.

### FOLLOW-UP

In patients with numerous or persistent nosebleeds, the blood pressure, plasma ascorbic acid level, blood platelet estimation and prothrombin time should be determined. We must always keep in mind that repeated epistaxis may be a sign of some underlying treatable disorder and that this disorder must be investigated.

### INSTRUMENTS

1. Head mirror and light
2. Nasal speculum
3. Bayonet forceps
4. Suction and tip
5. Absorbent cotton
6. Tongue depressor
7. "K" basin
8. Medicine glass
9. Cautery and Bakelite speculum
10. Caustic agents
11. Morphine and syringe
12. 12% cocaine and adrenaline solution or 2% pontocaine and 1/1000 adrenaline v/v.

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## INTRODUCTION

Traumatic injuries are playing an ever increasing role in the physician's practice. This is due to the mechanization of the modern age and the associated speed at which activities are carried out. Many of these injuries are minor and are readily dealt with in the doctor's office, or the emergency department of a general hospital. Others require the ultimate in surgical repair under optimum aseptic conditions in order to obtain satisfactory results. It is the purpose of this paper to present some of the aspects of managing minor fractures, crushed fingers, broken noses, splinter wounds and lacerations of the wrist and forearm, and to suggest some common errors committed by the unaware.

## MINOR FRACTURES

This term is somewhat arbitrary, but for the purposes here it implies fractures which are closed and uncomplicated.

Fractures are caused by a direct force at the fracture site, an indirect force at a distance such as twisting of a limb, or thirdly by muscle pull. They can be diagnosed on clinical examination, by finding angular deformity, abnormal mobility, grating of bone ends, along with pain and swelling at the fracture site. Multiple view x-rays should be used to further estimate the damage even though diagnosis may be obvious, if for no other reason than medicolegal purposes.

The treatment is best described in the standard method of first aid, reduction, immobilization and rehabilitation.

When the physician is applying first aid at the scene of an accident, he must be sure the airway is clear and all major bleeding is stopped before considering fractures. The patient should be made comfortable with analgesia such as morphine, or its derivatives, and the broken part be temporarily immobilized by use of splints or slings. The patient is then carefully transported to the place of definitive treatment, avoiding further damage to the broken part.

In the clinic, a more thorough assessment takes place, again with the fracture being only significant after respiratory involvements and hemorrhage are controlled.

The fracture is then examined and x-rayed before proceeding to the next stage.

Reduction of minor fractures may be unnecessary due to lack of displacement, or if the displacement is such that it does not affect the final results. Imperfect opposition is always more acceptable than imperfect alignment. When reduction is necessary, the patient is given a local, regional, or general anesthetic. The procedure is then carried out by closed manipulation, mechanical traction or finally by open reduction. In general, open reduction, is a last resort measure in treating minor fractures.

The immobilization procedure is carried out for the prevention of: further soft tissue damage, displacement of the fragments, movements which delay union, and for the relief of pain. Hence if in a given fracture none of these indications apply there is no need for immobilization.

Absolute immobility is not essential to union of a fracture. Only when movement might be in danger of shearing fine capillaries bridging the fracture site must movement be limited. A rotational movement is often the worst in this respect thus requiring fractures of the scaphoid bone, shaft of ulna and neck of femur always to have rigid immobilization.

Probably one half of immobilized fractures are so treated to relieve pain as a comfortable limb can be used much more efficiently than is otherwise possible.



Examples of fractures which can sometimes be treated without immobilization are those occurring in the ribs, clavicle, scapula, certain parts of the humerus and femur, metacarpals, metatarsals and phalanges.

When immobilization is indicated, it is carried out effectively by plaster of Paris cast or some other external splint, continuous traction, or internal fixation.

Rehabilitation is one of the most important aspects of treating any fracture. It should begin as soon as definitive treatment of the patient is started in order to preserve function during union, and to restore normal function when united. This consists of active use of the part within the limitation imposed by necessary treatment, as well as by active exercise of the involved muscles and joints. Rehabilitation may be partly supervised physiotherapy, although most of it can be done independently by the patient if its importance has been properly impressed upon him.

The most common errors in treating minor fractures are as follows: attempts to achieve perfect anatomical union when such is not necessary, especially if this entails opening a closed fracture, excess immobilization of a part causing muscle atrophy and stiff joints, and inadequate padding of casts which at first may inhibit swelling, and later be responsible for ulceration over bony prominences.

### CRUSHED FINGERS

These injuries are caused by the forces of compression or rotation of rollers, wringers, presses, car doors, falling objects etc.

Car door injuries usually involve only the distal phalanx and cause crushing of all tissues including the bony part. A subungual hematoma often forms as a painful complication. This injury is treated according to the dictates of the soft tissues and not as a fracture. A hole drilled in the nail will remove the hematoma. Warm soaks, elevation and rest of the part, and

protection against further damage is usually all that is necessary in managing these cases. Bony manipulation should not be attempted as the bone is well secured by soft tissue attachments.

Extensive crushing of the fingers presents a much more serious problem to physician and patient alike. Here it is of greatest importance to save tissue and restore the ultimate in function for obvious reasons.

The injury may be closed or may have become torn open by the crushing force. Even when the injury remains closed it is important to realize that the force of compression may cause a shearing effect on the various strata of tissue such that the latter may in fact be detached from its blood supply. This often is not evident at the time of accident, but later, edema and hemorrhage distend the fascial planes adding further insult to the injury. Compound fractures should always be suspected.

Hence management of these cases must be approached with the utmost awareness and care. First aid should be simple and confined to measures which prevent secondary contamination of the wound, control of bleeding and swelling, and immobilization of the injured fingers.

An adequate history is obtained at once including all the circumstances of the injury, as well as a general history of the patient. If the wound is open it is essential to find out the degree of initial contamination, and the time elapsed since this contamination.

The examination of the wound is carried out under aseptic conditions and should be sufficiently thorough to diagnose its extent, without actually meddling with any open parts. Motor and sensory nerve involvement and tendon injuries should be carefully ascertained by various function tests as their presence or absence greatly modifies the treatment. X-ray examination is an integral part of the examination of crushed fingers to outline fractures and detect possible foreign bodies.

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A general examination of the patient must also be carried out along with blood and urine tests if a general anesthetic is indicated in the treatment.

With the diagnosis made, the surgeon proceeds to repair the injury. The area must be thoroughly cleansed with the patient properly anesthetized. Wound excision is carried out and in crushing injuries, the amount to excise is somewhat difficult to decide. All tissue which will not survive must be removed to prevent further loss from infection, yet all tissues which will survive should be retained. The skin over a badly crushed area is usually seriously soiled and contaminated and can not even be saved for grafting. Dead subcutaneous tissue, fascia and muscle are carefully removed but excision of bones and tendons is carried out very sparingly as these structures are very important in reconstruction. The thumb should be saved for opposition in grasping if at all possible.

After wound excision, careful repair of deep structures is carried out only by a competent surgeon as this includes nerve and tendon repair, fracture reduction and joint closure. Several staged aseptic operative techniques are usually employed for this purpose and are followed by reconstructive grafting as necessary.

Following wound closure the finger is splinted in the position of function with voluminous compression dressing. If only one finger is involved, only that digit is immobilized. It is to be emphasized that the position of function or grasping is maintained and that uninvolved fingers are left free to exercise. Immobilization of injured fingers should be for as short a time as possible since permanent joint stiffness rapidly ensues.

The most common errors in treatment of crushed fingers are: inadequate wound excision, over-immobilization, and too rapid wound closure with inadequate drainage thus allowing infection to occur.

## BROKEN NOSES

It is said that fractures of the nasal bones are more often overlooked than diagnosed. This injury is usually caused by a blow to the face or a fall against some object. Direct frontal forces usually result in a transverse fracture of the nasal bone and fracture of one or both nasal processes of the superior maxilla. A lateral blow more often fractures only one nasal bone but may have associated fracture or dislocation of the nasal septum. The fracture may be compounded or comminuted with or without displacement of the fragments.

The presenting symptoms are bleeding from the nose due to tearing of the mucous membrane, nasal obstruction, ecchymosis of the eyelids by twenty-four hours, visible deformities, pain and swelling.

On examination application of alternate pressure to each side of the nasal process reveals crepitus, movement, and pain. The nasal cavity should be examined with a speculum to determine airway obstruction from a displaced septum.

The treatment can be carried out adequately under office conditions, and should be done as soon as possible before swelling and bleeding change the normal contour, and before infection sets in. In adults local anesthetic can be applied in the form of pontocaine and cocaine sprays, whereas in children a general anesthetic is preferable. The choice of instruments to be used include Walsham forceps, rubber sheathed hemostat or the handle of a Bard-Parker knife wrapped in cotton. One of these instruments properly lubricated is inserted into the nasal cavity and the displaced bones and septum are molded back into shape. If the fracture is comminuted, it should be supported after reduction by nasal packing, intranasal splint or an external type of bridge support.

If a compound fracture is not seen in the first seventy-two hours, it should be corrected in hospital under sterile conditions due to danger of complications.

The nose is then kept clean and open by the use of mild nasal drops, suction, and shrinkage.

The most severe complication is an associated fracture of the ethmoid bone with leakage of cerebral spinal fluid and the subsequent open pathway for intracranial infection.

The most commonly occurring errors of treatment are either completely overlooking the fracture which causes disfiguring deformities especially in children, or secondly delayed treatment which changes a simple procedure into a much more difficult and dangerous one.

### SPLINTERS

Splinters of steel, wood, and glass becoming imbedded somewhere within the body especially in hands and feet is an every day occurrence. Steel splinters are an occupational hazard of construction and foundry workers, whereas wooden splinters are more often encountered in the feet of children or hands of patients from any occupation. Pieces of glass are found in the feet of children stepping on broken bottles, in the hands of adults breaking glass objects in their hands, or in persons involved in automobile accidents.

The diagnosis of the condition is often obvious from the patient's history, signs of a localized painful lesion, and from x-rays if the object is radiopaque. Foreign bodies should always be suspected in wounds which heal but later break down and drain.

The treatment is relatively simple. In fact, wooden splinters are often removed by the family and are not drawn to the physician's attention at all. Particles of wood, glass and cloth are always contaminated and must be removed immediately if possible. This can best be achieved after exact localization of the particle and under optimum conditions of anesthesia, asepsis, lighting and bloodless field.

The localization is achieved by application of pressure to find a palpable object or

a painful area, by multiple view x-rays, and by probing with a sharp needle in the incised wound, keeping the needle perpendicular to the long axis of the foreign body.

Anesthesia may be applied locally with procaine infiltration or may take form of a regional block. Tourniquet application aids in attaining perfect hemostasis during excision.

The best means of removing tiny ill-recognized bodies, is by washing and scrubbing the wound surface while irrigating copiously with distilled water. With larger splinters the wound may be incised and the foreign body withdrawn along its path of entry, again thoroughly irrigating the wound. If the splinter lies beneath a nail, a v-shaped excision of the nail overlying the splinter will permit its removal. In other parts of the body it may be necessary to enlarge the wound entry and grasp the particle with a hemostat. The site of injury should then always be carefully examined for residual foreign material.

Occasionally in wounds with small relatively non-contaminated metal splinters, it is advisable to leave the particle in the body, especially if further tissue damage is likely to occur in the removal operation. Tissue foreign body reaction is then set up and will often wall off these particles with fibrous encapsulation. A palpable nodule may thus be formed and the foreign body be more easily removed. Secondly, the particle may produce an infection and be spontaneously removed during the ensuing drainage. If drainage persists, hot packs and antibiotics may be necessary with a repeated attempt to remove the splinters.

In all cases of puncture wounds it is essential to check the patient's tetanus immunity status as this disease is a most serious complication of an otherwise simple injury. If the patient has been actively immunized including a booster dose of toxoid within the past five years, and if his splinter wound is not associated with more serious injuries, 0.5 ml. fluid toxoid

should be given to raise the antibody titer. However, if the patient has had no toxoid in the past five years or if there is an associated serious injury, the 0.5 ml. fluid toxoid should be given accompanied by 1500 units of antitoxin subcutaneously. Finally, if signs of tetanus are presenting, a dose of 200,000 units of antitoxin is given intravenously. The patient must always be checked for sensitivity to horse serum before administering massive amounts of antitoxin.

When a foreign body has been in a wound for some time, the antitetanus immunity should be substantiated before disturbing the wound as there may be a local accumulation of organism-liberated toxin released into the blood stream at operation.

The common treatment errors with splinter wounds stem from inadequate wound cleansing and excision and from the improper understanding of the tetanus immunity principles.

## LACERATIONS OF WRIST AND FOREARM

These injuries commonly occur in patients involved in accidents with saws, farm machinery, automobiles and in attempted suicides. In order to properly manage these cases a good working knowledge of the involved anatomy is essential. This consists in general of the flexor group of muscle tendons on the anterior surface and the extensor group on the posterior surface of the forearm. In addition, the ulnar and radial arteries and the ulnar and median nerves are contained in the anterior compartment. For example, an extensive superficial cut across the anterior surface of the wrist would likely involve the following structures as it proceeded from radial to ulnar side: radial artery, flexor carpi radialis tendon, palmaris longus tendon, median nerve, flexor digitorum sublimus tendons, ulnar artery and nerve, and flexor carpi ulnaris tendon.

The problem of management thus becomes obvious and involves excellent technical skill in order to repair the damaged structures and prevent deformities.

First aid involves stopping the bleeding, prevention of further infection and damage to the structures, and giving the patient analgesia and physical comfort. The routine use of tourniquets to control bleeding is condemned. Direct pressure with a clean dressing over the bleeding point will serve the purpose well and does not run the risk of completely shutting off circulation to the part. The arm should then be immobilized with splints or dressings and sent to the place of definitive treatment as quickly as possible.

Diagnosis of the involved parts is made by general inspection, sensory examination and motor function tests. Hence on general inspection an involved artery is detected by the spurting of bright red blood. Similarly radial nerve involvement is characterized by obvious "wrist drop".

Sensory loss to the ring and small fingers indicates ulnar involvement, whereas any other palmar sensory loss must be due to median nerve injury. The radial nerve sensation on the dorsum of the hand is overlapped by ulnar and median branches and testing here is somewhat unreliable.

A fast and useful motor nerve test is as follows: approximate the tips of all fingers including the thumb, forming the "accoucheur's hand". This tests the motor power of the median and ulnar modalities. The ability to extend the thumb indicates that the radial nerve is intact.

Tendon involvement is tested by having the patient attempt to contract the involved muscle and see whether or not its action is carried out.

The treatment is surgical repair which should be carried out as soon as diagnosis of involved structure has been made. These wounds are usually relatively clean and fresh when brought to the doctor's atten-

tion, and repair can start immediately. Grossly contaminated wounds must of necessity first be carefully cleansed.

Blood vessels, including the major arteries can be clamped off if necessary, as the collateral circulation about the hand and wrist is adequate. Nerves should be approximated initially with fine wire or silk sutures to prevent retraction, although a secondary suturing in ten to twenty days after some epineural fibrosis has occurred, will give a better functional result. Tendon repairs in the absence of contra-indications should also be sutured initially for best results. Palmaris longus and flexor sublimus tendons alone may be sacrificed for reconstructive purposes. Finally, skin and fascia are sutured, in the absence of infection, or left open to drain if the latter is suspected. As with foreign bodies, the patient should be promptly immunized against tetanus.

Suitable immobilization, usually with plaster of Paris splints is then instituted and a process of vigorous rehabilitation carried out.

Errors in this area nearly always lead to a poorly functioning or useless hand. Structures at the wrist are confusing in

appearance and such mistakes as suturing the palmaris longus tendon to the median nerve have been recorded in the literature. Nerve and tendon suture should be turned over to the most competent surgeon available.

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"Seems it strange that thou shouldst live forever? Is it less strange that thou shouldst live at all? This is a miracle: and that no more."

Young

"Sometime we learn more from a man's errors than from his virtues."

Longfellow

"Indigestion is charged by God with enforcing morality on the stomach."

Hugo

"It is with disease of the mind, as with those of the body: we are half dead before we understand our disorder, and half cured when we do."

Colton

# Anaphylactic Emergencies

ROBERT C. MOFFAT, '62

## INTRODUCTION

A symposium on office emergencies would not be complete without a discussion of anaphylactic emergencies. In this day of pills and needles, the practitioner is destined to encounter the problem at some time. Fortunately, the treatment is relatively simple and recovery is usually the rule. Nevertheless, more and more fatal reactions are finding their way into the literature each year. The reaction is a frightening one for the doctor and should be contemplated every time an injection of penicillin or any other injection is to be given.

This paper will only mention several of the many possible agents. Penicillin, the greatest offender, and some of the pollen extracts will be discussed in a little more detail. Also the local anesthetics, especially the procaine group will be briefly discussed because they, too, are capable of producing a sudden vasomotor collapse and even death. Finally, since recognition of anaphylactic shock is usually fairly easy, more emphasis will be placed on management of such a condition.

## DEFINITION

Anaphylaxis is derived from an ancient Greek word meaning "without protection". Anaphylactic shock, the subject of this paper, characteristically occurs when one injects a given antigen into a hypersensitive host. However, as you will see later, anaphylactic shock may occur after inhalation, ingestion, or even mucosal application of certain substances. Typically, one would like to have a sensitizing dose, a waiting period, and an eliciting injection. Many times there is no history of such a sensitizing dose and severe systemic reactions may begin minutes after a single injection.

The anaphylactic response is characteristic for each species of animal. Generally, the syndrome consists of marked fall in blood pressure, smooth muscle spasm with breathing difficulties, leucopenia, and decreased blood coagulability. Convulsions and death may be seen in anaphylactic states as well.

## INCIDENCE

Despite the high incidence of allergic disease, anaphylactic emergencies are fortunately relatively rare. Fifteen years ago, most published reports would incriminate firstly, horse serum and then chemothera-

peutic agents administered by needle. Now, penicillin itself is way out in front as the cause of such reactions. In one recent series of anaphylactic reactions, 793 out of a total of 809 reactions were due to the administration of penicillin compounds. The breakdown of these cases was as follows:

| Administration  | No. of Cases |
|---|--------------|
| Parenteral penicillin (either alone or with streptomycin) | 733          |
| Oral penicillin   | 49           |
| Penicillin by inhalation                                  | 4            |
| Penicillin in ointment                                    | 1            |
| Penicillin in nosedrops                                   | 1            |
| Penicillin in skin tests                                  | 1            |

It is estimated that every year several hundred people die in the U.S.A. as the result of anaphylactic shock due to penicillin.

## ETIOLOGY AND PATHOGENESIS

### (a) General

Many substances are capable of producing anaphylactic shock. Some of them are listed in the table below, others are yet to be published.

### Agents That May Induce Shock

#### A. MOST COMMONLY ENCOUNTERED

1. Penicillin
2. Local anesthetics
3. Pollen extracts used in desensitization programs

## *Anaphylactic Emergencies*

### B. LESS COMMON

4. Sera
5. Vaccines
6. Iodides
7. Vitamin products
8. Organ extracts
9. Mercurials

### C. OTHERS

10. Foods and ingestants
11. Insect bites
12. Toxoids
13. Insulin
14. Gold salts
15. Barbiturates
16. Aspirin
17. Arsenicals
18. Aureomycin
19. Benadryl
20. Cortisone
21. Etc.

All the substances in the first two groups have been associated with fatalities, as well as many in the third group. With most of the above agents, especially penicillin, it is usually necessary to have had a previous exposure (sensitizing dose) followed after a lapse of several weeks, months, or even years by another dose (shocking dose). The antibodies that were built up after the first dose combine with the antigen on the second administration. This occurs within seconds to minutes, resulting in the clinical picture that will be described later. If antibody testing is carried out after the immediate reaction, especially in the case of penicillin, it may be possible to demonstrate, both direct, immediate wheal-type skin reactions and passive-transfer antibodies. This latter statement does not always hold true.

One should mention that in the case of local anesthetics and several of the other agents, since no antibodies can be demonstrated, it is not known whether this is a true reaction or a cellular idiosyncrasy to the drug. This will be discussed further.

In anaphylaxis, there are several major physiological disturbances. The most important is the liberation of histamine.

There is also a liberation of heparin, serotonin and other intermediates. Leukopenia is seen, with the cells adhering to the walls of pulmonary capillaries. Smooth muscle spasm as well as edema may be pronounced due to injury of the vascular endothelium. Finally, one is able to observe a fall in serum complement suggesting an antigen-antibody reaction.

Besides eliciting the symptoms in a sensitized person, it is possible experimentally to produce anaphylactic shock in an unsensitized person by a single injection of a soluble antigen-antibody complex. It has been postulated that these complexes attach to cells and release histamine, etc., which in turn acts on sensitive cells of the "shock organs" to produce the manifestations as mentioned above. Experimentally, it can be shown that histamine is capable of producing the signs and symptoms of anaphylaxis.

At autopsy, the only characteristic lesions have been confined to the lungs which reveal alveolar distention, presumably from acute emphysema following bronchial constriction and edema, and congestion with erythrocytes.

Perhaps to orientate our thinking, several examples might be considered.

### (b) Penicillin

Penicillin is the foremost cause of anaphylactic emergencies today. When first on the market, serious reactions were unknown and anaphylaxis seemed hard to achieve. In fact, the first case of anaphylaxis was reported in 1945 with an intramuscular injection and in 1953 with oral penicillin. Today, thousands of people have been sensitized by repeated injections, inhalations of penicillin aerosols, and frequent use of throat lozenges, ointments and penicillin-containing eardrops. The handling of syringes contaminated with penicillin has caused contact sensitivity in nurses and hospital personnel. People have also been sensitized at times with polio vaccines, milk, milk products, etc.

Because of this increasing incidence of immediate severe reactions to penicillin,

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people with a previous history of any reaction or a coincident history of bronchial asthma, hayfever or any other allergies, might be considered as candidates for sensitivity tests.

The tests for hypersensitivity will not be described here, but a skin test or conjunctival test are the ones usually carried out. When doing this, one should keep in mind a reported case in which a patient developed severe shock within a few minutes of oral penicillin administration. Shortly thereafter, a skin test with the scratch technique was carefully performed, and this minute amount so superficially applied, again induced shock within a few minutes. Positive skin tests and demonstration of passive-transfer antibodies demonstrate marked sensitivity and contraindicate the use of the penicillin. Negative tests do not necessarily rule out the possibility of anaphylactic reactions.

In general, reactions to parenteral administration of penicillin can be expected to occur in 2.5% of children, 5% of non-allergic adults and 15% of allergic subjects. Anaphylaxis makes up a small but significant number of these reactions.

#### (c) Pollen Extracts

Systemic reactions may occur at any time in the course of desensitization programs. Although the reactions are usually mild, such as itching of the palms and soles of the feet, severe reactions associated with acute asthma, marked fall in blood pressure, and loss of consciousness may occur.

Pollen overdose is the most frequent cause of systemic reactions during desensitization but any kind of specific allergic immunization can cause severe reactions. This applies to treatment with moulds, animal danders, house dust, cottonseed, etc.

#### (d) Local Anesthetics

These drugs have been responsible for numerous cases of sudden death. Although immune mechanisms may not play a part, these agents do fit into a category of

hypersensitivity. Shock, should it occur, usually is sudden without the development of skin eruptions, asthma, or other signs of allergy usually associated with systemic reactions.

Gilman considered local anesthetic reactions in three groups. In the first group, toxic influences seemed to predominate with resulting apprehension, excitement, delirium, convulsions and respiratory failure. This group was usually associated with overdose and the principal offenders were cocaine and procaine. His second group consisted of reactions that came on suddenly, almost immediately after contact with the drug, and were referable to the circulatory system. Clinically, there was sudden pallor, increased pulse rate, fallen blood pressure and syncope. In this group, injection into the circulation was the probable cause and many reactions followed sub-therapeutic doses. His third type was attributed to allergy but he did not define it clearly, although he did mention asthma.

### CLINICAL PICTURE

An anaphylactic emergency may provoke considerable anxiety for the practitioner. As mentioned earlier, it usually occurs within a few minutes of the injection, and hence the cause is rarely in doubt.

Often, there is rapid facial swelling, generalized urticaria and angioedema, frequently, rhinitis, tightness in the chest, and asthmatic wheezing. Symptoms may rapidly progress with acute pulmonary edema or irreversible vascular collapse. On the other hand, events may take place so rapidly that there is no time for the usual progression of allergic manifestations, and there is complete collapse with death in a few minutes. Fortunately for the sake of treatment, there is usually one or more of the following symptoms: strange taste, widespread flushing, urticaria, angioedema, dysphagia, crowing inspirations, nausea and vomiting, hunger pains, cold sweats, wheezing dyspnea marked pallor, cyanosis,



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visual and auditory disturbances, giddiness and extreme prostration or sense of sub-sternal constriction.

### MANAGEMENT

#### (a) Prophylactic

Penicillin must not be used without a good reason. Once again, it is the major cause of severe anaphylactic emergencies. If a patient has had any previous reaction to it, one should use another antibiotic. If penicillin must be used, give it orally and observe the patient carefully.

Careful testing via skin and eye must precede the use of substances such as tetanus antitoxin and penicillin in patients with a history of allergy. One should be guided by the results of these tests.

In patients sensitive to horse serum or dander, where there is any history of a prior reaction to tetanus antitoxin, one should start active immunization with toxoid and preserve the patient's immunity by means of "booster shots".

Vaccines must be given with care. Children with a history of egg sensitivity should be carefully skin tested before receiving influenza vaccine, for example, since it is grown on chick embryo.

Once again, as far as local anesthetics are concerned, a background of sensitivity should be looked into, keeping in mind that various drugs can cross-react. The dosage must be the correct dosage and the injection should not be into the circulation.

#### (b) Definitive

In many instances recovery may be completely spontaneous and no treatment is needed.

In other instances treatment may be life-saving and a plan of action should always be kept in mind. Firstly, whenever local anesthetics are used and excitatory reactions are observed, one should have on hand several short-acting barbiturates: Pentothal 4-10 cc. of 2½% solution;

Secobarbital 150-250 mgm.; Sodium Amytal 400-800 mgm. Given I.V., these compounds may stop the toxic reactions but are contraindicated where depression is a prominent feature.

One might now consider the treatment of anaphylactic reactions in general. All of the compounds mentioned below should be in the possession of the practitioner and a plan of treatment might be as follows:

1. Place patient in head-low (Trendelenburg) position so as to prevent cerebral ischemia.
2. Epinephrine 0.3 cc. - 0.5 cc. stat.  
I.M. if early,  
I.V. if already in profound shock.  
May repeat in 10-15 minutes.
3. Place tourniquet above site of injection.
4. Start I.V. 5% Glucose in other arm.  
May need cutdown and catheter.
5. May give Antihistamines in I.V.—  
Benadryl 100 mgm. or Chlor-Tripolon  
10-20 mgm.
6. May give aminophylline I.V. if wheezing—10 cc. ampule (3¾ - 7½ grains) slowly.
7. May give Solu-cortef (mix-O vial) I.V. at least 100 mgm.
8. May need norepinephrine  
—if failure to respond in 10 minutes,  
—4 mgm. in 500 cc. solution,  
—must maintain adequate blood pressure.
9. May give oxygen if available.
10. Should observe 12-24 hours, in hospital if necessary.

As in all emergencies, one must be sure that there is an adequate airway available. The tongue may have to be grasped with a sterile gauze and held forward to prevent suffocation. Artificial respiration may tide the patient over the first crucial

minutes. An intermittent positive pressure breathing apparatus may be used if available.

In general, anaphylaxis requires rapid and effective, rather than prolonged therapy.

## CONCLUSIONS

Anaphylactic reactions may be seen in everyday practice, and may constitute a grave medical emergency. They may be fatal. Most can be prevented and all can be treated. Since these reactions are increasing, the doctor should be aware of the problem and prepared to meet the emergency.

Anaphylaxis should always be considered in the differential diagnosis of shock of obscure origin.

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on flexion of the head may result and cause closure of the tube.

## SUMMARY

The differential diagnosis of the acute obstructed airway has been discussed. The age of the patient is the most important factor to consider.

The emergency treatment of obstructed airway should follow a preconceived plan based on basic principles. If an airway cannot be established through the patient's own respiratory passages then there should be no hesitation in establishing an artificial airway by laryngotomy or tracheostomy. However this often could be prevented if more physicians were adept at using the endotracheal tube which is a very compact

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instrument and life-saving in a majority of instances.

Finally, the best cure is prevention. The youngster should not be given peanuts, hard candies or coins until school age. The acute stage of soft tissue swelling may be prevented by instituting soothing gargles and irrigations early on. The physician should always attempt to educate the layman by pointing out some of the dangers to the child and the aged while teaching simple remedies in acute airway obstruction as well.

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# Poisoning in Office Practice

BRUCE McDONALD, '62

*A poison is a substance which, when introduced into the body in relatively small quantities, and acting chemically, is capable of producing death or serious injury to health in the case of an ordinary individual in average health.*

## INTRODUCTION

In recent years, a whole new group of clinical syndromes have appeared, which are often unrecognized by the medical profession, yet which often cause extensive morbidity and mortality. These are poisoning syndromes, resulting from the intake of a toxic material, and presenting a medical problem increasing in incidence and importance to the extent that many doctors cannot cope with it. So many agents with different toxicities are employed for the same purpose that it may be impossible to recognize those most toxic until victims appear. Recognition of the agent involved, without an adequate history to implicate it, makes the job doubly difficult since signs and symptoms are seldom specific.

## INCIDENCE

Accidental death is the chief cause of mortality today in people under 40 years of age, and poisoning ranks fifth as a cause of accidental death. In Canada, children account for 75% of the total cases reported; however, mortality is low and morbidity is high in this group. Adults have a higher mortality rate but suicide is the determining factor in this group. The highest number of poisonings in infants occurs at age two (time of first walking). A correlation is found between the type of poison ingested and the height of the child, e.g. cleaning fluid is usually stored under the sink, whereas drugs are usually kept at a higher level. Therefore, drugs become a greater threat as the infant increases in stature. Most children ingest poison in the kitchen or bathroom, often under normal supervision.

## MAJOR AGENTS RESPONSIBLE

Despite those poisonings appearing from new chemical compounds which are attracting wide interest, statistics show that the common, easily available household compounds still cause the majority of poisonings. There are two groups of compounds involved:

### A. Drugs

1. Acetylsalicylic Acid

2. Phenolphthalein

3. Barbiturates

4. Tranquillizers

### B. Household Chemicals

1. Javex<sup>®</sup>

2. Turpentine

3. Furniture Polish

4. Fuel Oil

Drugs cause most adult poisonings, while household chemicals cause a large proportion of poisoning in children.

## SEVERITY OF INTOXICATION

Most poisons are ingested by mouth and only occasionally inhaled, or absorbed by the skin. Regardless of the mode of entry, the clinical signs and symptoms are a fairly reliable index of the degree of toxicity. Nevertheless, in the case of ingestion, they reveal only the amount absorbed at that instant, and not the amount of poison yet to be absorbed. Absorption may be delayed due to food in the stomach or to a relatively insoluble toxic agent. Highly concentrated doses of poison may cause vomiting if eaten, or laryngospasm if inhaled, and, thus, may save the victim's life, whereas weaker dosages, which could be taken into the body, would probably kill him.

The time interval between the intake of the poison and seeing the physician generally determines the prognosis. In particular, if the poisonous substance causes coma from anoxia or hypotension, often the outcome is determined by the victim's individual resistance against these sequelae, rather than any heroic measures taken by a doctor, since these cases are often discovered late.

It is wise to remember that certain combined drugs, each in a non-lethal dose, can act synergistically to produce a total lethal effect, e.g., alcohol and barbiturates.

## DIAGNOSIS

Although poisoning is either acute or chronic, only the acute case presents as an emergency and is considered here. An adequate history implicating the kind and amount of material ingested is invaluable, and often available upon careful questioning, particularly in the case of child poisonings. Adults, especially if attempting suicide, may be more subtle and present in coma.

When a history is unobtainable in such cases, poisoning must remain prominent in the index of suspicion. Often, if strict notice is taken of the presenting signs and symptoms through continuous observation and a physical examination, they may seem atypical, i.e., one sign or symptom is missing which would lead one to disregard most of the other possibilities. Laboratory and X-ray findings may later confirm the diagnosis of poisoning. As a general rule, poisons range from corrosive agents to substances producing deep coma. Symptoms, therefore, vary from obvious burning in the throat, vomiting, nausea, abdominal pain, through stupor to the less obvious coma with generalized muscle flaccidity, large or small pupils, absent deep reflexes, depression of the cough reflex, and a host of associated signs.

Certain signs point specifically to the drug involved, e.g., decreased respiratory

motion and pin-point pupils with opiates, and a characteristic odor with Paraldehyde.

Yet, in many cases, the victim, by necessity must be treated symptomatically without any real knowledge of the causation. This is frequently the case in the comatose patient.

## DIFFERENTIAL DIAGNOSIS

If no history of poisoning is suspected, coma may be attributed to hypoglycemia, diabetic ketosis, convulsive seizures, Stokes-Adams Syndrome, meningitis, cerebral vascular accident, cerebral thrombosis, or unsuspected traumatic brain injury. Salicylate poisoning is frequently mistaken for bronchopneumonia, or diabetic coma, because of hyperpnea, pyrexia, and leukocytosis, although cardinal signs such as consolidation of the lung fields and sweating, generally prominent in bronchopneumonia, are seldom found in overdose with salicylates. Air hunger in young infants should be assumed to be primarily due to salicylate poisoning until proven otherwise. Ordinary aspirin and similar compounds are considered by adults to be so innocuous that only specific and persistent questioning of the parents will reveal that the drug was administered in adult dosages.

## TREATMENT

Theoretically, treatment should be individualized for each poison, but since the causative agent is not always known, and the antidote is less often available, general procedures of treatment are most important. A cardinal rule is useful here: "Successful therapy depends upon balancing the time spent on the diagnosis against the necessity of immediate treatment". If the diagnosis cannot be made immediately, treatment must be symptomatic. If the diagnosis is evident, treatment consists of:

- (a) removal of the toxic agent
- (b) detoxification of absorbed poison (by antidote, if possible)

### (c) treatment of symptoms

#### A. Removal of the Toxic Agent

##### (1) Vomiting

Vomiting can be induced if medullary centres still respond. Aspiration pneumonia is a danger unless care is taken in this procedure. Violent emesis may result in rupture of the stomach or esophagus if corrosive liquids have caused necrosis. Vomiting may be induced by mechanical stimulation or various drugs but these latter agents should produce emesis promptly.

##### (2) Chemical Antidotes

These may be used to precipitate poisons in the gastrointestinal tract but only in conjunction with gastric lavage and enemas. These substances delay but do not prevent ultimate absorption in most cases. The most widely used antidote is tannic acid which precipitates certain metals and alkaloids. This is one ingredient of the universal antidote (containing tannic acid, charcoal, and magnesium hydroxide), which is used as an emergency antidote where the agent may be in doubt.

Corrosive substances such as acids, alkalis, strong salts, and phenols require immediate neutralization to offset complications. Large quantities of a weak neutralizer must be used, otherwise sudden gaseous expansion may "explode the stomach and esophagus".

##### (3) Gastric Lavage

Always consider if this procedure is worthwhile especially in a comatose patient since injury can result. Generally, its use follows the giving of antidotes. It is continued until the washing material is free of toxic material. The washings can be analyzed for the type of poison involved if this is not known. As large a tube as possible should be used to allow thorough suction, flushing, and preventing of plugging. In comatose patients, or those who have swallowed corrosive substances, the tube must be put down with great care

to avoid getting the tube in the trachea, or puncturing a damaged esophagus or stomach. Small quantities of washing fluid are used at any one time. It may be wise to use an endotracheal tube with an inflatable cuff if the patient is comatose to guard against aspiration.

##### (4) Excretion of the Absorbed Poison

Prompt elimination of the toxic agent is paramount. In the body, the main routes of excretion are by the kidneys and liver; in the case of a volatile substance, excretion can take place by the lungs. Renal excretion can be maintained at a high rate by ample fluids; if the person is vomiting or comatose, by intravenous infusion. Diuretics may increase the renal output. Chelating agents, such as BAL or EDTA, tie up toxic metals, allowing excretion rather than deposition.

#### B. Detoxification of the Absorbed Poison

Despite lay opinion, there are only a handful of antidotes available which are specific neutralizers for specific poisons. However, there are many drugs which counteract the physiologic effect of poisons by producing an opposite effect. They must be used with utmost caution since they not only mask deleterious effects of toxic substances, but also in higher dosages produce a synergistic rather than an antagonistic action which can result in an immediate fatality. In other words, "be as radical as necessary and as conservative as possible".

#### C. Symptomatic Treatment

This follows the rules of emergency first aid with the support of the respiratory and cardiovascular systems, relief of pain, nausea, convulsions, and other complications. These rules are adequately reviewed in other journal articles and in medical texts.

##### Miscellaneous Measures of Treatment

Absolute rest is indicated in all cases of severe poisoning, especially in conditions causing hypoxemia or anoxemia, which may have damaged the cardiovascular or pulmonary systems.

Absolute quiet is the rule in overdosage of convulsants.

Good nutrition, especially in carbohydrates and proteins, with minimal fat, is of great importance.

Comatose patients must be guarded against urinary retention and formation of decubitus ulcers.

## LATE SEQUELAE OF POISONING

Pulmonary edema and pneumonia commonly follow exposure to pulmonary irritants, frequently after apparent recovery has taken place. Hepatic and renal complications may occur much later. Prolonged hypoxemia may result in nervous and mental disorders. Lye ingestion often results in esophageal stricture. Chlorine occasionally causes cardiac disorders. In some cases, poisons are deposited as inert substances in the body only to be released in an active form later due to stress, which may cause an exacerbation of the former toxic symptoms.

## PREVENTION VERSUS TREATMENT

Every physician is aware that poisoning is a common entity. He may be aware of its treatment, but only vaguely aware of the prevention of poisoning. Yet, through preventive education of the public and especially parents, the vast majority of childhood poisonings could be controlled. In the home, the physician could suggest that certain materials should be stored in safer locations, since he has an excellent opportunity to note these potential hazards. In the office, he could warn his patients about misuse of the drugs he

prescribes. Educational information concerning the dangers of drugs and household compounds, along with other common household dangers, could be available in the office waiting room.

Whether carelessness or ignorance are the causative factors in accidental poisoning is immaterial, for the effect is generally the same, with the result that greater emphasis must be directed at prevention.

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# Retention of Urine

HARRY HUDSON, '63

## INTRODUCTION

Retention of urine must be differentiated from other terms used in urology such as anuria, oliguria and incontinence. Anuria means absence of urine and although this state is rarely achieved, anuria is often used synonymously with oliguria which means a sharply reduced output of urine by the kidneys. Thus the etiology of anuria and, or, oliguria, must be some defect in kidney function, for example, in Acute Glomerulonephritis (Acute Bright's disease), or renal poisoning.

The term, incontinence, is a term applied to the inability to retain the evacuation of the bowels or the bladder. It is important to note that incontinence can be caused by a large retention in the bladder due to an increase in intraabdominal pressure coupled with only partial obstruction of the urethra.

The same set of circumstances can occur following an injury to the spinal cord.

## DEFINITION

The term, urine retention, is applied to cases in which urine is duly excreted by the kidneys, but for some reason is retained in the bladder.

## ETIOLOGY

In general, the urine may be retained either because the bladder is too weak to expel it or because of some obstruction to the passage by which it should be voided. The following is a classification of such conditions.

### 1. Congenital

- (a) congenital valvular obstruction in the posterior urethra of male.
- (b) pin point urethral meatus.

### 2. Acquired

- (a) traumatic
  1. Following surgery.
  2. Severe accidents.
- (b) inflammatory
  1. Prostatitis or Prostatic abscess.
  2. Acute or Chronic urethritis.

### 3. Neoplastic

1. Bladder
  - i) Benign papilloma.
  - ii) Malignant papillary carcinoma.
  - iii) Malignant non-papillary carcinoma.
2. Prostate
  - i) Benign prostatic hyper-

trophy.

ii) Carcinoma.

### 4. Miscellaneous

- i) Vesical and or urethral calculi
- ii) Neurogenic bladder dysfunction.
- iii) Blood clot from neoplasm or post-instrumentation.

## PATHOGENESIS

### 1. Congenital

Congenital valvular obstruction of the posterior urethra arises either from a persistent urogenital membrane or an exaggeration of the normal mucosal folds of the urethra.

### 2. Trauma

Following any operation near the bladder e.g., for hemorrhoids there may be difficulty in passing urine. In this case the difficulty commonly is due to muscle spasm or local inflammation and does not persist for more than a day or two. This is an example of an acute obstruction causing urinary retention.

Following serious accidents in which the spinal cord is severely damaged such as cord transection, there is a condition known as "spinal shock". Though transient in nature, this condition can last for many months and is important in relation to bladder function. Although the actual mechanics of "spinal shock" are unknown, the bladder is immediately affected as follows:

- (a) There is lack of tonicity of the bladder wall which leads to distention and over-filling.
- (b) Distention of the bladder normally causes a desire to void mediated through a reflex action. This stretch reflex consists of afferent fibres which are carried in the parasympathetic nerves to the sacral spinal cord, the impulses then being relayed to conscious centres in the cerebral cortex. In order to urinate, voluntary control is removed and contraction of the vesical muscle takes place via the parasympathetic nervous system. However, in "spinal shock" reflex contraction of the vesical muscle is absent. It is noticed here that complete recovery of bladder function depends upon the extent and level of injury. Other neurogenic disturbances, which cause urinary retention are syphilis of the C.N.S., sclerosis of spinal cord, congenital defects and inflammation of the spine.

### 3. Inflammation

When there is obstruction of the urethra as well as chronic cystitis, the bladder wall itself may be either thickened or atrophied.

The most important organism involved in the pathogenesis of acute and chronic urethritis is the gonococcus. The long term effects are much the same as those of chronic cystitis, that is fibrosis, scarring, and the formation of strictures which usually develop in the bulbous urethra. Extreme narrowing will produce the results of obstruction including marked urinary retention. A non-specific urethritis may have the same effects.

Inflammation of the prostate may be acute or chronic and in both cases the causative organism may be gonococcus or a non-specific organism. Acute gonococcal prostatitis forms part of an acute posterior urethritis being usually mild in type. However, prostatic abscesses may be formed and occasionally there is extensive suppuration.

It is the latter condition which can cause acute urinary retention.

Chronic prostatitis with foci of chronic inflammatory cells scattered throughout the gland, and varying degrees of fibrosis may occur. Thus, the prostate may be smaller or larger than normal depending on the degree of fibrosis. If the prostate is larger than normal, it is obvious that urethral obstruction can occur to varying degrees and thus chronic urinary retention can be set up.

### 4. Neoplasms

Bladder neoplasm may directly involve the vesical meatus and obstruct it. This produces a retention of urine proximal to the bladder with resultant hydronephrosis and hydronephrosis. It is noticed, however, that this is not urine retention according to the terms of the stated definition.

Neoplasms of the prostate, on the other hand, exert their effect by obstructing the prostatic urethra causing a progressively chronic retention of urine in the bladder.

Enlargement of the prostate is very common in men over the age of sixty, but according to Boyd only 8% cause obstructive symptoms.

Although the etiology of this benign hypertrophy is uncertain some authorities believe that it is due to male sex hormonal imbalance analogous to cystic hyperplasia occurring in post-menopausal women. In any event, a small percentage of these cases show benign prostatic hypertrophy to such an extent that obstructive symptoms appear in the form of chronic urinary retention. Moreover, the vesical sphincter mentioned above is rendered incompetent due to stretching by the middle lobe of the prostate.

Due to the close association of malignant carcinoma of the prostate with benign hypertrophy, invariably a small proportion of the former cases present with obstructing symptoms, such as bladder retention.



### 5. Miscellaneous

Perhaps the most important of the miscellaneous causes seen in the classification is the presence of calculi (stones) in the urinary tract. A urinary calculus is usually formed in the renal pelvis of the bladder causing symptoms in the kidney, ureter, or bladder. These calculi consist of:

- (a) uric acid and urates
- (b) calcium oxalate
- (c) calcium and ammonio-magnesium phosphate (triple phosphate)
- (d) mixtures of the above constituents.

A vesical calculus may form in the bladder as seen above or it may originate in the renal pelvis, pass into the bladder and grow to a great size. The effects of such calculi are:

- (a) Urinary retention due to obstruction of the urethral opening.
- (b) Infection.
- (c) Ulceration of the bladder mucosa as a result of direct pressure.

Cases of Psychogenic (Neurogenic) urinary retention have been reported. These cases presented with urinary retention, as a symptom of underlying severe emotional disease with no organic basis.

Very rarely the presence of retroperitoneal hematomas have been reported as causing urinary retention due to urinary obstruction. Such hematomas result from anticoagulant therapy following myocardial infarction. Trauma with perivesical bleeding may also cause sufficient pressure to result in retention.

Similar blockage results also, in rare instances, from the displacement of a neighboring organ such as the uterus in women.

### DIAGNOSIS AND SYMPTOMATOLOGY

In any discussion on the diagnosis and symptomatology of urinary retention it is necessary to differentiate those cases which present in the acute form from those which present in the chronic form.

#### I. Acute Form

The symptoms may be due to sudden

obstruction, for example, a calculus, or may occur as the end result of chronic retention.

#### History

1. Chronic inflammation
2. Severe accident
3. Recent surgery
4. Emotional disturbance
5. Spinal cord disease

#### Physical Examination

Inspection—with all the patient's clothing removed, the overdistended bladder may be seen to cause a definite rounded swelling in the suprapubic area.

On palpation of the distended bladder it is recognized as a smooth, rounded, firm, symmetrical protuberance extending upward above the pubic symphysis, not always directly in the midline.

The percussion note is dull and when enlargement is not sufficient to produce a palpable mass, it can sometimes be diagnosed by finding a circumscribed area of slight dullness above the symphysis. It is to be noted here that all these signs can be obscured by obesity or any other condition which causes lower abdominal distension.

#### Subjective Signs.

The patient feels an urge to urinate but cannot do so and regional pain is often severe.

#### Differential Diagnosis

1. Functional disturbance of the bladder reflex following surgery. (evident in history)
2. Disturbance of the bladder function presenting as a symptom of some underlying emotional disease.
3. Paralysis of the bladder mechanism following injury to the spinal cord or such acute disease as acute poliomyelitis.
4. Prostatic abscess or inflammation.
5. Vesical or urethral stone.
6. Rupture of bladder or urethra with extravasation of urine into surrounding structures.

## II. Chronic Form

### History

The history is usually one indicating partial urinary retention over many weeks or months. The patient will usually relate that the first thing he noticed was a diminution in force or size of the urinary stream. Later signs include frequent voluntary or involuntary urination. Nocturia is always an important finding. Pain is not common because the bladder, having time to stretch, develops greater capacity.

Previously diagnosed diseases to look for are:

1. Infection
2. Spinal cord disease

*Physical examination* reveals signs of acute retention without the symptom of severe pain. If chronic retention becomes complete, the picture changes to that of acute retention.

### Differential diagnosis

1. Benign hypertrophy or Neoplasms of the prostate
2. Urethral stricture
3. Vesical calculus
4. Chronic spinal cord disease such as tabes dorsalis

## TREATMENT

In any form of treatment the factors to be considered are:

1. Is the presenting symptom complex severe enough to be treated on its own merits?
2. What is the underlying cause which must be treated to prevent the return of the presenting primary symptom complex?
3. What are the potential future complications
  - (a) With treatment,
  - (b) Without treatment?

In the case under consideration here, the primary symptom complex referred to in the above remarks is that resulting

from urinary retention. It is obvious that immediate relief rests on some form of treatment which aims at decompressing the bladder. This is accomplished by catheterization of the urethra. The latter is also an important feature which can be utilized in the diagnosis of urinary retention i.e., the relief afforded by catheterization.

*Procedure*—There are several different types of catheters with which this procedure may be carried out. Sterile technique should be maintained throughout.

1. Soft rubber catheter either plain (Jacques) or Foley bag type.
2. Soft rubber catheter with catheter stylet.
3. Coudé catheter (one angle on the distal end).
4. Bicoudé catheter (two angles on the distal portion).

The type of catheter used and the exact procedure followed depend of course on the ease with which the catheter can be passed up the urethra, for example:

1. In the majority of cases urethral catheterization is usually very easy. A soft rubber catheter (either plain or Foley bag type) is passed gently up the urethra into the bladder. The urethral meatus is thoroughly cleansed and the catheter lubricated before the procedure.

2. In some cases especially those in which the underlying cause of urinary retention is prostatism or urethral stricture, it may be impossible to pass a soft rubber catheter. In this instance a curved catheter stylet may be used to increase the rigidity of the catheter. The catheter with the stylet is guided over the obstructing prostatic lobe. Filiforms and followers may be required.

3. If the above two manouvres are not successful a Coudé or Bicoudé catheter is passed.

4. To determine the presence and extent of a urethral stricture a bougie-a-boule is used. This instrument which is about 25

cms. long has an acorn shaped enlargement at one end and an olive shaped enlargement at the other. These enlargements are calibrated in size for Fr. No. 14 to Fr. No. 24 which enable the operator to chart the size, length and calibre of the stricture.

No form of treatment is free from potential complications and indwelling catheterization is no exception. Peri-urethral abscess may occur at the site of an inflammatory stricture or repair, the use of an indwelling urethral catheter for a prolonged period causing erosion of the urethra particularly if larger than No. 16 F. is used. This extremely dangerous complication must be treated radically with a diversion of the urinary stream by supra-pubic cystostomy.

This form of treatment does not, in most cases, suffice, and thus it is important to diagnose the underlying causes of urinary retention in the anticipation of treatment. A complete analysis of all the etiological factors and their treatment is beyond the scope of this article but certainly one of them deserve mention.

Since one of the most important factors in the production of urinary retention is the presence of obstruction due to urethral stricture (chronic inflammation), a definitive form of treatment is:

1. Dilatation of urethra with filiforms and followers (gum elastic dilators attached to a fine guide), Philips bougies, metal sounds (Lafortes) or by a Kollmann dilator.
2. Internal urethrotomy. A longitudinal incision of the stricture is made.

3. Surgical excision of the stricture.

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# Psychiatric Emergencies

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## INTRODUCTION

Psychiatric emergencies are similar to other medical emergencies. The urgency is due to three main factors; the potential toxicity of the underlying disease process, the danger of suicide, and the risk of injury to the patient or others during excessive psychomotor activity. Since the majority of patients are seen first by the family physician, it is essential that the practitioner must deal with the situation using independent medical judgment before having a psychiatric consultation.

## METHOD OF DIAGNOSIS

Psychiatric emergencies will require the physician to make a concise, but complete history, physical, and psychiatric examination, because the time factor indicates expediency in treatment. The differential diagnosis must be at the physician's fingertips; but the differentiation between organic and non-organic disease is more valuable towards treatment. In the patient's interest, the risk of obscuring the diagnosis by giving tranquilizers immediately, will be determined by the necessity of reducing excessive psychomotor excitement.

In some cases, the diagnosis may be made by listening to the quality of the symptoms, but the physician must be aware that neurotic and psychotic symptoms and behavior do not rule out organic disease. On the other hand, functional mental illness should not be diagnosed by exclusion. After careful examination of the case, it may be necessary to have a psychiatric consultation.

## HISTORY

The history should be taken from the patient and substantiated by the immediate family. If this is impossible, then a responsible relative must be contacted. The physician will lose his objectivity if he reacts to the patient or overempathizes with the family. The important aspect of the history is the patient's behavior because this is the reason the physician is called.

*The chief complaint* is usually the complaint of the family or the community, rather than of the patient.

*The history of the present illness* should be a concise statement of the nature, quality and duration of the symptoms, with special emphasis on the onset of these symptoms.

*The previous medical history* should be a summary of important physical and psychiatric illnesses.

*The personal history* is concerned with pertinent premorbid personality characteristics.

*The family history* should consist of a brief resumé of the illnesses of the immediate family to determine the influence of constitutional factors. This includes a history of mental illness, especially depression, schizophrenia, and suicidal tendencies in the family.

## PHYSICAL EXAMINATION

The routine physical examination should be supplemented by a neurological examination. Both of these will have to be modified to test the stuporous and unconscious patient.

## PSYCHIATRIC EXAMINATION

The appearance and clothing of the patient may be quite out of keeping with the person's station in life.

The behavior may vary from nervous fidgeting to posturing and aggressive acting out.

## —Psychiatric Emergencies—

The emotional state is directly reflected in the patient's mood and the appropriateness of his responses. The variation in the mood may be diurnal. There may be evidence of early morning awakening and autonomic imbalance which are due to a disturbance of the internal homeostasis of the emotional environment. These signs are pounding of the heart, increase in respiratory rate and other somatic symptoms.

Thought disorders may include pressure of speech, flight of ideas, blocking and mutism. Hallucinations, delusions and illusions may be present. The immediate preoccupation may be autistic or concerned with thoughts of unworthiness and guilt.

The orientation is one of the most important factors in differentiating organic and non-organic illness. Organic disease usually manifests itself with disorientation in one or all of the three spheres of person, place and time.

Memory should be elicited in two phases, the current and the remote memory.

The insight and judgment of the patient will be important in determining whether this patient will need to be hospitalized.

### EMERGENCY SITUATIONS

#### I. ACUTE BRAIN SYNDROMES

The acute brain syndrome, due to exogenous or endogenous causes, is a short but severe psychosis coming on abruptly and progressing to complete recovery or death within six weeks. This definition depends entirely on the reversibility of the brain lesion and accompanying symptoms. This does not mean that the untreated or prolonged delirium will not progress to a chronic brain syndrome.

#### History

The history will have to be taken from the immediate family or relatives. It will indicate a prodrome of non-specific symptoms of drowsiness, restless sleep and a general clouding of the sensorium. Due to sensory deprivation, these symptoms may

be more evident at night. In retrospect, the precipitating cause may be quite evident from the history.

#### Physical Examination

The neurological examination may elicit local signs, but, usually, these will be of a diffuse nature according to the underlying pathology. These signs and symptoms cover a large part of medicine and cannot be dealt with here.

#### Laboratory Tests

Spinal fluid, x-rays, and blood work may yield valuable information in confirming the diagnosis.

#### Psychiatric Examination

These cardinal symptoms are usually modified by the variability of the patient's clouding of consciousness.

- 1) *Disorientation* occurs in any of the three spheres of person, place and time. Time is usually the first to be absent, due to its abstract nature.
- 2) *Hallucinations*, usually of the visual type, will be bizarre and terrifying, but of a stereotyped nature—bugs, cockroaches, and other crawling insects.
- 3) *Delusions* are of a fleeting nature, non-systematized and lacking paranoid flavor.
- 4) *Illusions* will be proportional to the amount of external stimuli and are usually terrifying.
- 5) *The exaggeration of affect* will be characterized by fear and apprehension.
- 6) *Accessory symptoms* consist of terror, perplexity and excessive psychomotor activity.

#### DIFFERENTIAL DIAGNOSIS

Disorders due to or associated with:

- 1) intracranial or systemic infection.
- 2) drug or poison intoxication.
- 3) trauma.
- 4) circulatory disturbance.
- 5) convulsive disorders.

- 6) disturbance of metabolism, growth or nutrition.
- 7) intracranial neoplasms.
- 8) unknown causes.
- 9) unknown cause with a functional reaction alone manifest.

### Treatment

These patients can be best treated in a general hospital setting.

- 1) Treatment of the underlying cause.
- 2) Active treatment of the delirious symptoms.
  - i) Sedation with paraldehyde due to its large margin of safety. Dosage 10-15 c.c. p.r.n.
  - ii) Tranquilization with promazine, I.M. 25 mgms. q.i.d.

### CAUTION:

The potentiating effect of the tranquilizer on the initial sedation is very unpredictable.

- iii) Reduce environmental stimuli to reduce the illusions.
- iv) Correct dehydration and electrolyte imbalance if necessary. Large amounts of orange juice orally will correct hydration and prevent acidosis. I.V. fluids will have to be given to the unconscious patient.
- v) Protect the patient from inadvertently committing suicide while escaping delusional persecutors.
- vi) If possible, a member of the family should be allowed to stay with the patient in a dull room.

## II. SUICIDE

Suicide is a leading cause of psychiatric deaths. In a study by Stern of 167 successful suicides, 65 were associated with psychotic illness. The number of unsuccessful attempts far exceeds the successful ones. This should reduce the pessimistic attitude of the physician because this gives him time to prevent further attempts. The threat of suicide is a difficult problem to

evaluate quickly. Not even a manipulation threat may be taken lightly because the patient may take his life accidentally or to save face. Since the onus of responsibility lies with the physician, the reactions of the family against hospitalization should be negligible. Some of the questions the physician must ask himself concerning the threat are: Was the patient just thinking vaguely about taking his life, or has he made definite plans? How does the patient feel now about the situation? Does he show any insight into his problem? Does the future now look more promising? These factors must also be taken into account after an attempted suicide. In addition, these questions may determine the seriousness of the attempt. Did the patient use definite lethal means in the attempt? Were elaborate precautions taken to prevent detection? Was there any evidence that the patient was sure he would be successful—did he have his will made out recently? Is there any family history of suicide?

There is no shortcut to experience in dealing with these problems. A rule of thumb to follow would be to hospitalize those patients where doubt exists. Constant observation on a psychiatric ward may be a life-saving procedure.

### A. Acute Depression

The statement that every depression is a potential suicide becomes greatly intensified in the acute depression. This emphasizes the fact that it is more important to diagnose the depression itself, than to differentiate whether it is neurotic or psychotic, even though the risk of suicide increases in patients exhibiting psychotic symptoms. The depression, masked by somatic symptoms, may be difficult to diagnose, and, many times, these symptoms will be treated instead of the underlying depression. Often the qualities of the somatic complaints will indicate the underlying depression.

### History

- 1) Previous depressions of severe nature.
- 2) Family history of depressive illness.
- 3) Cyclothymic personality.
- 4) Somatic illness in recurring episodes.
- 5) Complaints of anorexia, insomnia, early morning awakening, headaches, chronic fatigue and nausea.

### Physical Examination

- 1) Physical findings of retardation of speech, thought and movement. This is the opposite in the agitated depression.
- 2) Poor hydration and nutrition with weight loss.
- 3) Typical sad or apprehensive facies.

### Psychiatric Examination

#### Important Criteria For Hospitalization

- 1) Suicidal preoccupation.
- 2) Severe hypochondriacal ideas.
- 3) Delusions of guilt, self-depreciation and self-accusation.
- 4) Feelings of futility about the future.
- 5) Intense concern about insomnia and early morning awakening.
- 6) Homicidal impulsives, especially in young mothers who feel that they and their children would be better off dead.
- 7) Agitation, with any of the above symptoms.
- 8) Family history of suicide.

### Differential Diagnosis

- 1) Neurotic depression.
- 2) Psychotic depression.
- 3) Manic-depressive, depressed.
- 4) Involutional depression.

### Treatment

The acute depression needs immediate hospitalization, preferably on a psychiatric ward.

### B. Other Causes of Suicide

*Alcoholics and senile dementias* make up a large number of the suicides in the older age groups. The former may try to take their life after a long drinking spree because they realize that they can not control their drinking, even after serious attempts to stop. The latter patient may see that his gradual deterioration is inevitable, and may attempt suicide to prevent this progression of events. The treatment in each of these cases is hospitalization in spite of the poor prognosis.

*Schizophrenics* are a very unpredictable group and usually are successful in their attempts at suicide because they are difficult to anticipate.

### III EXCESS PSYCHOMOTOR EXCITEMENT

These patients may be divided into two groups. The one group are those threatening to harm others, the others are dangerous to themselves. Many times, acting-out of patients is due to the reactions of those around them. When extremely excited patients are placed on psychiatric wards, they settle down very quickly because the trained staff accept their bizarre behavior and do not react to them. If the reality contact of the patient is still intact, the family physician may be the one person who can sit down and reason with the patient. In more malignant psychotic states, this approach will be impossible.

#### A. Manic Excitement

##### History

- 1) A previous history of elation or depression in the patient or members of the family.
- 2) A premorbid personality of endless energy which changes into continuous activity as the manic tendency increases.
- 3) The family may have noticed that the patient was becoming increasingly more intolerant, impatient, and difficult to appease in ordinary everyday situations.

### Physical Examination

- 1) Body injuries may be present.
- 2) Exhaustion syndrome with dehydration and electrolyte disturbances.

### Psychiatric Examination

#### Cardinal symptoms

- 1) Flight of ideas.
- 2) Increased psychomotor activity.
- 3) Emotional excitement.
- 4) The manic takes his springs of actions from his surroundings. An infectious mood is characteristic of the elated phase.

### B. Acute Schizophrenic Reaction

#### History

- 1) A family or personal history of schizophrenia.
- 2) A pre-psychotic personality of the schizoid type.
- 3) Signs of anxiety and apprehension early, with feelings of unreality progressing to withdrawal.
- 4) An onset between 15 and 30 years of age except in the paranoid types which usually onset later.

### Physical Examination

Physical findings are not consistent. The exhaustion syndrome and traumatic injuries may be present.

### Psychiatric Examination

- 1) Bizarre thought disorders with hallucinations and delusions which tend to be systematized.
- 2) Inappropriate affect, and irrelevant responses.
- 3) Deristic and autistic thinking.
- 4) The schizophrenic takes his springs of actions from his hallucinations and delusions. The excitement lacks an infectious element.

### Treatment of Manic and Schizophrenic Excitement

- 1) Some patients will respond to large doses of tranquilizers and may be treated at home.
- 2) Extremely assaultive patients will have to be certified and escorted to hospital by the police.

### C. The Epileptic Patient

These patients may attack others without provocation as they recover from a convulsion. The use of I.V. barbituates may quickly control these transient episodes. If the convulsions can not be controlled the patient will have to be hospitalized.

### D. Acute Alcoholic Hallucinosiis

These patients, unlike the alcoholic with delirium tremens, have no clouding of consciousness and may harm others in response to their delusions. These patients should be hospitalized.

### CONCLUSIONS

It is essential to differentiate between the organic and the non-organic illnesses in order to treat the underlying cause in the former case. If in doubt, in cases of depression, the patient should be hospitalized. Temporary, thirty-day commitment certificates should be used in all cases, if necessary, especially in psychomotor excitement. Each patient must be treated individually. The necessity of early treatment of this triad of emergencies is the first step towards maintaining a good prognosis.

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# Lumbar Puncture

WAYNE GRAINGER, '62

## INTRODUCTION

Lumbar puncture, the introduction of a needle into the subarachnoid space in the lumbar area, was first described in 1891 by Wynter in England, and Quincke in Germany. Since that time, it has come to play an increasingly important role in the neurological examination.

## INDICATIONS

The indications for lumbar puncture are many, and encompass much of the field of neurology. To say that lumbar puncture and subsequent examination of the cerebrospinal fluid should be carried out routinely, would be an overstatement of the case. However, in many cases, verification of diagnosis is dependent upon this procedure. It is for this reason that every student and practitioner should be acquainted with the technique, its complications, and the wealth of information which can be gained from it.

Lumbar puncture is often a most uncomfortable procedure for the patient, and is a potentially dangerous one. The major contraindication is elevated intracranial pressure, although there are, as usual, exceptions to this rule, the main one being benign intracranial hypertension, where C.S.F. removal is carried out therapeutically. If a lumbar puncture is carried out in the presence of papilledema, the cardinal sign of elevated intracranial pressure, sudden death may occur, due to herniation of the uncus through the incisura of the tentorium cerebelli, or to impaction of the medulla in the foramen magnum. This makes a thorough examination of the fundi mandatory before every lumbar puncture is performed, and cerebrospinal fluid removed.

## METHOD

The method of lumbar puncture is one of strict aseptic technique. For this reason, the physician must be scrubbed, masked, gloved, capped and gowned. The patient must be assured that the procedure will cause him only minimal discomfort, and

the doctor must see that this is so. The patient lies on his side on the bed or examining table, his knees drawn up to his chin so that his back is at the very edge of the bed and vertical. The skin over the lumbar area is prepared with a topical antiseptic solution and the patient draped. The doctor must then locate the interspinous space which corresponds to the level of the iliac crests. The level corresponds to the interspace between L<sub>3</sub> and L<sub>4</sub>, at which level, or lower, the puncture should be done. A skin wheal is raised at this point by injection of 1% or 2% novocaine, subcutaneously, after ruling out sensitivity of the patient to this agent. After a few moments, the needle is introduced directly into the interspinous ligament, injecting the local anesthetic as one proceeds, to anesthetize the needle track. One is then ready to introduce the lumbar puncture needle, which should be about 8 cms. in length, and less than 1.2 mms. in diameter, preferably a No. 21 or No. 22 gauge. The needle must contain a stylet which must not be removed while the needle is being introduced, or the needle lumen will be blocked by a tissue plug. The needle is introduced horizontally, in the mid-interspace, in the direction of the umbilicus, that is, slightly cephalad. It is most important to align the needle properly prior to its introduction, for a change of direction within the very dense interspinous ligament is almost impossible. The resistance of the interspinous ligament, the ligamentum flavum, and the dura will be encountered, the latter yielding with the sensation of a "snap" or "pop", at a depth of 5 to 6 cms. in the adult, and about 1.5 cms. in the newborn. The sensation of a snap is very diminished

or absent in infants and young children, and for this reason, one must rely heavily on an accurate estimation of depth to avoid piercing the posterior longitudinal ligament, or an intervertebral disc.

When the dura has been pierced, the stylet is withdrawn. If no fluid is obtained, the needle should be turned through 90°. It may be necessary to insert the needle a bit farther, always re-inserting the stylet before so doing. The cerebrospinal fluid will appear as a slow, steady drip, which is normally clear and colorless, and does not coagulate spontaneously. The C.S.F. pressure should be recorded by means of a manometer immediately, avoiding loss of any fluid, and while the manometer is in place, if a block in the spinal subarachnoid space is suspected, the Queckenstedt test may be done. This consists of compressing one or both jugular veins in the neck, and noting the rate and magnitude of the change in pressure as recorded by the manometer. This procedure may be extremely hazardous, and some clinicians tend to omit it and rely upon the results of myelography. In obstruction of the spinal canal, the rate and magnitude of change will be grossly diminished or even absent. In addition, the C.S.F. will be straw to brown colored (xanthochromia), and will often coagulate spontaneously.

About 5 c.c. of C.S.F. should be collected, (preferably discarding the first few drops) for chemical, microscopic and serological examination. No more than 10 c.c. should be taken away, or low-pressure headache, a complication of lumbar puncture, will occur. The more important determinations which can be performed on the C.S.F. for diagnostic assistance are:

1. Cell count
2. Test for blood
3. Quantitative protein determination
4. Quantitative glucose determination
5. Quantitative estimation of chlorides
6. Bacteriology—smear and culture
7. Virology

#### SPECIAL PROCEDURES

Lumbar puncture may also be performed for the introduction of a radio-opaque

material into the spinal subarachnoid space, to outline the canal and define any spatial abnormalities. This procedure is called myelography, and is an important radiological aid to diagnosis. Pneumoencephalography may also be carried out through lumbar puncture. This procedure is similar, only air is introduced instead of dye. The air will rise through the spinal subarachnoid space, provided that it is patent, into the cerebral ventricles and over the surface of the hemispheres to outline these chambers on a skull X-ray. Antibiotics may be instilled directly into the C.S.F. through a lumbar puncture although this is less frequently employed today than formerly.

#### COMPLICATION

The common complication of lumbar puncture is "low-pressure headache" due to "after-leakage" of C.S.F. from the puncture site. The management of this complication consists primarily of prevention, although treatment must be employed when it occurs. The prevention consists of: administering Sodium Amytal, gr. iii, one-half hour before proceeding with the puncture; using a small-bore needle; avoiding the drawing off of an excess of C.S.F.; keeping trauma to a minimum; and keeping the patient flat in bed, on the chest for an hour or two, then flat on the back without a pillow, for 18 to 24 hours. If headache occurs when the patient becomes ambulatory, he should be returned to bed with adequate sedation and analgesia.

#### SUMMARY

Lumbar puncture is a relatively simple procedure which yields valuable information in many cases. It may also be used in radiological diagnosis, and for therapeutic procedures. It is not without its complications and discomfort, and should be approached with some reserve.

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# Student Research

## OBSERVATIONS OF DIABETIC PREGNANCIES

A study of all those diabetic pregnancies at Victoria Hospital, London, since 1940, produced a population of 109 pregnancies of which 94 were diabetic and 15 were prediabetic.

The section rate was found to be 63.83% with a F.M.R.<sup>1</sup> of 20% and a vaginal delivery rate of 36.17% with a F.M.R. of 32.35%. The overall F.M.R. was 24.4% (11.7% SB and 12.77% NND).

Observations on fetal birth weight revealed an excess over the normal pregnancy for all periods of gestation. When the diabetics were classified by Priscilla White's Classification for severity of diabetes,<sup>2</sup> the weight excess over the normal population was found to be less marked for the more severe diabetics. A similar effect was seen to relate to the maximum insulin dose<sup>3</sup> which as it increased was related to a less pronounced fetal weight excess. Efforts to relate maximum insulin dose to P.W. Classification were non-contributory.

Factors which might influence the F.M.R. were observed. Pre-delivery acetonuria was found to have no greater relation to F.M.R. than it had in the overall population. Advancing gestation was associated with an increase in F.M.R. past 37 weeks for classes D, E, F; the relationship was ambiguous for Class C; for Class B the prognosis became more favorable toward term. The F.M.R. rose consistently with each successive P.W. class independent of maximum insulin dose and gestation thus indicating the value of this classification in obstetrics.

This survey was intended only to suggest possible avenues of investigation into the problem of diabetes mellitus in pregnancy. None of the figures derived bear

statistical significance; however, several interesting trends were found to exist.

<sup>1</sup>F.M.R.: Fetal mortality rate =  $\frac{(SB+NND)^{100}}{(\text{No. of births})}$

<sup>2</sup>P. White Classification:

Class A—Glucose tolerance test diagnosis only

Class B—Onset more than 20 years of age

Class C—Onset 10-20 years  
Duration more than 10 years

Class D—Onset less than 10 years of age  
Duration more than 20 years

Class E—Pelvic vasculature calcification

Class F—Diabetic nephrosis or Retinopathy

<sup>3</sup>Maximum insulin dose: The maximum amount of insulin given over any 24 hour period of 7:00 a.m. one day to 7:00 a.m. of the next.

Kenneth Brown, '62

Department of Obstetrics  
and Gynecology

Summer, 1961.

## METABOLITES OF NICOTINIC ACID AND NICOTINAMIDE IN MOUSE URINE

In the study of the metabolism of nicotinamide adenine dinucleotide (DPN) in mice bearing Ehrlich's ascites tumor, the animals received intraperitoneal injections of nicotinic-acid-7-C<sup>14</sup>. As part of this experiment, the incorporation of the isotopes into various urinary products was studied.

Three experiments were carried out. 1.8 mg. of nicotinic-acid-7-C<sup>14</sup> containing 5.2 uc. of activity was injected into tumor-bearing mice and the urine collected for three hours. In the second and third experiments, mice were injected with 18 mg. of nicotinamide-7-C<sup>14</sup> containing 5.3 uc. of activity, and the urine collected for three, and six hours respectively. The urine samples were taken to dryness, extracted from methanol, and the extract applied in a

streak to filter paper. Initial separation of radioactive materials in the urine was obtained by descending paper chromatography in an ammonia-saturated-butanol solvent. Standard solutions of nicotinic acid and nicotinamide, and other derivatives normally present in mammalian urine, N-methyl-nicotinamide, trigonelline, nicotinic acid, N-methyl-2-pyridone-5-carboxamide were spotted at the origin of each chromatogram, and served as markers for the identification of the urinary constituents. The bands were located by absorption of ultra-violet light; tertiary nicotinoyl compounds were identified by the orange compound formed by exposure to cyanogen bromide, and spraying with 2% p-aminobenzoic acid. N-methyl-nicotinamide was identified by a bluish-white fluorescence produced by ultraviolet light after exposure of the paper chromatogram to methylethylketone: ammonia. The radioactive bands were located by exposure of the chromatogram to X-ray film for ten days. The bands were cut from the paper, and the substance eluted off with water.

Radioactivity of eluates was measured in a liquid scintillation counter. The ultraviolet absorption spectrum of each component was obtained with a recording spectrophotometer. The concentration of the component in  $\mu$  moles/ml. was estimated from the molar extinction value. The assay for nicotinic acid, nicotinamide, and nicotinic acid was carried out by the cyanogen bromide method, in which the concentration of the dissolved component is estimated from the optical density. The chemical estimation of N-methyl-nicotinamide was based on the amount of fluorescence obtained in acetone, as measured in a fluorometer.

The concentration and radioactivity of nicotinic acid, nicotinic acid, nicotin-

amide, N-methyl-nicotinamide, N-methyl-2-pyridone-5-carboxamide were measured in all three samples. The identity of several other radioactive compounds was not established, but the spectral curve of one unknown suggested that it might be nicotinamide-N-oxide.

Dora Ann Stinson, '63  
Department of Biochemistry  
Summer of 1961  
Lederle Summer Research  
Fellowship.

#### METABOLIC PRODUCTS IN A YEAST

This summer, research was carried on in investigating the yeast *Lipomyces lipotera*, an organism that has the peculiar property of storing, under adverse conditions, approximately 60% of its dry weight as fat. Because of this property, its metabolic pathways are being investigated.

Research was confined to analysing substances found in the growth media after cultivating the organism for several days. These substances could be either products of disintegrated cells or excreted cell metabolites. They form the foundation for investigation of anabolic and catabolic pathways utilized by the yeast.

The techniques of analysis consist of paper chromatography for identification of amino acids, and ion exchange chromatography for identification of keto acids.

Gerald Fulton, '63  
Department of Biochemistry  
Summer of 1961

# News and Views

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On October 11th, 1961, the twenty-first Dr. F. R. Eccles Memorial Medical Alumni Lectureship was held in the Medical School Auditorium. A large audience of practitioners and medical students was in attendance.

Professor Harold G. Wolff of Cornell University, famed for his work on "Headaches" was guest lecturer.

The day's proceedings were divided into two sessions, that in the morning taking the form of a Medical Clinic concerned with "Problems of Pain in the Face and Head". Professor F. S. Brien of the U.W.O. Medical School chaired this session.

At the afternoon session, Dr. C. Lockwood spoke on "Diuretic Therapy", Dr. W. Keil on "Psychiatric Disease Masquerading as Organic Illness" and Dr. B. Goldberg on "Counselling the Family with a Severe Handicap in the Child".

Professor H. G. Wolff then delivered a talk on "Headache Mechanisms".

Professor G. E. Hobbs was the chairman at this session.

At the morning clinic cases presented were those of patients affected with:

1. vascular headache of the migraine type
2. ophthalmoplegic migraine
3. stilbamidine trigeminal neuropathy
4. post traumatic headache
5. tic doreux.

In the interim discussion, Dr. Wolff stated that headache was one of the most common complaints, due largely to vascular disturbances and only in 3% of cases due to tumors and other abnormalities.

Particular reference was made to vascular headaches of the migraine type which are very rarely seen in the classic form, i.e., unilateral with visual disturbances and vomiting. A particular feature of vascular headaches is their occurrence during the let-down period after sustained duress.

Methods of investigating vascular headaches were mentioned and special note was made of the fact that arteriograms were especially hazardous and could result in thrombosis and irreversible attacks.

In the prevention and treatment of migraine, the use of Ergotamine tartrate was stipulated, though nausea or vomiting might occur.

At the afternoon session, Dr. Wolff discussed Headache Mechanisms at length. These he classified under the headings:

1. vascular headaches of the migraine type
2. muscle contraction headaches (tension, nervous, psychogenic)
3. "mixed" headaches (combination of the above categories)
4. headaches and nasal discomfort (vasomotor rhinitis)
5. delusional or conversion reaction headaches (also called psychogenic).

Other lectures of the day were no less interesting. Dr. Lockwood covered the mechanisms involved in diuretic therapy, particular reference being made to electrolyte balance. Mercurials, sulphonamide derivatives, Aldosterone inhibitors, their indications, contraindications and uses were discussed. Other diuretics mentioned were: digitalis, Xanthines, Corticosteroids (e.g. Prederisone), Acid salt (Ammonium chloride), and Osmotic diuretics (Mannitol).

On "Psychiatric Disease Masquerading as Organic Illness", Dr. Keil emphasized the fact that a mind-body split existed only among observers, not the observed. Therefore, many of the organic illnesses were manifestations of attempts by the body to protect itself primarily against anxiety.

Striking examples, were given, and the speaker demonstrated the necessity of relying heavily on clinical examination.

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## Historical

Dr. Walter Bapty, Meds '06 reminisces on some of the early teachers and procedures around the Medical School.

### SOME NOTES ON DR. WAUGH

Do you remember Nellie? Nellie was the stocky bay mare that drew Dr. Waugh to the Medical School, with sleigh bells in the winter and a conservative buggy top when there was no snow. And if Nellie had been able to speak she would have told you that she had to get Dr. Waugh to the School sharp on the dot, two minutes before eight.

She was tied in the old driving shed behind the church, and in cold weather, the kindly doctor placed a blanket over her back. Because he was a kindly man, my purpose is to tell about Dr. Waugh, not his faithful mare.

Dr. Waugh, a horse-and-buggy doctor, was a man of few words. He looked the part of a family doctor. Erect and slim, you would not call him handsome but he was good-looking. His face side whiskers might have been copied from the old portraits of Lord Joseph Lister and the same with his clothes, clean but old-fashioned, and his white starched collar had a wide gap in front for freedom of his Adam's Apple. His lecture commenced sharp at

eight and if, conversationally, Dr. Waugh was a man of few words he was never at a loss for words in his lectures. He knew and recited without notes Rose and Carless from cover to cover. Dr. Waugh was the Professor of Surgery and took his duties seriously. Professor of *Clinical Surgery* was something quite different. Did Dr. Waugh operate in a proper operating room? I do not know. I never saw him perform an operation. As a General Practitioner he would treat fractures and ordinary trauma but—at that period—a Professor of Surgery taught in the lecture room, not in the Surgical Ward or Operating Room. We all liked and respected Dr. Waugh, and, since he kept us busy listening and taking notes, the problem of discipline presented no difficulty.

To his patients, he was beloved. It was not unusual for him to drive far into the country to make his daily visits on a house full of Typhoid Fever. I know one adult who proudly answers to the Christian name of Waugh.

God rest his soul. He left with his students a high sense of their responsibilities to humanity.

Walter Bapty, M.D., '06  
August, 1961, Oshawa.

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### *News and Views Continued*

In Dr. Goldberg's lecture on "Counseling the Family with a Severe Handicap in the Child" the four major types of families involved were classified as:

1. the reacting family
2. the family with prior marital conflict
3. the family with interval conflicts (neurotic or psychotic)
4. the outcast family.

Further to this he elaborated on:

1. normal defences—shock, repression, denial, searching, guilt, projection, clinging, adaptation.
2. pathological defences — projection, shame, guilt, magical thinking, rejection.

An interesting question period followed each phase of the day's proceedings.

S. Blizzard, '63

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## Book Review

**Surgery:** edited by G. L. Nardi, M.D. and G. D. Zuidema, M.D., 1034 pages, Little, Brown and Company, 1961, \$8.50.

This excellent, soft-covered volume presents clinical surgery most concisely and clearly. The chapters included in the book on special facets of surgical practice, such as: Pediatric Surgery, Cardiac Surgery, Eye, Ear, Nose and Throat are excellently written, and are valuable supplements to a knowledge of general surgery. The author presents them briefly enough to attract the interest of student and surgeon alike.

The book most appropriately begins with a dissertation on the "Psychological Aspects of Surgical Practice", a most valuable information source which is frequently omitted from other surgical texts. The "Legal Aspects of Surgical Practice", "Wound Healing", and "Electrolyte, Acid-

Base, and Fluid Balance", are other general chapters which are included in the text, making it almost all-encompassing in its scope.

The lettering is very clear and easily read, and the style of writing is most brief, yet not to the point of being staccato and difficult to follow.

The underlined, almost note-book arrangement makes this book especially suitable for a student text, as well as a ready-reference for the practitioner. Large, clear, simple line diagrams are used frequently to good advantage; however, there are no photographs. The authors have successfully incorporated a voluminous amount of material into a relatively small and inexpensive volume, and have succeeded in producing an excellent basic surgery text. Wayne Grainger, '62

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## Abstracts

### INCIDENCE OF BACTERIURIA WITH INDWELLING CATHETER IN NORMAL BLADDER

Cox, E. and Hinman, F., J.A.M.A. 178: 919, 1961.

It is currently assumed that infection always exists with retention catheterization. Some reports indicate the development of cystitis and urethritis within 3 to 4 days in 95% of patients with indwelling catheters. The present investigators felt that most studies of this nature have been done on people with abnormal bladders and that this might not be so with normal bladders.

A series was designed to test the response of the normal and the abnormal bladder to an indwelling catheter and also to determine if a bladder, infected as a result of an inlying catheter, could spontaneously rid itself of the bacteria after removal of the catheter.

An indwelling catheter was placed in 80 urologically normal patients. Of 30 patients with catheter drainage for 18 to 24 hours, only 2 developed bacteriuria (i.e. 500 or more bacteria per ml. of urine). Of 30 patients with catheter drainage for 36 hours, 6 became infected. Of 20 patients with catheter drainage for 36 to 72 hours, 9 developed bacteriuria. Hence in the entire series of 80 patients, 17 developed an infection as a result of the retention catheter. Antibiotics and urinary antiseptics were not used. Urine cultures were all **negative** by 4 months at the most.

From this study the authors deduced that the normal bladder could clear itself of infection, and that the incidence of bacteriuria with retention catheterization was dependent upon the bladder condition at catheterization time.

Robert Moffat, '62

## ARREST OF PREMATURE LABOR

Bishop, E. H. and Wooters, T.B., J.A. M.A. 178: 212, 1961.

Premature labor occurs in about 10% of all pregnancies and is the most frequent complication during the last half of pregnancy. It is also well known that premature labor poses a great threat to the welfare of the fetus.

In this study, the authors attempted to demonstrate the effect of a myometrial relaxant, inoxsuprine hydrochloride on the human uterus in premature labor. The study consisted of 156 patients in premature labor. Before treatment, several criteria had to be fulfilled:

1. Pregnancy between 20 and 36 weeks.
2. Evidence of premature labor such as dilatation of the cervix, bloody show, or abnormal uterine contractions.
3. Cervix less than 4 cm. dilated.
4. Intact membranes.
5. Absence of any complications contra-indicating the continuation of pregnancy.

When the drug was administered, it was found to have no effect on labor in 25% of all cases. In 11.5% of cases labor was interrupted for only a short period of time. In a third group labor was delayed for one week or longer in 21.2% of patients but the fetus at delivery weighed less than 2500 grams. Finally in 42.3% of patients, labor ceased after inoxsuprine administration and did not recur until the infant reached a birth weight of at least 2500 grams. Results were even better in a more selected group.

In 66% of patients, it was found that premature uterine contractions ceased for a significant period of time with inoxsuprine therapy.

Robert Moffat, '62

## TRACHEOTOMY—

### ITS COMPLICATIONS AND THEIR MANAGEMENT

Meade, J. W., *New Eng. J. Med.* 265:519, 1961.

It has often been said that tracheotomy, one of the oldest operations in surgery, is one of the most frequently done improperly, and most often mismanaged in the after-care.

The author once again brings this to our attention by presenting a series of 212 tracheotomies and their complications. The complication rate was 33% and the mortality 2.8%.

The complications were discussed under operative and post-operative headings. Operative complications consisted of emphysema (subcutaneous and mediastinal), pneumothorax and low incisions. Post-operative complications were much more numerous. Pneumonia was noted in 11 cases and resulted in 2 deaths. In 6 patients atelectasis secondary to obstruction from mucous plugs developed. Other post-operative complications were endotracheitis, cannula difficulties, hemorrhage, sepsis, and carbon dioxide retention.

It was also mentioned that meticulous post-operative care was most essential. If the tracheal air was not kept well humidified and the inner cannula frequently cleaned, then obstruction by mucous plugs and viscid secretions was bound to occur.

It was felt that most complications were preventable and could be avoided by careful operative technic and good post-operative management.

Robert Moffat, '62



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# Editorial

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For hundreds of years, the sole responsibility of the physician or surgeon was to attempt to cure disease in his patients, once the pathology was manifest. Gradually, over the years, a new concept of medicine has been developing; a concept which shifts some of the responsibility of the doctor from the cure of disease to its prevention. The ease with which he could prevent disease, compared to the difficulty which he had in effecting a cure has added to the ever-growing popularity of this concept. At first, a very few enlightened physicians accepted the task. In the past hundred years, the number of doctors involved in preventive medicine has steadily grown, to such an extent that today, every medical practitioner plays a vital part in the prevention of disease. He does this singly, using measures such as immunizing his own patients, and encouraging pre-natal check-ups; he does this collectively through his medical associations, which have significantly influenced legislation on matters of health at local, national and international levels.

These days, when a new disease appears on the horizon, teams of medical investigators work on the development of a new vaccine, which we can then use to protect our patients. Using the concept of preventive medicine, we don't wait until a full blown epidemic has erupted before we start these preventive measures.

As we read this symposium, we discover that the immediate effects, and many of the long term effects of a nuclear attack will be mostly medical in nature. Many suggestions are made for increasing our chances of survival, and those of our patients. However, these are mostly non-specific and supportive in nature. We have no effective therapeutic agent with which to treat a patient exposed to a sub-lethal or lethal dose of ionizing radiation, and, of course, we will have no chance to use even these supportive measures in the core area of an attack.

Doctors should regard this threat as the medical problem that it is, and not relegate its solution to far away politicians or nuclear physicists. WE must ourselves accept the responsibility for disseminating all the present knowledge on the effects of an atomic attack, in the hope that this knowledge will act as a major deterrent to atomic warfare.

We can use the media of the office visit, or the influence of our national medical organizations to pass on this knowledge to every citizen, making quite clear the consequences of atomic attack and our limited therapeutic means of coping with its medical effects.

If each of us does this he will be fulfilling part of his responsibility as a medical practitioner—that part that is included in preventive medicine.

# The Nature of Nuclear Explosions

JOSEPH VADAS, '63

## INTRODUCTION

The world became dramatically aware of the energy contained in the atomic nucleus by the explosions over Hiroshima and Nagasaki in early August, 1945. Since that time, we now live in the age of atomic power. On one hand, in this atomic age, nuclear energy has been used for many useful purposes, already providing many thousands of kilowatts of electrical power; some day, it may propel airplanes and robots. On the other hand, the possibility of nuclear war, with its tremendous potential destruction has hung over our heads for a half a generation and, yet, very few people know what the nature of the nuclear energy is or what the possible effects of a nuclear explosion are.

## NUCLEAR EXPLOSIONS

The nuclear bomb is a new weapon of great destructive power. It resembles bombs of the more conventional type in so far as its explosive effect is the result of the very rapid liberation of a large quantity of energy in a relatively small space. But, it differs from the other bombs in four important aspects:

(1) *Mechanical effects* of a nuclear explosion are much more serious and intense. The amount of energy released by a nuclear bomb is thousands or million times as great as that produced by the most powerful TNT (trinitrotoluene) bombs.

(2) *Thermal effects* are much more intense and are characterized by a large amount of heat and light.

(3) *Ionizing effect.* The amount of energy released by a nuclear blast is accompanied by highly-penetrating, deleterious, invisible rays which cause acute or chronic effects on the living tissues depending on the dose and duration of the exposure.

(4) *The after-radiation.* The substances which remain after the explosion are radioactive, emitting radiations capable of producing harmful consequences in living organisms.

It is on account of these differences that the effects of the nuclear bomb require special consideration.

## TYPES OF RADIATION

Radioactivity is the term used to describe the spontaneous transmutation of certain atoms into other forms, with the emission of radiations. These radiations are mainly of four types:

a) *Alpha radiation*, consisting of particles of high energy but with a power of penetration of less than one-tenth of a millimetre in human tissues and, therefore, irradiating cells only in the immediate vicinity of the source of radiation;

b) *Beta radiation*, consisting of electrons of various energies and powers of penetration, the rays travelling distances up to a few millimetres in human soft tissues before they are fully absorbed;

c) *Gamma rays and X-rays*, which are electromagnetic radiations, again of varying energy and commonly of high penetration and, therefore, capable of irradiating the whole human body fairly uniformly;

d) *Neutrons*, consisting of uncharged particles with a wide range of energy and penetrating power.

## NUCLEAR FISSION AND THE ATOMIC BOMB

An atomic explosion differs from one of the conventional type in the respect that the reaction taking place is not merely the rearrangement of the atoms among

themselves, but, rather, the redistribution of the extremely small particles among the nuclei of the atoms. All atoms consist of positively charged nuclei surrounded (at a relatively large distance) by negatively charged electrons. The number of electrons is equal to the number of positive charges on the nucleus, so that the whole atom is electrically neutral. All atomic nuclei contain a definite number of *protons*, each of which carries a unit positive charge, and of *neutrons*, which are electrically neutral particles. The number of protons in the nucleus of a particular atom is exactly equal to the number of electrons which orbits about the nucleus. We know that the simplest atom of all the elements, hydrogen, is made up of a nucleus containing a single proton with one electron outside it. One of the most complex of all the atoms is uranium which has 92 protons in its nucleus and 92 orbital electrons. It is this number of protons or electrons that characterizes the particular element, be it helium, sodium, iron or mercury. The number of neutrons in the nucleus does not affect the chemical characteristics of the atom, but merely adds weight to the nucleus. For example, ordinary hydrogen as we have seen, has only one proton, but heavy hydrogen (deuterium) has one proton and one neutron and the third isotope of hydrogen, tritium, has one proton and two neutrons in its nucleus. Similarly, at the other end of the scale, there are a number of isotopes of uranium. The most common of these, uranium-238, has a nuclear content of 92 protons and 146 neutrons (making 238 particles in all), while the type of uranium atom that is used in atomic bombs (uranium-235) has 92 protons and 143 neutrons in its nucleus.

If the uranium-235 nucleus is bombarded by a neutron bullet under the right circumstances, it *splits*, (or *fissions*) into approximately equal parts. A few extra neutrons are broken off as well. The parts, depending upon how many protons and neutrons they contain, are then nuclei of much lighter elements. These are the *fission products*. The extra neutrons arising from the fission can

then go on to produce fission in neighboring uranium-235 atoms. It is easy to imagine how, in an agglomeration of billions upon billions of atoms, this chain reaction can go on until all of the atoms have fissioned. Each individual fission is accompanied by an energy release in the form of very penetrating gamma radiation, and the chain reaction of the entire mass of atoms results in the emission of a tremendous amount of energy in the form of heat radiation. The energy emitted per pound of material in such a physical reaction as this is of the order of thousands of times greater than that emitted from a straight chemical reaction. Thus, in the simple fission of an atomic bomb, the process results in a tremendous energy release in a very small space over a very short period of time. This results in a huge explosion, with all the characteristics of a very powerful chemical explosion, but with the additional feature of the emission of penetrating gamma rays and high speed neutrons. The amount of energy released is usually compared to the energy release of conventional TNT. Thus, we speak of a 20 kiloton detonation, by which we mean that the energy release is equivalent to that from 20 thousand tons of TNT being detonated instantaneously. After an atomic explosion, there is an additional hazard, the radioactive fallout, added to the destructive power of the bomb.

### THERMONUCLEAR BOMB

It was mentioned previously that the atomic bomb results from the splitting of very heavy atoms. The hydrogen, or thermonuclear weapon, derives its energy release from quite the opposite effect. Here, we find that if we take very light atoms (for example, one atom of heavy hydrogen or deuterium and one atom of superheavy hydrogen or tritium) and under the right circumstances try to weld them together into a much heavier atom, we find that this *fusion* process is again accompanied by a tremendous energy release. This cannot be accomplished unless the original atoms

are at temperatures of millions of degrees. The only way we know at present of producing such temperatures is at the instant of a fission detonation. So, if we take an ordinary atomic bomb, surround it by deuterium and tritium in one form or another, and then detonate the atomic trigger, we then have a hydrogen or thermonuclear bomb. The term, *thermonuclear*, comes from this high thermal requirement for the fusion reaction. This also explains why it was not possible to produce the hydrogen bomb until atomic bombs had been developed.

The fusion of these isotopes of hydrogen does not produce any dangerous byproducts analogous to the fission products of a fission reaction. However, the neutrons given out at the instant of either type of detonation can render any material that they strike radioactive, and so the air in the immediate vicinity becomes radioactive, as does the material that may be sucked up from the ground if the fire ball of the explosion touches it.

#### DISTRIBUTION OF DEBRIS FROM NUCLEAR EXPLOSIONS

The distribution of the radioactive fission products which are produced in a nuclear explosion depends upon the size of the explosion, and on the position and conditions of the actual burst. If the nuclear explosions occur close to the surface of the land or sea, most of the highly radioactive fission products are deposited in rather coarse particles in a zone extending downwind from the site of the explosion. If the explosion is in the kiloton range or larger, the debris is very largely confined to the lower atmosphere (or troposphere) and about fifty percent of it is removed, chiefly by rainfall, in a period of about three or four weeks, although some of the particles may circle the earth one or more times before being deposited. If we consider explosions approaching or exceeding megaton size, a considerable fraction of the radioactive debris is carried into the upper atmosphere (or stratos-

phere) where rainfall processes do not occur, and where the rate of vertical diffusion is much slower than in the troposphere. This is particularly true with explosions occurring well above the surface of the earth, the mean residence time of debris in the stratosphere in these circumstances being measured in months or even in several years. Consequently, a large proportion of the original radioactive atoms decay before reaching the earth.

#### SUMMARY

Within a very close range of the nuclear explosions, ionizing radiations are but one element in the destructive effect. Blast and heat would be of major and probably of more immediate importance in producing casualties but survivors, unless very heavily sheltered, would have been exposed to such an intensity of radiation that they would be at risk of developing each and all of the effects that will be described in the following articles of this issue. Explosions of nuclear weapons always give rise to radioactive fission products, the heavier particles of which settle in the immediate vicinity of the explosion. With a ground burst of a thermonuclear bomb, the area of intense fallout may cover hundreds of square miles. Within this area, those who were not in shelter, and did not remain under cover until the radioactivity of the fallout had decayed substantially, would be exposed to doses of radiation sufficient to produce acute and chronic effects on the individual. Outside this area, there would be another zone, measured in thousands of square miles, where significant intensities of radiation would occur. The individuals exposed in this area would be at risk of serious consequences (chronic and genetic effects).

The importance of the effects of nuclear warfare which would be relayed through contamination of the atmosphere to many parts of the world remote from the actual conflict would depend upon many factors

*Continued on Page 95*

# The Genetic Effects Of Radiation

ANNE FANNING, '63

## INTRODUCTION

Radiation is a topic of interest by popular demand. The problems of the Atomic Age affect every man, woman and child—in fact, every living thing in our country and, of course, in the entire world. As governments urge the building of fallout shelters, questions are raised as to the significance of radiation therapy in the treatment of disease and the use of radiation as a diagnostic tool. It is the responsibility of the geneticist and the radiologist to future generations, to consider this problem. As investigations proceed, a philosophy of radiation and genetics is evolving. It centres about the search for a balance between the good results achieved and the risk assumed by future generations in order to achieve such results.

## BASICS

At cell division, the giant chromosomes with their band-like thickenings have been studied in the salivary gland cells of insects, (order; Diptera). Each undergoes reproduction by duplication and division. Once in a million, a gene may undergo a chemical change, or the new gene is not exactly like the old, or the genetic order is changed.

Ionizing radiation, on its passage through matter, produces charged particles or ions, and, in dividing cells, each ionization which hits a target gene causes a mutation. Mutations may be of two types, chromosomal and genetic. This paper will be concerned only with genetic mutations.

Genetic mutations are inherited and become perpetuated. Severe abnormalities result in death and are known as lethal mutations. But, mutations may affect such characteristics as size and shape, or physiological functions such as metabolism, fertility, or efficiency of the sense organs. The effects may be drastic or slight.

The expression of the genetic mutation depends on the mutant allele (i.e. the partner gene). If it is a dominant gene, it will be expressed in the immediate progeny. However, if the gene is recessive, it can only be expressed if it chances to occur in a cell which already carries a mutant partner gene. The mutant gene may be

masked for many generations by a normal partner gene. Such individuals act as carriers. Mutant genes, whether spontaneous or radiation-induced, are just as stable as the original genes. Therefore, there is ordinarily no repair.

## INVESTIGATIONS

Early studies of the genetic effects of radiation were carried out with *Drosophila*, species *melanogaster*, a fruit fly which was manipulated and bore noticeable effects. H. J. Muller received the Nobel Prize in 1946 for his original work on the genetic effects of radiation. His work of 1927 proved simply that mutations occur more frequently in the progeny of flies irradiated with X-rays than in flies not subjected to such treatment.

Muller's "CIB" method for detecting sex-linked lethal mutants was ingenious in its simplicity. "C" stands for a long inversion of the X chromosome which protects it from cross-over; "I", for a known recessive lethal on the inverted X; "B" for bar-eye, a marker of this chromosome. Male *Drosophila* were X-rayed, then mated with "CIB" females. Their progeny of bar-eyed females were then mated with normal males. In this second generation, if there were males, Muller concluded that no lethals were introduced. If males were absent, then he concluded that a lethal was

present in the treated X. Time has shown flaws in Muller's "CIB" method, but his results were nonetheless very significant. Muller's specific results were as follows: 1,177 chromosomes treated with a massive dose of X-rays yielded 143 lethal mutants; 741 chromosomes treated with a dose only  $\frac{1}{4}$  as large yielded 59 mutants and, in the control, in which flies were not exposed to X-rays, 6,016 chromosomes yielded 5 lethals.

In 1956, the National Academy of Sciences of the United States, published the first of a series of reports on the Biological Effects of Atomic Radiation. These filled the genuine need of providing the latest technical information about the effect of high-energy radiation and of pointing out the need for further study in specific fields.

In 1958, an American Mid-Western Conference was held on Genetics, Radiobiology, and Radiology proceedings. From their report, certain main points of agreement can be stated rather concisely:

1) Radiations cause mutations. (Muller, 1927) It would be unwarranted to examine the progeny of irradiated people such as those of Hiroshima and Nagasaki, and conclude that, because few mutations have appeared in first or second generations, little or no damage has been done. It may be a thousand years before two heterozygous mutants mate.

2) There appears to be no threshold level or minimum amount of radiation which must be exceeded before any mutations can occur. This fact is still open to question. However, there is no proven level below which damage is not induced.

3) In all species, there occur spontaneous mutations at a rate constant for that species. Environmental changes affect this rate, for example, temperature and chemical substances, as well as ionizing radiation. G. H. Mickey, a zoologist of Louisiana State University, explains radiation effects as follows: ". . . It is in the water of the body cells that primary effects of

radiation take place by the production of free radicles which elaborate  $H_2O_2$  and other cell poisons. These move about until they alter a receptive molecule, for example an enzyme or the large protein molecule of the genes. One enzyme molecule modified continues by transforming others and, thus, the process of multiplication transforms a small radiation effect into an eventual observable injury to the cell."

4) Non-transmittable effects to non-germinal cells may cause damage. Poisonous products released by radiation-killed cells can circulate in the blood stream to other tissues. Therefore, radiation damage is not entirely direct but can spread to a certain extent from the point of damage to other parts of the body.

5) The quantitative relationship between X-ray dose and genetic mutation is believed to be a linear one, regardless of the intensity of the radiation. However, in recent studies with very high doses of radiation, the mutation rate appeared to drop from the expected linear response. The target theory assumes that the gene is the target, that the ionization is a hit and that one hit equals one mutation. It had been speculated that, at high dosages, a two-point hit would result with one ionization, giving two mutations. But, if the linear curve drops off at high doses, we must reassess the target theory.

Chromosomal aberrations, on the other hand, vary exponentially with the dosage, and are influenced by the intensity of radiation. It is likely that at low intermittent dosage, the chromosome break will heal in its original configuration. This explains a recent observation that, in mice, fewer mutations are produced in spermatogonia and oocytes by chronic irradiation (i.e., a low dose rate) than by the same amount of acute irradiation (i.e., a high dose rate), when the total dose is the same. The belief that it is the total dose that counts, because the genetic damage done by radiation is cumulative, must be discarded since the definitive experimentation by Russell and

Russell, geneticists, of Oak Ridge, Tennessee. In one experiment reported by the Russells, one half of mouse sperm were killed by 22 r. radiation, but at 100 r. of acute exposure only 1% of the mice were sterile.

## SPECULATION

If one can assume that a close correlation exists between the genetic effects of radiation to mice and men, a number of conclusions can be drawn.

J. F. Crow, Professor of Genetics at the University of Wisconsin, made some startling predictions from experimentation with mice. In his experiment, 30 to 50 r. were required to cause a mutation rate in mice equal to the spontaneous rate in men. Thus, a 30 to 50 r. increase in dose per generation might be expected to double the human mutation rate (according to the linear scale). Background medical radiation at 3 r. is estimated, therefore, to be responsible for a 10% increase in mutation rate. This should change the rate of children with a serious genetic impairment from 2% to 2.2%. This seems a small increase but the overall impact of individually small mutants would be much larger.

Consanguinous marriages show a general weakening in the progeny. Close relations are more likely to have a similar genetic pattern and similar mutant alleles. The offspring show higher death rate and morbidity, rarely due to recognized genetic disease but to various minor impairments. This is important because the less lethal they are, the longer they will be carried in the population.

## CONCLUSIONS

The amount of natural radiation is only acceptable because it is unavoidable and since nothing can be done about it, the consequent damage is accepted. Society must avoid additional exposure by keeping the unnecessary radiation to a minimum.

This is the job of the medical profession and the politicians.

The conflict remains as exemplified by the man who objects to a chest X-ray. The gonadal dose is estimated at 0.5 mr., by A. M. Brues, Director of Argonne National Laboratories. On the grounds that he risks the health of his progeny, this gentleman refuses a chest X-ray. The dose is equal to that which would be added by an air plane trip to the West Coast or to Europe at 21,000 feet. The worts statistical hazard is one chance in  $10^{-7}$  per year of leukemia. But, at his age he has a chance of 1 in  $10^{-4}$  per year of having lung cancer, and assuming a 20% chance of cure of disease discovered radiologically, there leaves a factor of 100 between any conceivable risk and what benefit could possibly be gained.

A final answer to the problem of genetic effects of radiation cannot yet be given. The facts are not all in. There must be further study, publication of results, and a constant re-evaluation of available findings in terms of contribution to society and social cost.

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# Somatic Effects of Radiation

ROBERT T. RICHARDS, '62

## INTRODUCTION

The harmful effects of irradiation, can be divided into those developing within a few weeks of exposure, and those developing after two months. In this way, somatic effects of irradiation are divided into the acute radiation syndrome, and chronic, long-term effects. The symptoms of radiation injury, generally, are no different from those that develop in a variety of diseases. Radiation produces its effect by structural or functional disturbances in tissues and in cells. The body responds, as it does to any insult, with regeneration and repair. The serious aspect of radiation, however, is its ability to penetrate to any of the cells of the body.

## A. GENERAL PRINCIPLES

### 1. Terminology\*

#### *Roentgen (r)*

A roentgen is a purely physical unit with no direct relation to absorption or biological effect of irradiation.

#### *Radiation Absorbed Dose (rad)*

The rad denotes radiation energy absorbed by a small volume of tissue, divided by this volume.

#### *Rad Equivalent Man (rem)*

This denotes the rad, multiplied by the biological effectiveness of a particular quality of radiation, relative to that of standard X-radiation.

\*For exact terminology, consult "National Bureau of Standards Handbook 62, Report of International Committee on Radiation Units & Measurements 1957".

### 2. Effects of Radiation

The effects of radiation depend upon 4 main factors:

#### (i) *Total Dose*

Here we are concerned with the rate and the duration of exposure, as well as the type of irradiation received.

#### (ii) *Number of Exposures and Interval Between Exposures*

Here we are concerned as to whether the total dose received was acquired in a single massive exposure, or the result of many minor exposures.

#### (iii) *Extent and Part of the Body Irradiated*

#### (iv) *Age of the Patient*

The biological effects of irradiation in turn can be divided into 4 main groups:

#### (i) *Type*

Structural, functional, or both.

#### (ii) *Manner*

The effects may be direct upon the subject irradiated, or indirect upon the progeny. Similarly they may be divided into local effects in irradiated area, or transmitted effects in tissues remote from the irradiated part.

#### (iii) *Time*

Again, the effects may be acute or delayed. Indeed in most cases, a definite latent period exists between irradiation and somatic effects. This latent period becomes longer as irradiation dosage decreases.

#### (iv) *Effectiveness—reversible or irreversible*

This, of course, depends upon the importance of the tissue destroyed, or damaged, and its ability to recover.

One of the great secrets of life is the ability to maintain a relative homeostasis in a changing environment. Therefore, as the result of any stress, mechanisms are brought to bear, to block or minimise the harmful effects so produced, and to promote repair. In this particular context, the endocrine system, the blood and the reticulo-endothelial systems, are of paramount importance.

### 3. Radiosensitivity

According to the Law of Bergonie and Tribondeau, 1960:<sup>10</sup> "The radiosensitivity of a cell is directly proportional to its reproductive capacity and inversely proportional to its degree of differentiation." It has also been recognized for many years that dividing cells are more sensitive, that cells with an increased metabolism have a decreased resistance, and that poor blood supply has a deleterious effect.

TABLE NO. 1

#### Cells in Order of Decreasing Sensitivity

Lymphocytes  
Granulocytes  
Basal cells  
gonads, bone marrow, skin, epithelium of GI tract  
Alveolar cells of lung  
Bile duct cells  
Kidney cells  
Endothelial cells  
Connective tissue cells  
Muscle cells  
Bone cells  
Nerve cells

### 4. Radiation Exposure

Determination of radiation exposure depends upon:

- (i) Nature of radioactive material.
- (ii) Amount of material present.
- (iii) Route of entry.
- (iv) Site of deposition of radioactive product.
- (v) Biological half-life.

### 5. Organ and Tissue Effects

See Table 2.

#### Pathological Triad

##### (i) Necrosis

Cells with only a short life span are particularly susceptible to necrosis. Clinically this becomes manifest in hematopoietic tissue, lymphocytes and lymphoid tissue, and the mucosa of the gastro-intestinal tract, predominantly.

TABLE NO. 2  
The Effects of Acute Total Body Irradiation\*

| Dose     | Clinical Effect  |
|----------|--|
| 100,00 r | Spastic seizures, death within seconds.  |
| 10,000 r | CNS death within minutes to hours.   |
| 1,500 r  | GI death, in 2-5 days.   |
| 1,000 r  | Shock, neuromuscular reaction, death in a few days.  |
| 700 r    | Hematologic death within 3-4 weeks.  |
| 4-500 r  | LD <sub>50</sub> .   |
| 300 r    | 20% deaths, all the others are mentally incapacitated and stringent supportive measures are necessary to help the survivors over the acute radiation sickness. |
| 200 r    | Probably no deaths, but 50% will be incapacitated with psychic shock and moderate radiation sickness.  |
| 100 r    | About 2% of patients will present with nausea and vomiting over a short period of time, or mild radiation sickness.  |

\*It is interesting to note that in Hiroshima and Nagasaki only 20% of deaths were due to radiation sickness and 80% were the result of burns and trauma.

## Somatic Effects

### (ii) Hemorrhage

Radiation produces a lessening of the cement substance of vascular endothelium and this, in association with the concurrent necrosis of tissues, results in purpura, melena, hematuria and hemoptysis. When these effects occur to a sufficient degree, clinical hypovolemic

anemia results, and this in turn enhances the symptoms of the aplastic anemia to follow as a result of suppression of the bone marrow.

### (iii) Infection

Here, there are three factors involved. First, actual destruction of gastrointestinal mucosa circumvents

TABLE NO. 3  
Summary of Clinical Findings\*

| Interval  | Lethal Dose<br>(600r)  | LD <sub>50</sub><br>(4-500 r)  | Sublethal Dose<br>(1-200 r)  |
|-----------|--|--|--|
|           | Nausea and Vomiting<br>within 2 hours  | Nausea and Vomiting<br>after 2 hours   | Occasional vomiting<br>after 2 hours   |
|           | Latent Period<br>(mins. - hrs.)  | Latent Period<br>(7 - 10 days)   | Latent Period<br>(15 - 20 days)  |
| Week<br>1 | Intractable vomiting<br>Diarrhea<br>Tenesmus<br>Leucopenia (24 hrs)<br>Inflammation of<br>mouth and throat |  |  |
| Week<br>2 | Fever<br>Massive H <sub>2</sub> O and<br>electrolyte<br>disturbance<br>Rapid loss of weight                | Epilation<br>Anorexia<br>General Malaise<br>Fever<br>Inflammation of<br>mouth and throat   |  |
| Week<br>3 | Death 100%   |  | Epilation<br>Anorexia  |
| Week<br>4 |  | Pallor<br>Hemorrhage<br>Purpura<br>Diarrhea<br>Loss of weight<br>Profound water and<br>electrolyte<br>disturbance<br><br>Death 50% | General Malaise<br>Sore throat<br>Pallor<br>Hemorrhage<br>Purpura<br>Diarrhea<br>Moderate loss of<br>weight<br><br>Recovery likely |

\*Adapted from "Effect of Atomic Weapons" U.S. Dept. Defence, and U.S. Atom. Energy Comm., New York, 1950.

the natural protection it affords to invasion of bowel bacteria. Secondly, circulating lymphocytes, granulocytes, and tissue macrophages are selectively destroyed because of their high radiosensitivity. Lastly, there is an ill-defined detrimental effect on humoral protection.

## B. ACUTE RADIATION SYNDROME

See Table 3

### 1. Introductory Statements

*Clinical Course - Triad*

- (i) Initial malaise, nausea and vomiting - within hours.
- (ii) Latent period - duration varies inversely with magnitude of dose.
- (iii) Terminal fulminating illness - sore throat, melena, hematuria, hemoptysis, purpura, epilation, fever, diarrhea, weakness, emaciation, etc. resulting in death or recovery depending upon the extent of infection and metabolic failure achieved.

**N.B.** It has been shown that adrenal insufficiency, infection, trauma, exhaustive exercise, nutritional deficiencies, general debilitating diseases and the extremes of life-span enhance susceptibility to irradiation.

Conversely, irradiation increases the toxicity resulting from any of these factors. Hence, we see the importance of so-called "Cross-stresses".

*Presumptive Evidence - Triad*

- (i) Early malaise followed by a symptomless latent period.
- (ii) Hemorrhage and purpura.
- (iii) Epilation.

*Management*

Treatment of acute radiation sickness is entirely supportive and symptomatic. It consists of rest, adequate hydration and nutrition, maintenance of electrolytes, control of infections, *as they arise*, with antibiotics and transfusions. Prophylactic antibiotics are generally not given because of the increased risk of isolating a resistant strain, with a resultant fatal septicemia. There is no specific therapy.

### 2. Blood and Blood Forming Tissues

See Table 4

It has already been stated that all stem cells are highly sensitive to irradiation. However, immature forms of granulocytes, erythrocytes and platelets do develop some resistance. Indeed, by the time these constituents have reached their mature forms, they are highly resistant compared

TABLE NO. 4  
Summary of Blood Changes

| Formed Element | Source          | Life Span  | Radiation Induced Depletion | Clinical Significance   |
|----------------|-----------------|------------|-----------------------------|---|
| Lymphocytes    | Lymphoid Tissue | 8-24 hours | Within hours                | Leucopenia and agranulocytosis with a marked decrease in resistance to infection, e.g. sore mouth and throat. |
| Granulocytes   | Bone Marrow     | 72 hours   | Within days                 |   |
| Platelets      | Bone Marrow     | 2 - 6 days | Within one week             | Bleeding tendency with petichiae, purpura, etc.   |
| Erythrocytes   | Bone Marrow     | 17 weeks   | Within 7 weeks              | Anemia due to hemorrhage, hemolysis and marrow depression.  |

to lymphocytes, which retain a high degree of radiosensitivity.

For this reason, lymphocytes are the first constituent to disappear from peripheral blood. The other constituents are depleted at varying intervals afterwards. Although, the mechanism is not fully understood, both granulocytes and platelets show an initial rise before their counts begin to fall.

Obviously, peripheral blood changes vary with the radiosensitivity of the precursor cells, their ability to recover, and the life span of the mature forms. Life span increases progressively from lymphocytes, to platelets, to granulocytes, and finally to erythrocytes, and represents the order in which changes occur. Regeneration, however, does not follow the same sequence. Recovery is ordinarily first seen in platelets, then granulocytes, then erythrocytes. So long as the W.B.C. remains in excess of 1000 cells/cubic millimeter, the patient has some appreciable resistance to infection.

The abnormal bleeding has been variously attributed to the thrombocytopenia, blood vessel damage, and the presence of a circulating anticoagulant.

### 3. Gastro-Intestinal Tract

Vomiting is the earliest sign of acute radiation sickness. It is interesting that it appears to be related to the time of onset of the radiation, and not to the time of termination. With massive doses, the vomiting soon becomes intractable.

Profound weight loss, dehydration and electrolyte disturbance are the result of the vomiting, diarrhea, altered food and water intake, and tissue breakdown. However, disturbances of water and electrolytes, except in lethal doses, are probably mild and will not constitute a problem in therapy.

The first physiological effects of irradiation on the gastrointestinal tract are diminished secretion, discontinued cell production, and necrosis of mucosa. Clinically

this becomes manifest as nausea, vomiting, dehydration and diarrhea. If widespread and severe, an acute necrotising enteritis results with ulceration and hemorrhage. Normal architecture may be distorted or lost when repair is completed.

The exact mechanism of the fever of 103-105°F, in lethal irradiation, is unknown. There may well be a relation to dehydration, but it spontaneously returns to normal within 24 hours, usually, despite or before therapy is instituted.

### 4. Skin and Hair

Skin is very sensitive to irradiation injury; even minor doses result in desquamation, necrosis and sloughing. It is well documented that heavy doses—acute or chronic—may result in skin cancer. Similarly, chronic exposure appears to predispose to premature aging.

A patchy alopecia is characteristic of radiation sickness; the hair literally falls out in handfuls. Premature greying is also a common feature. The normal pattern of baldness is followed, such that the scalp is affected to a far greater extent than the axillae, eyebrows or beard. The alopecia usually lasts about one month.

### 5. Genito-Urinary System

Irradiation, external or internal, can result in nephritis with hematuria and incontinence. Doses in excess of 400 rem are sufficient to produce sterility, the ovaries being more sensitive than the testes. Smaller doses (about 100 rem) may result in impaired sperm production or ovulation. Impotence is rarely seen, and then only in patients subjected to massive irradiation. If the patients survive, their impotence usually spontaneously disappears after the acute phase is terminated.

### 6. Emotional Reaction

During the first 24 hours, the victim suffers from a profound psychic shock and

is generally quite apathetic. However, during the following latent period, the patient starts to feel better, regains his contact with reality and shows a return of appetite. With the return of symptoms, the patient's mental outlook again regresses and he becomes miserable, unhappy and irritable.

## C. DELAYED EFFECTS OF RADIATION

### 1. Introductory Statement

Delayed effects of radiation may occur any time after two months. The interval of two months is strictly an arbitrary limit. Disorders of skin and underlying soft tissues, and of bones, may subsequently become neoplastic. Cataracts, severe anemia, and leukemia, have been well documented. There is evidence from animal studies that irradiation may cause death at a prematurely early age.

### 2. Ocular Manifestations

By reason of its anatomical structure, the eye is particularly susceptible to varying forms of irradiation, especially in younger patients.

The corneo-conjunctival epithelium is particularly vulnerable to the ultra-violet band, and keratitis and conjunctivitis are commonly seen as the result of arc welding and snow blindness.

The lens is avascular and the transparent lenticular cells cannot be replaced, with the result that damage produces cataracts. Irradiation cataracts develop over 4-5 years usually, especially following exposure to infra-red, microwave, neutron and X-irradiation.

Unfortunately, harmful rays may be brought to focus and concentrated upon the retina producing severe burns. Occlusion of central retinal vessels only follows massive irradiation.

### 3. Genetic Effects

At present, there is considerable controversy concerning the relationship of ir-

radiation and genetic defects.

Geneticist Haldan's opinion is that even our so-called "natural" mutation rate, is a result of background environmental irradiation.<sup>9</sup> Others would remind us that recent advances in the causation and subsequent management of genetic disorders have in large part been responsible for their apparent increase in recent years. As a result, humans who would previously have died, now survive and procreate, to transmit their hereditary weaknesses to further generations. However, radiation can affect genes in such a way that either "dominant" or "recessive" characteristics will differ from those of parent. Should these changes show up in the first generation, they likely occurred in a "dominant" gene. More commonly, however, these mutations will be in "recessive" genes, and, therefore, the second or even the third generations must be awaited before such changes can be detected. It must also be remembered, that what is true of the Japanese studies of Hiroshima and Nagasaki survivors, is not necessarily true of other races.

About 99% of all gene mutations are undesirable. Mutation occurs normally at a rate of about 2% per individual. It is claimed that a dose of 20 r increases the rate of mutation to 2.5%; and 80 r, to 4%.<sup>10</sup> Therefore, the optimistic conclusion that man is fortunately not very sensitive to the mutagenic action of ionizing radiation is untenable.

### 4. Radiation and Cancer

Cancer is most likely to occur in skin, lungs, bones and bone marrow. But, there are two important characteristics of radiation-induced cancers. First, the neoplasms tend to occur in tissues already severely damaged by irradiation. Secondly, they tend to occur only after a long latent period of 20-30 years.

Although radiation is a cause of cancer, it is even more important as an adjunct in cancer therapy. Generally, the higher the

cellular activity of the tissue, the more sensitive it is. It is for this reason that malignant cells are selectively destroyed.

It is believed that massive doses are required to induce malignant change. Although in the skin, only 150 rem will produce skin erythema, massive doses of 2-5000 rem are probably required to produce cancer.

Evidence of radiation-induced cancer is convincing. Carcinoma of skin, as a result of chronic irradiation in pioneer research workers, was documented as early as 1911. Carcinoma of bones and joints was a prominent occupational hazard in researchers, radiologists, and watch dial painters, etc. It may even occur as a result of excessive therapeutic X-irradiation. Bone-seeking isotopes such as Strontium 90, Plutonium 239, may result in tumors and marrow suppression. Cancer of lungs was found in unusual numbers of pitch blende miners of Schneeberg and Joachimsthal. The causative agent was found to be inhalation of the radioactive gas, Radon.

A particularly virulent form of cancer has occurred in children where irradiation of neck and chest for thymic tumors produced thyroid cancer within 7 years—an unusually short latent period.

### 5. Blood Disorders

Aplastic anemias have occurred after acute or chronic radiation exposure but they are rarer than leukemias.

There would appear to be little doubt that ionizing radiation can produce leukemia in man, after acute or chronic exposure, with an average latent period of only a few years. Since 1920, there has been a marked increase in recorded cases of leukemia and the lymphomas. There is still considerable controversy, however, as to whether this represents a real increase, or only an apparent one. Concurrently, exposure to ionizing radiation has been on the increase in the environment as well as in medical usage. The Japanese atomic

bomb survivors represent the most important single series of cases for study. However, a specific relationship between incidence of leukemia and radiation dose has not yet been shown, and it is now suspected that no threshold dose exists.

### 6. Miscellaneous Effects

Abortion and stillbirth as a result of irradiation during pregnancy do not constitute a problem unless the dose of irradiation is large.

Evidence from Hiroshima suggests that a fetus, irradiated between 12-18 intra-uterine weeks, is more likely to develop microcephaly and perhaps a number of other anomalies.

Finally, a shortening life span has long been suspected from animal studies. But, clinical evidence would suggest that even if this is true, it is only an insignificant decrease of a month or so over a lifetime.

### SUMMARY

Supralethal irradiation is followed by a shocklike reaction and death within a few days, despite treatment. Severe gastrointestinal hemorrhage and central nervous system disturbances are prominent sequelae. After median lethal irradiation there is an initial mild disturbance, followed by a short asymptomatic period, before a final phase of progressive deterioration that ends in death or recovery.

Many factors are involved with associated injuries, hemorrhage, gastro-intestinal damage, leucopenia and infections being the most important. Death is not due to blood damage primarily, although treatment aimed at correcting the deficiencies involved appears to favorably influence morbidity and mortality.

The long term cancer hazard complicates difficulties of establishing permissible doses of irradiation for diagnostic or therapeutic purposes. The development of

*Continued on Page 71*

# Practical Aspects in Protection Against Ionizing Radiation

W. PAT MAZIER, '63

## INTRODUCTION

Since Hiroshima and Nagasaki, the term radio-activity has become a household word. With the ever increasing fear of nuclear war constantly confronting us, the term conveys the feeling of a lingering and painful death. Yet, most lay people are far from understanding the scope and true nature of the hazard problem. Briefly, then, it can be stated that if living cells are exposed to ionizing radiation, i.e., alpha, beta, gamma, x-radiation and neutrons, damage can result. This ionization sets in motion chemical reactions inside the cell resulting in effects which depend upon the size of the dose of radiation and the type of cell receiving it.

## PRESENT EXPOSURE LEVELS OF THE HUMAN RACE

Humans have been exposed to ionizing radiation since the beginning of time. The earth contains uranium and thorium together with radioactive products derived from these very long-lived materials. As well as receiving external radiation from the earth, we also eat and deposit in our tissues significant quantities of radioactive potassium, traces of radium and other active materials which give internal radiation. In addition to these, the earth also receives cosmic rays from the sun.

Generally, all humans on earth receive approximately 0.15 r./annum, while those living at higher altitudes receive considerably more. These doses, as far as we know, are below the threshold for biological damage; however, they may play a part in genetic change. These types of radiation are inevitable.

## RADIATION FROM SOURCES CREATED BY MAN

The discovery of x-radiation (1895, William Roentgen) and radium (1898, The Curies), yielded two wonderful medical tools. Shortly after their discovery, it was found that these same tools also had very harmful effects. Since that time, many other radioactive elements have been discovered, most of them useful, but all of them harmful in high enough dosage.

And so  $I^{131}$ ,  $Co^{60}$ ,  $P^{32}$ ,  $Au^{198}$ , are only a few of the hundreds of radioactive isotopes now being used in Medicine, Industry and Research.

To "preserve peace", man also made the atomic and hydrogen bombs and maybe other bombs as well. It is against all these man-made forms of radioactivity that we must protect ourselves.

## PRINCIPLES OF PROTECTION

Three fundamental physical factors, distance (length), density (mass) and duration (time) underlie the firmest foundation upon which protection can be built. Add to these three factors adequate instruction and rigid enforcement, and humans should be able to protect themselves quite adequately against most forms of radioactivity.

## PROTECTION AGAINST IONIZING RADIATION IN MEDICINE

The ever increasing use of radioactive materials in medicine makes protection against their harmful effects a matter of paramount importance. This can be divided into three categories:

- A. Protection of the patient,
- B. Protection of technicians and other regularly employed workers in the use of radioactive materials,



C. Protection of the public.

A. Protection of the Patient

The patient being exposed to ionizing radiation may be receiving anything from 0.006 r. of x-radiation for a chest radiograph to repeated high dosages of cobalt-60 or indwelling radium. The patient is protected by being given the least amount of radiation which will be effective; by being exposed to the source of radioactivity for the shortest length of time and by being placed close enough to the source to reduce scatter to other tissues. Also, the source delivering the radiation is designed to deliver a beam no wider than is necessary. In the use of x-ray, improvements in technique such as the use of more sensitive screens, faster film and high voltage will reduce the patient-dose and also will reduce scatter and stray radiation. Efficient coning also limits the beam and limits scattering. At all times, those parts of the body not being examined radiologically are protected, especially the very susceptible parts such as the gonads. These same principles of course apply to any other situation where radioactive materials are being used.

B. Protection of Technicians and Other Regularly Employed Workers in Use of Radioactive Materials

The most important single factor here is instruction. Hence, these people are constantly taught that at no time should they needlessly or carelessly expose themselves to sources of radiation or, if they have to as would be the case with nurses and doctors attending patients with indwelling radium, their time of exposure should be limited. For personal protection, lead rubber gloves and aprons are provided as well as metal screens and long-handled cassettes. Simple instructions such as leaving the room whenever x-ray films are being taken, and not holding children during x-ray examination make a great deal of difference in total exposure dosage. In addition to all these instructions, these persons are required to wear film badges which are a means of checking on how

much radiation each person has received in a given length of time.

C. Protection of the Public.

In the medical use of ionizing radiation, the public is protected by the careful use of radioactive equipment; by the use of protective casings and housing such as thick concrete walls, lead-lined rooms; by displaying conspicuous warning signs wherever there is any danger of possible exposure; finally, by constantly monitoring equipment for safety, the detection of leaks, unsafe areas, etc.

Protection Against Ionizing Radiation In Industry and Research.

The same general measures applicable to safety and protection against ionizing radiation in medicine apply here. The only difference would be in the use of very specialized safety equipment such as remote control instruments, safety alarm systems, etc. However, because of the increasing use of radioactive isotopes in industry, a certain amount of legislation is being adopted to ensure the safety of all concerned.

IONIZING RADIATION AND ATOMIC WARFARE

In considering practical aspects of protection against ionizing radiation arising from the explosions of atomic weapons, one should at least know that several types of radiation arise from an explosion as well as from the fire ball and radioactive fallout. Briefly these are: gamma rays, beta particles, neutrons, and alpha particles

Gamma Radiation

Gamma rays are highly penetrating rays (comparable to x-rays) which are capable of causing acute radiation sickness in man. These rays are readily scattered but do not render materials with which they come in contact radioactive. Four basic physical factors govern the quantity of gamma radiation to which a target is exposed from a source:

- A. The quantity of gamma radiation released from the source.

- B. The distance of the target from the source.
- C. The shielding effect of materials interposed between the target and the source.
- D. Scattering in the air.

For the sake of completeness, two other factors should at least be mentioned i.e., the time over which exposure is maintained and the volume of tissue involved.

#### A. Quantity

In general the quantity of radiation energy absorbed can be reduced by distance from the source and by shielding of the target.

#### B. Distance

The intensity of gamma radiation decreases in accordance with the inverse square law. Two very obvious principles of protection can be gathered from this—remove persons from fallout areas and, if persons in fallout areas cannot be moved, then push back the topsoil and thus remove the contamination to a distance.

#### C. Shielding

Shielding is defined as the interposition of materials between the source and the target. The decrease in radiation intensities is roughly dependent on the density of the interposed material.

The effectiveness of a given material in decreasing the radiation intensity is usually described in terms of its "half-value layer thickness". This value is the thickness of a given material which absorbs 50% of the radiation falling upon it. The common materials in order of decreasing value are lead, steel, concrete, earth, water and wood. If we, therefore, consider the protection factors of buildings against radiation, which is the factor by which the out-of-doors radiation dose rate is reduced by a building, we will find that the buildings with the highest protection factors are those large buildings built from steel, concrete and bricks, while ordinary wooden frame houses have the lowest protection factor of all. Roughly speaking, the base-

ments of large brick buildings have a protection ratio of between 40 and 50, while the protection ratio for a fallout shelter covered by three feet of soil is approximately 1,000. Basements afford more protection than ground floors and corners of rooms are safer than the centre except in those situations where centre rooms are surrounded by other rooms.

#### Beta Particle Radiation

Beta particles are less penetrating than gamma rays, and can be stopped by a few centimetres of air and less than two millimetres of tissue. Clothing of ordinary thickness and the walls of building give adequate shielding. The effects of beta particle radiation can be conveniently discussed under two headings:

- A. The contact hazard,
- B. The internal hazard.

#### A. The Contact Hazard

External injury from beta particle radiation can be prevented by avoiding radioactive fallout areas; by the proper disposal of refuge; by removing clothing contaminated by radioactive dust and by washing contamination from the skin with water free from radioactivity.

#### B. The Internal Hazard

Injury takes place by three main routes:

1. Ingestion.
2. Through open wounds.
3. Inhalation.

1. The ingestion of water and foodstuffs contaminated by fallout will be the main source of injury.

*Water:* Protection of water supplies can be brought about by utilizing underground sources, such as covered wells or by storing water in tanks, cans or bottle in a protected place. If this has not been done, then all water must be subjected to radioactive survey before it is drunk and, in extreme cases, radioactive water can be mixed with clay, mud or iron filings to remove the very active radio-strontium and radio-barium and thus render the water potable.

**Food:** The preservation of a good supply of food in the event of a nuclear war poses the most difficult problem of all. Unprotected food will be readily contaminated by fallout. Gamma or beta radiation can destroy or injure animals or crops as well as stored foods. Indirect injury such as that which would result from drinking milk produced by animals feeding on radioactive grass would have to be guarded against. On the other hand, our crops might be utilizing radioactive elements as part of their metabolic pathways while, at the same time, we are guarding against other contaminated foods. With regard to stored food, man can protect himself by following a few simple measures:

i) Food stored in dust proof containers and storehouses is safe.

ii) Food containers should be monitored by counters before they are opened.

iii) Contaminated containers can be satisfactorily decontaminated by washing with soap suds, rinsing with pure water, and, once more, checking before they are used.

iv) Food storage buildings should be sealed in the event of an anticipated nuclear attack.

v) Proper technique in the opening of food packages helps in minimizing the chances of contamination.

2. All open wounds and burns should be covered in the event of radioactive fallout. This very simple procedure greatly reduces the chances of injury.

3. For the present, it is generally agreed that the inhalation of beta particles seems to do no great harm to the body.

### Neutrons

These particles are constituents of radiation released immediately at the time of explosion. Their range is less than gamma radiation. The particles are highly penetrating and often cause secondary gamma radiation in elements upon which they impinge. Since material within effective

neutron range will be destroyed by blast and heat, protection against these particles has been of no great concern to the health professions.

### Alpha Particles

These particles have very low penetrating power and can be stopped by the keratinous layer of the skin. They are toxic only when ingested and are considered a minor health hazard.

### SUMMARY

1. Man is constantly exposed to naturally occurring ionizing radiation which seems to exert no harmful effects.

2. Man-made sources of ionizing radiation are useful but can be harmful in high enough concentration.

3. Distance, density and duration are the three physical factors concerned in the principles of protection from ionizing radiation.

4. Ionizing radiation resulting from the explosion of nuclear weapons is harmful mainly because of gamma radiation and beta particles.

5. By shielding the target with suitable materials and by maintaining as great a distance as possible from the explosion, adequate protection can be gained.

6. Beta particles are abundant in radioactive fallout and exert their harmful effects by external or internal contact.

7. External contact is best protected against by avoiding radioactive areas or by taking refuge in shelters or the basements of buildings. Radioactive dust may be removed from surfaces by washing with water free from radioactivity.

8. Internal contact is best protected against by consuming food and drink free from radioactivity.

9. Underground water or water from deep wells is usually safe from radioactivity.

10. Food stored in dust-proof containers is usually safe from fallout.

11. By monitoring fallout areas and the food supplies therein, added protection against ionizing radiation is obtained.

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cancer in irradiated organs may take 30 years or more to become apparent. Similarly, other aspects of delayed effects may be so slight that they are not detected. The long, relatively asymptomatic latent period is characteristic of most radiation lesions.

The total number of known cases in most categories of delayed effects is small and the amount of radiation required to produce the more serious side effects, is large. Furthermore, there is a marked individual variation.

At present, there is thought to be no cause for curtailment of clearly indicated diagnostic or therapeutic irradiation. But, particularly in young children, adolescents, pregnant women, and benign disorders, indications for its use must be carefully considered.

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# The Role of the Doctor In Civil Defence

STEPHEN BLIZZARD, '63

## INTRODUCTION

"The truly great leader is one who, by his own personal example, inspires his followers with such confidence that they carry out quickly, cheerfully and thoroughly, whatever duties they are called upon to perform."

*Winston Churchill*

Civil Defence may be defined as a program of human welfare, designed to save and sustain life, and as such is a vital element in the survival of mankind. In this connection, we think in terms of national disaster as well as warfare involving weapons of mass destruction, which may be nuclear, chemical, biological and even psychological.

Opinions have often been voiced as to the apathy of our general public with regard to any Civil Defence plan and, because of our democratic way of life, interest cannot be enforced. However, the position of the doctor in our society is such that he may contribute in no small way to the dissipation of this lack of awareness, possibly at the risk of being branded a "scaremonger".

Be this as it may, the choice is his as to whether he will be involved as part of a formed and disciplined body, or pressed into service at the last moment by the nearest authority, if and when the occasion arises.

Upon acceptance of this position, he should at least see just where he would fit into any course of action, the two major considerations being *Planning* and *Activity*. Under *Planning*, one may consider, Emergency Blood Services, Hospital disaster planning (including Evacuation), and Primary Treatment Services. *Activity* may be subdivided into Militia and Training, Fall-Out Shelters, and Mass Inoculations.

## EMERGENCY BLOOD SERVICES

The necessity for this particular feature

cannot possibly be overemphasized. At the moment, the Red Cross Transfusion Service exists mainly as a provincial entity and serves as a source of supply for our hospitals. However, very little imagination is needed to comprehend its inadequacy in the event of national disaster or nuclear attack.

Present plans incorporate the establishment of alternate blood depots (Shadow depots) in safer areas than those in which the present depots are now established.

The physicians in charge of existing transfusion services come into the picture, in being responsible for the development and co-ordination of the Emergency Blood Services program which has the following objectives:

- (a) To organize a whole-blood procurement and distribution program which will mobilize rapidly to meet emergency situations.
- (b) To supplement this whole-blood program with plasma expanders, glucose and saline mixtures, as well as plasma and blood fractions.
- (c) To provide for the procurement and storage of supplies and equipment required for the emergency blood program.
- (d) To recommend staff requirements and methods of training of personnel.

## HOSPITAL DISASTER PLANNING

Canadian Hospital Disaster Planning can be divided into two phases. The first phase has to do with planning for the

reception of large numbers of casualties with present facilities and staff intact. The second phase is concerned with evacuation of the premises due to some urgent threat, either in peace (fire or flood), or war (evacuation as a means of survival in certain critical areas).

With the close co-operation of the Canadian Hospital Association and the Civil Defence Branch of the Department of National Health and Welfare, plans for the implementation of both these phases have been developed for hospitals throughout the country, and, in each instance, the doctor plays a very active part.

Essential features of the plans include: good organization for control and direction, the laying down of general policies with regard to adequate notification of hospital staff, reception of casualties, sorting and distribution of casualties to designated areas, standard methods of treatment under emergency conditions with particular reference to wounds, fractures and burns.

Control of the traffic and visitors around the hospital, the handling of information on casualties—release of information to relatives, press and radio, and the availability of adequate supplies are also considered in Hospital Disaster Planning.

### Casualty Reception

Casualties may be divided into three major categories, viz: Surgical and Medical emergencies requiring immediate or urgent treatment, those requiring hospital admission but not immediate treatment (a number of psychiatric cases will be included here), and those requiring merely first aid treatment, subsequent to which they return home.

Surgical and Medical emergencies include patients who require surgical care and who are in fit condition for immediate operation. These people are sent directly to the operating rooms. As well, there are those who require care, but are in severe

shock. These receive initial treatment and are then sent to a resuscitation centre. Burn cases are also considered here.

In the overall organization of this emergency set-up, the Chief of Surgery is responsible for the receiving, first aid, burn, anesthetic and surgical units, the operating room teams and surgical casualty wards.

The Chief of Medicine has under his jurisdiction the evacuation, resuscitation and psychiatric units, the non-casualty patients and the medical interns.

Under the Director of Laboratories, the functioning units are those concerned with emergency laboratory, blood, plasma, and morgue services.

The Radiologist is responsible for carrying on the X-Ray service as required.

### Evacuation Phase

The Evacuation phase is planned from two standpoints: on the one hand, that of evacuation of non-casualty patients, experience having proven this to be in the region of 70-80%; on the other hand, that of removal of the entire hospital to another area, though this likelihood is a secondary consideration since the advent of the Megaton bomb.

In preparation for both of these, a system of patient categorization is established, so that a census of hospital patients according to their movement status in an emergency is available from day to day.

This differentiates self-mobile adult patients from those who are mobile with help or in custodial care, as well as contagious, infectious and stretcher cases.

Non-self-mobile patients may be adults, children, or children who need to be carried.

It is essential, too, that both Doctors and members of the general public know that any emergency period will of necessity mean the suspension of the normal doctor-patient relationship.

## PRIMARY TREATMENT SERVICE

This section of the Civil Defence Health Services plan provides for First Aid and Primary Treatment as close as possible to any disaster site.

Casualty Collecting units operate in the disaster areas, examine the injured, control hemorrhage, immobilize fractures, apply dressings to wounds, treat burns, relieve pain, tag the casualties, transport stretcher cases and direct the walking wounded to the Advanced Treatment centre, at which level the physician operates.

Here, emergency medical treatment is provided, priorities established, casualties accommodated if necessary, then evacuated either to their own homes, hospitals or other centres.

## MILITIA AND TRAINING

The futility of attempting to achieve reasonable effectiveness in any of the previously mentioned schemes without adequate provision for training is obvious.

Consequently, the doctor may avail himself of the opportunity by joining the Militia or any other Civil Defence Organization so that he can be indoctrinated in the special implications of nuclear, chemical, biological and psychological warfare, particularly with respect to the handling of mass casualties.

In this latter, methods of treatment are contrary to those normally carried out, the principle here being that of doing "the best for the most".

At this juncture, it may be suggested that "Bone Marrow" banks be established, each individual physician having a small portion of his marrow frozen and kept at some storage centre so that he may be transfused with his own marrow if the occasion arises, following exposure to nuclear radiation.

## FALL-OUT SHELTERS

This is still a very controversial issue. Conflicting opinions are inevitable in an area where everything seems ultimately to be defined by guesses, estimates and wishful thinking.

The view of the author, however, is that they should be built. The question then arises whether this should be an individual effort or whether the Government should intercede and build public shelters (inevitably at great cost to John Taxpayer).

It is felt that the doctor should act independently to build his home shelter, thus setting the example to other citizens. He may also contribute by educating the public as to their value, and, of course, their limitations.

Basement shelters may be built at a cost of \$500 which may be obtained, in Canada, as a Home Improvement Loan repayable in 20 years. Surely, this is worthwhile.

## MASS INOCULATIONS

Attention has been drawn to the numerous health hazards resulting from the break-down of Public Utility Services. It has been suggested that mass inoculation be carried out. The problem here is, "mass inoculations against what?" As far as national disaster is concerned, many believe that our various Departments of Health are adequately capable of handling the situation, and, if necessary, help from adjacent areas could easily be recruited.

Regarding total warfare, we have no idea whatsoever as to what agents will be used by the enemy and it is impossible to inoculate against all possible agents.

Nevertheless, the physician may play his part by seeing to it that as far as possible all his patients keep their standard inoculations up to date.

*Continued on Page 82*

# Student Research

## CHRONIC OBSTRUCTIVE PULMONARY DISEASE IN FARMERS

During the months from June to September, a survey was conducted by the Department of Medicine concerning the incidence of obstructive pulmonary disease in the male farm population. The study was prompted by a preponderance of farmers in the hospital's pulmonary ward.

The two populations selected were, firstly, male farmers, at least twenty-five years of age, resident within a fifteen-mile radius of London, Ontario, and, secondly, male insurance executives with the same age qualification, resident within the city proper.

In examining the farm population, a car was provided, and the test made mobile by converting the battery's direct current to the alternating current necessary to run the spirometer. This allowed the writer to visit the farm directly. A farmer could therefore, conveniently perform the test

with the least possible delay, either at the fieldside or near the home.

Items included in our questionnaire covered the topics of asthma, bronchitis, allergic rhinitis and eczema both in the individual's own history as well as in his family's. The type of farm and the number of years spent on the farm were noted when examining the rural group. Similarly, questions covering the environmental background of the urban residents were also asked and the responses recorded.

Spirometry included both the vital capacity estimation and the more significant figure of the percentage of air exhaled forcefully during the first second of expiration. A reading of the latter figure below sixty-five percent was considered abnormal.

Auscultation was specifically intended for musical rhonchi, which were predominantly heard in the apical areas on the anterior chest wall.

### Preliminary Findings

(The survey is continuing for the summer of 1962)

| I*   | Positive History | Rhonchi | Positive Test<br>(Spirometrical) |
|--|------------------|---------|----------------------------------|
| A. Farmers   | 21.6%            | 14.4%   | 10.0%                            |
| B. Office Staff  | 8.3%             | 6.2%    | 3.0%                             |
| II Positive History Plus At Least One Objective Finding  |                  |         |                                  |
| A. Farmers   | 11.1%            |         |                                  |
| B. Office Staff  | 3.1%             |         |                                  |
| III All Three Headings Positive  |                  |         |                                  |
| A. Farmers   | 7.2%             |         |                                  |
| B. Office Staff  | 0%               |         |                                  |
| *Allergic rhinitis and eczema were considered separately since they are essentially non-obstructive. |                  |         |                                  |
| IV OTHER ATOPY   |                  |         |                                  |
|  | Hay Fever        | Eczema  |                                  |
| A. Farmers   | 3.7%             | 3.17%   |                                  |
| B. Office Staff  | 6.25%            | 8.33%   |                                  |



## CONCLUSIONS

The above initial findings obviously indicate gross differences in the incidence of obstructive pulmonary disease in the groups studied.

One factor in the extremely high percentage of those with positive histories is the difficulty in subjectively defining the difference between chronic bronchitis and the episodic nature of some exposure to acute bronchitis. This factor is eliminated to a great extent once the positive history is qualified by including at least one positive objective finding. (See II)

One explanation for the high incidence of obstructive pulmonary disease observed in the farm population is the great number of men with an obstructive picture who indicated a history of winter threshing. This activity was carried out before the advent of the threshing machine and consisted of threshing the wheat in the barn, where, as one farmer put it, "You couldn't see your own shoes for the dust." It is unfortunate that a controlled study can no longer be done on a growing population.

Another surprising difference, of course, was the lower incidence of the overtly allergic backgrounds of eczema and allergic rhinitis. A possible reason for this may be that the allergic individual in the farm environment progresses much earlier into an obstructive chest, whereas his city counterpart, unexposed to high doses of sensitizing dusts, escapes with only a history of allergic rhinitis.

In summary, that the farm environment is of significance in the high incidence of obstructive pulmonary disease, is obvious. What is not obvious, however, is what etiological agent or agents in the farm are producing this difference! It is to this end that the project is continuing during the coming summer.

Donner Dewdney, '63  
Department of Medicine  
under Dr. N. Lefcoe,  
Summer of 1961.

## A COMPARISON OF THE EFFECTS OF A COLD ENVIRONMENT AND HYPERTHYROIDISM, ALONE AND TOGETHER, ON THE RESTING METABOLIC RATE AND FOOD CONSUMPTION

It has previously been shown that thyroxine-induced hyper-metabolism causes a greater increase in resting metabolic rate but a smaller increase in food intake and inhibition of weight gain than does chronic exposure to an environmental temperature of 50°C. The following experiment was done to determine if the effects of thyroidal hypermetabolism and cold are additive.

Twelve male Sprague-Dawley rats each weighing approximately 180 grams, were housed in individual cages at 23°C. They were fed ad libitum a diet in which 20% of the calories were from carbohydrate, 59% from fat, and 20% from protein that provided 5.5 cal./gram. Food intake, body weight and oxygen consumption at 30°C. according to the method of Ferguson and Sellers were measured at regular intervals.

After being allowed 13 days to adjust to these new conditions, six rats were given a daily injection of 50 ugm. L-thyroxine subcutaneously. Each control rat was given an equivalent injection of normal saline subcutaneously daily. After four weeks of injections, three control rats and three thyroxine-treated rats were placed in an environment of 5°C.

From the experimental observations, it was found that during the four weeks of thyroxine injections at 23°C, the resting metabolism of the thyroxine-treated rats (measured at 30°C) increased 95% while their food intake increased 50%. In the control group, there were no appreciable changes in these parameters. The rate of weight gain in the thyroxine group was only 70% that of the controls.

When the rats were placed in the cold environment (5°C), the thyroxine-treated animals showed no increase in resting metabolic rate over the level that had been

achieved at 23°C. However, these thyroxine-treated animals in the cold did increase their food intake 30% by the end of two weeks; the thyroxine group at 23°C did not. The untreated controls after living in the cold for two weeks showed a 15% increase in resting metabolic rate (measured at 30°C) but an increase in food intake of 55% thus raising it to 80% of that of the thyroxine group of animals in the cold.

A high dose of thyroxine was given to ensure a maximal response in metabolic rate; the metabolic rate continued to increase after seven weeks. With such a high level of heat production, caused by this increased metabolic rate, no further increase in metabolism in response to cold was observed for the first two weeks, although there was an increase in food intake. This increase was no greater absolutely, and much less, relative to previous intake, than that of normal animals exposed to cold even though the resting metabolic rate of these controls under standard conditions was much lower. The resting metabolic rates measured in the environments of two animals are not comparable if there is a temperature difference in the two environments. However, in this experiment, it might have been a better means of analysing the energy balance than to have taken all resting metabolic rates at 30°C.

It has been shown that excess thyroxine causes a hypermetabolism that is accompanied by some increase in food intake which, however is not proportionate to the increased energy requirement. On exposure to cold, these hypermetabolic animals did not increase their metabolic rate any further, but they did increase their food intake. Therefore, it is concluded that a cold environment has a direct effect on food intake, likely mediated through the hypothalamus, that is independent of the indirect effect it may have through increasing the requirement for energy.

Pat Keeling, '64,  
Department of Physiology,  
Summer of 1961.

## INVESTIGATION OF ABNORMALITIES OF THE DEEP VEIN SYSTEM OF THE LEGS WHICH LEAD TO STASIS DERMATITIS AND ULCERATION

### PART I: STUDY OF THE VEINS IN THE LOWER LIMB

#### Venography

Two methods are used to obtain a venogram—intravenous, for those patients who are not edematous and who present good-sized veins in their feet, and interosseous, for those patients on whom venopuncture can not be performed.

#### Intravenous Technique

This method for doing venograms is by far the simplest and safest. The patient is positioned at 45 degrees on a tilting table beneath which a Potter-Buckey film holder is placed. The foot is positioned above the film holder so that half films can be used, and a control x-ray is taken. A pressure cuff is placed around the ankle of the limb to be viewed and is inflated to 60 mm. Hg. Twenty-five c.c. of "Hypaque" (Na diatrizoate) is injected intravenously. Pictures are taken on injection and at one, two, three, four, five, seven and one half, and ten minutes after injection.

Early stages in the project showed that in order to get dye to accumulate in the valve pockets, a semi-erect posture was necessary. The patient was tilted at 45 degrees, arbitrarily, because it was found that syncope often terminated the experiment if the patient were at a full 90 degrees and because the project involved many elderly subjects.

The pressure cuff was used to occlude the superficial venous system over the ankle and thereby force dye into the deep venous system by way of the perforating veins.

The exposures were taken at the above intervals to show the amount of stasis, the valve structure, and the amount of leakage into the superficial system. Because each patient is an individual, different times were needed to show these various things in different patients.

Safety precautions were taken to prevent allergic reactions. The patient was given a wheal test with Hypaque, and adrenaline was available throughout the experiment.

#### Interosseous Technique

The position of the patient and the x-ray procedure are the same as for the intravenous method. The subject is first premedated with 75 mg. Demerol and 1.5 gr. Seconal. Local anesthetic is then infiltrated subcutaneously and intraperiostally over the medial malleolus. A small puncture is made in the skin with a dagger blade. A sternal puncture cannula is inserted and driven into the bone marrow by means of bradawl action. One percent xylocain (Lidocain), up to 5 c.c., is given by way of the cannula and then 2.5 c.c. of 4% xylocain is mixed with 22.5 c.c. of 50% Hypaque and injected into the marrow cavity.

The areas suggested for injection by Begg<sup>5</sup> and Arnoldi<sup>1</sup> are the os calcis, the lateral malleolus and the medial malleolus. At first, the lateral malleolus was used, but it was found that the dye did not enter the venous system fast enough; therefore, the medial malleolus was selected. It was suggested that the amount of xylocain injected might be dangerous; therefore, 22 c.c. pentothal and an ambu respirator were kept on hand during the procedure.

#### The Experiment

Victoria Hospital records of 37 patients were selected according to the ability of these patients to withstand examination. All 37 were notified to report to the Wednesday morning clinic. Of these, thirteen responded and were subsequently venogrammed one or more times, giving a total of 18 venograms of cases with venous disease.

#### Summary of Patients and Findings

Mrs. M. A., Age 47.

Mrs. A.'s legs became swollen after her first pregnancy. Five years ago, she developed varicose veins, crampy feet, painful calves and swelling in the right leg. Thereafter, she developed bilateral stasis ulcers. She had been "stripped" bilaterally before she was seen by this clinic.

On July 8, 1961, an I.V. venogram was done on the right leg and on July 15th, a similar procedure was done on the left. The results of these venograms showed incompetent valves in the perforating veins of the right lower calf. On August 3rd, Mrs. A. underwent incision and deep ligation of these veins. Once healing is complete another venogram is to be done.

Mrs. E. C., Age 50.

Following an appendectomy 30 years ago, Mrs. C. developed phlebitis. During her third pregnancy, two weeks before parturition, she developed a swollen left leg. Shortly thereafter, an ulcer appeared.

Her left leg showed moderate varicosities and telangiectasis on the medial part of the foot. She was scheduled for an I.V. venogram on July 12, 1961 and was subsequently admitted to hospital to have the incompetent perforating vein found by this procedure, tied off.

Mrs. A. D., Age 76.

Mrs. D. has had chronic venous insufficiency in both lower legs for many years, and she has suffered bilateral ulceration over both malleoli. She claims that this is not the result of phlebitis.

An I.V. venogram on the right leg was done on July 14, 1961. It was decided that due to evident arterial insufficiency and due to her age there should be no operative procedure; instead she should be treated with viscopaste dressing.

Mrs. B. D., Age 64.

In 1949, Mrs. D. suffered a bilateral attack of phlebitis following a resection of

her right colon for carcinoma.

On August 5, 1961, an interosseous venogram was done on a very edematous right leg. This showed that from the valve standpoint and from the condition of the deep venous system, there was no need for surgical intervention. It was stated that any further examination should be carried out lymphatically.

Miss V. D., Age 59.

This patient showed chronic stasis changes over her right tibia. A history was unavailable and the patient was not interviewed by this experimenter. A venogram was done on August 23, 1961, but has not yet been analysed.

Mrs. T. D., Age 47.

One year after a disc operation in 1959, Mrs. D.'s ankle began to swell. A diagnosis of cellulitis was given, but from the findings in this clinic, it was felt that she had suffered an attack of phlebitis. The left leg was x-rayed on July 21, 1961 and on July 29, 1961 by interosseous technique. Both attempts were unsuccessful. However, she was the first patient in whom a painless interosseous venogram was done. She should return for further investigation.

Mrs. M. N., Age 59.

This woman has had trouble with stasis ulceration in both extremities over a seven year period. The ulceration began following a post-partum attack of phlebitis after her first pregnancy 35 years ago. Several skin grafts have been applied to the leg unsuccessfully. In March, 1960, the superficial veins were removed and a skin graft was applied to the whole lower limb. Since this last operation, she has had no trouble but still has to wear an elastocrepe stocking.

Mrs. H. has had a series of x-rays previous to this clinic. The first was by intravenous means and the following two by descendent venography. The fourth was done July 5, 1961 in this series by the interosseous technique. A good deal of pain was felt and only 10 cc. of Hypaque

could be administered. This venogram showed a large perforating vein in the upper outer calf with moderate incompetence. Operative therapy was questionable since her previous operation showed good results. One further venogram on her right leg was done on August 8, 1961. No diagnosis has been made as yet.

Miss P. K., Age 33.

This woman was found to have a psychopathic personality and was easily addicted to drugs. It was seen that she self-inflicted stasis by placing a band obstruction on her leg. In March, 1957, she entered hospital and tried to obtain Demerol to ease her complaint. She has been 'stripped' once from knee to ankle in 1955. In April, 1961, she entered hospital again with a complaint of venous stasis. On August 23, 1961, the left leg was venogrammed by interosseous methods, but she was given no premedication. There was some pain recorded in this procedure.

Mrs. D. M., Age 21.

Mrs. M. came to hospital for venous stripping and was subsequently venogrammed. She had prominent veins for four years and complained of pain and cosmetic defect. The venogram was the first of a series and was done on June 6, 1961 on the left leg with the patient at 90 degrees. She felt faint after five minutes. The deep venous channels looked healthy and normal but another venogram should be done to see the effects of stripping.

Mr. A. P., Age 59.

Mr. P. had gross varicose veins for six years and showed a positive Trendelenburg. He was treated by venous stripping. Two venograms were done on the right side. The first, on July 28, 1961, before stripping, showed little because the volume of blood was too great for the amount of dye injected. The second was done on August 11th, after operation, and showed perforators on both sides of the leg.

Mr. A. S., Age 30.

Two years ago, Mr. S. developed dia-

phragmatic pleurisy. He was treated by decortication, but developed thrombophlebitis post-operatively. He presented with stasis dermatitis and ulceration of his right leg. He was venogrammed twice: the first by intravenous technique at 90 degrees and the second by interosseous technique at 45 degrees with no premedation anesthesia or anesthetic with the dye. The second venogram was very painful, and showed exactly the same picture as the first. It was felt that there was questionable deep venous competency and that the value of operation was also questionable.

Mrs. S. W., Age 31.

This gravida six female developed thrombophlebitis after the birth of her first child. Varicosities developed and she was "stripped" thereafter. She entered the hospital for repeat "stripping" of her left leg. A bilateral venogram was done. The left side showed no saphenous system and, at mid-calf, perforators were seen. There was some question as to whether the right side was normal.

Mrs. M. W., Age 60.

Mrs. W. has complained for many years of bilateral stasis ulcers, which began shortly after her first child was born. A venogram was done on July 26, 1961 on the right leg. Surgical interference was questioned. Another venogram should be done.

### Discussion

The box score of this series of venograms shows that out of eighteen patients venogrammed, two were found in which surgery could definitely help. One patient showed no trouble in the deep venous system. Three venograms were used as aids in "stripping" to locate the areas of greatest trouble. All eighteen showed that where there has been thrombophlebitis, there is a decrease in the number of competent valves and a great deal of recanalization which reaffirms the findings of Bauer<sup>2,3,4</sup> and Dewese<sup>6</sup>.

All venograms were subjected to a critical diagnosis before the patient was seen.

In every case, the diagnosis was substantiated almost exactly.

### Summary and Conclusion

The use of venography or phlebography as a diagnostic tool has been found to be useful in cases of varicose veins, stasis ulceration, and stasis dermatitis. In eighteen venograms reviewed, it was felt that all of them showed the experimentors what course should be followed in the future management of the patient.

## PART II: EXPERIMENTS TO DEVELOP EXPERIMENTS TO DEVELOP A PAINLESS INTEROSSEOUS VENOGRAM

### Introduction

During the course of the summer, it became clear that a way should be found to do a venogram on patients whose legs would not permit ordinary I.V. techniques. It was found that interosseous venography has been used in several centres with success.

On performing this technique by the methods first recorded by Arnoldi<sup>1</sup>, it was seen that two problems faced us. First, the interosseous venogram was painful and second, it was very difficult to get the dye into the patient fast enough to get the proper concentration for x-ray.

### Methods for Faster Injection

To inject the dye, the lateral malleolus had been used, but it was found that the Hypaque could not be injected at a rate sufficient to give a satisfactory x-ray. It was found that the medial malleolus was much better and gave a picture of the same veins as before.

### Elimination of Pain

To eliminate pain, several remedies were tried. Premedation with 75 mg. of Demerol and 1.5 gr. Seconal lessened the pain and especially the apprehension of the patient a great deal.

One method used by Arnoldi<sup>1</sup> for anesthesia was to inject 5 c.c. of 1% xylocain; however, it was found in the project that considerable pain was still experienced after this procedure was carried out. The experimentors felt that the blood flow in the marrow cavity was so great that the xylocain was washed away before it could give complete anesthesia. Injecting a local anesthetic along with the radio-opaque dye after preinjecting 5 c.c. of 1% xylocain was thought to be feasible.

It was found that 50% Hypaque (sodium diatrizoate) and xylocain were miscible in all proportions. Then, animal experiments were carried out to find if the dye changed the properties of xylocain.

#### Method

For this experiment, 5 guinea pigs were used. Pain thresholds were measured with a square wave stimulator set at 50 m. sec. duration and 60 shocks per minute frequency. Injections were made subcutaneously and the pain thresholds again measured until the sensitivity returned to within 20 volts of its original mark.

#### The Experiment

Half c.c. injections of normal saline, xylocain 2%, Hypaque 50%, and 50% Hypaque plus 2% xylocain in equal proportions were made. Pain thresholds were determined at each of the four injection sites in each guinea pig.

This experiment indicated that the duration of the anesthetic properties of xylocain were diminished slightly by Hypaque; however, it was thought that changes towards the shortening of anesthetic effect were due to the dilution of xylocain. In some instances, it seemed that the Hypaque-xylocain mixture was more potent, i.e., onset of anesthesia, but it was felt that this was due to the irritant properties of the 50% dye.

The experiment also showed that the guinea pigs suffered no toxic or allergic reactions to this mixture.

#### Review of Patients Done by Interosseous Technique

Mr. A. S.

Mr. S. was venogrammed first by the intravenous technique and showed a great deal of leakage into the superficial system. It was decided that an interosseous technique should be done to show the deep system to better advantage. The patient was prepared with no premedication and no xylocain mixed with the opaque dye. The patient stated that the technique was "ten times" more painful than the intravenous phlebogram he had had previously.

Mrs. M. H.

Mrs. H. had no visible veins on her foot due to a previous operation. An interosseous venogram was done without premedication and without xylocain in the dye. The patient was in so much pain that the injection was stopped before it was half way through.

Mrs. T. D.

Mrs. D. had two interosseous venograms. The first was done without premedication and the dye-xylocain mixture and was quite painful. The second was done with 75 mg. Demerol and 1.5 Secondal pre-anesthesia, as well as 5 c.c. 2% xylocain in 15 c.c. of the dye. She said she felt no discomfort whatsoever during this second procedure.

Mrs. B. D.

Mrs. D. was venogrammed in a manner similar to the second method used on Mrs. T. D. She felt no discomfort and nearly went to sleep during the procedure.

Miss G. K.

Miss K. was given no premedication and said that the procedure was uncomfortable; however, she did not exhibit the reaction of the patients who did not have xylocain injection with the dye. One other change was made in the procedure done on this patient—2.5 c.c. of 4% xylocain were used in 22.5 c.c. of dye.

## Discussion

The interosseous phlebogram has been available to radiologists for a long period of time, but its use was restricted because there was so much accompanying pain. Begg<sup>5</sup> stated that to do this type of venography, he preferred general anesthesia. Arnoldi<sup>1</sup> was the first to record a practical method which, he stated, was not uncomfortable; however, application of his method at this centre showed that the procedure was still far too unpleasant, and, therefore, inspired modification.

The technique used here now is as follows. Presedation of 75 mg. Demerol and 1.5 gr. Seconal are given to the patient one-half hour before the venogram is to start. The patient is placed on a tilting table at 45 degrees and 1% xylocain is then infiltrated subcutaneously and intra-periostially. A sixteen gauge 1.5 inch sternal puncture needle with stylet is inserted into the bone marrow cavity by bradawl action. The stylet is removed and a 5c.c. syringe filled with 2% xylocain is injected slowly into the marrow cavity. A second syringe filled with 22.5 c.c. 50% Hypaque and 2.5 c.c. 4% xylocain is injected into the bone as rapidly as possible and x-ray pictures are then taken. Throughout the

venogram, the usual adequate safety precautions should be taken. A wheal test with Hypaque should be done prior to injection and adrenaline kept handy throughout. Pentothal and a positive pressure respirator should be available to take care of unforeseen accidents with the local anesthetic.

## Conclusion and Summary

A method has been outlined by which painless interosseous venography can be done. In institutions where venography is used as a means of investigation, methods must be found by which all candidates can be x-rayed. This painless interosseous method gives the radiologist a simple technique to use in patients previously requiring venous cutdowns.

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George DeYoung,  
Department of Surgery,  
under Dr. A. D. McLachlin,  
Summer of 1961.

Continued from Page 74

## SUMMARY

An account is given of the many ways in which the doctor may participate in a Civil Defence program. This involves making full use of his position in society by setting the example and stimulating interest.

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# Historical Roentgen His Discovery and its Effects

RICHARD A. STEEVES, M.D.\*

"In the history of Science, nothing is more true than that the discoverer, even the greatest discoverer, is but the descendant of his scientific forefathers; he is always essentially the product of the age in which he is born."<sup>1</sup>

Sylvanus P. Thompson, speaking these words to the Roentgen Society in London on November 5th, 1897, was probably thinking of Roentgen at the time. It is because of this truth that Roentgen's scientific forefathers and their achievements have been briefly described as an introduction.

## I HISTORY LEADING UP TO HIS DISCOVERY

Before any advance could be made towards Roentgen's discovery, two techniques had to be mastered:

- 1) the production of a good vacuum
- 2) the production of an interrupted electric current.

It is interesting that both of the appliances necessary were discovered by the same man,—Otto von Guericke, and his results published in the same book, in 1672.

The date of the discovery of the air-pump is uncertain but was probably around 1640. He demonstrated his pump by sucking the air out of wooden casks and later from a copper sphere, all of which collapsed when a certain degree of evacuation had been attained. In 1654, he demonstrated his results by showing that thirty horses were required to pull two hemispheres apart after he had evacuated the enclosed air with his pump.

His frictional electric machine was fashioned by filling a large glass globe with molten sulphur. On cooling, the glass was removed and the sulphur sphere was rotated by hand.

Of the many later workers who continued these lines of research, only those who

Awarded the Rowntree prize in Medical History 1960-61 Session.

\*Written when Dr. Steeves was an Undergraduate in February, 1961.

were instrumental in perfecting a vacuum in association with electrical phenomena are mentioned below.

Francis Hauksbee began to experiment in 1705 on the effect of agitating mercury in a vacuum. He found that the mercury, violently rushing into the container, looked like a flaming mass made up of innumerable little glowing balls. Hauksbee was therefore the first to produce an electrostatic discharge in a vacuum, but thought the luminosity was a property of the mercury and therefore termed it "mercurial phosphorus". He studied the effect of different degrees of exhaustion of air on the quality of light produced, and showed that even light friction (such as his hand revolving in a glass globe) in a partial vacuum would produce luminosity. He also noted that the light altered with the re-admission of air.

In 1785, William Morgan, a brilliant actuary, did meticulous work to show that there could be no electrical discharges in a "perfect vacuum" and suggested that the particles of air were too far apart to conduct electrical fluid. He demonstrated clearly that the color of the light rays depended on the amount of exhaustion of air from his container.

Other workers in the field, such as Faraday, observed a dark space around the cathode of his vacuum tube when he applied current to the terminals. This led to Hittorf's discovery that discharges through a partial vacuum produced rays that passed



from the cathode, and these were called the cathode stream by Goldstein in 1876. It was also shown that obstacles in the stream cast a shadow on the glass tube. Varley and Crookes showed that the cathode stream was deflected in a magnetic field, and that the rays consisted of electrified particles shot out from the cathode.

Although Crookes also discovered the focusing effect of a concave cathode in 1874, Sir Herbert Jackson was the first to adopt this design for practical purposes, using it to restrict the area of the phosphorescent material. In January, 1894, he used a tube with the concave aluminum cathode and an inclined platinum anode;—the original Jackson "focus tube". With it, like other early workers, he undoubtedly obtained X-rays from the anode, but he thought they were long wave ultraviolet radiations. In fact, immediately after Roentgen's discovery, he was able to use his original tube for X-ray work, but expressly stated on several occasions that the characteristic penetrating power of the radiations emitted by the anode had neither been discovered nor suspected by him.

## II ROENTGEN'S EARLY LIFE

Wilhelm Conrad Roentgen was born on March 27th, 1845, the only child of a prosperous textile merchant in Lennep, a small provincial town in Germany. When he was three, the family moved to Apeldoorn, Holland, where he spent a pleasant childhood and attended primary and secondary schools. At fourteen, he registered at a Technical School in Utrecht. He was an average student at his sciences, preferring to spend his time in skating, riding, making mechanical contrivances or roaming the countryside. One day, a fellow student had drawn a caricature of an unpopular teacher on a fire screen in the school, and Wilhelm was enjoying it to the full when the instructor came in. In a towering rage he demanded the name of the offending artist, but the boy would not reveal it. The director of the institution was accord-

ingly summoned, and, in order to pacify the angry teacher, he ordered that Wilhelm be expelled.

Though only a few of the Roentgens had received a university training, and though his father secretly hoped that Wilhelm would succeed to his business as a merchant, he obtained permission for private examinations to furnish his son with credentials to enter college. After a year, when he had added Latin and Greek to his studies, his examiner (who was favorably disposed toward him) suddenly took ill the day before the exam, and was replaced by a teacher who had taken part in the expulsion;—Wilhelm failed! He next attended two semesters of sciences at the University of Utrecht as a special student. At the age of twenty, in November of 1865, he attended the Zürich Polytechnic School which accepted students without the usual credentials but only those who could pass difficult entrance exams. Fortunately for Wilhelm, a letter from his Doctor for eye trouble as well as good reports from Utrecht persuaded the authorities to accept him without the usual exams. For three years, Roentgen did well, studying mathematics and engineering, taking during this time only one course in technical physics. In 1868, he graduated in mechanical engineering, and in June of the following year, he attained his Doctor of Philosophy degree from the University of Zürich. He was interested in the physical properties of gases at this time and became assistant to August Kundt, traveling with him to the University of Würzburg in 1870. In January, 1872, he married Anne Ludwig of Zürich, a well educated, charming woman, six years his senior. They settled in a house in Würzburg, but all did not go quite so merrily as the proverbial marriage bell; Wilhelm had been spoiled by his parents and was not easily domesticated. Besides lacking money, Roentgen was not entirely happy in his work, having a poorly equipped laboratory and little chance of advance without additional formal education. In April of 1872,

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he travelled with Kundt to the University of Strasbourg, where the atmosphere was more youthful and liberal. In two years, he was on the faculty and in another three years, he took a full professorship in the Agricultural Academy at Hohenheim. However, the facilities here were worse than ever, overrun with vermin. His wife, as he wrote to a friend in a letter, soon established more or less friendly relations with the rats in return for kitchen scraps and she managed to beat the cockroaches down.<sup>2</sup> It was with relief, therefore, that he settled back in Strasbourg as associate professor in 1878. He did excellent work here studying gases and crystals. He saw each problem clearly, tested his findings rigidly before publication and described the results briefly and precisely. As a result, he was recommended for the chair of physics at the University of Giessen in 1879, studying crystals and heat. Soon he began to receive many good offers but he couldn't resist the professorship of physics as director of the new Physical Institute at the University of Würzburg in 1888. To him, this was a great triumph, sixteen years after his "impasse" at the same institute. He was very comfortable here, among good friends, and apparently did not work entirely at physics, because in 1884, he was elected to rectorship of that University, the highest honor that it could bestow. His department was well organized, he had few academic worries, (except the nuisance of teaching) and spent much time hunting and botanizing.

### III THE DISCOVERY

Late in the afternoon of Friday, November 8th, 1895, Roentgen was working alone in his laboratory. He had been working with cathode ray tubes for two or three weeks now, and recently had begun to cover them with black paper in which a window had been cut for the passage of the cathode rays. Then, he decided to test the density of the black cover by closing the window over his modified Crookes tube. In the darkened room, he saw no

visible glow from the cover on the tube, but suddenly, he noticed a weak glow shimmering on a bench nearby like faint green clouds, and moving in unison with the alternating electric discharges that were passing through the tube. He lighted a match, and discovered to his surprise that the source of this mysterious phenomenon was a small fluorescent cardboard screen that he had coated with barium platinocyanide for the detection of cathode rays. He repeated the experiment again and again, moving the screen farther away each time, and continued to get similar results. He was amazed that invisible energy from the tube should make itself visible by its effect on the fluorescent screen as far as two meters away, while the maximum range of cathode rays was little more than an inch. He then interrupted the rays by various bodies which would have been quite opaque to cathode rays, and found that the penetrating power of this new type of radiation was many times greater, and varied roughly with the density of the interrupting body. When he placed his hand in the path of the rays, the shadows of his bones appeared upon the screen!

There followed seven weeks of intensive work, during the early part of which Roentgen ate and slept in his laboratory. According to his wife, he was morose and abstracted, and resented the intrusion of mundane matters. On December 28th, he presented his "Preliminary Communication" to the President of the Physical Medicine Business House in Würzburg, and it was printed a few days later, entitled "On a New Kind of Rays", in which he proposed that they be called "X-rays", and he described their properties in considerable detail. He considered that X-rays move with the same velocity in all substances and classified various substances according to their radio-opacity. He was unable to refract or reflect the rays, nor could he deflect them with a magnet. Finally, he hazarded the tentative suggestion that X-rays were "longitudinal vibrations in the ether".<sup>3</sup>

## —Roentgen Discovery—

On January 6th, 1896, the news of his discovery was cabled from London to the whole world, and the reaction was immediate. Then the first translation of his "Preliminary Communication" appeared in *Nature* magazine on January 23rd. On that same evening, Roentgen gave a public lecture in his institute, after which he discussed the possible uses of X-rays in medicine and surgery. Despite some openly expressed skepticism on the part of some physicians and surgeons, the University of Würzburg conferred on Roentgen the honorary degree of Doctor of Medicine on March 3, 1896.

A point should be made regarding the suggestion, frequently made, that the discovery was an accident. Years later, Middleton, who had been one of Roentgen's students at the time, stated that the discovery was made because Roentgen happened to mark the page of a book which he was reading by placing a metal key between the pages. By accident, also, he happened to lay this book on a photographic plate. Later, when he developed the plate, there was the shadow of the key. However, not only is there a high element of coincidence in this story, but Middleton was only a student, and even Roentgen's assistants knew very little about the discovery. Roentgen later said that he had been "looking for invisible rays"<sup>4</sup>; he probably knew what he was looking for, but hardly could have foreseen its properties.

#### IV SOCIETY'S REACTION TO THE DISCOVERY

Immediately after the discovery, pandemonium had broken loose. Almost overnight, he had become a focus of international praise and condemnation, for the daily newspapers everywhere were filled with the news, and often embellished it with fantastic speculations. The medical journals soon followed, although somewhat skeptical at first, for on January 11th, *Lancet* treated the whole matter as a Dicken-

sian joke. On the following week, this journal unbent to the extent of saying: "The possibility of the application of this discovery as an aid in medical and surgical practice is a shade nearer probability". By January 25th, *Lancet* mentioned with apparent gratification that "the application of this remarkable phenomenon to the discovery of bullets and abnormalities in the structure of the bone has already been made, with very promising results".<sup>5</sup>

From every quarter of the world came letters of congratulation, and through the doors of his institute passed scientists, reporters and mere curiosity-seekers, some of whom did not hesitate to filch his X-ray photographs. Postal cards bearing Roentgen's signature mysteriously failed to reach their destinations. His mail was full of popular magazines and letters, bearing advice on the best ways of exploiting the discovery for monetary gain. But how little their writers knew this great man, or were able to understand his belief that discoveries by German university professors belong to the world, and should not be restricted by patents or controlled by any one group.

Many cults and business groups, of course, had to express their opinions as well. Spiritualists maintained that his work proved as well as any material equipment could—the existence of a spiritual body in accordance with the teaching of St. Paul—for which the natural body was but an envelope. Prohibitionists thought that the new rays would rapidly advance the temperance movement—by showing those who smoked and drank the progressive damage to their systems brought about by these deplorable habits, and as one American temperance worker put it, "seeing is believing!" There was obviously a belief that some sort of waistcoat pocket X-ray apparatus might be developed, and grave fears were expressed that women's modesty would no longer be safe from assault. One progressive London firm was quick to respond with an advertisement of underclothing that was impenetrable to X-rays. And on February 19th (of 1896), an

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Assemblyman from New Jersey, actually introduced a bill into the house at Trenton, N.J. "prohibiting the use of X-rays in opera glasses in theatres".<sup>6</sup> But let us not be too hard on New Jersey. A New York newspaper said that the new rays were being employed in a large medical school in that city to reflect anatomical diagrams directly into the brains of its students, where they made a more lasting impression than did the ordinary method of learning the details of anatomy.<sup>7</sup>

The discovery had a powerful and direct effect on Roentgen, as well. Within a short time, it seemed that he and his wife would have no escape from the invasion of the curious. She complained to a friend that their domestic peace was gone, and he was annoyed and perplexed by the excitement and confusion. At last, it became too much for the Roentgens, and on March 10th (1896) they fled to seek some peace of mind in Italy, but they were often recognized, made objects of public curiosity, and had to turn down many invitations to lecture. They returned to Würzburg early in the summer of that year, but Roentgen received such a flood of invitations to lecture that he and his wife left for Switzerland after a few weeks, where they took refuge from the crowds in the home of old friends. Offers continued to pour in from one university after another, but all were refused. Finally, however, at the special request of the Bavarian Government, he reluctantly agreed on April 1st, 1900, to take over the new Physical Institute in Munich.

## V FOLLOWING TECHNOLOGICAL DEVELOPMENTS

Because of Roentgen's refusal to hamper the further development of his discovery in any way, the improvement of the X-ray tube began almost immediately. Before long it was found that a bit of platinum, mounted in the centre of the tube, made a more efficient "target" than the glass wall of the tube in the original models. Over

the years, thousands of improvements and new techniques have been discovered, and now, just over sixty-five years after the discovery, X-ray tubes vary in size from that used in dentistry (about the size of a finger), up to a nine foot giant, the rays from which can penetrate twelve inches of steel. Roentgen's induction coil, which provided electrical discharges that alternated back and forth at an intensity of about 10,000 volts, has been replaced by transformers with a potential as high as several million volts. With improvements in apparatus, and in the photographic films employed, the exposure for an X-ray photo has been reduced from twenty minutes to as little as a fraction of a second for tissues usually penetrated by X-rays.

Methods of applying the use of X-rays in medicine and surgery have altered a great deal as well as the X-ray apparatus itself. Early X-rays were limited to the diagnosis of fractures or the localization of foreign bodies such as bullets, but in a short time, concretions such as gallstones or renal tract stones were noticed. An important advance came in December of 1896, when an American Physiologist, Walter Cannon, fed bismuth subnitrate to small laboratory animals, and later saw the outline of their intestines with the aid of X-rays. Gradually, techniques were developed for studying many other hollow viscera, various spaces, and even blood vessels in living subjects. The use of X-rays in the treatment of new infections and several neoplastic diseases, particularly those of the skin, was recognized in early 1896. Although other methods of treatment are now more satisfactory in many of these disorders, X-ray therapy still has an important contribution to make.

## VI MARTYRS TO X-RAYS

But along with the fascinating developments and advances in technology, came a hostile force which at first lay in ambush. Early workers began to notice serious ulcerating burns on their hands in particular, and

## —Roentgen Discovery—

several reported their findings in early 1896. Dr. Grubbé of Chicago remarked:

"At first my symptoms were erythema, edema, hyperemia and hyperesthesia. A few days later, there was bleb and blister formation with skin desquamation and epilation of the hair. Later, the skin cracked and ulcer formed. (Parenthetically I would state that this hand was amputated piecemeal and for some years has been gone entirely.)"<sup>8</sup>

Lesions most commonly began on the back of the left hand and at the finger tips. This was often due to the fact that during the exposure of the patient, the radiologist would test the degree of penetration of the rays by means of a hand fluoroscope. Since most of the workers were right-handed, they would hold the pyramidal hood to their eyes with the right hand, and would place the other free hand between the fluorescent screen and the X-ray tube.

The twenty-seven biographies that Mr. Percy Brown presents in his book of martyrs represent only a few spectacular cases of the many early workers who suffered amputated appendages, often followed by carcinoma and massive pulmonary metastases.<sup>9</sup>

The reason for such maiming of these intelligent people can hardly be attributed to ignorance after Roentgen's Second Communication in early March of 1896. As to indifference, the application cannot be a general one, but must be considered as qualified by individual temperament. Indifference in the sense of apathy might be applicable to a certain proportion of the pioneer attitude, and in the sense of disdain, the term admits an even wider application. It must be remembered, as well, that enthusiasm was very prominent at this time. To add to these conditions, there was an extraordinary lack of concern on the part of some of the producers of X-ray apparatus—regarding the physical welfare of their medical customers.

Roentgen himself did not suffer because he had carried out his experiments in a large zinc box that shielded his instruments against static electricity emanating from

the X-ray tube. In this box, he remained with his measuring apparatus, the rays entering through a window cut in its walls. For reasons of his own, he had added a lead plate to the zinc wall between the tube and his body, and so had worked in safety.

### VIII ROENTGEN'S FINAL YEARS

Roentgen was the recipient of almost countless honors, and seldom have such distinctions been more thoroughly deserved. Amongst the many which I shall not list here, he was awarded the first Nobel Prize in Physics in 1901. Characteristically, he gave the prize money to the University of Würzburg to be used in the interest of science.

By the end of the war, Roentgen was a desolate old man, for he had survived not only his wife but many friends as well. Furthermore, he had lost a very comfortable fortune by changing his foreign investments into German war loan bonds. In his closing years, a lifelong love for the Swiss mountains had been intensified, but professional responsibilities and his wife's last illness had kept him at home. After the war, the journey was made very difficult by inflation of the German mark. However, he did make the trip in the summer of 1921, and again in the following summer. Upon returning to the laboratory, he resumed his work with a new enthusiasm until a few days before his death, on the morning of February 10, 1923, at the age of 78.

### VIII SUMMARY

In looking over Roentgen's life briefly, there were several interesting facts worthy of note:

- 1) Roentgen, the great experimental physicist, had never attended a fundamental course in experimental physics during his years at college.

- 2) His early work had ranged through a wide variety of fields:
  - a) Electromagnetic rotation of the plane of polarization of light in gases.
  - b) Absorption of heat in water vapor.
  - c) Compressibility of liquids and solids.
  - d) Production of magnetic effects in a dielectric.
  - e) Various studies on the properties of crystals.
- 3) He started to experiment with cathode ray tubes in late October, 1895, and his discovery occurred only two or three weeks later, on November 8th.
- 4) Roentgen was the first man to discover, but not to produce X-rays.
- 5) Roentgen was one of the very few pioneers of X-rays who protected himself carefully from exposure.

It is still rather difficult to determine Roentgen's place in the history of science. It is certainly true that the stage was set for the discovery of X-rays, and that Roentgen was the actor chosen by fate to take the cue. Had he failed to do so, the discovery would certainly have been made by another.

It is also undeniable that the achievements of men such as Sir William Crookes, Sir J. J. Thompson and Sir Ernest Rutherford were consistently more valuable in the development of atomic physics, although Roentgen's work must bear greater medical significance.

Otto Glasser, an enthusiastic biographer of Roentgen, sums up his attitude to scientific investigation in the following passage:

"The salient feature of Roentgen's work which makes him an excellent representative of classicism was his persistence and his critical honesty in making observations and measurements. He approached the solution of physical problems with great acuity and relentless thoroughness; and with great skepticism he always warned against accepting any hypothesis which was not based upon sound experimental evidence. Therefore, the results of his work which were published in his papers are distinguished by a rare reliability, combined with remarkable classical brevity and simplicity. Roentgen was an experimental physicist in the truest sense of the word."<sup>10</sup>

Even allowing for Glasser's enthusiasm, and the role of fate, the value of his work is in no way diminished, and his fame is secure as one of the greatest of mankind's benefactors during the nineteenth century.

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## Book Reviews

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**Introduction to Anesthesia: The Principles of Safe Practice:** by Dripps, Eckenhoff, and Vandam. (2nd Edition), W. B. Saunders Co., 1961. 393 pages, line drawings, graphs and charts. \$4.75.

Anesthesia to the student is a rather shadowy world of chemicals, complicated apparatus, pharmacology, therapeutics and operating theaters. The authors have attempted to set down the science, art, and safe practice of anesthesia in a manner designed to make sense to the student, while leading him gently through the complexities of the specialty. The volume serves as a guide to student and intern alike, an introduction to safe practice in anesthesia.

The subject matter is divided into seven sections dealing, in order, with pre-anesthetic considerations, the day of anesthesia, the operation, postoperative period, resuscitation, consultant anesthesia, and special topics. Each of the forty-one chapters deals with a specific topic, arranged in orderly sequence. Controversial and confusing points are omitted; fundamentals are emphasized, especially in the technical matters.

The "Preanesthetic Period" deals with patient-anesthetist relations, evaluation of patient status and risk, choice of anesthetic agent, and pre-operative medication. Inadequate knowledge of the patient's history and condition on the part of the anesthetist adds just as much to the operative risk as does incompetent surgery.

"The Day of Anesthesia" includes chapters on essential pre-operative measures, elements of a gas machine, monitoring devices, properties, choice and use of all the common agents, indications and techniques for endotracheal intubation, muscle relaxants, and others. Numerous line diagrams serve to explain the complexities of vaporizers, rebreathing circuits, absorbers, and monitoring devices. A simplified explanation of the gas machine is designed

to help the student orient himself on any of the many commercial models. Labelled photographs would have been a valuable addition here. Chapters on obstetrical and pediatric anesthesia are excellent. Charts and graphs abound, but are occasionally inadequately explained, or set at some distance from the appropriate text.

"During Operation" describes the anesthetic record, how to determine the depth of general anesthesia, intravenous therapy, and the common complications encountered. The anesthetic record is adequately outlined and explained; means of determining depth of anesthesia—an especially crucial test for the novice—are set out clearly and briefly, with emphasis placed upon the need for constant monitoring of the vital signs. Acid-base balance is oversimplified, but this is in keeping with the authors' purposes. Emergency treatment of anesthetic complications is clearly explained. A chapter on "Fire and Explosions" compares the various agents' combustibility under all conditions; these are hazards rarely talked about, but constantly in the mind of the surgical team. The authors wax philosophical when dealing with Surgeon-Anesthetist relationships, and emphasize obvious considerations.

Especially well handled in "The Postoperative Period" are treatment of postoperative pain and sepsis in anesthesia. The anesthetist is in the best possible position to supervise the aseptic technique in the operating room.

"Resuscitation" covers respiratory and cardiac arrest—their causes, diagnosis and treatment—clearly and concisely enough to be of use in any field.

An interesting section is "The Anesthetist as a Consultant". Management of coma, immediate and long-term and the anesthetist's place in supervising inhalation therapy, are the topics covered.

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# News and Views

## NEWS AND VIEWS THE DOCTOR IN MODERN SOCIETY

New Democratic Party leader T. C. Douglas speaking before the 62nd Annual Hippocratic Banquet held on January 12th, 1962, stressed the need for a comprehensive national health scheme. He emphasized that "the social and economic aspects of medicine have failed to keep pace with the scientific and technological progress of recent years". Thus, although our medicine ranks with the best in the world, he is of the opinion that the resultant increase in costs are beyond the means of the one-third of the Canadian people who do not earn enough to pay Federal income tax, as well as the middle class person who he feels is unable to budget for any extended illness, especially if he is the bread earner.

Mr. Douglas continued by outlining a five-point program including what he considered to be the essential features of any national health scheme.

1. Any health plan, which includes all services, should be financed, at least in part, on a prepayment principle with the remainder coming from corporation tax and a surcharge on income tax. This, he stated, would tend to dispel any public misconception that they are getting "something for nothing".

2. To be successful, it must have universal coverage. Although, he conceded, the voluntary plans in operation to-day have been beneficial for two-thirds of the population they fail to cover those who can't afford them; this latter group has the highest incidence of illnesses. Of economic necessity, these plans also exclude the congenitally ill as well as the people with a bad medical history.

3. Any health plan must have as its major objective a high quality of care. This, he stressed, is the main value of such a plan. He feels that by establishing greater financial incentives, opportunity for planned

holidays, periodic refresher courses, etc. for doctors more of them will be encouraged to enter general practice since the need for the family physician, especially in the rural areas, is ever increasing. He reminded the gathering that "people need someone to see them as a whole, not just as a diseased organ". In time, he envisages group practice, combining the family physician, specialist, and public health officials to administer both preventive and therapeutic services.

4. The health plan must be government sponsored and publicly administered by a board directly responsible to the government. This, he stated, is necessary because only government can collect taxes as well as equally distribute the financial burden. He is of the opinion that many of the doctors' fears concerning political interference are understandable; however, many are also unrealistic. For the record, he conceded that he would be an advocate of a fee-for-service plan.

5. The health plan must be acceptable to both those providing the service and those receiving it. This, he stated, can be accomplished by a consideration of the basic wants of both the doctor and the patient. He summed up the doctor's wants as—an adequate income in recognition of his long years of training, his responsible position, and as a protection against the short period of his earning capacity; an opportunity for retraining and refresher courses to keep abreast with modern medical developments; and security for his family, future, etc. The patients' wants are a right to good health and protection against the financial embarrassment of a prolonged illness.

In concluding, Mr. Douglas emphasized that the financing of such a scheme is certainly feasible. He stated that in 1960, the Canadian people spent almost two dollars on tobacco and liquor for every one dollar spent on medical and dental



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services. Therefore, he concluded, the money is obtainable and the costs should not be considered excessive. Mr. Douglas stated that this problem is quite analogous to the educational problem our country experienced during its early development when only those children whose parents could afford to send them to a private school, could obtain an education. People at that time also complained when the

government took control, especially since school taxes had to be paid by all property owners, even though they may have had no children. In time, he continued, most people came to realize that without an educational system for all, a country's democracy is a farce, just as people to-day are beginning to think of health in the same way.

Paul Fisher, '63

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*Continued from Page 90*

The section on "Special Topics" deals very fully with pulmonary function and the tests useful in its evaluation. An outline for a training program in anesthesia is included; no startling teaching programs are proposed, merely the principles of good training in any specialty. For the student and practising physician, many timely and important hints regarding malpractice are given. There are so many legal traps in which the physician may become enmeshed, that it behooves him to be fully aware of them.

This text is very well written. At no time do the authors lapse into highly technical language, but everywhere strive for clarity, conciseness and ease of reading. The print is large, the headings in bold type, the paper of fine quality without that annoying glare which is so often a feature of textbook pages. The book can be heartily recommended to the medical student and practising doctor for its clear exposition, ease of reading and good sense.

Loren Amacher, '62.

**Postpartum Psychiatric Problems**, by J. L. Hamilton, 156 pages. The C. V. Mosby Co., St. Louis, 1962, \$6.85.

The incidence of severe postpartum psychiatric illness is approximately one in every one thousand deliveries, and this author feels that this group shows many unique features which set them apart from

other psychiatric states.

The text is excellent and includes chapters on the syndrome of delirium, the affective syndromes, the dissociative syndrome, anxiety, and postpartum sex problems. The author then deals with each syndrome in relation to its particular postpartum manifestations. This approach is valuable to both the student and practitioner, allowing them to correlate general concepts with the specific psychiatric manifestations as seen in the postpartum period. Each chapter includes an extensive bibliography which should be of further interest to the special student of this subject. Chapters on the history of thought regarding postpartum psychiatric illness and on the possible endocrine relationships in these disorders, add completeness to the study. A brief, but exceedingly interesting chapter on the reaction of the family, the physician and the psychiatrist to the postpartum psychiatric case, rounds out the picture.

This is a well written, clear text; each chapter is concise and the entire volume may be read in a few hours. This topic is either neglected or only briefly discussed in various texts of obstetrics or of general psychiatry, yet its incidence demands that more attention be directed to these disorders. This small book more than adequately introduces us to this hiatus in our knowledge.

E. David Burk, '63

# Abstracts

## **MULTIPLE SCLEROSIS: Treatment of Acute Exacerbations with Corticotrophin (A.C.T.H.)**

Miller, H., Newell, D. J., and Ridley, A.: *Lancet*, 2:1120, 1961.

Many people feel that the characteristic lesion of multiple sclerosis is secondary to an inflammatory process. In the study of 40 patients, it was observed that 1/3 of the exacerbations followed overt infections, 1/4 were accompanied by low fever, 1/3 had elevated sedimentation rates and 1/2 had a CSF inflammatory response.

Over a 3-year period, the authors examined 120 patients with multiple sclerosis and chose 40 consecutive patients with unequivocal multiple sclerosis. All of these latter patients presented with an assessable new symptom or symptom of less than 14 days' duration and showing no spontaneous improvement. The 40 patients were randomly allocated between two treatment groups, one receiving corticotrophin and the other, comparable injections of saline. The results were assessed by a single observer who was unaware of the patient's group.

As many studies have done, the authors concluded from their clinical trial that corticotrophin has a part to play in acute exacerbations of multiple sclerosis. On the other hand, oral prednisone was of little benefit. The authors were especially impressed by the rapid improvement often observed in acute retrobulbar neuritis treated with corticotrophin.

Robert Moffat, '62

## **OSTEOSARCOMA: A Review of 96 Cases** *Acta Radiologica*; Lindbom, A., Soderberg, G. and Spjut, H. J.: 56: 1, 1961.

The largest single group of osteosarcomas published to date is a series of 435 cases from the Mayo Clinic, covering the period 1909-1955. In this study, a 5-year

survival rate of 19.3% was reported which was higher than what is generally believed.

In the present study, 96 cases were reviewed with a minimum follow-up of 3 years. All were histologically confirmed tumors and those located in the skull, facial bones and mandible were excluded.

Of the 94 classifiable tumors, 66 were of the osteoblastic type, 15 of the chondroblastic and 13 of the fibroblastic type. Tumor sites were as follows: femur in 39 cases, tibia in 26, humerus in 13, pelvis in 5, ulna in 3, fibula in 3, bones of the feet in 2, and in the sternum, clavicle and scapula in 3 cases. Fifty-five (57%) of the lesions were located in the region of the knee. Fifty-seven (60%) of patients were male and 39 (40%) were female. No standard method of therapy was used. Treatment was mostly surgical with 78 patients having amputation or resection of the affected part. Eighteen patients had a biopsy only and were treated with irradiation. The 5-year survival was 18.5% for 86 eligible cases.

Generally, it was felt that older patients had a somewhat better survival rate than younger ones. The prognosis seemed slightly better for women. Preoperative irradiation slightly decreased the survival rate. No differences in survival could be detected between those patients having sarcomas distal to the knee and elbow joints as compared to those in which the tumor was located in the humeri or femori. The size of the tumor seemed to bear no relationship to the survival of the patient.

Finally, the authors felt that the basic principle of preliminary biopsy of a tumor prior to surgical or irradiation therapy should be maintained. Approximately 2/3 of osteosarcomas in the study presented typical roentgenographic appearances.

Robert Moffat, '62

## PRIMARY TUMORS OF THE LIVER IN INFANCY AND CHIDHOOD

Abine, F. H. and Mokhtar, N. A.: *A.M.A. Arch. Path.*, 72: 216, 1961.

Tumors of the liver are commonly secondary carcinomas. Primary hepatic carcinomas are rare and account for only 1% of all carcinomas in many populations. However, very young patients have a significant proportion of these tumors.

Bigelow and Wright (1953) collected 95 cases in the literature; of these, 55 occurred in children less than 2 years old and 35 in infants below 1 year. Edmondson (1956) reported that carcinomas of the liver are the commonest carcinomas of infancy.

A case is presented by the authors, of a male aged 11 months, who presented with the typical clinical findings. A swelling was noticed in the upper abdomen which was associated with discomfort. Anorexia, pallor and weight loss were also present. The child also had a fever and was anemic. Ascites and jaundice were not present. Transfusions were given for the anemia, but the general condition of the patient became worse and death occurred within two weeks.

An autopsy was performed and the authors discussed the pathology of this tumor as well as primary hepatic carcinomas in general. It was felt that hepatic carcinomas could be classified into a large group in which the lesion resembled that seen in adults and a small group of mixed embryonal or teratoid tumors.

It was also stressed that one must differentiate such hepatic enlargements from commoner forms of intra-abdominal neoplasms in such age groups, namely Wilms tumor and neuroblastoma.

Treatment should consist of surgical resection of the tumor.

Robert Moffat, '62

## NON-SPECIFIC MESENTERIC LYMPHADENITIS

Madore, P., Webster, D. R. et al.: *Can. J. Surg.*, 5: 59, 1962.

Non-specific mesenteric lymphadenitis was introduced as a clinical entity in 1929 by Freeman. The condition occurs most commonly in patients under the age of 20, with equal incidence in males and females.

In this study, the investigators did not observe a seasonal incidence nor epidemic occurrence and only 20% of over 200 cases had associated lymphadenopathy.

Clinically, pain was the most common symptom, beginning in the upper abdomen, varying in intensity, and finally localizing lower down in the right lower quadrant or genito-crural area. The abdomen was often mildly tender but not rigid. Palpation was often useful when the patient lay on his left side. Sometimes nodes were palpable. Rectal examination was negative. Laparotomy was the only means of making a definite diagnosis, as such diseased glands could simulate an abdominal condition.

The authors also discussed many theories of etiology. Many experiments concerning pathogenesis were mentioned including several of their own. No specific organisms were isolated. Transfer experiments attempting to induce the lesion experimentally in animals using material from human cases were unsuccessful. Pathologically, the lymph nodes showed a non-specific hyperplasia.

In summary, mesenteric lymphadenitis was considered to be a separate clinicopathological entity that must be differentiated from other abdominal conditions such as appendicitis, regional enteritis, specific granulomatous inflammations, etc.

Robert Moffat, '62

Continued from Page 56

including the number and type of bombs exploded. If we consider a sufficient number of bombs exploded over a short period of time, no part of the world would escape exposure to biologically significant levels of radiation. The genetic and delayed effects of the explosion will be discussed in following articles of this issue. Although it is difficult to imagine the general occurrence of radiation intensities which would eliminate the entire human race, nuclear warfare on a large scale would produce a tremendous amount of distress and suffering that individuals and all human societies would be called upon to support.

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MP-901

# The Meaning and Responsibilities of Marriage Counseling

FREDERICK W. SHERRIN, '62\*

## INTRODUCTION

Marriage counseling is an "art" in the practice of modern medicine. Its foundation is constructed on the emotional and subjective aspects of study which render it difficult to regurgitate in the form of statistical analyses; it is best conveyed empirically in the forms of personal evaluations, successes, and advice.

The meaning of marriage counseling is made clear by noting the factors causing marital failure, its results, and methods employed in an endeavor to halt the march of marital dissension. The responsibilities will follow as self-evident facts.

## FACTORS CAUSING FAILURES IN MARRIAGE

1. Conflicting backgrounds and differences of religion.
2. Time factors (especially the first year of marriage and the years soon following the children's departure from home).
3. An individual's inability to adjust to a changing condition (as a spoiled child, illness in the family, and immaturity).
4. Financial.
5. Sexual.

It has been stated many times that most divorces start in the boudoir. Sexual incompatibility, being by far the commonest cause of marital failure, will be the factor most heavily stressed in the following discussion.

Drs. Abramson and Martin wondered about the role of sex in marriage and the place of marriage in the world and wrote: "In this modern world, with its Sputniks, Vanguard, and Explorers attempting to conquer outer space and to visit the moon, and with our 'summit' conferences dedicated to the task of working ways to live together peaceably in world neighborhood, with our increasingly complex tech-

nology and advance standards of living, it might be well to give some special attention to marriage and the family. In such a world, marriage and human reproduction certainly should not be left to caprice, and much less should these subjects be taboo. It would appear as important to understand the art of married happiness, together with the miracle of conception and reproduction, as to learn the secrets of the atom, the nature and extent of space, or what lies on the opposite side of the moon."

The need, as so elegantly expounded above, is made more apparent when one considers the lack of knowledge of the average individual, married or single, regarding his or her physical self and, more particularly, his or her reproductive system. But, either because of cultural environment or lack of a healthy early home-training, the average individual has a clouded, distorted approach to the enjoyment and creation of life which are causes for concern and produce the following results:

1. Divorce. The divorce rate is steadily increasing and in the United States now averages 1:4. In a small county in Indiana, the following statistics were compiled over a five year period: There were 34,000

\*Obstetrics Seminar, presented Fall, 1961.

applications for marriage, and 23,000 applications for divorce of which over 13,000 (or 60% ) were granted. However, it must be remembered, even in the face of such formidable numbers, that in addition to the many couples who seek divorce as the answer to their discord, there are many others suffering similar symptoms who never reach court and, therefore, fail to become a statistic—but are no less unhappy thereby.

2. Insecure, neurotic children tending to increase the number of juvenile delinquents.

3. Wasted industry. Only a satisfied worker is a good worker.

One answer to this problem lies in marriage counseling which, until recently, was regarded as heresy. The physician is of paramount importance in the alleviation of this problem for he is usually the first consulted. His attitude is most important if he is to make a contribution to preventive psychiatry. He must know himself, and certainly he must believe in what he is doing and genuinely believe that he is helping. So, in counseling, the skill to do comes in doing. For the most part, this consists of holding a mirror up so the patient can see herself. What she sees must be correctly interpreted. The counselor must, therefore, have an honest attitude and be willing to dedicate a great deal of his time listening to, and interpreting his patient.

Yet, certain facts, as stated by Dr. Hudgins, must be remembered: "In our enthusiasm for the dissemination of sex knowledge and breaking down barriers of reticence, we are in danger of going to extremes that might prove as unfortunate as the old policy of silence. It would be unfortunate, if not disastrous, to persuade people that the facts of sex are the only essential things in marital experience, and therefore, matters for constant thought and speculation. It is a long trek from the Puritan meeting house to Freud, but one extreme is as undesirable as the other."

## METHODS OF COUNSELING

Knowing the causes and the results of marital failure, one can naturally place the methods of marriage counseling on the following three fields:

- A. Premarital counseling (prophylaxis).
- B. Post-marital counseling (therapeutics).
- C. Group counseling (to school, church, and adult organizations).

### A. Premarital Counseling

The most successful premarital counseling is achieved when both parties are available—first singly, then together—over a period of several sessions. I shall discuss at greater length the dealings with the female partner although this does not mean that the discussions with the male partner are any less important. On the contrary, the male partner is often the more ignorant. It must be stressed to both partners that successful marriage means teamwork, each party having his role of obligation and partnership. To this end, both parties must realize several basic concepts of normal sexual experience, as enumerated by Gauss:

1. There is a great variability in individual sex-drive. The completion of the sex act by the female is the common denominator of good adjustment.
2. Therefore, the orgasm by the wife is an absolute must if harmony is to prevail. (This does not say that such is to be the case in every coitus; but it should not be lacking in all. There is a duty of each partner that the other should enjoy orgasm. The majority of failures in achieving female orgasm is due to the hurry and the technical ignorance on the part of the male.)
3. Most important of all, anything necessary to bring the above about is normal for that particular marriage. The above precludes the necessity for the 'delicate, cultured darling' of North American

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society to undergo a vast metamorphosis in the boudoir, becoming the hussy satisfying her husband's dreams and demands.

These points must be stressed by the counselor as he carries out his meaningful examination, attempting to answer all questions. To this end, a format, such as the following, must be followed:

1. History. The history is a careful drawing-out of the patient, eliciting her entire psycho-sexual history (from sex play in childhood to premarital knowledge of sex) to discern her attitude toward sex.

2. Physical. The physical examination must be complete and include a pelvic examination.

3. Reassurance as to the patient's ability to bear children. Included is a discussion of the physical and emotional aspects of childbirth, conditions favorable for pregnancy, advice on conception and interval.

4. Advice regarding infertility. The couple should be advised that following 9-12 months of unsuccessful attempts at conception they should seek medical advice.

5. Information on the sexual side of marriage. Using the patient's emotional maturity as a guide post and employing pelvic models and illustrations to good use, the counselor must orientate the patient as to the anatomy, physiology, psychology, and technics of sex and reproduction. He should add a 'liberal sprinkling of healthy philosophy'. Only too often is stress placed on the mechanics without due regard for the less tangible, but no less important, psychic factors which 'provide for the milieu of sexual expression'. Misconceptions, distortions, erroneous concepts of normal and abnormal should all be corrected to avoid resultant frustrations and disappointments. Serious conditions (such as hemophilia, neuro-psychoses, severe endocrine disorders, etc.) should discourage marriage, or, at least, their significance should be candidly discussed.

6. Contraceptive advice.

7. General information. Too often the adult female knows little concerning menstruation, douches, personal cleanliness, and other everyday personal matters. These can all be made clear at this time.

8. Referral of patient. The medical consultant must know his capabilities and must refer the patient to the clergy, social worker, lawyer, or even psychiatrist when she taxes his means.

Adherence to the above format may produce a profound difference in the partner entering marriage—the difference between a woman ignorant and fearful of the approach of marriage to one adequately equipped to make a satisfactory adjustment.

## B. Post-Marital Counseling

Post-marital counseling leaves the field of prophylaxis and enters the active field of therapeutics. The cause of discord was observed by Sands: "While marriages may be made in Heaven, they are contracted here on earth and are subject to many mundane influences." The frictions most commonly involved are in the spheres of housekeeping, recreation, and sex. Again, the major maladjustment is centered, either directly or indirectly, on sex and is made manifest in one of four common varieties, as follow:

1. Superficial maladjustments.

These occur early in marriage and are due to lack of knowledge. The remedy consists of reassurance and the dissemination of the information discussed at premarital counseling. The prognosis is as sure as the treatment is easy.

2. Maladjustments manifested by overt disturbances in psychosexual sphere.

Frigidity, impotence, and the many other medical and emotional problems of sex adjustment occur later, are more serious, carry a graver prognosis, and are not due to lack of knowledge, but rather to a lack of, or loss of insight. These rarely



## —Marriage Counseling—

respond to simple measures and are usually beyond the scope of the average doctor.

3. Maladjustments stemming from changes in the marital situation as a result of changing conditions of health.

Occurring in families in which one partner has contracted cancer or venereal disease, or has undergone a mastectomy or colostomy, or is suffering from a fear of another pregnancy or menopause, or any similar complaint, it is the maladjustment most amenable to treatment, but is often the most neglected. Education and reassurance produce remarkable results. The physician must explain to the patient, in an unhurried and confident manner, both the nature of the illness and its treatment, the significance of the condition in terms of marital adjustment, and possible solutions to any potential problems. The situation, its outlook, and approach are candidly discussed with the husband that his understanding might lead to his co-operation. An informed partnership can then meet any problems that might arise.

4. Psychosomatic symptoms as manifestations of social, sexual, or family maladjustment.

Constituting a large segment of the non-surgical gynecological practice, these patients present themselves "guised in the patient-acceptable cloak of somatic illness" as lower abdominal pain, dyspareunia, pruritus, menstrual disorders, *ad infinitum*. Although they may not fool the wary for long, these unfortunate people are difficult to manage because the etiological factors are not superficial. The basis of the treatment is an accurate diagnosis followed by appropriate education and skilled psychotherapy, often with a psychiatric consultation, and over a considerable length of time.

With more concrete pre-marital counseling, this latter group will dwindle in number and importance. But, with prophylactic counseling in its infancy, this unfortunate group still demands and taxes

both the time and skilled effort of many doctors. Often the physician's only satisfaction lies in the knowledge that to salvage a marriage is a worthwhile endeavor.

### C. Group Counseling

Planned and programmed group classes are not only the most recent, but also the most promising method of marriage counseling. Originally organized as a result of student requests for information and advice regarding sex, the idea has spread far and wide in the past decade.

The physician plays an important role in these classes, for he is completely at home with marriage and parenthood and, therefore, can manage an air of objectivity and a freedom from tension which are important for all teaching. Furthermore, as a delicate subject, sex should still be communicated precisely and completely without disturbing the emotional balance of the students nor that of the teacher. With adequate teaching, without apparent anxiety or distortion, and at the college and teen-age level, definite improvements have already been accomplished in preparing for tomorrow's maternity cases.

### SUMMARY

It has been said that a stable society depends, among other things, upon a stable home, and that a stable home is the result of a happy marriage which rests upon a harmonious partnership between two mature and responsible personalities. A stable society, therefore, is dependent, to no small degree, on the conglomerate satisfaction of all the mature partnerships between a man and his wife. Therefore, marriage counseling is a "constructive and necessary discipline" to insure the continuance of a civilized social system. Furthermore, the physician, with his training and experience, is the person most qualified to institute marriage counseling, both prophylactic and therapeutic, and to call on specialists or other professional people if the need arises.

*Continued on Page 125*

# Psychiatric Indications for Therapeutic Abortion

BERYL A. CHERNICK, '62\*

## INTRODUCTION

The problem of inducing abortions is millenia old and just as controversial a topic to-day as it was in Hippocrates' time. With our modern development of specialization in medicine, each new field adds its own views to the question. Moreover, the controversy is not limited to our profession. It involves and is influenced by the laws of the land in which we practise medicine, by the rules of the hospital with which we are associated, by the predominating religion in our country or hospital or chief of service, and by each physician's and patient's own religious, moral and ethical beliefs and standards.

The word, therapeutic, implies the active treatment of a disease. "Induction of abortion nowadays rarely offers hope of improvement or cure of the patient's disease; it generally aims to do more than prevent deterioration of the mother's condition, and is, therefore, more often prophylactic than therapeutic".<sup>13</sup>

## PSYCHODYNAMIC ASPECTS OF PREGNANCY

Dr. D. Cappon,<sup>3</sup> a psychiatrist at the University of Toronto, published a paper on the psychodynamic aspects of pregnancy. He described four psychic settings which influence the child-bearing woman:

1. the social—how society regards these functions,
2. the biological—reproduction of the species by motherhood,
3. the physiological—the maturation of her genital and endocrine systems, the unique experience of parturition,
4. the intrapsychic—the personally psychological meaning of childbearing to the woman in terms of her psycho-sexual development.

Motivation for conception, her marital status when it occurred, and physiological and psychological factors must be considered in the assessment of each case.

Despite all this turmoil in and about the pregnant woman, it is strange that pregnancy seems to be protective against the manifestation of mental disorder. That many normal women experience a particular sense of well-being while pregnant is recognized by the application of the term,

*spes gravida*, the euphoric mood of pregnancy. The symptoms of some well-established psychotics and neurotics may become quiescent during pregnancy.<sup>12</sup>

## PSYCHOPATHOLOGIC STATES

Puerperal mental disorders occur in 1/400 to 1/1200 deliveries. They constitute between two and eight per cent of female admissions to mental hospitals. Half of the women who have further pregnancies after having suffered a puerperal breakdown, have no recurrence of mental illness associated with childbirth. About 1 per cent do have a recurrence with each pregnancy and another 20 per cent have a later recurrence of mental illness not associated with childbearing. The probability of mental illness associated with subsequent pregnancies after a puerperal psychosis is approximately one in seven.

Cappon<sup>3</sup> described a so-called "puerperal" psychosis, schizoaffective in nature, which arises for the first time in the gestational period. He found it in one or two of every thousand new female admissions to the Toronto Psychiatric Hospital. Queen Charlotte's Hospital in London saw only five cases of this type in 21,282 female admissions between 1943 and 1954.

\*Obstetrics Seminar, presented January, 1962.

## —Therapeutic Abortion—

Most psychiatrists do not believe that there is a specific "puerperal" psychosis.

Schizophrenia, the affective psychoses, toxic psychoses, hysteria and other neuroses all occur in association with childbearing. Their course and treatment are much the same as when they occur in any other setting. Noyes<sup>18</sup> estimated that of the mental illnesses associated with pregnancy and the post-partum period, 50 per cent are schizophrenic, about 25 per cent are manic-depressive and 20 per cent are psychoneurotic reactions. Because of the unusual protective nature of pregnancy, the incidence of these disorders in the nine months of gestation is only one-fifth or less the incidence in the post-partum period. In the post-partum period, however, they occur with the same frequency as in any other setting.

From the prognostic standpoint, "most recent publications indicate a favorable outlook in puerperal breakdown, even in schizophrenia. This contrasts with the attitude and publications a decade ago when a gloomier outlook was far more prevalent, particularly in schizophrenia. At least part of the improvement is due to modern therapeutics."<sup>12</sup>

### EFFECT OF PREGNANCY AND ITS TERMINATION ON MENTAL DISORDERS

Few psychiatric illnesses are fatal, so that termination of pregnancy for psychiatric indications does not usually save the woman's life. Chronic well-established psychoses are usually unaffected by pregnancy and psychoneuroses do not usually benefit from its termination. Psychopaths sometimes benefit from pregnancy itself. Unfortunately, mental deficiency in a woman has never been remedied by terminating her pregnancy. Some mental disturbances which manifest themselves early in pregnancy, improve with time. Many first trimester depressions disappear after the mother has felt the developing fetus

move. Those mental disorders arising late in pregnancy are uninfluenced by its termination. On the other hand, post-abortion psychosis can occur just as unpredictably as post-partum psychosis. Ekblad reports that from 25 per cent in 1955 to 59 per cent in 1951 of therapeutic abortions for psychiatric reasons have been followed by guilt reactions of varying degrees of severity.

The threat of suicide poses a special problem because it is occasionally carried out successfully, although, statistically, this is very rare. In fact, the Canadian suicide rate in 1958 was only 7.5 per 100,000 population of which only about one quarter was in females. (Canada Year Book, 1960). Further more, the rate decreases with increasing parity of the woman. But, the incidence of suicidal gestures and attempts without success are very much higher in women than in men. It has been stated that the incidence of suicide in pregnancy is the same as that in the total female population, but, in New York in 1953, it was only one-tenth the total female suicide rate.<sup>17</sup> Those who are most likely to commit suicide are women with depressive moods and feelings of guilt and unworthiness. If electroconvulsive therapy is necessary for treatment of this condition, it is not contraindicated in pregnancy.

### LEGAL ASPECTS OF THERAPEUTIC ABORTION

The laws in most countries leave the indications for therapeutic abortion ill-defined and subject to a wide variety of personal interpretation. Many countries are lenient while others are restrictive.

Scandinavian laws are both lenient and definitive.

In 1938, the Swedish Abortion Act was passed and in 1946, it was modified to allow termination of pregnancy for the following indications:<sup>10</sup>

1. Medical, where, on account of illness or physical defect, the advent of the child

would entail serious danger to the mother's life or health.

2. Medical-social, where, on account of weakness in the woman, the advent of the child would entail serious danger to her life or health. (This particularly refers to worn-out mothers.)
3. Social-medical, where, in view of the woman's condition of life and her circumstances in other respects, it may be presumed that her physical and mental forces would be seriously impaired by the advent of the child and its subsequent care. (This is considered to be the "foreseen weakness" clause.)
4. Humanitarian, where the woman becomes pregnant through coitus which has implied a criminal act and certain other sexual offences.
5. Eugenic, where it may, with reason, be presumed that the woman or the father of the expected child will transmit to the offspring, through hereditary channels, insanity, mental deficiency or serious physical disease. These cases must, however, submit themselves to compulsory sterilization.

In Denmark, a similar law came into force in 1930, allowing therapeutic abortion:<sup>15</sup>

1. when the interruption of pregnancy is necessary to avert a serious danger to the life or health of the woman.
2. when the pregnancy is due to rape or incest.
3. when there is imminent danger that the child, due to a hereditary disposition, will become a sufferer from insanity, mental deficiency, other major mental disorders or serious and incurable bodily disease.

In 1958, in clarifying what is meant by "a danger to life and health", the Danish legislature stated it to be:

1. present physical and mental illness,
2. threatening physical or mental illness,

3. social circumstances under which the woman lives for which there is no other solution to the problem.

For reasons other than present illness, a decision is reached by a board of two physicians and one psychiatrist to whom the case is presented by a maternity welfare worker.

Norwegian law has been changed from permission for abortion for strict medical reasons to ethical sociological and medical indications which are intended to cover rape, alcoholism, housing difficulties and other conditions which might render the birth of the child disastrous. According to Zarfes,<sup>20</sup> the *psychiatric* indications still remain ill-defined.

This recent Scandinavian legislation was enacted mainly as an attempt to eliminate illegal abortion. The number of legal abortions has risen from about 500 to 5,000 per year since the laws were passed. The bulk of this increase has been among married women. At the same time, there is an indication that, far from being eliminated, the incidence of abortion has actually increased in these countries.

Japanese legislation, passed in 1948, allows abortion.<sup>20</sup>

1. in case the person in question or the spouse has mental disease or mental weakness,
2. in case the continuance of pregnancy or the delivery seems to be injurious to the health of the mother owing to her physical and financial conditions,
3. if the female conceived by violence or threats or by adultery while she was unable to resist or refuse.

A strong motivation for the enactment of this legislation was the reduction and control of Japan's exploding population. In the first year, the birth rate fell from 33.1 to 23.6, while the death rate fell from 11.6 to 9.1. 546,104 legal abortions were performed in that year.

## —Therapeutic Abortion—

In Russia, laws prohibiting therapeutic abortion have been passed and repealed twice since the revolution in 1917. The repeal resulted in a successful attempt at control of the growth of the population, but failed completely to reduce the incidence of criminal abortion. During the repeal, it was legal to perform an abortion merely at the request of the patient.

The law in Britain is more restrictive than in Scandinavia. The Offences Against the Person Act of 1861 implies that there are certain lawful indications for inducing abortion without explicitly stating what they are. The Infant Life (Preservation) Act of 1920 rules that the act of causing death of the child must be done in good faith and only for the purpose of preserving the life of the mother. The legal precedent on which this modification of the act is based, follows the judgment in the case of *Rex vs. Bourne*. Bourne, a reputable practising gynecologist aborted a young girl who had been raped and, then, he voluntarily reported the matter to the Crown. In ruling on this case, Mr. Justice MacNaughten<sup>12</sup> said that: "If pregnancy is likely to make the woman a *physical or mental wreck*, the jury is entitled to take the view that a doctor, who in the circumstances and led by his belief operates, is operating for preserving the life of the mother." This ruling liberalised British law to include psychiatric indications for therapeutic abortion. Neither social factors nor eugenic grounds are legal indications. American and Canadian law are based on British law. In the United States, the law varies with each state. In New York, for example, the law allows abortion only to preserve the life of the mother; this has been interpreted to include the danger of suicide, but not abortion for rape or incest.

Canadian legislation on this subject is contained in the Criminal Code. Section 209 reads:<sup>7</sup>

"1) Killing unborn child. Everyone who causes the death of a child that has not become a human being, in such a

manner that, if the child were a human being, he would be guilty of murder, is guilty of an indictable offence and is liable to imprisonment for life.

- 2) Saving. This section does not apply to a person who, by means that, in good faith, he considers necessary to preserve the life of the mother of a child that has not become a human being causes the death of the child."

There has never been a test case like *Rex vs. Bourne* in Canada.

These last three countries have relatively low rates of therapeutic abortion.

### VIEW OF THE MEDICAL PROFESSION

On this controversial subject, each branch, and, indeed, almost each member, has a different opinion.

#### The Obstetrician-Gynecologist

-who must perform the operation.

There are those who NEVER perform this operation. Of these, Mr. Justice MacNaughten<sup>12</sup> said: "A person who holds such a view should not be an obstetrical surgeon for, if a case arose where the life of the woman could be saved by performing an operation and the doctor refused to perform it because of his religious opinions and the woman died, he would be in grave peril of being brought before the court on a charge of manslaughter by negligence."

There are those who consider the fetus to be a human being and feticide to be a very grave operation. They would perform it after very serious consideration, if they considered it necessary to save the mother. These include Dr. Bernard J. Hanley<sup>11</sup> whose Presidential Address to the Pacific Coast Obstetrical and Gynecological Society in 1958 was entitled "The Rights of the Unborn Child". Our own Professor Kinch teaches us that inducing an abortion means taking a human life, a

matter which should not be undertaken lightly. In most cases of medical and surgical illness occurring during pregnancy, the illness should be treated, as it would be in the non-pregnant woman, by the appropriate physician and the pregnancy allowed to "take care of itself" under adequate prenatal supervision of the obstetrician. This approach has become increasingly valid with advances in therapeutics, although internists and surgeons have been slow to accept this philosophy.

There are those who, like Kolstad of Norway,<sup>16</sup> think that the question of the evaluation of the fetus as a living being, upon which this entire problem seems to be based, is extremely involved and far too much a matter of sentiment.

There are those whose guiding light may be a fear of criminal prosecution. They put this fear before the best interests of their patients and may hesitate to perform even apparently indicated abortions. Others, believing that there is justification for a more liberal approach to this matter, may stretch the law to its utmost. Their interpretations will allow them legally to widen the indications for the operation.

There are those who believe, as in Russia, that the abortion should be done if the mother but requests it.

Until very recently, when committees and consultations began to come into vogue for consideration of proposed cases of therapeutic abortion, the obstetrician-gynecologist was being placed in the position of being the technician who wielded the curette at the order of the internist-surgeon or psychiatrist. These physicians should realize that the obstetrician's great experience in caring for and studying women before, during and after parturition is very valuable in assessing the ability of the woman to live through her pregnancy and her disease.

#### **The Psychiatrist**

—who recommends whether or not there are psychiatric indications for inducing an abortion.

Psychiatric indications for abortion depend upon the individual psychiatrist's views and whims. Some are conservative and think that there are very few cases which should be considered. These cases usually include psychoses and, possibly, suicidal intention. But, even in these conditions, each psychiatrist has his own list of circumstances which he considers valid reasons for abortion.

Psychiatry is still one of the less scientific disciplines in medicine. It is difficult to detect where normality ends and abnormality begins. Majury,<sup>17</sup> in a recent study in Winnipeg, claims that the psychiatrist rarely gives a diagnosis and, often, just lists the symptoms or even the statements of the patient when recommending an abortion.

Some psychiatrists, even though they feel "sympathy" for the woman, do not recommend abortions only because they can find no legally acceptable indications. If the case should come to trial and be found criminal, the psychiatrist can be prosecuted at least as an accessory. On the other hand, some psychiatrists feel that other physicians are "passing the buck" to them in sending them cases in the hope that *they* may be able to find an indication for therapeutic abortion when no obvious, legally allowed reason exists in other medical fields.

However, in other instances, a therapeutic abortion may give the psychiatrist an apparently easy answer to his and the patient's problem in the same way as, in the past, the internist and surgeon more freely advised getting rid of the pregnancy to make their work easier. But, with modern advances in the treatment of mental illness, the same attitude should encompass the psychiatrist, that is, that he should treat the mental illness and let the obstetrician care for the gestational state, and bury the old bogey that illnesses cannot be treated as well during pregnancy as at other times. In addition, the psychiatrist should realize that the abortion itself may

## —Therapeutic Abortion—

lead to a guilt complex or even to another psychotic breakdown worse than the original for which the abortion was supposedly therapeutic or prophylactic.

Frankenthal,<sup>6</sup> in an eloquent Letter to the Editor of the American Journal of Psychiatry, wrote that "legal recognition of severe health hazards as a valid reason for abortion must be demanded . . .". She urges that we accept the World Health Organization's definition of health as the complete physical, mental and social well-being of the individual and not merely the absence of disease.

Moore and Randall have been quoted<sup>17</sup> as writing in 1952: "To deny that these forces (personalities, social pressures, socio-economic factors, convenience) had not influenced us, would be incorrect, to accept them would be unwise, and the best course would be to view future indications (for therapeutic abortion) in the light of strict medical principles."

### INCIDENCE OF THERAPEUTIC ABORTION

As can be seen from the multitude of factors impinging on the problem, the incidence of this operation varies greatly from country to country and from hospital to hospital.

At Victoria Hospital, London,<sup>15</sup> from 1956 to 1959, inclusive, 24 therapeutic abortions, that is 1/426 deliveries, were performed. Of these, 9 were performed for maternal medical diseases, no more than 2 for any individual malady; 8 were performed apparently for fetal indications including 4 for maternal Rubella infection; 7 were performed for psychiatric indications, one of these for mental deficiency at age 15 but with no specific psychiatric diagnosis listed for the remaining 6. These figures are comparable to an incidence of one therapeutic abortion per 373 deliveries in the seven years between 1953 and 1959 at the Winnipeg General Hospital.<sup>17</sup> Psychiatric disease was again the

commonest single indication, comprising 35.1 per cent of cases. Of these, two cases had had a previous therapeutic abortion for psychiatric reasons.

An English series,<sup>12</sup> in 1957, reported 39 per cent of therapeutic abortions performed for psychiatric reasons.

Some figures in the United States include: one study in New York City<sup>17</sup> in 1950, reporting an incidence of one therapeutic abortion per 213 deliveries; one study in Chicago<sup>17</sup> in 1956, reported 1/191 deliveries; one in Oregon, in 1958,<sup>17</sup> recorded 1/227 deliveries. Perlmutter,<sup>7</sup> in 1947, performed 1/76 deliveries while Cosgrove and Carter,<sup>17</sup> in 1947, did only 1/16,750 deliveries.

In Guttmacher's review<sup>10</sup> of therapeutic abortions at the Mount Sinai Hospital in New York City from 1952 to 1956, 117 requests for abortion came before a committee of six; 84 per cent were aborted and 16 per cent were rejected. This was an incidence of one therapeutic abortion for 160 total deliveries, or 1/154 private deliveries and 1/373 clinic deliveries. Psychosis with suicidal attempt, the only psychiatric indication accepted, constituted 37 per cent of those aborted, the next highest category being 24 per cent for maternal Rubella. 80 per cent of the 117 applicants were married.

### COMPLICATIONS

Therapeutic abortion is never easy. Early in pregnancy, it is usually done vaginally, most often by curettage. Later in pregnancy, abdominal hysterectomy is the usual method. The mortality rate from these procedures is zero or very low. The maternal mortality rate in those hospitals that do therapeutic abortions is no different from the rate in those that do not. However, the incidence of morbidity from therapeutic abortions is high. Besides the complications which might follow any surgical procedure, perforation by the curette and serious hemorrhage are special risks.

## RESULTS

It is interesting to read of recent studies of therapeutic abortion in Scandinavia since the institution of liberal and definitive legislation.

In a Norwegian County hospital from 1940 to 1953,<sup>16</sup> of 897 women applying for abortion 968 times, 73.6 per cent met with consent while 26.4 per cent were refused. 83.4 per cent were married at the time of application and most of them had previously given birth to from one to three children. The number of applications increased greatly over these thirteen years; the increase in the number performed consisted mostly of abortions on psychiatric and medico-social grounds. 5.5 per cent of all pregnancies seen at the hospital were terminated by legal abortion, 45.8 per cent of them for purely medical indications, 22.3 per cent for psychiatric indications, 22.6 per cent for medico-social indications, 7.3 per cent for eugenic indications and 2.1 per cent for humanitarian indications. Housing conditions were involved in 67 per cent of the medico-social group and abuse of alcohol in the home in 25 per cent.

No deaths resulted from the 712 operations performed, but post-operative complications occurred in 10.3 per cent with the greatest number occurring after the first trimester of pregnancy. Secondary complications included: involuntary sterility appearing in 3.4 per cent, menstrual disorders, frigidity or dyspareunia in about 13 per cent, and decided late mental results in the form of nervousness, remorse or a feeling of guilt in 4.5 per cent.

About 30 per cent of the patients who were not sterilized at the time of or subsequent to therapeutic abortion became pregnant again despite efforts to teach them contraception. Half of these women had a further abortion performed, legally or illegally.

In surveying the situation in Sweden, in the last decade, Aren<sup>1</sup> saw a rise in the rate of therapeutic abortion since the

expansion of the Swedish Abortion Act in 1946, to a maximum of 57.4 per 1000 live births in 1951. At the same time, the criminal abortion rate did not decrease and, thus, the total abortion rate increased, contrary to the purpose of the legislation. Also, a new abortion clientele developed among married women, mainly due to the "foreseen weakness" clause in the law, which places a very heavy burden on the psychiatrist and gynecologist.

Hospital records of 284 women who had had legal therapeutic abortions and had become pregnant (389 pregnancies) again were analysed. About one-quarter of these underwent a new legal abortion (one-third had applied), while about two-thirds gave birth on one occasion or more, the remainder having ectopic pregnancy, spontaneous criminal abortion.

Interviews of 100 unselected women who had had a legal abortion prior to giving birth to a child revealed that none of the latter pregnancies had been accompanied or followed by any appreciable injury to their health or impairment of their working capacity. About 50 of these were still living under the same conditions as at the time of their legal abortion. 14 women stated that they had desired to have a substitute for the child that had been aborted, and 20 stated that, although the pregnancy was unwelcome, they could not bear the thought of going through a further abortion.

Of 197 women in whom pregnancy had not been interrupted although permission for legal abortion had been granted, 2 had died and 33 had had spontaneous abortions. Of the 162 births, 7 of the babies had died during or within one week of delivery, and 12 were given up for adoption. The remaining 143 women kept their child. In all of these cases, abortion had been granted on psychiatric or socio-psychiatric grounds. No serious complications occurred during pregnancy or delivery in any of the cases. 94 per cent of the women were psychologically adjusted to



## *Therapeutic Abortion*

the child. In 79 per cent, mental health was the same as before the pregnancy or better. In about half of the remaining 21 per cent, in whom some, usually slight, deterioration of mental health occurred, the deterioration was apparently mainly due to factors other than the arrival of the child. Subsequent study showed that refraining from operating had been justified in 89 per cent of the 143 cases.

Aren concluded from these observations that, if legal abortion is to be regarded as a therapeutic measure, a more restrictive attitude should be adopted in the evaluation of the indications.

### RECOMMENDATIONS

1. The committee system of evaluation of cases for possible therapeutic abortion should be used in every medical center. One example of such a committee is that used in Mount Sinai Hospital, in New York, where the Chief of Obstetrics and Gynecology is the Permanent Chairman and the remaining members include the Chief of Psychiatry and one senior member from the departments of Pediatrics, Medicine and Surgery. The obstetrician-gynecologist's opinion must bear the greatest weight in making the decision. It is he who best knows the abilities of the pregnant woman. In view of the justifiably wide variations in psychiatric opinion, it would be advisable to have more than one psychiatrist on the committee.

2. Prospective studies and not merely retrospective surveys of cases considered should be done to allow for more scientific evaluation of the problem. This should include long-term following of cases aborted and not aborted. In particular, the psychiatrist should have more contact with the patient than just the one interview on which he bases his recommendations for abortion.

3. The psychiatrists should concern themselves with the treatment of the patient's psychiatric disease and allow the

obstetrician to care for her pregnancy. Psychiatric therapy, including electroconvulsive therapy, is not contraindicated during pregnancy.

4. Any patient who is granted a therapeutic abortion, on psychiatric indications, should be sterilized. If her psychiatric disease can be treated so that she can be allowed to have further pregnancies following her abortion, then her disease can be treated during her pregnancy, and abortion is unnecessary.

5. In removing a living fetus by therapeutic abortion, we are attacking the problem at the wrong end. More emphasis should be placed on contraception and sterilization as well as upon efforts to correct poor social and living conditions.

### SUMMARY

The controversy over the indications for therapeutic abortion, which has long raged, continues. The psychic and social settings influencing the pregnant woman must be considered in each case. Pregnancy provides a certain protection against mental disorders, but even in the postpartum period, the incidence of mental illness is no greater than at other times. Termination of pregnancy does not cure mental illness and may even precipitate a psychotic breakdown or a guilt neurosis. Threat of suicide must receive special consideration, but, numerically, it is a small problem.

The laws in most countries leave the indications for therapeutic abortion ill-defined and subject to a wide variety of personal interpretation. Scandinavian laws, which are both lenient and definitive, are based on the Swedish Abortion Act which allows abortion for medical, medical-social, social-medical, humanitarian, and eugenic reasons. Enacted mainly to reduce the incidence of criminal abortion, these laws have produced a new clientele for legal abortion among married women, while at the same time, the incidence of

criminal abortion has also increased. British law, upon which Canadian and American are based, allows abortion only to preserve the life of the mother. British Case Law allows abortion to prevent the woman from becoming a physical and mental wreck.

Each branch, and indeed, almost each member of the medical profession has a different opinion on this controversial issue. The incidence of the operation varies widely from country to country and from hospital to hospital. Although the mortality from therapeutic abortion is almost non-existent, there is a high incidence of morbidity in the form of perforation of the uterus, hemorrhage, and long-term psychological derangements.

Recommendations include the committee system of evaluation of cases of possible therapeutic abortion, extensive follow-up studies of these cases in order to determine the true value of the granting or refusal of an application, and the preventive approach to the problem in the form of contraception and sterilization. Psychiatrists should realise, as physicians and surgeons have gradually come to do, that their responsibility is to treat the patient's mental illness. Psychiatric therapy, including electro-convulsive therapy, is not contraindicated in the pregnant patient. The pregnancy will "take care of itself" under the adequate supervision of the obstetrician, who is, after all, a specialist in the care of the child-bearing woman.

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# Enuresis and Voiding; Their Mechanisms

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## INTRODUCTION

For many years, the true nature of micturition has been a puzzle to physiologists. The most popularly held theory was one of direct voluntary control of the bladder detrusor, and of voluntary and reflex contraction but no inhibition of the external sphincter. In 1960, Muellner (Boston) proposed a different theory whereby the pubococcygeus part of the levator ani is the key factor. It is the purpose of this paper to compare both theories and their application to enuresis—a common and distressing pediatric problem.

### (A) GENERAL CONSIDERATIONS OF ENURESIS

#### I. Definition

An enuretic child may be defined as a child who has not acquired nocturnal urinary control by three years of age.

#### II. Types

1. Primary enuresis is said to occur when a child never acquires nocturnal control.
2. Secondary enuresis is said to occur when a child, who has previously acquired urinary continence, reverts to the infantile state.

#### III. Importance

Enuresis is a common and annoying disorder of childhood, accounting for up to 20% of a pediatrician's practice. It is estimated that it involves 13% of the overall population of 3-year-olds.

#### IV. Clinical Characteristics

In the majority of children, night wetting is continued from infancy and proper bladder control is never established. The amount of urine passed is usually copious. The habit may cease at any time during childhood, commonly around puberty, and only a small percentage continue into adult life. The characteristic symptoms are extreme urgency and frequency. Day wetting may be an associated factor, and may well indicate an organic basis.

### (B) NORMAL PHYSIOLOGY OF MICTURITION

#### I. Efferent Supply of the Bladder

##### (a) *Sympathetic Nervous System (S.N.S.)*

Fibres originate in L<sub>1</sub> and L<sub>2</sub>, and pass either via the lateral sympathetic chain to the lateral roots of the presacral nerve plexus, or, via the celiac and superior mesenteric ganglia to form the middle root of the presacral nerve plexus. At the level of S<sub>1-2</sub>, the presacral nerves divide to form the two hypogastric nerves that in turn end on the lateral aspects of the rectum on the hypogastric ganglia.

##### (b) *Parasympathetic Nervous System (P.N.S.)*

Fibres originate from S<sub>2</sub> and S<sub>3</sub>, and pass via the nervi erigentes to end in the hypogastric ganglia. Then, from the hypogastric ganglia, post-ganglionic fibres of S.N.S. and P.N.S. pass to the bladder to innervate the detrusor and the internal sphincter muscles.

##### (c) *Somatic Supply*

Both the prostatic urethra and the external sphincter receive efferent somatic fibres from the pudendal nerves, S<sub>2-3-4</sub>.

##### (d) *Actions*

Stimulation of the P.N.S. produces voiding by relaxation of the internal sphincter and stimulation of the detrusor muscle. However, stimulation of the S.N.S. produces closure of the ureteric orifices, contraction of internal sphincter and increased

tone of the trigone, resulting in continued retention of urine.

## II. Efferent Supply of Bladder

### (a) *Anatomy*

There are two routes: one via the S.N.S. to the dorsal nerve roots of  $L_1$  and  $L_2$ , and the other via the P.N.S. to the sacral dorsal nerve roots,  $S_2$  and  $S_3$ .

### (b) *Actions*

- i. Indicate degree of distension of bladder.
- ii. Convey pain (predominantly via S.N.S.).

## III. Cortical Control

### (a) *Afferent* (paths still unknown)

### (b) *Efferent*

Efferent control originates at the top of the motor area (area No. 4) in the cerebral cortex, on the medial aspect of the hemisphere, and passes via motor fibres lateral to the pyramidal tracts, intermingled in the spino-cerebellar tracts ultimately to the external sphincter and those muscles associated with the increasing of intra-abdominal pressure.

## IV. Theories of Voluntary Micturition in Adult

Both theories accept that pressor receptors in the bladder wall, upon stimulation, send afferent impulses via the A.N.S. to the spinal cord where they are relayed to higher centres to produce a cortical awareness of the state of the bladder. However, they differ in their interpretations of how voluntary micturition is subsequently initiated.

The old theory suggested that impulses from the cortex then passed via the parasympathetic nervous system to stimulate the detrusor and relax the internal sphincter. It was only then that somatic nerves produced relaxation of the external sphincter and perineum, plus contraction of the diaphragm and abdominal musculature, to

result in an increased intra-abdominal pressure and micturition.

Muellner, however, contends that the voluntary mechanisms producing increased intra-abdominal pressure first result in a downward movement of the vesical neck. Afferent sources of the autonomic nervous system then register the displacement and activate the detrusor mechanism via the hypogastric plexus, resulting in micturition.

Hatam and his co-workers, using cine-fluorography, have graphic evidence in support of Muellner's theory. They demonstrated that first the pelvic diaphragm descended and urine (contrast media in this case) entered the proximal urethra. At the point of maximum descent, a wave-like detrusor contraction resulted in complete emptying of the bladder. The external sphincter was only momentarily involved, the essential structure being the pubococcygeus part of the levator ani. Voluntary cessation by the external sphincter, however, resulted in retrograde flow back into the bladder and ascent of the pelvic diaphragm. In the male, further assistance was gained by contraction of the bulbocavernosus muscle.

In women, disruption of this pelvic diaphragm mechanism, by decreasing the support for the vesical neck, results in the so-called "stress incontinence". Similarly, any lesion of the ano-rectal region, by means of reflex involuntary perineal muscle spasm, produces difficulty in initiating the act of voiding.

## (C) PATHOGENESIS OF ENURESIS

### I. Associated Factors

#### (1) *Emotional Status*

These children do worry about the stigma of being called "bed wetters". They have a natural fear of going visiting and, possibly, of ultimate marriage. Enuresis is often associated with other manifestations of developmental immaturity, such as

thumb-sucking, nail-biting, speech impediments and temper tantrums. There may well be a relation between broken homes and enuresis, and some authors point out a definite correlation between juvenile delinquency and enuresis. They would point out that both disorders are those of an impulsive psychopathic character who is action oriented.

(2) *Deep Sleep*

This probably is of no consequence.

(3) *Decreased Urinary Concentration Capacity*

This has been disproven, except in such conditions as diabetes and nephritis.

(4) *Decreased Bladder Capacity*

Various studies show that this is a common finding; however, interpretation of its importance varies with the author. Generally speaking, however, these patients do exhibit a decreased volume capacity.

(5) *Electro-encephalography*

Abnormal, even epileptiform patterns are not uncommon in enuritic children but the significance is not understood.

(6) *Urologic Studies*

These presented conflicting evidence; however, a small percentage of enuresis is due to congenital anomalies of the genito-urinary tract and this should always be investigated in patients who do not respond to ordinary methods of therapy.

(7) *Spina Bifida Occulta*

Although this was one of the first possible factors to be postulated by Fuchs about 50 years ago, recent studies would indicate that it has no relation to enuresis.

(8) *Socioeconomic Factors*

Enuresis is commoner in the children of poorer families. This could be the result of many factors.

(9) *Familial Tendency*

Clinical observation long ago noted this fact. Stockwell and Smith found that 60% of parents of enuritic children were enuritic themselves. Usually, only one parent

was so affected. Oddly enough, these parents were generally not very understanding in their treatment of their afflicted children and tended to be unduly harsh.

## II. Hypothesis

### 1. *Emotional or Psychogenic Origin*

This is a popular theory. It proposes that parental maladjustments, parental failure or undue severity, sibling rivalry, inferiority, etc. are responsible for the majority of enuritic children. Several authors believe that too early and too rigid training, in order to lessen the work load of the mother, and sometimes to furnish boastful conversation at bridge parties and other gatherings, by fatigued, overworked and frustrated parents, tends to create emotional disturbances in many a child.

### 2. *Anatomical Causes*

These, at the most, probably account for no more than 10% of the total, although they may well be suspected in cases refractory to treatment and time. The majority of patients, however, do grow out of the condition and this would not be expected if they were victims of congenital anomalies of the genito-urinary system.

### 3. *Poor Toilet or Habit Training*

This also is probably only a small factor. Unless the child has developed to the physical stage of necessary development, no amount of training will produce significant results.

### 4. *Muellner's Developmental Theory*

"The infant has an automatic bladder, and empties it by means of 'detrusor micturition'. Within a short span of 4½ years, most children acquire an adult type of control over their bladders, and are able to hold their urine, and to start the urinary stream at will, at any degree of bladder filling."

Just as the child's initial efforts at walking are awkward and uncoordinated, so are his efforts to initiate micturition. Therefore, you see the little boy standing in front of the toilet straining mightily with arched back and ballooned tummy—all to

no avail. However, within a very short time after giving up in vain, he wets spontaneously.

Only when mastery of this voluntary manipulation of intra-abdominal pressure is obtained, can the child increase bladder capacity to the state where he can go all night without voiding. The learning of this talent occurs in certain distinct steps.

#### Stage I

The infant voids automatically without any apparent sensation of bladder fullness or sign that it is about to do so. However, between the ages of one and two years, maturation of the autonomic nervous system enables the child to first become aware of its state of bladder fullness and imminent voiding.

#### Stage II

The child then learns to inhibit a detrusor contraction by manipulation of its pubococcygeus when its bladder is almost full. It then has time to warn the mother, and some measure of daytime control is established. By two years, the child still cannot voluntarily initiate its stream and cannot void before the bladder is full.

#### Stage III

By three years of age, the child's bladder capacity gradually increases and day control is well established. The child learns to manipulate its intra-abdominal pressure by means of its diaphragm and abdominal musculature and to initiate the stream with a full bladder.

#### Stage IV

By the age of  $4\frac{1}{2}$ , most children have night control, as well, and only 10% are enuretic. Most have finally developed the skill of initiating their stream at any degree of filling of the bladder. Manipulation of intra-abdominal pressure directs it upon the levator ani and pubococcygeus with subsequent descent of the bladder neck and stimulation of the detrusor mechanism.

The principles of management of an enuretic child are, therefore, obvious. The child must be encouraged to drink all that he can hold during the day but to void as infrequently as possible. By this means, bladder capacity can be increased to the state where it is sufficient to carry the child through the night as well. He can do this, however, only when he is awake and alert. The mistake must never be made of treating the enuresis and not the total situation. The child's age, size, mental status, ability to cooperate, and the attitude and continued interest of the parents are all important factors which must be considered.

#### SUMMARY

Most cases of primary enuresis can readily be explained by Muellner's theory of retarded development. However, in secondary enuresis, psychogenic factors are of prime importance. Organic factors account for only a small percentage of enuretic children, and must be ruled out in patients refractory to time and treatment as outlined above.

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# Mammography

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## INTRODUCTION

Breast disease is a very commonly encountered condition and is of great importance. Undoubtedly, the most important disease of the breast is cancer, a disease that will take the life of 25,000 women in the United States this year alone! It is the purpose of this paper to describe one of the newer methods used to aid in the diagnosis of breast disease and to attempt to determine its true value in this respect.

## ANATOMY OF THE BREAST

The breast usually extends from the second to the sixth rib and from the edge of the sternum to the anterior axillary line.<sup>16</sup> It is covered by the superficial fascia and lies on the pectoral sheath. An extension which penetrates through the deep fascia into the axilla usually is present.

In brief, the main arterial blood supply consists of the internal mammary artery arising from the subclavian artery, and three branches of the axillary artery, the lateral thoracic, the pectoral branch of the acromiothoracic artery, and the superior thoracic artery. In addition, there are small branches from the subscapular artery and the lateral perforators of the intercostal arteries in the upper intercostal spaces. The venous drainage usually follows a similar pattern.

The lymphatic drainage of the breast is of supreme importance because of its role in the early spread of mammary cancer. The two main pathways of primary lymphatic drainage extend into the ipsilateral axillary and internal mammary lymph node groups.

## HISTORY AND METHODS OF MAMMOGRAPHY

Ever since the time of Roentgen's pioneer work with X-rays, the breasts have been visualized by this method. However, the first real attempt at using mammography in order to study breast disease was conducted by Warren in 1930.<sup>23</sup> There are

numerous ways to photograph the breast and the three most useful and commonly used methods will be presented.

Lindell and Boyle<sup>19</sup> use superior-inferior and tangential views of the breasts. They use Type M Eastman industrial X-ray film in cardboard holders. Physical factors vary, but the range is from 28 kv. and 400 mas. for small atrophic breasts, to 38 kv. and 700 mas. for very large and secretory or fibrous structures.

Gershon-Cohen uses cephalocaudad and lateral projections.<sup>4</sup> The cephalocaudad projection is taken with the patient erect and the lateral projection with the patient in the lateral decubitus position. Variation in the mas. factor depends on the size and solidity of the breasts. He prefers roentgenograms that are slightly overexposed.

Another recently proposed method is called xeroradiography<sup>15</sup> which was first described by Carlson in 1937, but has only recently been used widely. In this method, a selenium coated and charged metal plate is used instead of a film. Roentgen rays, according to their intensity, cause a varying run-off of the charge of the plate that they strike. After exposure, one dusts the plate with charged cadmium carbonate powder. An image similar to that seen on conventional roentgenographic film is thus produced. With this method, the entire processing is dry and no dark room is necessary. The image may be preserved by transferring it to paper by an adhesive technique or by photographing it. The resolving power of the xeroradiographic plate is used, by those who use it, to exceed

that of the conventional roentgenographic film. This permits greater image detail. This method is especially good for breast lesions adjacent to the chest wall. Xeroradiography is a relatively new method and, hence, the majority of series have been done using a method similar to that proposed by Gershon-Cohen.

## X-RAY APPEARANCE OF BREAST DISEASE

### 1. Adenosis

Adenosis appears on X-ray as fluffy or blurred opacities with a texture suggestive of ground glass.<sup>9</sup> The patches are oval or partly oval rather than round, and breast trabeculae are visible through these opacities. The involved areas may be partly outlined by sharp curvilinear margins. However, closer inspection shows that portions of the margins are irregular. In older or obese women with fatty breasts, the ground glass opacities are isolated between clear zones of fat. In all cases, the films show bilateral lesions, more developed on one side than on the other. Adenosis must be distinguished on film from cysts or fibroadenomata which at times it closely resembles. The following points should be borne in mind:

1. The lesions of adenosis are bilateral and the margins are indistinct, at least around part of the mass.
2. Cysts and fibroadenomata show smooth sharp margins not connected with breast trabeculae. Breast trabeculae run over them, but are not present within the lesion.

### 2. Mazoplasia

Many patients with mazoplasia are diagnosed clinically as having cystic disease.<sup>5</sup> However, the X-ray findings in this group do not support the clinical diagnosis. One sees a uniformity and homogeneity of the tissue density in the breast. The breast appears healthy and resembles the normal breast of the adolescent or young adult, or that of early pregnancy. The anterior con-

tour of the glandular portion of the breast is smooth, and lacks the bulges or lobulations which might be caused by isolated cysts or tumors.

### 3. Secretory Cystic Disease

This is a result of hormone imbalance, like mazoplasia. X-ray shows coarse digitations, often flame-like in shape, which run in the line of the breast trabeculae. Should plasma cell mastitis supervene, a localized tumor appears surrounded by a zone of edema or a zone of fuzzy opacity.<sup>7</sup>

### 4. Intraductal Hyperplasia

This condition is often precancerous. On X-ray, one sees minute, scattered, punctate calcifications within the breast. The calcifications may be very small. A cluster of tiny calcific deposits in one area is suspicious of an intraductal cancer.<sup>17</sup> When it resembles early ductal carcinoma on X-ray, unequivocal differentiation between it, carcinoma-in-situ, and early duct carcinoma is not possible at this time. Therefore, surgical removal of all lesions showing localized clustering of punctate calcifications is indicated.<sup>10</sup>

### 5. Fibroadenoma

Fibroadenoma is a common and generally harmless tumor, the removal of which affords satisfaction to the surgeon and patient. The majority of fibroadenomata occur in late adolescence and early adult life, and the compactness of the breast in this age group is apt to obscure the tumor. This is especially true in pregnancy and leads to a discrepancy in clinical and X-ray findings.<sup>6</sup> The clinician palpates a movable solid tumor, but the radiologist fails to visualize it. These circumstances in a young adult with an appropriate history are evidence of a fibroadenoma.

Since fibroadenoma has the same density as normal breast tissue, there must be either a natural or an artificial medium of contrast before the tumor can be demonstrated. Fat is a natural contrast medium, and in those breasts where it is present, fibroadenomata become discernible. The



greater the amount of fat, the easier the discernment. Since a subcutaneous layer of fat is present in all breasts, any tumor projecting into this layer becomes at least partly visible on the X-ray film. In older females, where atrophy of the parenchyma conjoins with increased fatty invasion of the breast, a clear visualization of the tumor occurs. The tumor density is then greater than that of the perifocal tissues, and the sharp tumor margins, which are usually lobulated or bosselated, contrast well with the fatty tumor bed. The density of the fibroadenoma is uniform and the perifocal tissue is pushed aside rather than invaded as in cancer. Thus, there are three degrees of discernment of fibroadenomata on X-ray:

1. no visibility in compact adolescent or pregnant breasts,
2. partial visibility where the tumor projects into the subcutaneous layer of fat or where there is sufficient fat invasion to serve for contrast purposes,
3. complete visibility because of the large tumor size or a high fat content of the breast.

Many fibroadenomata undergo cystic or mucinous degeneration or calcification. Calcification is easily seen on X-ray. It can assume all sorts of bizarre forms on X-ray, but is not readily confused with the scattered fine punctate deposits of scirrhous carcinoma. Calcification that is parallel on X-ray often signifies a calcified blood vessel.<sup>18</sup> Occasionally, calcification occurs after suppurative breast infection<sup>11</sup> but, unlike carcinoma, this calcification adheres to the trabecular architecture of the breast. It should be mentioned that the usually flaky and lamellar calcification of a fibroadenoma is always localized to the tumor and is often found around its periphery.

### 6. Cysts

Cysts vary in size from microscopic to those occupying a large segment of the breast, but only those more than 0.5 cm. in diameter can be seen on X-ray. They

appear as well-defined opacities with a smooth outline.<sup>8</sup> They are not usually as opaque as fibroadenomata, nor as frequently calcified, and the walls do not have the bosselations of fibroadenomata. Isolated simple cysts are usually spherical; conglomerate and loculated cysts are either oval or have irregularly scalloped borders. Cysts are most distinctly visualized on a background of fat. Fortunately, they occur most often after twenty-five, when the fat begins to be a normal component of the breast, and hence they are usually easily seen on X-ray. If the cysts contain bloody fluid or hemosiderin, their density is increased.

### 7. Papilloma

#### a) *Intraductal*

X-ray shows that the affected ducts are elongated, subareolar, and varicose. There may be some resemblance to secretory cystic disease, but broad, finger-like trabeculations are usually not seen, and if present, are scanty.

#### b) *Intracystic*

This papilloma is most easily recognized by the remarkable ease with which the cyst can be seen. This is not due to the papilloma itself but to the fact that most papillomas bleed. In addition to the growth, the cyst contains hemosiderin from the disintegrated blood and necrotic debris, as well as fresh blood. The iron-containing hemosiderin especially is radio-opaque.

### 8. Cancer

This is by far the most important breast disease, and it is in the ability of mammography to aid in its diagnosis that mammography plays its biggest role. One of the most important diagnostic features is that the X-ray size of a malignant tumor mass is smaller than the palpable size, if the lesion is palpable. On X-ray, the borders of a malignant lesion are usually not as sharp as in a benign lesion. There are numerous spicules of various lengths which radiate from the periphery into the surrounding tissue, especially if the lesion is a scirrhous carcinoma. The malignant

tumors cause compression and displacement of normal tissue, but they also infiltrate and destroy, whereas benign tumors push aside normal tissue. Circumscribed or medullary carcinoma appears as a sharply circumscribed rounded density with a linear localized extension of abnormal density or "tail" into surrounding tissue. Duct carcinoma is very similar to duct papilloma in most cases. Sarcoma appears as a large, dense, rapidly growing, well-defined mass.<sup>1</sup> It is not infiltrative and tends to resemble benign lesions such as cysts or fibroadenomata. The history of rapid growth should put the roentgenologist on guard and lead him to urge a diagnostic resection, even though the lesion may resemble a benign process on the roentgenograms.

Calcification in a malignant tumor takes the form of innumerable punctate opacities with angular margins resembling grains of salt clustered in a region of the breast. The calcification may be found either inside the tumor nodule, or inside and surrounding it, or as the only roentgen sign. When it occurs within the tumor and, especially, in a small circumscribed area, the lesion is probably a scirrhous carcinoma. When the calcification surpasses the borders of the nodule, or is seen without it, the diagnosis is usually a canalicular carcinoma, especially a comedo carcinoma.

## INDICATIONS FOR MAMMOGRAPHY

The majority of the indications are centered around the hope that mammography can be of value in early diagnosis of breast cancer. This disease will kill over 25,000 women this year in the United States, while approximately 60,000 women will develop the disease during the same period. The 5-year salvage rate of primary breast cancers treated by radical mastectomy has increased twofold in the last 50 years. Most clinics now report a 5-year salvage rate of about 55%, as compared with Halsted's first published 5-year salvage rate of 28.97%, in 1907. Since the

operative procedure has remained essentially unchanged, some of this improvement at least must be attributed to earlier diagnosis.<sup>22</sup> The results are even better if the lesion is discovered early enough for an extended radical mastectomy to be performed. Some clinics have reported as high as a 66% 5-year survival with this method.<sup>21</sup> However, if the disease is diagnosed too late to be successfully removed surgically, and radiation is employed, the 5-year survival is 30%. Thus, with the general statement that mammography is indicated in any situation where it may aid in the earlier diagnosis of breast cancer, one should look at the specific indications, which are as follows:

1. Mammography is indicated in the evaluation of the lumpy or cystic breast. The nodular lumpy breast constitutes a distinct problem as regards clinical evaluation and management. Often, there are numerous palpable masses or nodules within both breasts, with no distinct area upon which attention or concern may be focused to the exclusion of other areas. This type of breast may be screened by roentgenographic study for exclusion of any unsuspected pathological change other than the cystic condition itself. The characteristic roentgen appearance of breast cancer is usually quite distinct from the surrounding cystic lesions. Biopsy of any suspicious areas is recommended by the roentgenologist. It is important to note that mammography is not a substitute for biopsy, and biopsy should be done promptly when indicated. However, the X-ray examination of the breasts can help to elucidate the indications.

2. Mammography is indicated in the evaluation of localized breast pain with no palpable mass, or where the patient complains of vague, unusual, or unaccountable symptoms referable to the breast. Roentgen study of the breast whether normal or abnormal will frequently afford a solution to the problem.

3. The detection of occult malignancy in patients without a possible mass but

showing other local or distant signs of possible malignant disease is aided by mammography.

4. Mammography may help to confirm a clinical impression of breast malignancy prior to surgical intervention. Such confirmatory evidence as may be afforded by roentgenographic examinations, even in cases of obvious cancer, will reassure the surgeon. Mammography is also indicated to confirm a clinical impression of a benign breast tumor.

5. Mammography can aid in the differentiation between benign and malignant breast disease. This is in addition to all of the established indications for biopsy, and serves as a supplemental diagnostic tool. If mammography is negative, but the lesion is suspicious clinically, it should be biopsied.

6. Mammography is indicated in the evaluation of a patient with cancerphobia and a positive family history of breast cancer.

7. Mammography is indicated in patients where breast disease is more likely to occur, e.g., Geshicter found that the incidence of carcinoma of the breast is 6 times higher in women cured of cancer in the opposite breast than in women without a previous history of breast cancer.

8. One of the most controversial indications for mammography is its use as a survey project among healthy women for the early detection of breast cancer. If more radiologists would become skilled in the methods and interpretation of mammography, this would be one of its most important indications. However, at present, this is being carried out in only a small number of centres.

9. The examination by palpation of large pendulous breasts is notoriously inaccurate. Mammography is indicated in such a situation.

10. Mammography is also indicated in the study of anatomy and physiology of

the breast before, during, and after the reproductive span.

11. X-ray examination of the breast is indicated for the purpose of studying possible existence of precancerous conditions of the breast<sup>14</sup> as well as for obtaining a baseline record in mastoplastic breasts where malignant change may go undetected for a long time. These latter indications would demand re-X-ray examinations at intervals.

### RESULTS OF MAMMOGRAPHY

After reading the numerous indications, one might ask the following question. Is mammography widely used? If it is not, why not? What have the results been so far that might indicate whether or not mammography is of any value?

X-ray of the breast has been little used on this continent so far. One of the reasons has been the technical difficulties in obtaining good X-rays. However, with modern apparatus and using the methods outlined earlier, this should not be a problem any more. More important is the difficulty in interpretation of the X-ray. This requires training and experience which can be obtained by strict adherence to a program of clinical evaluation of the patient by a physician who is to interpret the X-ray, as well as close pathologic correlation in each case which has undergone surgical intervention. If such a program is followed, one can rapidly become very skilled in mammography interpretation.

In 1930, Warren published a report on 119 cases of breast disease examined by X-ray. The diagnosis proved to be right in most cases. In 8 cases, the diagnosis was wrong and there were 7 malignancies missed. Most of his errors were due to a hesitancy to label doubtful ones as cancer, when they should have been labelled that way. Several cases of cancer were diagnosed that were missed clinically. This was the first series published on the results of mammography.

Gershon-Cohen et al. published a report, in 1954, of the results of consecutive X-ray studies of 210 breast tumors. They found a 95% accuracy in light of clinical findings. Without clinical knowledge, the results were over 90%. There was a 97% accuracy with benign lesions. They found that their errors were due to:

1. technically defective examination,
2. malignant infiltrations camouflaged by the complex architectural components of a physiological hyperactive breast in the younger adult,
3. failure to correlate the clinical with X-ray findings due to lack of experience.

All their diagnoses were confirmed by the pathologist, right or wrong.<sup>12</sup>

Gershon-Cohen et al. examined 1000 breast disease cases by X-ray and found 175 malignancies. Of the 175, 5 were occult carcinomas, i.e. ones in which the discovery of some remote sign or symptom such as localized pain over the spine, or an enlarged axillary lymph node was the only evidence of disease, the primary lesion in the breast remaining undetectable clinically. In these 5 cases, positive X-ray findings led to a correct pre-operative diagnosis.<sup>13</sup>

In another recent study, Gershon-Cohen et al. started a pilot roentgen survey of breasts of 1200 healthy women. A 10-year periodic X-ray follow-up of the group is planned. They want to bring to treatment early mammary cancers. They also hope that long term follow-up will reveal much concerning the too little known physiological and pathological changes in the female breast, especially those conditions which tend to be associated with breast cancer. During the first year of the survey, they detected 3 tumors that were non-palpable breast carcinomas, detected by X-ray and proved by surgery and pathology. They found 6 tumors that they diagnosed as benign. However, surgeons insisted on removing the 6 which all turned out to be benign.

Berger et al. diagnosed 234 cases as benign by X-ray, of which 229 proved to be so, an accuracy of 98%. They diagnosed 118 cases as malignant, by X-ray, of which 108 were operated on and 106 were confirmed by pathology, an accuracy of 98%. Of 91 lesions that were diagnosed as probably benign on X-ray, 83 proved to be so, an accuracy of 91%. They found that in 10% of all X-ray examinations of the breast, the results are non-contributory and the radiologist is better advised to state so in his findings, especially in adolescent young females.<sup>2</sup> If the radiologist could make a definite diagnosis, they found the accuracy to be better than 95%.

In another series carried out by the same men, there were 209 consecutive breast cancers, of which 151 were diagnosed correctly by the surgeon, and 194 by the radiologist using mammography. Axillary node metastases were present in only 13% of X-ray cases. However, they were present more commonly in the surgeons' cases. They found that X-ray often showed cancer in an area other than the dominant breast mass. They found the X-rays valuable in studying physiological changes in the breasts. From a study of 16 cases with delayed operations, they found that the X-ray examination was positive from 1 1/2 to 4 years before the lesions became evident to the patient or surgeon.

In an article written by Egan in 1960, the X-ray findings of 1000 consecutive soft tissue examinations of the breast were given.<sup>23</sup> His group diagnosed 238 cases as malignant on X-ray. They missed 2 out of 240 malignant lesions for a 99% accuracy. There were no false positives. They also diagnosed 19 cancers by X-ray that were missed clinically. They did find that there were certain cases where the radiologist could not be sure of the diagnosis especially in young females under 25.

Kremens studied 1000 breasts by X-ray. Of 144 females studied by biopsy following a diagnosis of a benign breast condition radiologically, pathological verification of the X-ray finding was obtained in

141 cases. Cancer was not detected by X-ray, but occurred in 3 cases, an accuracy of 97.9%. There were 82 definite cases of cancer diagnosed radiologically, and 81 proved so on pathological report. One lesion was benign, an accuracy of 98.8%. A number of the cancers were clinically obvious, a fair proportion were clinically indeterminate, and in a few cases the cancer was not even suspected clinically. Kremens found it difficult to diagnose everything in a dense actively-secreting breast.

Lindell et al., in one of the most recently published series, diagnosed 34 cases as breast cancer on X-ray. Surgery was performed on 32 cases and in all of these cases the pathological diagnosis was carcinoma.

### SUMMARY AND CONCLUSIONS

Mammography at present is not a widely used aid in the diagnosis of breast disease. It is also not yet widely used to study breast physiology. However, reports show that it should be used in both respects because it can often yield valuable information unobtainable by any other present method, as well as adding to the knowledge obtained by other methods. The indications for its use, as outlined previously, are all quite reasonable. The accuracy of mammographic diagnosis is very high, provided that the radiologist is experienced in the methods and interpretation of this procedure, and provided that he realises its limitations in not being able to provide a diagnosis in every case. Because breast disease is so common, and because breast cancer is such a serious disease often offering a reasonable prognosis only in very early cases, it is essential that all diagnostic aids available be used and evaluated to the best advantage. This would therefore support a more frequent, wider future use of mammography than is at present being carried out.

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# Infectious Hepatitis

CRAIG H. COLE, '63

## INTRODUCTION

Typical infectious hepatitis is an acute viral disease which begins with vague influenza-like symptoms and progresses to febrile jaundice. Recovery is usual within six weeks of the onset of symptoms.

This article will deal only with infectious hepatitis, a disease which is easily confused with serum hepatitis. These two diseases have identical clinical characteristics, but are believed to be caused by two different viruses. Serum hepatitis has a two to six month incubation period, while infectious hepatitis has an incubation period of only ten to forty days. Serum hepatitis is transmitted solely by the parenteral inoculation of infected human blood. Infectious hepatitis is also transmitted by this route, but its most important mode of transmission is by fecal-oral spread.

Infectious hepatitis has attracted increased attention in the last few months because of two factors:

- (1) There is good evidence that the virus which causes it has been cultured.
- (2) Its incidence is increasing markedly.

## INCIDENCE

Infectious hepatitis is present in endemic form throughout the world. Epidemics occur sporadically, varying the yearly incidence greatly. In the United States, where hepatitis has been a reportable disease since 1952, the yearly case rates have varied from less than 15,000 cases in 1954 to over 70,000 cases in 1961.\* In Canada, the incidence for the last four years has been:

1958 — 4,515 cases

1959 — 4,715 cases

1960 — 6,476 cases

1961 — 12,007 cases

Apparently, the incidence is still increasing, since in the first six weeks of 1962 there were 2,374 cases reported, compared to 1,429 cases in the first six weeks of 1961.<sup>1</sup> These figures do not, of course, include subclinical cases. The ratio of subclinical to clinical cases has been conservatively estimated at 2:1; some reports suggest that the ratio is as high as 12:1.<sup>2</sup> These subclinical cases are believed to be an important source of infection in the population.

The incidence of infectious hepatitis has a marked seasonal variation. In Canada in 1961, the rate varied from 128 cases (during the second week in July) to 499 cases

(during the third week in December). This peak incidence during the winter months is typical of countries having a temperate climate.

Infectious hepatitis attacks all ages, but the greatest incidence is in children in the five to fourteen age group.

It occurs with equal frequency in men and women, although complications may be more frequent in women.

## ETIOLOGY

It had been strongly suspected for several years that infectious hepatitis was caused by a virus, but it is only within the last year that this virus has been grown successfully in tissue culture and the cultured virus used to infect human volunteers. The importance of this feat lies in the fact that once a virus has been isolated, a vaccine can be developed to give protection from that virus. In the case of poliomyelitis, it took about four years between the growth of the virus in tissue culture, and the development of Salk vaccine. Much

\*The statistics for infectious hepatitis and serum hepatitis are usually grouped together. Infectious hepatitis, however, accounts for a much larger percentage of the total number of cases than does serum hepatitis.

work remains to be done before a vaccine for infectious hepatitis can be developed.

In September, 1961, Richtsel and Boggs<sup>1</sup> reported a study in which they cultured virus from the blood of patients with infectious hepatitis on a strain of Detroit 6 (P.D.) cells. Five to six days after inoculation, electron microscopy of the tissue culture cells revealed changes similar to those seen in liver biopsies of patients with infectious hepatitis. The virus was serially transferred for at least four passages in tissue culture. It was then injected into human volunteers. This resulted in the development of viremia, an antibody response, and, in some of the subjects, the development of an illness which had all the earmarks of typical infectious hepatitis. Virus was re-isolated from these subjects.

This study demonstrated three distinct virus serotypes, two of which produced hepatitis with jaundice. The clinical picture produced by these two strains was slightly different. One strain produced hepatitis with a gradual onset and low grade fever. The other strain produced hepatitis with an abrupt onset and high spiking fever. Because of the small size of the trial, these differences could be coincidental.

Previous to this report, Davis reported the isolation of thirteen serologically related viruses from the stools of children with infectious hepatitis.<sup>3</sup> These produced characteristic lesions in tissue culture cells, and were neutralized by the serum from convalescent infectious hepatitis patients.

The work to date, then, would seem to indicate that there is more than one strain of virus responsible for infectious hepatitis. If it is found that the number of strains is large, and if cross resistance does not exist between them, it will probably not be economically feasible to manufacture a vaccine. This is a question that is likely to be resolved within the next few years.

### **PATHOLOGY**

Study of liver biopsy sections reveals early swelling and irregularity of hepatic

cells, plus inflammatory cell infiltration of periportal areas. This is followed by degeneration of the hepatic cells. In an uncomplicated case, hepatic parenchyma regenerates very rapidly, usually with complete restoration by three months. Swelling of the parenchymal cells results in compression of the small intrahepatic biliary ducts. Thus, an intrahepatic obstructive jaundice may be superimposed on the hepatocellular jaundice resulting from hepatic cell degeneration.

Electron microscopy reveals the presence of dense intra-cytoplasmic inclusion bodies, about 2,000 Angstrom units in diameter in the hepatic cells. These are thought to represent the etiological viral agent. It is interesting to note in passing that sections from patients with serum hepatitis show much smaller inclusion bodies, about 500 Angstrom units in diameter.<sup>7</sup>

In fulminant cases of infectious hepatitis, the liver is reduced in size, and there is widespread disintegration of parenchymal cells. This is the condition to which the name "acute yellow atrophy" used to be applied.

### **CLINICAL CHARACTERISTICS**

The onset of infectious hepatitis may be abrupt or insidious. It starts with a preicteric phase, during which the patient complains of nausea, anorexia, diarrhea, chills and fever, maybe mild abdominal discomfort, headache and malaise. Diagnosis, not surprisingly, is seldom possible during this phase.

The preicteric phase lasts one to twenty-one days (average ten days) and is followed, in the typical case, by an icteric phase in which jaundice becomes apparent. The patient usually experiences pain in the upper right quadrant due to stretching of the peritoneum over the liver, the liver being enlarged and tender. The jaundice usually becomes maximal within one week, and then slowly fades. The patient often feels markedly improved at about the time when his jaundice is worst. From this

point on there is steady recovery in the uncomplicated case.

Non-icteric cases occur frequently, but these are seldom diagnosed as infectious hepatitis unless associated with an epidemic.

In children, the clinical picture is similar to that in adults, although, generally, the disease is milder and of shorter duration.

When infectious hepatitis occurs during the last trimester of pregnancy, it has been reported to be much more severe. It also occurs in a severe form in older patients.

The differential diagnosis of the icteric phase of infectious hepatitis includes:

- 1) other forms of hepatitis,
- 2) exacerbations of chronic hepatic disorders,
- 3) biliary obstruction.

## PROGNOSIS

The majority of cases of infectious hepatitis proceed to recovery within six weeks. However, residual malaise and easy fatigability are frequent aftermaths. Rarely, infectious hepatitis is a fulminant fatal disease. The death rate is one to three per 1,000 cases. Death is most likely to occur at two points in the illness: three to ten days after the onset of symptoms, or later, three to eight weeks after the onset of symptoms. This fatal form of the disease should be suspected if there is sudden mental confusion, loss of emotional control, hemorrhagic phenomena, and coma. If these signs are present, energetic steroid and other supportive therapy should be started immediately. Fatal cases are usually those in which a superimposed nutritional factor increases the susceptibility of the liver cells. This occurs in elderly patients, pregnant women, and alcoholics.

True complications of infectious hepatitis are rare. Whether or not infectious hepatitis leads to post-necrotic cirrhosis is debatable.

The frequency of recurrence of infectious hepatitis is given as anywhere from 0.6% to 18% of cases. These recurrences may be due to relapse before complete recovery; or to infection with a different strain of virus, since it is believed that infection (clinical or subclinical) produces a lasting immunity.

## LABORATORY TESTS

Laboratory tests are all non-specific. They tend to be confusing, and differ from patient to patient. Liver function tests become abnormal at varying times throughout the disease. The SGOT would seem to be one of the most valuable tests, being elevated early in the preicteric phase of the disease. The determination of antibody titre by the agglutination of Macaca Rhesus erythrocytes must still be regarded as a research technique.

Top has a good review of laboratory tests for infectious hepatitis on page 546 of his textbook.<sup>13</sup>

## TREATMENT AND SPECIFIC PROPHYLAXIS

The treatment of infectious hepatitis is symptomatic. Hospitalization is not usually required. Bed rest (not necessarily absolute) and a well-balanced, palatable, nutritious diet are the best therapeutic measures.

Corticosteroids or ACTH may shorten the total period of jaundice by about one week, and result in considerable improvement, but their routine use is not recommended.

During an epidemic of infectious hepatitis normal immune gamma globulin should be given to all individuals exposed to the disease. This is supplied in Canada by the Department of Health whenever its use appears to be indicated. It will abort the hepatitis if given during the incubation period (up to six days before the de-



velopment of symptoms) or before exposure. Passive protection lasts six to eight weeks. A much longer active immunity may also occur as a result of infection which is rendered subclinical through protection by the immune globulin.

### EPIDEMIOLOGY

Infectious hepatitis is transmitted by two routes:

1. Fecal-oral transmission. This usually involves personal contact, but water borne, food borne and milk borne epidemics have been described.
2. Parenteral inoculation of infected material.

The former mode of transmission probably accounts for the vast majority of cases. The virus of infectious hepatitis is very hardy, being able to withstand pasteurization, boiling in water for five minutes, and chlorine residuals of 2 p.p.m. for up to thirty minutes.<sup>8</sup> Epidemics are likely to occur when sanitation standards are lax. One interesting epidemic was reported in 1958 in the Kenora area of Ontario. During this outbreak, the incidence of infectious hepatitis in the district where piped water and waterborne sanitation were unusual was four times the incidence in the area served by a municipal sewer and water supply.<sup>5</sup>

The most infectious period of infectious hepatitis is probably during the first week of the disease, although virus has been isolated from the gastrointestinal tract for months after apparent recovery. The American Public Health Association recommends that the patient be isolated during the first week of the disease. Infective subclinical cases, however, make control of the disease very difficult.

Infectious hepatitis due to the parenteral inoculation of infected material should be of special concern to all doctors. In order to minimize this iatrogenic form of infectious hepatitis, blood should not be accept-

ed from donors with any past history of hepatitis, and large pools of serum should be avoided. Needles, syringes, and other instruments which are likely to become contaminated with infectious hepatitis virus should, of course, be thoroughly sterilized. One source of possible cross infection arises from the widespread habit of using one syringe for four or five patients during mass inoculations, merely changing the needle between patients. It has been shown that the small amount of fluid which always enters a needle in the tissues may be aspirated onto the nozzle of the syringe when the needle is taken off. In this way, the whole contents of the syringe are likely to become contaminated.<sup>6</sup> Thus, many experts insist that the only way to prevent post inoculation hepatitis is to use a clean needle and syringe for every injection.<sup>9</sup>

### SUMMARY

The subject of infectious hepatitis has been reviewed. Cases of infectious hepatitis, although rarely fatal, are becoming increasingly frequent in North America. Iatrogenic infectious hepatitis is a problem which should concern all medical personnel.

The infectious hepatitis virus has now been grown in tissue culture. This may lead to the development of a vaccine against infectious hepatitis.

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# Hypothermia

JAMES DORKO, '65

## INTRODUCTION

The scientific mind—"one hating every kind of imposture" . . . *Francis Bacon*

The history of hypothermia bears witness to the fact that a true medical scientist adheres to the principles of honesty in his experiments, actions, and scientific reports. A medical man cannot profess to be a researcher, and yet so disdain his fellow man as to expose him to cold temperatures, causing him to shriek from pain as his extremities become white from freezing.

Dr. Sigmond Rascher, of Dachau Concentration Camp infamy, devised the above diabolical experiments. His results, like so many obtained in the Nazi Research Program, have been proved to be unreliable. For example, Rascher stated that it took from 53 to 100 minutes to kill a human being by immersion in ice water; however, pilots in the last war survived periods of exposure exceeding the above.

A lesson can be learned from these observations. To avoid the degradation of medical science as it occurred in Nazi Germany, we must recall that corrosion begins in microscopic proportions. Once corrosion of one man's ideals sets in, others in the profession, to avoid the jeers of cowardice and especially the fear of ostracism by the group, come to his support. The medical reputation must remain as free of corrosion as the surgical steel employed by the profession.

## DEFINITION

Hypothermia, as used in this paper, is defined as the induced or spontaneous reduction of body temperature. The temperature 37°C (98.6°F) is taken to be normal, for this approximates the temperature of the deep central areas (e.g. heart, brain).

## HISTORY

James Currie observed some of the earliest recorded effects of hypothermia over 155 years ago. He measured mouth temperatures in subjects whom he immersed in water at 70°C, and together with other observed events, published an article "The Effects of Water, Cold and Warm, as a Remedy in Fever (1798)".

## GENERAL RESPONSE OF THE BODY TO COLD

At first there is a sympathetic vasoconstriction, and then, with further cooling, the adrenal is stimulated and further vasoconstriction occurs. This vasoconstriction leads to a reduction of heat loss and causes a rise in blood pressure and heart

rate. Also, the thyroid is stimulated so that heat production is increased. With further chilling, there is additional heat production through the process of shivering. When the skin temperature falls to 15° to 25°C, the skin becomes cold and cyanosed, and the arterioles are "more or less" contracted. Further lowering below 15°C causes the skin to redden, and at 10°C there is a definite red color indicating an excess of oxygen due to the lack of oxygen needed by the tissues, and a lowered dissociation of oxygen at this temperature. When the temperature falls still further, the skin becomes bright pink and painful. After this has lasted a few minutes, the skin temperature suddenly rises 5° to 8°C as a result of dilation of the arterioles, but later contraction again sets in. With continued exposure, alternate dilation and contraction of the arterioles take place (Hunting Reaction) while the minute vessels stay more or less dilated all the time. At a still lower temperature, the minute vessels may contract, giving the white reaction of Stray (1943).

During the initial stage of cooling, the rectal temperature does not fall; it falls only with continued or intensified heat loss at the periphery, or when the acute

reactions fail by exhaustion or are inhibited by anaesthesia. As the rectal temperature falls, the heart rate, due to the lowered temperature of the pacemaker, decreases. Blood pressure falls, but only gradually, during this period. There is an accompanying hemoconcentration (concentration of red blood corpuscles increased by 25%) due to a fluid shift from the plasma to the tissue. Heart rate becomes progressively slower and arrhythmias appear, and at rectal temperatures of 30°C or lower, auricular fibrillation is common. When rectal temperatures reach 25° to 27°C, blood pressure may fall precipitously, but more importantly, ventricular fibrillation and consequent death results.

Failure of arterial blood pressure with consequent failure of coronary circulation, resulting in myocardial ischemia, coupled with the poor function of the conducting tissue of the heart, are the chief cause of ventricular fibrillation. Covino made the following observations in dogs that were about to fibrillate: calcium was shifting into the myocardium; potassium was leaving and hydrogen ions were shifting into the myocardium (reduction of potassium lengthens the action potential). It is known that a disturbance of the acid-base balance will initiate a series of changes:

1. a rise in hematocrit,
2. shift of H<sub>2</sub>O into the cell,
3. loss of potassium from cell, and
4. increased myocardial irritability with subsequent tendency to fibrillation.

The lethal temperature (that which triggers ventricular fibrillation) is variable with constitutional and physiological factors, as was demonstrated by a Negro woman who survived a fall in rectal temperature to 18°C, though with loss of portions of all four limbs.

An important observation is in order at this time. Cold, short of freezing, is not lethal to any tissue. Death of the organism, or man, is really a coordination death; that is, at 25° to 27°C for man, the ventricular myocardium undergoes fibrilla-

tion; coordinated contraction for proper pumping action is lacking; the result is that all tissues are deprived of a sufficient supply of oxygenated blood. Metabolism is thus impossible and death results.

What happens to the tissues depends on the time for which they are exposed to any given temperature. As one can imagine, the lower the temperature the shorter is the time necessary for cold injury to result; for example: exposure at 8° to 12°C requires several days; at 0° to 8°C, one half to two hours; at -50°C, one or two minutes. If the critical time-temperature level is not exceeded, the tissues become normal after return to normal surroundings; if exceeded, then local lesions or death results.

The amount of tissue damage tends to be greater (as would be expected) in patients showing marked hypothermia.

Local lesions take the form of frostbite, in which the tissue is cooled to the point of ice-crystal formation. The injury is twofold:

(1) *Physical*

The cells rupture with the growth of the ice crystals.

(2) *Biochemical*

Dehydration results and leads to protein denaturation and consequent paralysis of enzymatic activity.

## METABOLIC CHANGES ON COOLING

Universally the rate of chemical reactions is affected by temperature; that is, the Law of Arrhenius applies: the logarithm of the rate is proportional to the reciprocal of the Absolute Temperature. In most cases the rate of metabolism of living cells decreases two to three times for a temperature drop of 10°C.

In the situation of hypothermia, the metabolic rate increases in the first stages of cooling; this increase does not persist, however, below the rectal temperature of

## Hypothermia

35°C. Thereafter, there is a gradual decline to reach basal value (or lower at 27° to 30°C). Shivering usually ceases at rectal temperature of 30°-33°C, and is followed by a persistent muscular rigidity.

Oxygen requirements fall to 50% of normal at 30°C, and below 15°C, it approaches zero.

In the Dachau experiments (German experiments on unanaesthetised prisoners of war), it was found that the blood sugar varied inversely with body temperature. Further studies with rats have indicated that the blood sugar response depends on the rate of cooling. In *acute hypothermia*, liver glycogen is rapidly depleted and hyperglycemia results, but with *gradual cooling*, hypoglycemia is the rule (the glucose is fuel for heat production by shivering).

Rosomoff's investigation of the central nervous system's responses to cold has shown that cerebral metabolism decreases at a rate of 6.7% per 1°C fall in temperature, with an association fall in cerebral blood flow, and a slight reduction in brain volume.

Gross neurologic responses to cooling are as follows:

1. loss of pain and consciousness at 29°-30°C;
2. electroencephalographic silence at 20°C;
3. cessation of nerve conduction at 10°C.

Other effects are congestion and edema of lungs; watery and serous exudates in the tissues and air passages.

### CLINICAL APPLICATIONS

As stated in the opening paragraphs, James Currie (156 years ago) was one of the first men to apply mild hypothermia in the practice of medicine; he used it to relieve muscle pains and headache. His observations also led him to warn against the use of cold effusions in severe diarrheal disease. (The studies of Dent et al

in 1961 upheld the validity of his warning.)

### Neurological Applications

Smith and Fay, in 1940, used hypothermia in a series of neurological studies on terminal cancer patients. Few useful clinical applications were put forth at this time. Drs. C. G. Drake and T. A. Jory (Victoria Hospital, London, Ontario) reported in 1961 that their studies indicated that hypothermia could be of value in the treatment of human brain injury provided that its induction was early in the evolution of the inflammatory response. The benefit would result from:

1. a reduction of metabolic activity,
2. lessening of brain swelling,
3. lessening of the cellular response, and
4. shortening the time interval required for the development of collateral circulation to areas which might otherwise become infarcted.

In neurosurgery, hypothermia is employed for operative treatment of cerebrovascular lesions, certain brain tumors and aneurysms. The decreased metabolism and subsequent oxygen need enables the stoppage of blood flow for 45 minutes in profound hypothermia.

### Cardiovascular Surgery

#### Historical Development

The work of Bigelow et al in 1950 gave surgeons a means of operating within the heart (or brain) for ten minutes. Limited by time and the danger of ventricular fibrillation, many cardiac surgeons soon turned to the use of the more versatile "heart-lung" machine.

Gollan and his co-workers suggested in 1952 that the heart-lung machine be coupled with the principle of hypothermia. Sealy et al (1957), using a heart-lung machine in conjunction with a Brown-Emmons heat exchanger, easily cooled patients to 8°-10°C (esophageal temp.). The advantages of this combination are obvious:

1. The heart is arrested,
2. the open heart is empty, while the coronary circulation is artificially maintained by perfusion,
3. O<sub>2</sub> requirement of all tissues greatly decreased (50% or less).

### Other Clinical Applications

- (1) *Carbon monoxide poisoning* has been successfully treated by hypothermia.
- (2) *Local gastric hypothermia* has been employed in the control of massive upper gastrointestinal tract bleeding.
- (3) In *burns* early cooling may reduce edema.
- (3) In conjunction with *nitrogen mustard therapy*, hypothermia has been used experimentally to protect the bone marrow from nitrogen mustard spillage.
- (5) Management of *Surgical Thyrotoxicosis*.
- (6) *Kidney Protection*. Local hypothermia to protect kidney (or any other organ) in acute emergencies.
- (7) *Radiography*. A cold barium enema (10°C) is retained and dispersed much better than one of 20°C.

it leads to a sudden drop of the deep body temperature as the result of a sudden return of a large volume of cold blood to the heart. Ventricular fibrillation will occur if the drop of the temperature is below 25°C.

### 3. Slow Rewarming

This method is acceptable as long as a positive heat balance exists during the extended rewarming period. This is the logical method to employ during times of widespread catastrophe (floods, exposure to winter weather after breakdown of a train, and after prolonged exposure to cold during combat, etc.), when rapid rewarming at 42°C would be unavailable.

Anoxia would be no problem, for the rewarming rate would be in step with the increased rate of metabolism. As the rate of metabolism increases, due to the rewarming process, the oxygen supply also increases due to the increased flow of blood that is being pumped by the heart. Hypovolemic shock is not a problem during slow rewarming.

## DRUGS AND SPECIAL TESTS

### (1) Norepinephrine

Studies on 73 dogs at the U.S. Army Medical Research Laboratories, Fort Knox, Kentucky, has produced evidence that norepinephrine delayed the abrupt fall in blood pressure usually observed at body temperatures below 24°C, and that it was associated with prolongation of normal cardiac rhythm. Moreover (and this fact

## REWARMING PROCEDURES

### 1. Rapid Rewarming

Extensive investigation, both clinical and experimental, has demonstrated that rapid rewarming in a constant water bath of 42°C is the best method.

### 2. Moderate Rewarming

This procedure is not practical because

TABLE I

TYPES OF COOLING FOR CARDIOVASCULAR SURGERY

|          | Temp. (°C) | Cardiac Arrest    | Time available for Surgery Minutes | Use                                      |
|----------|------------|-------------------|------------------------------------|--|
| Mild     | 28-37      | no                | 1-10                               | Operations permitted by inflow occlusion |
| Moderate | 18-28      | yes, at 25°-27°C) | 10-20                              | Ventricular septal defects               |
| Profound | 8-18       | yes               | 20-45                              | Complex Anomalies                        |

## Hypothermia

has clinical value) it lowered the mean temperature at which ventricular fibrillation occurred from 18.9°C to 15.1°C.

### (2) Glycine

Beavers, reporting at the *5th Cold Injury Conference*, stated that glycine (given intravenously) was found to diminish markedly the incidence of fibrillation in dogs subjected to hypothermic cardiac surgery. It was felt that glycine's ability to increase serum potassium levels helped to protect against ventricular fibrillation.

### (3) Test for Degree of Hypothermia

If the hematocrit is found to have increased a significant degree, hypothermia has persisted for a long period of time and a decrease of blood volume has occurred. If the hematocrit is essentially normal the degree of hypothermia experienced must have been relatively minor.

## PRECAUTIONS

### (1) Drug Therapy

Its use during hypothermia involves special risks. Slow absorption or decreased metabolism at low body temperatures may lead to over-dosage and accumulation in tissues. Upon rewarming, sudden release of stored drugs may be lethal.

### (2) Exchange Transfusions

The transfused blood should have the temperature of normal physiological blood.

### (3) The Elderly

Hypothermia (accidental or other) may impair cerebral function. The characteristic electrocardiogram of induced hypothermia is found in patients with accidental hypothermia. The accidental hypothermia may be masking an underlying disease (myxedema, diabetic coma, intoxication from ethanol, etc.).

### (4) Newborns

Newborns must be protected from accidental hypothermia. Over a period of 11 years, 183 hypothermic newborn babies were admitted to Children's Hospital, Bir-

mingham, England. The diagnosis of primary cold injury (with signs of edema, immobility, a florid complexion, and sclerema) was made in 70 of the 183. Incidentally we have here an additional reason for recommending breast feeding for infants; if the infants had been nursed and kept in the mother's bed, cold injury would not have occurred. It is questionable, however, that hypothermia is a danger to the newborn, for the studies on the newborn of many species have shown that the newborn can better accommodate to the conditions of hypothermia than the adults. Further clarification is needed on this point.

### (5) Anesthesia

For mild hypothermia, thiopental and nitrous oxide have been widely used, with *halothane* gaining in popularity rapidly. Ether is becoming popular again for profound hypothermia as there is a growing distrust of other chemicals that may be poorly metabolised by a cold liver.

It should be noted that the physiological changes of the body under hypothermia are modified by the use of anesthesia. The only experiments carried on with unanesthetised humans were the now infamous Dachau experiments, where prisoners of war were submerged in 4°C water (they died at body temperatures of 27°C).

## SUMMARY

### Beneficial Effects of Hypothermia

1. *Reduced oxygen requirements*  
Oxygen requirements fall to 50% of normal at 30°C.
2. *Lowered glucose metabolism*  
Below 30°C glucose is metabolised slowly or not at all.
3. *Inhibition*  
Harmful enzymatic and bacterial activities are inhibited.
4. *Reduced cardiac activity*  
This occurs even though the tissues are

supplied with adequate oxygen. (The reduced blood flow supplies adequate oxygen for metabolism at the reduced temperatures.)

5. *A direct anticoagulant effect*  
This effect reduces the danger of thrombosis in the presence of circulatory disturbance.
6. *A reduction in the amount of anesthetic required.*

#### Potential dangers of cooling

1. *Avoidance of excessively low temperatures*  
For accurate temperature measurement use a thermocouple device.
2. *Loss of consciousness*  
Consciousness is generally lost, or at least clouded, at rectal temperature of 29° to 31°C.
3. *Disturbance of acid base balance*  
Unless prevented by hyperventilation the pH of the blood is lowered during cooling and may be aggravated if the patient is rewarmed quickly.
4. *Danger of air embolism*  
When using the heat exchanger in conjunction with the heart-lung machine, one must avoid too rapid rewarming, as air embolism may occur.
5. *Reduction of platelets*  
This phenomenon leads to clotting defects.
6. *Sludging of red blood corpuscles*  
This may be avoided by adding dextrans of low molecular weight to circulating blood.
7. *Interference with hepatic and renal function*  
This may lead to the potential danger of accumulated substances like heparin and glucose.
8. *Undesirable cardiac effects*  
Low temperatures lead to an increase in the conduction time with prolonged P-R intervals and widening of the Q.R.S. intervals. For man 25°-27°C is the lethal temperature, for ventricular fibrillation occurs at this point. If ven-

tricular fibrillation occurs during surgery the condition may be corrected by giving an electrical shock to the myocardium.

9. *Undesirable General Responses of the body to the stimulus of cooling:*
  - (a) Shivering occurs with an increased oxygen requirement in the first stages of cooling if an anesthetic is not given.
  - (b) Profound endocrine activation occurs. This is often referred to as the "cold stress response".
  - (c) Arterial constriction in peripheral areas. This may lead to local cold injury of the limbs, especially frostbite, with the danger of resulting tissue necrosis.
10. *An afterdrop in deep body temperatures*  
This occurs after cooling has been in effect for some time, but is more likely to occur in the initial stages of rewarming when vasodilation at the periphery causes a sudden return of an increased volume of cold blood to the heart. The heart, in particular, may experience a temperature drop that can be lethal (example—below 25°C).

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# Prefrontal Lobotomy

## (A Therapeutic Review)

R. MEEN, '63

### INTRODUCTION

The first case of frontal lobe surgery was done in 1889 by a Swiss psychiatrist, Burckhardt. Since that time, thousands of patients have undergone frontal lobe surgery in one form or another. Many papers have been published by different psychiatrists and neurosurgeons reviewing the effects, the indications, the contraindications, the efficacy, and, in fact, all the facets of this procedure. However, since the introduction of "tranquilizers" into the field of psychiatry a decade ago, the number of surgical interventions has decreased and the approach to psychosurgery has changed radically. If properly applied, however, psychosurgery continues to be a valuable and indispensable therapeutic method in psychiatry.

### FRONTAL LOBE FUNCTION

Before doing surgery of any type, it is agreed that the purpose of the organ being operated on should be known. Are the functions of the frontal lobes known? The frontal lobes form the latest stage in the evolution of the brain. There has been much speculation as to their function, and still there is no definite answer to this problem. The consensus is that the frontal lobes are involved with the imagination, the social sense, self-consciousness, and the projection of the self into the future. If the Freudian view is taken, this means that the frontal lobes are the seat of the super-ego. Continuing with Freud, functional mental disorder is due to a conflict between the super-ego and the libido. The seat of the libido is said to be the thalamus; thus, by separating the fibres between the thalamus and the frontal lobes the conflict is stopped and the disorder is brought to a standstill. This hypothesis, which may have no basis in fact, is nevertheless helpful in choosing suitable cases for prefrontal lobotomy, and in explaining its effects.

### THERAPEUTIC TRIALS

Prefrontal lobotomy is never the treatment of choice in any case of mental illness. Only after all other forms of treat-

ment such as electro-convulsive therapy, insulin coma therapy, drugs, and even psychotherapy have been tried to their fullest extent is it resorted to. Even then, the majority of patients are not suitable for such a procedure. But, these preliminary treatments are all important factors in deciding whether the patient is suitable or not. How long should the other treatments be continued before surgery is done? Most psychiatrists agree that the ideal time for operation is at least one year, and not longer than five years, after the last remission of the illness.

### PSYCHIATRIC EVALUATION

The most important factor in selecting a patient for lobotomy is his premorbid personality. The extent to which patients show the symptoms of postoperative "encephalopathy" varies greatly and seems to depend largely on this factor. Unpleasant traits become magnified after lobotomy, whereas a pleasant, well-adjusted personality diminishes the threat of post-operative difficulties. The patient's personality must still be intact under the psychosis, and the suitability of the patient for lobotomy depends on the intensity of his emotional reaction to his abnormal experiences. This is extremely difficult to evaluate; for example, schizophrenic manifestations can completely mask the underlying situation.

When evaluating a patient, the psychiatrist should ask himself the following questions with regard to the particular case:

- (1) Which symptoms can be removed, and which symptoms will remain uninfluenced?
- (2) How will the patient's personality be altered by after-effects of the operation?
- (3) What can be expected within the constitutional and environmental setting of the individual patient?

Of course, each case must be judged on its own merits, but past experience in this field is invaluable; from the data tabulated, certain generalities can be made for the many different psychiatric disorders as to the prognosis of any particular patient after the lobotomy has been done.

#### THE PSYCHIATRIC SYNDROMES: INDICATIONS AND RESULTS

Psychosurgical procedures reduce anxiety and the emotional impact of delusions and other symptoms shown by many different psychiatric patients. There are few chronic conditions in psychiatry where brain surgery has not been tried. McKissock, a British surgeon, noting the change in the type of clinical case referred for psychosurgery, states: "It seems evident that psychiatrists have now a fairly clear concept of the type of symptomatology or syndrome likely to be beneficially affected by the operation. This has been reflected in a marked diminution in the number of deteriorated schizophrenics referred for surgery, although a number of dangerous or disturbed patients are still referred and can often be adequately sedated by a standard prefrontal operation. There has been a corresponding increase in number of patients suffering from the symptoms of anxiety, tension, agitation and depression who have failed to respond to all the other accepted forms of treatment. It is in this group, as well as in the obsessional states, that limited leucotomies seem to produce

eminently satisfactory, if not perfect results."

#### SCHIZOPHRENIA

Schizophrenics, more often than other patients, have an inadequate personality to begin with; thus, the post-operative prognosis is not as good. As pointed out previously, it is often difficult in an individual case to determine how far the patient has deteriorated, and how far the clinical picture is still reversible. Anxiety, frequent in schizophrenia as in many other psychiatric conditions, is more susceptible to psychosurgery than any other symptom. Where it is a dominating symptom, as in the pseudoneurotic form of schizophrenia, it makes for a particularly favorable prognosis. The same is true for obsessions, compulsion, tension ruminations, physical symptoms, hypochondriacal preoccupations and other neurotic symptoms as they may occur in any schizophrenic.

#### Chronic Catatonic Excitements and Stupor

Surgery usually modifies the aggressive behavior and, often, the dangerous response to delusions and hallucinations. The patient may have to remain hospitalized but he is quiet and peaceful. The results in the stuporous phase are far from being satisfactory, and exacerbations in both phases are common.

#### Paranoid Schizophrenia

These patients have a good prognosis. This is due to the fact that their personality is usually well preserved and their pre-psychotic personality has often been good, particularly as to their work record.

#### Simple and Hebephrenic Schizophrenia

The best results of psychosurgery are seen in this category. The operation relieves the dominant symptom of "pan-anxiety", and, therefore, radically reduces the patient's suffering, at the same time relieving the florid schizophrenic symptoms.

## *Prefrontal Lobotomy*

By categorizing schizophrenic symptoms into three groups, we can see how they are affected in different ways after lobotomy.

The first group, comprising motor activity, aggressiveness, speech and awareness, shows improvement without any alteration of the preoperative pattern. Thus, it appears that no new disturbances in these mental functions occur as a result of lobotomy. So far as such functions are concerned, the patient becomes more tractable, but loses some of his ability to react to stresses.

The second group, which includes responsiveness, mood, attention, and socialization, also exhibits improvement, but at the same time, new disturbances make an appearance. A shift takes place from inwardly to externally directed tendencies. The preoperative predominance of preoccupied or shut-in behavior decreases and a tendency to distractible and out-reaching conduct becomes evident. Instead of shutting himself off from the world, the lobotomized patient is apt to react excessively to external stimuli. This may be regarded as a favorable development.

The third group includes feeling and associations, disturbances which are generally regarded as being of primary importance in schizophrenia. These functions fail to show any noteworthy improvement, though the overall picture is to some extent altered after the operation. Apparently, lobotomy results in a substitution of certain disturbances for others which are equally severe, if not more severe. Thus, a labile affect is apt to be replaced by a blandness and tension by dullness or apathy. Such changes tend to make patients more tractable, but they can scarcely be regarded as a real improvement of the schizophrenic disorder. On the contrary, one can argue that they indicate an impairment of adaptive capacity, since they render the patients more passive and less able to react actively.

Prefrontal lobotomy gives rise to clinical improvement largely by ameliorating some

of the secondary or less important symptoms, by rendering the patients more susceptible to external stimuli and by reducing certain active reactions to more passive ones, without producing any noticeably favorable effects on the fundamental disturbances of schizophrenia.

### **Affective Disorders**

Surgery almost constantly gives relief from anxiety, but the depressive mood in whatever setting it occurs may easily continue, although often with diminished depth. If the depression is preceded by a manic attack, the prognosis is worse. However, chronic depressives may be excellent candidates for psychosurgery, especially if accompanied by somatic delusions, hypochondriacal symptoms or other atypical features.

### **Psychoneuroses**

The best results of psychosurgery obtained in any psychiatric disorder are reported in severe psychoneuroses. The problem with these patients is that postoperative personality changes may be greater than desired; however, neurotic patients do not deteriorate and personality changes should be much less pronounced. The obsessive-compulsive neuroses present the most important indication. Such patients, often unable to live a normal life for years, frequently confined to their home and tortured constantly by their compulsions and obsessive fears, obtain relief from their suffering with adequate psychosurgery.

### **Hypochondriasis**

Wherever hypochondriasis is the main symptom, a favorable outcome results in practically all cases. The patient's self-preoccupation is relieved, and he can resume a normal life.

There are some other syndromes in the field of psychiatry that have been treated by psychosurgery, but data is limited for these entities; drug addiction, alcoholism, psychopathic personality, mental deficiency and epilepsy. However, it appears that the

associated psychiatric disorders accompanying these problems are the important points for consideration.

### Somatic Conditions

Some patients with a psychosomatic condition such as ulcerative colitis, asthma, neurodermatitis and cachexia, have undergone prefrontal leucotomy with favorable results. But this is a new aspect in the therapy of these disorders and very little is recorded concerning it.

Freeman and Watts were the first to report that prefrontal lobotomy could relieve unbearable pain. They observed that while pain was still perceived, and might even be more easily provoked, nevertheless, suffering was reduced, and narcotics could often be discontinued.

### COMPLICATIONS AND SEQUELAE

Any type of surgery implies hemorrhage, and sometimes it cannot be controlled. Surgical mortality of lobotomy varies from 1 to 3 per cent, usually as a result of hemorrhage.

The incidence of post-lobotomy epilepsy varies from 1 to 30 per cent, being more likely to occur in patients with extensive operations, operative complications, and pre-existing brain disease. The seizures may begin soon after operation and come under control easily, or may first appear five to ten years after operation. Approximately 75 per cent of patients with seizures following lobotomy can be controlled by Dilantin and phenobarbital.

Gain in weight is quite usual after lobotomy. Not only is the emotional turmoil of the mental disorder overcome, but the lowering of activity and decreased pride in appearance make for overindulgence in food. It is the responsibility of the family to control food intake.

Incontinence is often seen after prefrontal lobotomy, but this can usually be controlled within a few days if proper care is given.

Undesirable personality changes may occur as a result of surgery, for example, incessant activity, distractibility, irritability, profanity, and rudeness. Some people say this is due to the incisions' being too extensive; others regard it as evidence that the patient's premorbid personality was not evaluated adequately.

### CONCLUSIONS

In 1936 Moniz, reporting on twenty patients, stated that one third had recovered, one third were improved, and one third showed no improvement. Since that time this proportion has persisted independent of the surgical method employed, and has been altered only by the selection of more favorable or less favorable patients.

Psychosurgery plays a definite role in the treatment of mental illness today. Affective disorders, the psychoneuroses and paranoid schizophrenia are reported to have the best prognosis. It must be emphasized however, that extreme care in evaluating all facets of the patient's premorbid and morbid personality must be taken. Then only, after all other forms of therapy have had an extensive trial period, is prefrontal lobotomy indicated.

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# A Clinical Approach to The Cardiac Patient

CAROL ANN REED, '63

## INTRODUCTION

The clinical approach to the cardiac patient implies an approach which pertains directly to the symptoms and course of the disease state in the heart and cardiovascular system as observed by the physician, as opposed to the anatomic changes found by the pathologist.

The importance of heart disease is easily recognized when it is realized that it is the most common cause of natural death in civilized communities in the more temperate zones of the world, being responsible for two-fifths of such deaths and for an annual mortality rate in the general population of about 0.45%. Both incidence and mortality curves have been rising steadily for many years, a fact which is not fully explained by aging population and by the control of infectious fevers, pulmonary tuberculosis, and pyogenic infections.

The diagnosis of heart disease rests upon the three basic principles of a careful history, thorough physical examination of the patient and complete laboratory investigation. Because of the extensive nature of this subject, only the history of the cardiac patient will be discussed, omitting the physical signs, laboratory investigation, treatment and prognosis.

## HISTORY

The recording of an accurate and relevant history is one of the most difficult, yet most important arts in medicine since, sometimes, a complete diagnosis can be made from the history alone, or at least narrowed down to two or three possibilities. A good history should at least:

1. Indicate the system involved, or point to some group or groups of diseases.
2. Sufficiently analyze any given symptoms; in cardiovascular disease this would involve particularly pain, breathlessness, palpitations and syncope.
3. Record the history as much as possible in the patient's own words without the accounts being verbose, irrelevant, inaccurate, or misleading.
4. Intelligently use and interpret replies to leading questions when it is impossible to avoid them.

### A. General Considerations

The physician who sees, questions and examines a patient himself has a great advantage over someone who reads or hears another person's report since there are some things in dealing with a patient that

are difficult to put down on paper. Some of these clues and aids in diagnosis may be summarized as follows:

1. The general appearance and mental attitude of the patient are of great importance. Is the patient impetuous, over-anxious, or slow in seeking advice, minimizing his troubles, exaggerating his troubles?
2. Rapport between physician and patient, if established, can facilitate the establishment of a correct diagnosis and proper treatment.
3. Also helpful is the evaluation of the physical and mental attitude of the patient by the doctor's secretary, friends and relatives of the patient, or a referring physician and their attitude about him or his illness.
4. The extent of the patient's knowledge and insight into his medical status may be helpful.
5. Be careful to examine a patient more thoroughly than usual before excluding "organic" heart disease and diagnosing "cardiac neurosis".
6. Generally, it is wise to take the patient into one's confidence if he is of average

intelligence and to inform him of his physical condition.

7. General observations as to:

- (a) *age* — a child is more likely to have congenital heart disease, whereas coronary artery disease is commoner in the older age group;
- (b) *sex* — this is important in youth and middle age when angina pectoris, coronary thrombosis and serious hypertensive cases occur mainly in males;
- (c) *body build* — primarily, the stocky, muscular male is the typical early candidate for coronary heart disease;
- (d) *state of nutrition* — obesity favors hypertensive and coronary artery disease, whereas loss of weight and malnutrition suggest thyrotoxicosis, heart failure and prolonged effects of drug therapy such as digitalis, which can produce anorexia;
- (e) *other congenital anomalies* — this suggests that a congenital cardiovascular system defect may also be present.

#### B. Patient's Past History

The past history of the patient is often full of clues, and yet it is frequently the most neglected part of the entire examination due to haste and lack of systematic inquiry. Some areas of inquiry which may provide clues are as follows:

1. Information directly from the patient regarding his past medical history, particularly heart and blood pressure.
2. Examinations for life insurance, when and how carefully done, as well as other physical examinations for school, work or military service, former records, ECG's and X-ray films.
3. Previous stays in other hospitals.
4. Heart murmurs of congenital or rheumatic origin dating back to the first few weeks or years of life which may have been picked up on routine examination in schools.
5. Also, one common condition, anxiety neurosis or neurocirculatory asthenia, which commonly gives a history of faint-

ing, a nervous heart or nervous prostration in early adult life.

6. Operations which can provide clues: was there special care for the heart in preparation, anesthesia or surgical technique, or have there ever been any operations to help the heart or circulatory apparatus and with what success?

7. Diet and salt restriction and habits regarding tobacco and alcoholic beverages and narcotics.

8. Drug treatment in the past, past habits of work and play, and other aspects of life.

9. For women, investigation of menstrual and child-bearing history.

10. Occupation, whether sedentary or strenuous physically, and also activities in sports, clubs, etc.

11. Education.

#### C. Family History

It is the obligation of every family physician and specialist to know as much as possible about the family history of his patients. This entails information about:

1. Ages of near relatives, if still living or at time of death, and their important illnesses.
2. Family events producing strains; i.e. divorce, suicides, dependants on patient.
3. Incidence of inherited diseases, or family susceptibility to certain diseases such as rheumatic fever and heart disease, hypertension, coronary atherosclerosis, neurocirculatory asthenia.
4. Longevity in family.
5. Health of spouse.

#### D. Symptoms

There is a considerable variation in the symptomatology of heart disease according to the pathology and also the kind of physiological disturbance in the circulation. It is helpful to know that cardiovascular disease may be severe without any symptoms whatsoever, and that often a patient may not be able to appreciate what is or is not a heart symptom. Also, with any record of symptoms, it is also valuable

to note the absence of any important symptom, which might have been expected under the clinical circumstances. The main symptoms of heart disease are: pain, dyspnea, edema, fatigue, cyanosis, syncope, palpitations, hemoptysis, recurrent bronchitis and cough, insomnia, systemic embolism, other conditions pointing to heart disease including: pulmonary embolism, cardiac cachexia, cerebral symptoms, swelling of the abdomen, jaundice and vomiting and oligemia and nocturia, and other symptoms.

#### 1. Pain

Cardiovascular pain is mainly limited to that dependent on coronary insufficiency or thrombosis, to pericarditis and to dissection of the aortic wall, there being very little else of importance concerning pain in the heart and great vessels. The four main characteristics of pain are—site, quality, duration and behavior—and its proper analysis is of the greatest importance in differential diagnosis. There are two basic considerations which must be taken into account at the outset, i.e., the patient's definition of pain which varies in different individuals, and the sensibility or nervous sensitiveness of the patient.

#### (a) CORONARY INSUFFICIENCY

The diagnosis of coronary insufficiency is based on the characteristic symptoms of angina pectoris, although it can also occur without pain. Pain in angina pectoris is characteristically central in position, pressing in quality, brief in duration and closely related to effort. It is a heavy, squeezing sensation felt more across the chest than in the midline and may radiate to the shoulders, both arms, neck and jaws, and through to the back. It lasts a few minutes at a time, is induced by effort or excitement and relieved by rest or nitroglycerine.

Angina pectoris is ruled out by the following findings:

- (1) Sharp stabbing or needle-like character of the pain.
- (2) Throbbing pain.

- (3) A very short duration of a few seconds only.

- (4) A very long duration of one-half hour or more, unless coronary thrombosis or some continuing strain such as continuous effort, excitement or tachycardia is in progress.

- (5) Induction of the discomfort during rest, seated or recumbent.

- (6) Relief of chest pain by effort.

- (7) Induction of the pain by light or moderate use of the arms.

- (8) Induction or aggravation of chest pain by deep breathing.

- (9) Tenderness over the site of the pain.

The causes of the above findings are:

- (1) digestive disorders, especially spasm of esophagus or cardiospasm;

- (2) bruises, sprains, arthritis, bursitis and other such abnormalities in chest wall, spine, shoulders and neck;

- (3) neurocirculatory asthenia;

- (4) neuritis as in herpes zoster;

- (5) pericarditis.

#### (b) ACUTE CORONARY THROMBOSIS

The pain of acute coronary thrombosis is due to myocardial anoxia or infarction and has the same characteristics as angina pectoris except for a longer duration and tendency to collapse. Three severe accidents resemble closely coronary thrombosis and should be differentiated; i.e.,

- (1) pulmonary embolism.

- (2) acute abdominal emergencies, such as the passage or obstruction of a gall stone, rupture of a viscus, mesenteric thrombosis or embolism, or a rupture of an arteriosclerotic aneurysm.

- (3) aortic wall dissection in the chest.

#### (c) PERICARDITIS

Pericardial pain is sharper, more left-sided than central and may be referred to the neck or flank. It is relatively long lasting and independent of effort. It is often associated with pleuritis, aggravated by breathing and attended by fever, leuco-

cytosis and serial changes on the electrocardiogram.

(d) **RUPTURED AORTIC ANEURYSM AND DISSECTING ANEURYSM**

These pains are easily identified by their character, duration and X-ray confirmation of the presence of an aneurysm.

(e) **NEUROCIRCULATORY ASTHENIA**

Neurocirculatory asthenia is common and readily diagnosed on the basis of its character, of the type of person affected, and of the coincident symptoms which always accompany it.

2. *Dyspnea*

Cardiac causes of dyspnea, whether acute or chronic, are essentially two: failure of the left ventricle and mitral stenosis, the former due to myocardial insufficiency, and the latter to valvular stenosis or regurgitation or both, that is, a mechanical factor. Common causes of dyspnea other than heart disease are bronchial asthma, infections of the lungs or bronchi, pleurisy, nervousness, poor physical fitness, extreme obesity, emphysema, anemia. Less common causes are pericarditis, pneumothorax, intrathoracic tumors and disorders of the brain or of its circulation.

Heart disease as a cause of dyspnea is ruled out by:

- (a) X-ray evidence of a small heart shadow, not infrequently vertical in position, with low, poorly moving diaphragm in the case of pulmonary emphysema;
- (b) a normal ECG;
- (c) wheezing induced by certain foods, pollens, or dusts and cleared by elimination of such factors or by epinephrine;
- (d) asthmatic attacks which have recurred for many years;
- (e) sighing respiration with a tendency to hyperventilate, along with multiple other symptoms, in particular heartache, palpitation, faintness, marked fatigability, and nervousness in the case of neurocirculatory asthenia;
- (f) pain on breathing, deep or superficial,

whether or not one hears a pleural or pericardial friction rub, in the case of pleurisy or pericarditis;

(g) fever, tachycardia, and leucocytosis in the case of respiratory infections and pulmonary infarction.

3. *Edema*

When due to heart disease, edema is a sign of failure. It is attributed to sodium retention and it is thus renal in origin, and in the majority of cases it is associated with a low cardiac output and a raised venous pressure. The causes of edema most often confused with cardiac edema are Milroy's lymphatic deficiency, premenstrual hydremia, bilateral phlebotrombosis and chronic nephritis. But edema can also be due to venous thrombosis, cirrhosis of the liver, obstruction of the superior or inferior vena cava, protein starvation, severe chronic anemia, gross protein loss in exudates, burns, trench feet, insect bites, allergy, famine and renal edema.

4. *Fatigue*

Fatigue is often underestimated as a symptom of heart failure since it cannot be seen. Patients complain of heaviness of the limbs on exertion, weakness or lack of vigor, or general tiredness and exhaustion. It is distinguished from fatigue due to anxiety and mental conflict since cardiac fatigue is related to effort, and is always associated with signs of congestive heart failure.

5. *Cyanosis*

Cyanosis is a physical sign rather than a symptom, but because of its importance in the patient's history, it may be considered here. A blue color is imparted to the skin when the capillary blood contains 5 grams or more of reduced hemoglobin per 100 ml., or with polycythemia. The cyanosis may be central or peripheral, central meaning that the arterial oxygen saturation is low, and peripheral meaning a low cardiac output. Cyanosis, when present, is most obvious in the mucous membranes of the mouth, but it may also be apparent in the skin of the nose, ears, cheeks, fingers and toes. The source is to be looked for in the



heart or lungs, but it can be produced in the skin physiologically by exposure to cold, particularly in polycythemia. The general causes are commonly:

(a) pulmonary disease — emphysema, extensive infection, pulmonary arterial occlusion by embolism or thrombosis, arteriovenous fistula;

(b) congenital defects with a large volume right-to-left shunt;

(c) failure of either ventricle; left produces pulmonary vascular engorgement and anoxemia; right produces peripheral circulatory stasis.

There may be a local circulatory fault producing local cyanosis, i.e. stasis due to a vascular defect. Polycythemia increases cyanosis, anemia decreases it. The gray color of the skin in argyria resulting from the chronic use of silver salts must be distinguished from the purple blue of cyanosis.

Cyanosis of the conjunctiva, palate, tongue and inner side of lips and cheeks, associated with clubbing and polycythemia and deepening on effort is central. Peripheral cyanosis is limited to the ears, nose, cheeks, outer side of lips, hands, feet and digits and these parts are cold. There is no clubbing but polycythemia may be present if there has been a prolonged low cardiac output.

#### 6. Syncope

There are many causes of transient loss of consciousness, and a complete list would include the causes of epilepsy, coma, concussion, and asphyxia, but syncope has come to mean transient loss of consciousness of sudden onset due to inadequacy of cerebral blood flow. Syncope then, occurs in cardiac, vasomotor, cerebral and anoxic forms, only cardiac causes being discussed here.

Cardiac syncope occurs when the heart through some fault in itself or the great vessels fails to maintain an adequate cerebral circulation. There are five disorders of rhythm that may cause these symptoms:

(a) extremely fast heart rate due to atrial paroxysmal tachycardia;

(b) ectopic ventricular rhythm;

(c) high grade partial heart block or ventricular standstill;

(d) high grade sino-atrial block with standstill of whole heart;

(e) paroxysmal ventricular fibrillation.

Other cardiac causes are:

(a) ball-valve thrombus or pedunculated myxoma;

(b) aortic stenosis;

(c) massive pulmonary embolism;

(d) cardiac compression from hemopericardium;

(e) low cardiac output states under certain conditions.

#### 7. Palpitations

Palpitation is the conscious awareness, usually disagreeable, of the heart beat, whether regular or irregular in rhythm and whether fast, slow, or of average rate. It occurs whether the heart is diseased or not and is in major degree dependent on the nervous sensibility of the person under consideration. Palpitations may be rapid and regular, with abrupt onset and offset, as in paroxysmal tachycardia; rapid and chaotic, as in auricular fibrillation; or fleeting and repetitive, as with ectopic beats. Palpitations may be heavy, rather than fast or irregular, however, and an increased stroke volume may be responsible. Physiological or pathological hyperkinetic circulatory states, aortic or mitral incompetence, patent ductus, ventricular septal defect and atrial septal defect may also cause heavy thudding of this kind.

#### 8. Hemoptysis

Hemoptysis can occur in a wide variety of cardiovascular diseases, but only under strictly defined circumstances:

(a) rupture of a necrotic arterial lesion, i.e. disseminated lupus, pulmonary tuberculosis, arteriovenous aneurysm, mycotic aneurysm, bronchiectasis, bronchial carcinoma;

- (b) first symptom of mitral stenosis, precipitated by effort or pregnancy;
- (c) blood-stained sputum may accompany an attack of paroxysmal cardiac dyspnea in mitral stenosis or left ventricular failure, and may be a result of intense pulmonary venous congestion;
- (d) pulmonary infarction.

#### 9. Recurrent Bronchitis

Trivial upper respiratory tract infections may rapidly develop into bronchitis in two main types of disturbed physiology in cardiovascular disease:

- (a) pulmonary plethora occurring in patent ductus, ventricular or atrial septal defect;
- (b) Pulmonary venous congestion occurring in left ventricular failure and mitral valve disease.

Recurrent bronchitis is not a feature of pulmonary ischemia in congenital anomalies with right-to-left shunt or in low output states.

#### 10. Insomnia

Two obvious symptoms may interrupt sleep in cases of heart failure—paroxysmal nocturnal dyspnea and Cheyne-Stokes breathing.

#### 11. Systemic Embolism

Under certain circumstances a clot may form in the left side of the heart or in a pulmonary vein and embolize to some cerebral, visceral (mesenteric, renal, splenic, coronary) or peripheral vessel. The chief causes of thrombosis in

- (a) the cavity of the left ventricle are
  - (1) cardiac infarction
  - (2) isolated myocarditis
- (b) in the left atrium
  - (1) mitral valve disease
  - (2) auricular fibrillation
- (c) in the aortic or mitral valve
  - (1) bacterial endocarditis.

The commonest cause of embolism is mitral valve disease with auricular fibrillation.

#### 12. Other Conditions Pointing to Heart Disease

- (a) pulmonary embolism is usually secondary to phlebothrombosis in the leg and commonly complicates heart failure with a low output.
- (b) cardiac cachexia is a late sign of chronic heart failure in aortic mitral or tricuspid stenosis.
- (c) cerebral symptoms including dementia in advanced hypertension, encephalopathy in malignant hypertension and psychotic states due to anoxia, decreased cerebral blood flow or impaired hepatic function.
- (d) swelling of the abdomen due to increased size of the liver, with or without ascites complicates chronic heart failure from tricuspid incompetence associated with chronic right ventricular failure, constrictive pericarditis, severe tricuspid stenosis.
- (e) jaundice and vomiting
- (f) oligemia and nocturia, aggravated by congestive heart failure or acute coronary thrombosis.

#### 13. Other Symptoms

Headaches, aphasia, visual disturbances, cough and hoarseness, dysphagia, cardio-spasm, anorexia, nausea, abdominal pain, gaseous distension of the abdomen, diarrhea, sweating, dizziness, confusion and weakness may also be symptoms of underlying heart disease.

### SUMMARY

The clues which lead to the diagnosis of heart disease are many and varied. They are found in the history of the patient's family and in the patient's own history of past events and present symptoms. Often the diagnosis can be made on the basis of the history alone if it is carefully elicited. Otherwise, a thorough physical examination will help to discover the signs of heart pathology and a careful laboratory investigation will be of further aid in making the diagnosis. The clinical approach to the

cardiac patient or any patient should be mastered by every doctor and include not only the history which has been discussed here but also the physical examination and laboratory investigation.

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# Autoimmunity

DONNER DEWDNEY, '63

## INTRODUCTION

In 1898, Bordet demonstrated hemolysis in a rabbit when antiserum was injected from a rabbit of another species which had received erythrocytes by injection from the first animal. Interest died in these experiments until 1929 when Masugi produced glomerulo-nephritis in rats using a similar technique.<sup>9</sup> Since then, experiments with animals have been refined to the point of injecting tissue back into the same animal and producing internal pathology characteristic of certain human diseases. Today, the phenomenon of autoimmunity and its application to modern medicine is under study by groups across the world. Since the number of human diseases in which autoimmunity seems implicated is steadily enlarging, it should be of the utmost importance to the medical student and practitioner alike that he be reasonably aware of this phenomenon.

## DEFINITION

The term autoimmunity may be applied to any disease where one individual produces antibodies responding abnormally with his own tissue. In some cases, an outside antigenic "trigger" is necessary to initiate this reaction. In other cases, no such stimulus has been found and the autoimmune process appears to begin spontaneously. Nevertheless, regardless of how it may begin, autoimmunity is a disease process which reacts with the body's own antigenic structure in order to continue its effect.

## ETIOLOGY

In 1942, Kidd and Friedewald demonstrated normally-occurring antibodies in rabbits which reacted with cellular sediments from various organs including liver, kidney, lung, brain, spleen and heart selected randomly from several animal species.<sup>7</sup>

This and other research projects have led to a serological classification of animal tissue and cell antigens:<sup>12</sup>

### 1. Heterogenic Antigens

By definition, this group of antigens is active in more than one species. The so-called "Forssman" antigen has been isolated in species ranging from bacteria to man.<sup>4</sup> It has been found intracellularly in blood, blood vessel endothelium as well as

free in perivascular connective tissue. Landsteiner's studies with this antigen indicate that a carbohydrate is the moiety providing the specificity.<sup>8</sup>

### 2. Species-specific or Homologous Antigens

These antigens are apparently confined to individuals within a certain species. Examples of this have been found in certain animal hemoglobins, in the spermatozoa of different species including man, and in sheep and ox red cells. Their nature has hitherto been described as proteinaceous. Landsteiner suggests that the amino acid variability accounts for this specificity.

### 3. Iso-Antigens

These antigens appear to characterize only certain members of a single species. Examples include the human blood groups (A B O, M N, etc.), hemoglobin types, leucocyte typings and blood platelet differences.

### 4. Organ-Specific Antigens

Antigens which seem to be specific for a particular cell or organ are referred to as organ-specific. They may be either heterogenic or homologous in action. Masugi's classical demonstration of nephritis in rats mentioned above serves to illustrate heterogenic organ-specificity.

If an individual then carries a host of such antigens potentially dangerous both to himself and to other members of his own species, one may well ask why he does

not wander through life as an immunological cripple?

Several authors have attempted to answer this question. All, however, seem to agree essentially on one point, and that is the existence of a barrier in the "normal" individual between his tissue and lymphatic and vascular channels. Teraski and Chamberlain demonstrated the destruction of epidermal cells in vitro using both autologous and heterologous normal sera in rats and rabbits. It is their feeling that a block exists between the basal cells of the epidermis and the plasma.<sup>13</sup>

The controversy begins when one attempts to explain why this barrier breaks down.

Burnet postulates an answer based on his studies in embryology. It is this author's feeling that "clones" of cells never entirely deleted during fetal life are triggered by infections (e.g. streptococcal) or merely random mutation to produce auto-antibody. The mutation, then, if occurring in globulin-producing cells, could quite conceivably result in a defect in globulin synthesis and a consequent release of aberrant proteins.<sup>3</sup>

Other studies indicate the importance of an exogenous antigenic stimulus. It is the feeling of some authors that potential auto-antibody in the susceptible individual exists in a "haptene" state.<sup>5</sup> Thus, when killed tubercle bacilli (Freund's adjuvant) or killed streptococci are added to an animal's own tissue extract and reinjected into that animal, the pathological lesion develops because the adjuvant has rendered the auto-antibody molecule complete.

These theories may not be as incompatible as they might appear and a third explanation has been forwarded drawing from both. That is to say, an exogenous stimulus activates a latent mutational defect in the body's globulin system resulting in the formation of an auto-antibody capable of breaking the aforementioned barrier to reach the antigen, and the resultant

combination effecting tissue damage. Moreover, "cross-reaction" may occur. The globulin defect may produce incomplete antibodies which "confuse" the hyaluronic acid present in streptococci with chondroitin sulphate in that individual's own connective tissue, resulting in the fibrinoid necrosis of "collagen diseases".

### DISEASES IN MAN WHERE AUTO-IMMUNITY SEEMS IMPLICATED (Modified from Dixon)\*

#### I Hematologic Autoimmune Diseases

1. Acquired hemolytic anemias
2. Paroxysmal hemoglobinuria
3. Atypical pneumonia
4. Idiopathic thrombocytopenic purpura
5. Certain chronic leukopenias

#### II Autoimmunity Induced by Immunization with Tissue Antigens

1. Allergic encephalomyelitis
2. Allergic polyneuritis
3. Uveitis
4. Aspermatogenesis
5. Disseminated lupus erythematosus
6. Thyroiditis
7. Idiopathic adrenal necrosis
8. Some instances of dermatitis

#### III Endogenous Immune Response to Exogenous Antigens

1. Laennec's cirrhosis
2. Glomerulo-nephritis
3. Rheumatoid arthritis
4. Rheumatic fever
5. Multiple sclerosis
6. Homograft rejection

It would be arduous and time consuming to discuss all the above diseases as to their probable, or as the case may be, suggestive autoimmune background. Consequently, an example shall be chosen from each group and its possible autoimmune perspective discussed.

\*Dixon, F. J.: *A Classification of serological reactions*, *Ann. Rev. Med.*, 9: 257, 1958.

## 1. Hematologic Autoimmune Diseases

### *Acquired Hemolytic Anemia*

Coomb's test for the demonstration of cell-attached antibodies was applied, in 1946, by Boorman et al., to the phenomenon of acquired hemolytic anemia, affirming an earlier hypothesis of just such antibodies' existing in an "incomplete" state.<sup>2</sup>

Whether these antibodies represent specific responses to the patient's own antigens is not known. Burnet regards this disease as an example of somatic mutation resulting in the formation of aberrant proteins.

Certainly, the relief obtained by splenectomy in these patients is due to the removal of a bed of phagocytosis rather than a site of auto-antibody formation.<sup>12</sup>

## 2. Autoimmunity induced by immunization with tissue antigens.

### *Thyroiditis*

It is certainly here that autoimmunity presents a convincing case. Anti-thyroid antibodies have been demonstrated in both the circulation and the serum in patients suffering from chronic thyroiditis. Moreover, this condition is experimentally reproducible in animals. Witebsky et al. injected rabbits with their own thyroglobulin and Freund's adjuvant, finding not only circulating antibodies but also a condition developing in rabbits similar to chronic thyroiditis in the human.<sup>14</sup> The role of this adjuvant is still really not known as no author seems willing to indicate which of the two possibilities he prefers; that of the adjuvant modifying the antigen in some way or changing the host's response to that antigen.

## 3. Endogenous immune response to exogenous antigen.

### *Systemic Lupus Erythematosus*

Here, a number of tissue reactive antibodies have been isolated. Compatible with this are statistically higher incidences of B.F.P.'s (Biologic False Positives) in this disease when compared to normal control populations regarding tests for syphilis. In

other words, these are patients who are known already to be antitissue antibody producers.

It has been suggested that if autoimmunity is indicated in Systemic Lupus Erythematosus, cross-reaction may be to blame. The individual may develop antibodies to exogenous nucleoproteins which "cross-react" with his own nucleoproteins.

Lending support to this, Godman et al, as a result of their work on the L. E. phenomenon, suggest that protein not normally found in the nucleus enters the latter and displaces histone, combining with D.N.A. (Desoxyribonucleic acid).<sup>6</sup>

Similar findings to the above have occurred in studies of rheumatoid arthritis.

## TUMOR RESEARCH

It would be audacious to describe an autoimmune basis in the growth of neoplasms at the present time. Nevertheless, the future may provide some interesting autoimmunological answers for some of the following questions:

Why do terminal cancer patients accept and hold heterologous and homologous skin grafts for longer periods of time than normal individuals?<sup>11</sup> Does this indicate that cancer possesses a capability to alter the immune reaction in that individual? If it is true, one may well infer the production of antibody against tumor cells. In conjunction with this trend, Möller has recently reported that neoplastic mouse cells could be made sensitive to a mixture of antisera produced in different donor genotypes.<sup>10</sup>

Certainly, the answer to these questions is not to be found at the present time, but it is interesting to note the increasing role immunity is playing in cancer research.

## SUMMARY

A brief survey of the phenomenon of autoimmunity has been presented. Although

*Continued on Page 162*

# Changing Patterns Of Medical Care

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## INTRODUCTION

The purpose of this paper is to survey the changes that are occurring in medicine today, and to discuss what implications these changes may have for future medical practice. An attempt has been made to view these changes in perspective and to see how they fit together.

I have not considered here the possibility of a radical change which would render these considerations invalid. The most obvious and ominous would be nuclear war. The most unexpected would be a cure-all, but research will undoubtedly produce some surprises. There are those who predict a much more rapid and decadent fall in Western society than doctors, in their relative security, are likely to imagine.

The paper is divided into two parts. The first outlines the background of present changes and then presents these changes from the patient's viewpoint and from the doctor's viewpoint. The second part considers some of the solutions that have been proposed to four of the most pressing problems which are arising as a result of these changes.

## PART 1. CURRENT CHANGES IN MEDICINE THE BACKGROUND OF CURRENT CHANGES IN MEDICINE

The old American family practitioner drove his horse through the snow to the home of the woman with the threatened abortion. Today, she may be whisked by ambulance to the efficient (well, relatively efficient) emergency department of a large hospital. Medicine has experienced, along with many other disciplines, the rapid social and technological changes of the past half century.

The source of these changes could be traced to the origins of man, to his basic needs and desires, and to his curiosity. But, in particular, it was the application of that method of controlled observation and recording that we call the "scienterrific" method that led us to our present state of triumph and turmoil. It led to the industrial revolution, urbanization, increased standard of living, and mobility of the population. The most important factor behind current changes in medicine is the tremendous growth of medical knowledge that has occurred since the application of the scientific method to medicine.

While C. Northcote Parkinson studied the exponential growth of bureaucracy in the British Admiralty and published his results as Parkinson's law, his colleague, Derek J. Price, also at the University of Malaya, studied the exponential growth of science. He used such criteria as the number of science degrees being granted and the number of scientific journals being published. He found that these indices have been doubling every 10 to 15 years ever since the time of Isaac Newton.<sup>8</sup> Medical knowledge is presently in the forefront of this explosion. By 1975, a Medical student will have about double the volume of material at his disposal that we have to-day.

The medical sciences have expanded to touch anthropology on the one hand and physics on the other; there has been specialization and sub-specialization; services to the patient range through promotion of health, diagnosis, treatment, and rehabilitation. The results are well known. In our part of the world, the bacteria have had antibiotic monkey-wrenches thrown into their enzyme systems, and the viruses,

\*Presented at a meeting of Beta of Ontario Chapter of Alpha Omega Alpha, London, March 8, 1962.

those tiny animolecules, find human habitat forbidden by high prophylactic antibody titres. CNE's Mediscope highlighted the gadgetry that has become more than an ancillary aid in diagnosis. We are able to boast in North America of the highest standard of medicine in the world.

Yet, there is increasing talk of a widening gap between what the public wants and what the profession is able to provide. Let us consider from the point of view of patient and then doctor, what these changes have meant. "It is impossible to exaggerate the importance of the changes that are taking place, but I will do my best!"

## I. CHANGES FROM THE PATIENT'S VIEWPOINT

Men generally take for granted the good things of life and complain about the bad. The public has come to accept, even to expect as a right, the great improvement in medical care. But there are two matters that are often complained of in modern medicine: one is its high cost, the other is its increasing impersonality.

### The High Cost of Medicine

With better care has come higher cost—the result of more complex gadgetry, more highly trained doctors and more highly advertised drugs. There seems little likelihood of these costs being reduced. Major accident or illness in the family without insurance would likely bring financial disaster. The average family therefore, has some sort of insurance to cover this eventuality.

Each province except Quebec has a hospital insurance plan. 50% of the cost is paid by the federal government, the rest by the provinces through premiums and taxes.

There has been a rapid growth in private insurance plans. These include insurance company policies and non-profit plans like Blue Cross and physician-sponsored plans such as Manitoba Medical Service.

It is apparent that Canada has yet to solve fully the problem of the high cost of medical care.

### The Impersonality of Medicine

There is no particular reason why a doctor who knows a patient's ESR, BMR, PSP, and EEG, should be any less interested in the patient as a person, and I think it would be unfair to say that doctors do care about their patients less today than formerly. Yet the feeling has arisen that the doctor-patient relationship is deteriorating, or at least that the patient and doctor are less likely to know one another well. There are a number of reasons why this is so:

#### 1. *Increasing Mobility of the Population*

The family doctor, who had known the family for years, lived in the same town and often visited in the home, earned the patient's confidence. Today, Mr. Smith's job may require that he move every few years, and he may need to consult a doctor only a few times in each place.

#### 2. *Increase in Specialization*

In Sarnia, Mrs. Smith may go to an obstetrician for pre-natal care. In a Toronto suburb, she consults a pediatrician for baby's croup. In London, she simply brings the boy to Vic's emergency when he gets a speck in his eye. And Mr. Smith, who gets his coronary while on holiday in Muskoka, has his history taken in turn by an unknown intern, resident and internist. When he leaves hospital, it is probably one of the nurses whom he knows best.

#### 3. *Decreased Appointment Time*

The increased work load has left to the doctor less time for lengthy office chats. The population per active physician in 1901 was 972; in 1959, it was 918, about the same. But the average citizen consults a doctor about twice as often now as 25 years ago.<sup>11</sup> A recent study showed that the average Canadian practitioner works six 10-hour days a week and sees 20 patients a day.<sup>11</sup> The traditional supporting forces, the family and the church, have tended to



weaken, and about 1/3 of office calls are said to be for psychological reasons. Psychosomatic illness can only be treated effectively in the context of a close and time-consuming doctor-patient relationship. Such a patient is prone to say, "Oh yes, he's a good doctor I guess, but he didn't give me much satisfaction. I think I'll try so-and so."

#### 4. Changes in Method of Practice

The old practitioner might spend the night with a boy who had pneumonia, trying to reduce the fever and, at the same time, comforting the family by his presence. Today, he would inject one million units of procaine penicillin into the buttocks. This is infinitely more effective and takes only a minute, but it stings and understandably does not engender the same sense of gratitude.

Dr. Warwick in an article called "The Impersonality of Medicine" points out that "there is no doctor-patient relationship when you step into the TB van for a miniature chest X-ray, and no doctor-patient relationship when you attend a blood donor clinic at the Red Cross. Yet, to-day, activities like these are part of the practice of medicine in its broadest sense."<sup>18</sup>

Finally, the public not only expect more but they *know* a lot more about what to expect. To quote again from Dr. Warwick's article: "People have come to know a great deal more about medical matters by reason of a veritable flood of information from newspapers, periodicals, radio, and television. Some of it is excellent, some hogwash, but it all adds up to the unpleasant effect of putting the doctor on the spot, of questioning his actions, his diagnosis and his treatment."<sup>18</sup>

## II. CHANGES FROM THE DOCTOR'S VIEWPOINT

### 1. His Patients are Different

Their diseases are different. Notably, they are older. The life expectancy in Canada has risen from 50 to 70 in the

past 30 years.<sup>11</sup> This means more chronic illness and more degenerative disease. Also, they are more anxious. A high percentage of office illness is psychosomatic and mental illness fills 50% of hospital beds. The doctor's training has poorly prepared him for such patients. He may never have heard an answer given to the patient's question: "How can I live with my Colostomy? I'm nothing but a worry to the family and an expense to society."

### 2. His Pattern of Practice Has Changed

*Specialization* increased in Canada from 24% of doctors in 1948 to 43% in 1959. Specialists have more prestige, higher fees, and greater hospital privileges. The growth of knowledge has forced the issue; the trend will undoubtedly continue.

*Group Practice* involves the practice of several doctors as a unit with prearranged division of income and responsibilities, and includes different types of specialists. This provides for easy consultation, and spreads the medical manpower, especially night duty and week-end work. In the United States, 6% of doctors are group members and the figure is rising rapidly. In North Dakota it is over 50%.<sup>8</sup>

*Salary.* The number of doctors on salary has risen to roughly 30%. This includes full-time teaching, research, industry, and government service such as mental hospitals, DVA, and Indian and Northern Health Services.

### 3. Shortage of Doctors

There are now about 20,000 doctors in Canada as compared with 5000 in 1900. But, as I mentioned, this has only just kept pace with the rise in population. And many now, such as anesthesiologists and radiologists, are not directly responsible for patients. And much more is requested by patients. This is the widening gap between demand and supply of physicians' services. At the same time that the financial barriers are falling so that more services can be given, there are fewer doctors and fewer applicants for medical school.

Perhaps more ominous, there is a falling off of the quality of applicants to medicine. In the United States and Canada in 1950, 40% of applicants had first class or honors standing.<sup>11</sup> In 1958, the figure was only 16%. Why is this so? A number of reasons have been suggested:

1. Increased opportunities in other careers such as chemistry, physics, and engineering, which draw top high school graduates.

2. Decrease in the prestige of medicine and the likelihood of socialization, with a resulting decrease in maximum income.

3. The length of medical education.

4. The high cost of medical education, which is over \$10,000, during the four medical years and for which there are few scholarships and bursaries. 84% of medical students depend largely on parental support in the 4 years after pre-meds, whereas in other sciences, only 20% depend on parents while studying for their doctorate.<sup>11</sup> The quality of medical care in this country is in danger unless greatly increased financial support of medical students is forthcoming.

## PART 2. PROPOSED SOLUTIONS TO FOUR PRESSING PROBLEMS

We must now consider what all these changes are likely to mean in the future. There are in particular, four difficulties emerging: the shortage of doctors, inadequate medical training in terms of future practice, the high cost of medicine, and its increasing impersonality. Fortunately, each of these problems is being extensively studied and a number of suggestions have been put forward. Let us see what some of them are.

### I. SHORTAGE OF DOCTORS

The answer to this problem is to make better use of available doctors and to provide increased incentives to students to enter medicine. If this is not done, one can expect overwork of doctors, an influx

of doctors from other countries, and, perhaps, an increase in osteopaths and naturopaths.

Better use of available doctors includes:

1. Specialists who are also primary practitioners to a group of patients.
2. Group practice which uses medical manpower more efficiently than solo practice.
3. Better use of auxiliary personnel, such as nurses, social workers and various therapists.

As Dr. Wendell MacLeod, Dean of Medicine at the University of Saskatchewan, has said: "We are still guilty of the misuse of highly trained health personnel. Too often the bed is still made by a graduate nurse, the needle administered by the doctor, and for even simple surgery, the most senior consultant in town is demanded."

Increased incentives to students include:

1. Increased financial aid.
2. Too often, doctors, when they hear that someone plans to enter medicine say half-jokingly: "You're nuts. We slave 20 hours a day for nothing." The rewards of practice should not be undersold.
3. *Shortening of the Curriculum*

In the United States, several schools such as Johns Hopkins, Boston and Northwestern have begun experiments in shortening the course and integrating premedicine and medicine. Some have moved the medical school bodily onto the university campus.

At Northwestern last fall, a new class of 25 entered a 6-year program directly from high school (which corresponds to grade 12 here). There is no summer vacation but there are two three-month blocks of time in which the student may do research, basic science, a clinical clerkship, or take a holiday. The premedical and medical courses are fully integrated, but a student may transfer at the end of two years and lose no time toward his B.A.<sup>8</sup>

It has been suggested by Dr. McCreary, Dean of Medicine at the University of British Columbia, that all members of the health team, that is, doctors, nurses, social workers, clinical psychologists and the various therapists, should be educated together. He says: "From the day of their registration, the undergraduates in these various fields will study together, eat together, take lectures together. They will learn to accept the contribution the other has to make. Then and only then will we truly have a health team. This should be an effective method of spreading the medical manpower."<sup>11</sup>

## II. PROBLEM OF INADEQUATE TRAINING

There is considerable feeling that present systems of teaching need overhauling but there is great discussion as to what should be done. It has been suggested that present teaching is too departmentalized, that more practical work is needed in preventive medicine and psychotherapy, that the care of the chronically ill is neglected, that comprehensive medicine should be emphasized more, and that too much emphasis is placed on examinations.

The Association of American Colleges has held a number of Teaching Institutes, since 1952, on various aspects of medical education. The Eighth, in Florida in November 1960, was on Medical Education and Medical Care and gave detailed consideration to many of the problems mentioned. Experiments at a number of schools were described. I shall mention only two, both of which are attempts to improve the curriculum.

### 1. Cornell

At Cornell an attempt to teach comprehensive medicine has been introduced. For 22 weeks the 4th year students attend a general health clinic. There, they each work with a given number of outpatients who return for appointments with the student. Faculty from all departments are

present for consultation, and the student attempts to apply knowledge from all fields, from health education to rehabilitation. A special effort is made to understand the psychological and social factors of illness. It is found that the students take great interest at first, but as the time of interning approaches, they become somewhat more restless and anxious to cram more theory on the diagnosis of medical and surgical conditions.<sup>8</sup>

### 2. Western Reserve

At Western Reserve, a famous experiment was introduced in the fall of 1952 in which teaching was almost fully interdepartmental and vertical, and the courses were planned by an interdepartmental subject committee. There were multidiscipline laboratories in which the student had the same laboratory spot throughout his study and where he could do personal research. Only pass, fail or honors grades were given to reduce the pressure of exams. The faculty was farseeing enough to set up a program of research into the effectiveness of its teaching program and so it modified and improved constantly. Other schools are watching closely, but are not convinced that the Western Reserve program is the one for which they are looking.

McKeown of Birmingham has proposed that teaching centres should make use of the acute hospital, the chronic hospital, the mental hospital and the ambulatory services for both teaching and research so that students will get a more balanced view of the task of medicine.<sup>8</sup>

## III. THE COST OF MEDICAL CARE

The obvious answer to the high cost of medical care is to extend insurance. Canada and the United States are the only well-developed countries which do not have some form of medical insurance for all the people. However, any form of prepaid medicine sets in motion complex changes in the organization of medical services. One cannot simply transfer the bill from

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the doctor to the third party as Mr. Douglas has suggested. One has at least to explain to the third party what the bill was for.

In Canada, the cost of medicine will probably be met with some government plan. In a survey in the spring of 1961, 80% of 10,000 doctors replying thought that this was inevitable.<sup>11</sup> It is part of the platform of the New Democratic Party and the Liberals. At the suggestion by the Canadian Medical Association, the Conservatives have established a Royal Commission to study the question. It is generally agreed that the profession is wiser now to try to influence the government toward an acceptable plan than to flatly oppose any form of government involvement.

Before considering what type of plan Canada is likely to get, it will be helpful to consider briefly, events in Britain and the United States that are likely to influence directly what happens in Canada.

The best summary of events in Great Britain that I have seen is the statement of Stalker that the National Health Service introduced by Bevan in 1948 was a masterpiece of government planning, that it raised the standard of hospital services and consultant services of the nation almost to the university hospital level, but that its basic general practice service has been a sad, sad story.<sup>15</sup>

Why has the G.P. service been disappointing? The public was encouraged to think that the Government had given it completely free care. There was an open invitation to misuse the service, and many are the stories of its abuse. The G.P. was overworked and underpaid, and the capitation system which the British Medical Association originally bargained to get in preference to salary, has encouraged many doctors to take on more patients than they can properly handle. These problems are being corrected, but there is great debate about the future of the G.P. in Britain.

In the United States the American Medical Association has been a powerful and unpopular pressure group in Washington, dedicated to maintaining the *status quo* and, as one of its spokesmen said, "to prevent any further intrusion of government into medicine no matter how worthy the cause." It is increasingly unpopular with its membership too, as this quotation from the *New England Journal of Medicine* for January 18, 1962 shows: "The compulsory extraction of dues from physicians who already have elected not to be identified with the A.M.A., which will be used to support lobbying activities over which they have practically no control, and with which they may violently disagree will not be tolerated . . . Either the Association will be rebuilt from within or a competing National Academy of Health, which already has support from medical leaders all over the country and in great numbers, will appear."

What sort of plan will we get in Canada?

Any government plan will almost certainly be a *provincially-administered* plan. This is good because it permits a certain amount of experimentation between the provinces.

It will be a *compulsory* plan, with everyone in Canada paying. A voluntary government plan would not be workable. It will not eliminate private practice. No plan elsewhere has done so, not even, apparently, the Russian one.

The other details will depend on the extent to which the planners accept the proposals of labor and the proposals of the profession.

*Organized labor* as represented by the Canadian Labor Congress has a detailed plan for fully socialized medicine similar to the National Health Service in Britain. It would be administered by a government Department of Public Health so that it would be subject to the scrutiny of the people; it would be paid for out of general taxes so that the cost would not be obvious; and it would place all doctors on salary with no deterrent fees—all services would

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be free. It would be fully comprehensive, and support medical research and medical education.

The Canadian Medical Association has been more liberal than the A.M.A. Ever since 1943, it has given approval in principle to health insurance, and is thus in a position to influence planning. The policy statement of the C.M.A. (also accepted by the O.M.A.) reads as follows:

"Basically, the C.M.A. agrees that the population has a right to determine:

- (a) whether or not they wish to pre-pay the cost of medical services,
- (b) whether payment will be made on a voluntary or mandatory basis,
- (c) the degree of financial participation by the government in any plan,
- (d) the comprehensiveness of the plan.

"The medical profession believes it has the right to determine:

- (a) that a high standard of medical service be maintained,
- (b) the worth of the medical service, and
- (c) the method of remuneration for medical service."<sup>6</sup>

The C.M.A. has not agreed on any detailed plan, but one might deduce that they would favor a system that could best be described as government-administered health insurance rather than a national health service. Such insurance would be administered by a government commission or Crown corporation in which doctors have a voice. It would be paid by premium, at least in part. And, it would retain the fee-for-service method of payment.

This is a controversial subject—how is the doctor to be paid? The capitation system will not likely find approval in Canada; the alternatives are fee-for-service and salary.

The disadvantages of fee-for-service are:

1. Excessive paperwork in a pre-paid system.

2. Difficulties in setting a fee on many items such as just listening.

3. Disproportionate emphasis on treatment

4. Poorer distribution of doctors who go to big centres rather than areas of need.

5. The doctor is tempted to perform unnecessary services. George Bernard Shaw put it this way: "The surgeon has a pecuniary interest in cutting off your leg. The more appalling the mutilation, the more the mutilator is paid. He who corrects the ingrowing toe-nail receives a few shillings, he who cuts your insides out receives hundreds of guineas, except when he does it in a poor patient to practice."<sup>5</sup>

The disadvantages of the salary system are:

1. The patient may demand unnecessary services.

2. The patient may be less appreciative of service without a bill.

3. The doctor has less incentive to put himself out for the patient.

Several studies seem to show that the doctor is more likely to provide unnecessary services under fee-for-service than under salary. A United Metal Workers of America report showed that where doctors were on salary, hospital admissions of groups declined 22% and appendectomies declined 59%. In comparing a population under the Health Insurance Plan of Greater New York, with a similar population under Blue Shield, which is fee-for-service, hospital admissions were 20% less and perinatal mortality, an index of quality of care, was only 21.3/1000 live births vs. 38.1/1000 under Blue Shield.<sup>5</sup>

Labor will not allow government to forget these statistics. Nor will the C.M.A. readily consent to a salary plan. One might predict that some compromise is likely in which a basic salary is provided and so-called deterrent fees for services are added. As Dr. MacLeod, Dean of Medicine at Saskatchewan says: "The fee per item can be small enough to remove the temptation of overservicing, and large enough to re-

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ward the doctor who commands a larger following."<sup>12</sup>

It is possible that private non-comprehensive plans can cover 75% of the population, and that the government will be called on only to subsidize these plans, make them compulsory for certain groups, and pay for the remainder.

Although some doctors may migrate to the United States and the volume of work will increase, any form of prepaid health insurance in Canada will bring many advantages which are not mentioned here, but which cannot be overlooked.

#### IV. IMPERSONALITY

This is due chiefly to social change which is irreversible, to shortage of personnel which has been discussed, and to the organization of medical services which will now be considered briefly.

Due to increasing specialization and the growth of group practice, there is a tendency to share responsibility for the patient. It has been a cornerstone of medical practice that one doctor is ultimately responsible for each patient. Several answers have been proposed to the question: Who is now to look after the patient personally?

The first answer is to preserve the G.P. In the British National Health Service, a sharp division was made between the G.P. practising in the community who is there restricted from hospital and paid by capitation, and the specialist, whose domain is the hospital and who is on salary. But, the G.P. there has not maintained his role as personal physician as well as was hoped. He is too busy, and he sees himself as chiefly sorting patients for more definitive therapy by someone else. If everything that other people can do better be removed, there is little challenge left to the general practice of medicine. It is now being asked if this division between home and hospital is necessary. The G.P. is too isolated from the hospital and the specialist is too isolated from the community.

In America, too, most writers agree that the G.P. as we have known him, will become extinct. Fox, after visiting the United States, has argued that the G.P. will only survive if he can do something the hospital based team cannot do, and he feels that this something is looking after people as people. It is unrealistic to think that those who elect to take the least training are best qualified to cover the broadest spectrum of services. The most valuable feature of the G.P. is not his generality of care, but his knowledge of the social and economic environment of his patients.

The second answer is to find a new role for the G.P. Various suggestions have been made for extending the training of the practitioner to create a sort of certification in general practice. Last spring, 70% of those replying to a questionnaire sent out by the College of General Practice of Canada favored some sort of a Fellowship being created for General Practice.<sup>3</sup> Others have suggested that as medicine becomes more impersonal a medical counsellor becomes more necessary, perhaps someone who could also be a health teacher and psychotherapist to the patient. But it seems doubtful that the personal doctor can survive if he does no doctoring in the traditional sense.

The third answer is so to organize group and specialist practice that personal care will be provided. This could be done in several ways.

One is to divide the tasks of the former G.P. among a small group who share responsibility for each patient. Thus, in one American practice, a card for patients says: "To render good medical service on a 24-hour a day basis we three general practitioners operate as a group practice. We would like you to feel that you are a patient of all three rather than any specific one, and to consult any one of us about your health problems as they arise."<sup>10</sup>

A more likely possibility is a larger group clinic in which each doctor takes

full care of his patient in home, in clinic and in hospital. This is most effective when operated by so-called vertical specialists who specialize in one type of patient rather than in one type of diseased organ, for example, obstetricians, pediatricians, geriatricians and internists. 50 specialists from the Montefiore Medical Group look after a group of 26,000 Health Insurance Plan patients in this way.<sup>10</sup>

A final method of organization is hospital-based comprehensive medical care for the community. In this case, medical care from prevention to rehabilitation is fully integrated and hospital clinics handle patients on an outpatient basis. Visits to homes are largely made by auxiliary personnel. The hospital is, however, inevitably an impersonal monster, and this type of program would provide technically excellent care, but in an environment in which the patient has lost almost all control over his medical destiny.

In a recent editorial in *Lancet*, two questions are asked: "Is personal medicine an anachronism or is it needed more than ever?" "In the coming years, should patients get their regular medical care from an independent practitioner or should they get it from a unified service based on the hospitals?"<sup>9</sup>

## PREDICTION

What will medicine in Canada become? To attempt a prediction: There will be a government health service, with a combination of salary and fee-for-service; there will be almost universal specialization with major changes in the type of specialty; there will be hospital-centred medicine in the larger cities, group clinics in the suburbs and smaller towns, and a few high salaried G.P.'s in outlying areas; and in spite of efforts to the contrary, medicine will become increasingly impersonal.

Fortunately, people are very adaptable. They will always seek counsel from those

closest to them, whoever such people may be. People will never become impersonal for they are humans first, and doctors and patients second.

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# Student Research

## Some Aspects of Blood Coagulation Research

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### INTRODUCTION

Because of the inherent difficulties in studying blood coagulation mechanisms, the obvious need for more basic knowledge in this field, and our personal interest in the problem, it was decided to undertake this study during the summer months of 1960 and 1961. A number of tests currently used to measure the important variables in blood coagulation were set up and investigated critically. Certain of these which were most valuable and reproducible in our hands were then used to study (a) proper methods of obtaining samples, (b) possible blood coagulation differences between arterial and venous blood and (c) the effect of hemorrhage and hypovolemic shock on the dynamics of coagulation.

### BLOOD COAGULATION LABORATORY TESTS

An ever-increasing number of clinical laboratory tests are being developed for use in blood coagulation studies. A number of these were investigated. It is obvious that analyses other than those finally employed would have provided interesting and possibly important data, e.g., the thromboplastin generation test and the analysis of various factors. It was decided, however, to limit the tests to a reasonable number which could be properly performed. Initial training in blood coagulation methodology was carried out at Sunnybrook Hospital, Toronto, under the supervision of Dr. J. F. Mustard over a two-week period in June, 1960.

In order to obtain satisfactory results, certain preliminary principles were established:

1. The performance of a specific test became the responsibility of one individual.
2. Blood was placed into the different collection tubes in the same order each time.
3. All collection tubes were precalibrated to prevent differences in results due to varying proportions of blood and anti-coagulants.

4. The time between obtaining the blood specimen and performing the test was strictly defined and kept constant.
5. Samples which were suspected of being unsuitable for analysis due to the inadvertent introduction of tissue juices or air bubbles were discarded and a new sample obtained.

The tests chosen for this investigation included: whole-blood clotting time (Lee-White<sup>10</sup>), one-stage prothrombin time of Quick,<sup>15</sup> Thrombotest (Owren<sup>14</sup>), and platelet adhesive index.<sup>13</sup>

It was necessary to standardize rigidly and, in some cases, to modify the specific tests. Certain of these changes may be of use to other investigators and are included in the appendix.

### METHODS OF BLEEDING

Probably the most important factor in blood coagulation studies is to obtain a proper sample. In a research project where serial samples are required over a long period of time, they must be free of tissue juice, representative of the blood coagulation system of the animal, and readily available in the quantity desired.

\*From the Departments of Pediatrics and Pharmacology, The University of Western Ontario Faculty of Medicine.



Although some investigators have used rabbits with success, we were unable to achieve satisfactory results with them where small alterations in results might be significant. When performing direct ear-vessel punctures, either the frequent and sometimes unrecognized introduction of tissue thromboplastin into the sample or the sudden inability to bleed the rabbit after previous successes, made the procedure unacceptable. Other methods of obtaining samples were attempted. These included direct incision of ear vessels, ear-vessel catheterization with a siliconized polyethylene catheter, cut-down and direct puncture of vessels (e.g., femoral), large vessel catheterization (e.g., carotid artery), and the use of a teflon T tube (see below). None of these procedures satisfied our basic criteria of simplicity, reproducibility, and reliability for a suitable period of time. Acute experiments can satisfactorily be carried out using catheterization or direct punctures and a two-syringe technique of e.g., the external jugular vein and the common carotid artery in the anesthetized rabbit. A problem exists, however, with regard to a satisfactory method of anesthetizing a rabbit.

When the dog is used, larger vessels and a hardier animal are available. Regardless of the proficiency of the technician, however, the problem of the daily venipuncture in an unanesthetized dog cannot be ignored either from the standpoint of damaged vessels (with fibrous reactions and hematomas) or the release of adrenaline into the circulation.<sup>6</sup> A comparison of one-syringe and two-syringe venipuncture techniques was carried out in anesthetized dogs to determine if differences in reproducibility would be found. From the results, it would appear that there is little to choose between the two methods. However, some apparently good venipunctures did result in the inadvertent presence of tissue juices as evidenced by clot formation in the syringe. It would appear best to use a two-syringe technique if only on a theoretical basis (see also reference 12).

An entirely different way of bleeding animals was also attempted, based upon the insertion of a teflon T-tube into a vessel. Our tube (figure 1) was purchased from The Mark Company, 31 West Street, Randolph, Mass. It consists of a tube and plug, machined together so that when the plug is inserted to its full depth against the shoulder, the inner surfaces line up. Upon removal of the plug, blood flows rapidly into a receiving tube. Thus, no puncture of the vessel wall or surrounding tissue is required and a sample free of tissue thromboplastin is theoretically obtained. The initial external diameter was later buffed down to about one-third of its original size in an effort to prevent platelet breakdown and to decrease stasis as the column of blood encountered the wall of the T-tube.

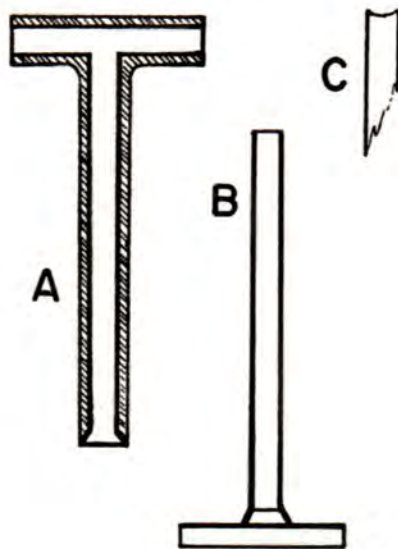


Figure 1

### Teflon T-Tube and Plug

- A: Teflon T-tube
  - B. Inside plug
  - C: Tip of plug, side view
- Scale - 1" = 1/2"

The requirements of vascular prostheses, i.e., strength, a smooth junction between the tube and vessel, an extremely smooth

lumen, tissue toleration, and an elasticity similar to that of the vessel, are well described by Hufnagel.<sup>8</sup> These criteria, as well as the meticulous procedures required in vascular surgery,<sup>4</sup> were followed as carefully as possible. The rapidly deleterious effect of slight trauma, drying, or stasis, particularly upon veins, was noticed (as described also by Bryant et al.<sup>3</sup>). The presence of a thrombus in the area (including nearby branches) was usually followed by clot formation at the ends of the T-tube within a short time.

A number of attempts were made to insert the T-tube into various veins and arteries of rabbits, cats and dogs. These invariably met with failure. Periods of patency with apparent absence of clots ranged from a few seconds to four hours. Several samples were obtained after 24 hours but the presence of clots in the area and the need for saline flushes to start the flow made these trials unacceptable. Removal of a clot in or near the T-tube by either suction or thrombectomy<sup>11</sup> was followed by blood flow for a short time only. The venous blood appeared very viscous and dark. Administration of Heparin during and after (up to 24 hours) insertion of the tube into the vein did not help.

Problems were encountered in finding vessels into which the tube would fit. By decreasing its size, insertion into a peripheral artery of rabbits or cats is feasible, but it is doubtful if the lumen would remain patent.<sup>2,9</sup> Further efforts to utilize peripheral veins also appear to hold little promise at the present time.<sup>3</sup> In dogs, it would be possible to use larger tubes in such vessels as the femoral artery.

Future efforts to develop such a method of bleeding would probably be of value. Certain modifications might be useful:

1. A number of different-sized tubes should be available so as to match the size of the artery and the arm as closely as possible. Larger vessels (e.g., femoral artery of dog) should be used.

2. A valve or spigot-type mechanism for controlling the flow out of the T is necessary.
3. Anticoagulant therapy before and for some time after intubation may be required.<sup>1</sup>
4. A flexible tube similar to the sleeves used in cardiovascular surgery might decrease any adverse hemodynamic effects. Only the area around the orifice, where the plug would be inserted, need be stiff.

#### Comparison of Venous and Arterial Blood

Although the literature pertaining to blood coagulation becomes more voluminous each year, comparison of arterial and venous blood as well as the effects of hemorrhage have received relatively little attention (see e.g., references 5, 7, 16, 17, 18, 19, 20).

#### Methods

Ten mongrel dogs (5 female and 5 male) were anesthetized with Pentobarbital Sodium. Blood was withdrawn from the femoral artery and vein by cutting down and inserting siliconized polyethylene catheters (first 3 dogs) or by direct puncture, using a two-syringe technique (siliconized needle and syringe). The order of withdrawal and analysis of the sample was alternated, i.e. vein first on one day and artery first on another day. These specimens were analysed as soon as possible.

#### Results

Several trends were found (Table I):

1. A higher whole-blood clotting time appeared to be present in the venous blood than in the arterial samples.
2. A higher platelet adhesive index appeared to be present in the venous blood.
3. More platelets appeared to be present in the venous blood than in the arterial samples in dogs.
4. No apparent differences were found in prothrombin time or thrombotest values.

Experiments were also performed in the rabbit, samples being obtained from the external jugular vein and common carotid artery either by catheterization or direct puncture and a two-syringe technique. A similar trend toward higher whole-blood clotting time and platelet adhesive index values in venous blood was observed.

Statistically significant results were not obtained. A further series employing a greater number of animals is required.

## EFFECT OF HEMORRHAGE IN THE DOG

### Method

This experiment was carried out concurrently with the previous project. After withdrawal of the initial samples, twenty-five per cent (22.5 ml./Kg.) of the theoretical blood volume of the dog was withdrawn, the blood pressure being measured both before and after bleeding. About 90 minutes later, the response of the coagulation system to this blood loss was determined in both arterial and venous blood. A further 25% (later 15% because of the high mortality rate) of the calculated total blood volume was then withdrawn, in an effort to obtain a state of shock. About 90 minutes later, the final arterial and venous samples and blood pressure reading were taken. All of the post-hemorrhage results from the first three dogs were discarded because of the presence of clots (found upon autopsy) in the vicinity of the catheters. This had produced an initial false impression that a significant increase in the platelet adhesive index was occurring because of hemorrhage. Of the seven dogs, four survived the "shock phase" of the experiment (90-minute period between the second bleed and the final sampling).

### Results

Several trends were found (Table I):

1. There is a decrease in the whole-blood clotting time of the venous and arterial blood when comparing the 90-minute post-hemorrhage and control values. This has been reported previously.<sup>5</sup>

2. There appears to be an increase in the whole-blood clotting time of both the venous and arterial blood when comparing samples obtained 90 minutes after the second bleed with those obtained 90 minutes after the first bleed.

3. A rise in the prothrombin times between the baseline and 90-minute post-hemorrhage arterial samples is present. These results are not statistically significant and a further series should be conducted.

## DISCUSSION

Student projects carried out during the summer months at a medical center vary greatly in the scope of the problem and the degree of responsibility permitted. Because of the short period of time available and the necessity of learning new techniques, the results obtained are necessarily limited and confirmatory investigations are required. Only by increasing the availability of summer student fellowships and by encouraging personal initiative, however, will research become attractive to the medical student. Even should the individual not be destined for a research career, such an experience provides him with a clearer picture of the research field and promotes closer understanding between the basic sciences and clinical medicine. We consider ourselves fortunate for having had this opportunity.

## SUMMARY

1. Efforts to bleed laboratory animals for long periods of time using a teflon T-tube were unsuccessful. Further research devoted specifically to this problem might yield valuable results.

2. A comparison of different methods of bleeding dogs suggested that a properly performed venipuncture using a one-syringe technique is usually acceptable but that a two-syringe technique is, at least theoretically, more satisfactory in prevent-

ing erroneous influences by the introduction of tissue thromboplastin.

3. The reproducibility of most of the various laboratory analyses carried out is high under carefully standardized conditions. In our hands, however, the platelet clumping test was poor.

4. Samples of blood taken from dogs and rabbits tended to show higher whole-blood clotting times and greater platelet adhesive indices in venous blood as compared to arterial blood. More platelets appeared to be present in venous than arterial blood in dogs. This tendency could not be confirmed by statistical analysis. A greater number of cases in another series is required.

5. A carefully performed experiment comparing arterial and venous blood before and after hemorrhage in the dog yielded several interesting trends, some of which apparently have not hitherto been reported. Another similar experiment is required to confirm these findings.

#### *Acknowledgments*

We gratefully acknowledge the financial support for this project provided by the Pediatrics Research Fund, War Memorial Children's Hospital, London; the Toronto chapter of the Canadian Hemophilic Society; the Department of Pharmacology, The University of Western Ontario; and private donations.

We should also like to express our thanks to Dean J. B. Collip for his interest and encouragement. Similarly, the assistance of Dr. J. F. Mustard, Sunnybrook Hospital, Toronto, was of great value particularly in the initial training and in helping us gain an overall perspective of this field.

Finally, we thank Professors J. C. Rathbun of the Department of Pediatrics and C. W. Gowdey of the Department of Pharmacology. Through their encouragement, guidance and patience, they helped to make this project an enjoyable and stimulating experience.

## APPENDIX

### *Whole-Blood Clotting Time— Lee and White<sup>10</sup>*

1. Start the watch at the time of transfer of the 1 ml. of blood from the siliconized syringe to the calibrated, prewarmed, uniform bore glass tubes.

2. Allow all three tubes to remain undisturbed for the first two minutes in the 37° C water bath.

3. Slowly tilt the tubes through a 45 to 90° angle at 30-second intervals, thereafter, to observe if blood flow is still present.

4. Take the end-point as that time when the tube can be inverted through 180° without any flow of blood down the side. Using this method, our results were consistently reproducible.

### *One-Stage Prothrombin Time of Quick<sup>15</sup>*

This test should be performed in accordance with the instructions of the manufacturer of the commercial thromboplastin used. It is very useful to prepare a large batch of extract at one time, divide it into aliquots, and freeze. A comparison of results over a long period of time is thus feasible.

### *Thrombotest<sup>14</sup>*

The instructions of the manufacturer should be followed. It is possible, however, to use the same plasma as that obtained for the Quick one-stage prothrombin time and to record results in seconds (not as % using the manufacturer's curve).

### *Platelet Clumping and Plasma Clotting Time<sup>13</sup>*

This test was found to be unreliable in our hands regardless of the precautions taken. It is important that the centrifuge speed be very close to 1,000 r.p.m. as checked with a tachometer.

### *Platelet Adhesive Index<sup>13</sup>*

The effect of a warm environment is disastrous in performing this analysis. In order to prevent rapid hemolysis of erythrocytes, we kept all our reagents at re-

refrigerator temperature and rinsed out the counting pipettes with cold diluting fluid before use.

The procedure includes direct platelet counting. Although this procedure is frequently condemned as being highly inaccurate, we were consistently impressed with the reproducibility of carefully performed analyses.

#### Glassware

Both siliconized and non-siliconized glassware are used in blood coagulation studies. It is essential that they be kept separate when being washed, dried or stored. Re-siliconization should be carried out frequently and properly.

Our method of preparing siliconized glassware and needles is as follows:

1. Use a mixture of 5 ml. of SC-87 (General Electric Co., U.S.A.) and 95 ml. carbon tetrachloride. Keep stoppered.

2. Wash and dry glassware thoroughly.

3. Pour the silicon mixture from one receptacle to the next. Place pipettes in a bath of silicon mixture. Carry out in a well ventilated area. The mixture may be used repeatedly.

4. Immediately after siliconizing glassware, drop in cold tap-water.

5. Rinse again with tap-water and with distilled water.

6. Air dry or place in hot oven separate from other glassware. Mark each piece of siliconized glassware.

7. Store away from non-siliconized equipment.

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TABLE I

## Arterial and Venous Sample Comparison and the Effect of Hemorrhage in the Dog

| Dog Number | Sample | Baseline |       |         |        | At 90 Minutes after First Bleed |       |         |        | At 90 Minutes after Second Bleed |       |         |        |
|------------|--------|----------|-------|---------|--------|---------------------------------|-------|---------|--------|----------------------------------|-------|---------|--------|
|            |        | W.B.C.T. | P.T.  | P.C.    | P.A.I. | W.C.B.T.                        | P.T.  | P.C.    | P.A.I. | W.C.B.T.                         | P.T.  | P.C.    | P.A.I. |
| 1          | A      | 7:20     | 10.25 | 230,000 | 0.91   | 6:40                            | 12.75 | 250,000 | 1.04   | 6:50                             | 11.75 | 190,000 | 0.94   |
|            | V      | 7:00     | 10.75 | 250,000 | 1.05   | 5:00                            | 12.00 | 230,000 | 0.78   | 7:40                             | 12.50 | 300,000 | 1.08   |
| 2          | A      | 7:10     | 13.00 | 240,000 | 1.12   | 6:50                            | 16.25 | 230,000 | 0.88   |                                  |       |         |        |
|            | V      | 6:00     | 13.25 | 320,000 | 1.56   | 7:00                            | 13.00 | 290,000 | 1.37   |                                  |       |         |        |
| 3          | A      | 6:20     | 10.75 | 340,000 | 1.38   | 5:40                            | 12.00 | 230,000 | 1.31   | 5:00                             | 11.00 | 260,000 | 1.27   |
|            | V      | 8:10     | 10.75 | 270,000 | 1.10   | 4:40                            | 12.00 | 310,000 | 1.26   | 6:10                             | 11.25 | 400,000 | 1.18   |
| 4          | A      | 6:00     | 10.00 | 250,000 | 0.73   | 5:30                            | 12.50 | 250,000 | 0.82   |                                  |       |         |        |
|            | V      | 7:20     | 10.75 | 280,000 | 0.80   | 4:40                            | 11.00 | 180,000 | 0.81   |                                  |       |         |        |
| 5          | A      | 7:10     | 12.00 | 250,000 | 1.01   | 7:00                            | 13.25 | 310,000 | 1.07   |                                  |       |         |        |
|            | V      | 8:10     | 13.00 | 310,000 | 0.97   | 8:00                            | 13.00 | 368,000 | 1.10   |                                  |       |         |        |
| 6          | A      | 5:30     | 12.75 | 320,000 | 1.35   | 5:30                            | 11.75 | 290,000 | 1.02   | 6:10                             | 11.00 | 400,000 | 1.02   |
|            | V      | 6:30     | 10.75 | 400,000 | 1.33   | 5:20                            | 11.75 | 300,000 | 1.07   | 4:10                             | 10.25 | 430,000 | 1.46   |
| 7          | A      | 7:10     | 11.75 | 200,000 | 1.14   | 5:30                            | 11.25 | 260,000 | 1.82   | 6:00                             | 13.75 | 250,000 | 1.23   |
|            | V      | 6:00     | 13.00 | 290,000 | 1.31   | 6:30                            | 12.25 | 240,000 | 1.33   | 6:10                             | 14.00 | 220,000 | 1.11   |
| Average    | A      | 6:40     | 11.50 | 261,000 | 1.09   | 6:06                            | 12.75 | 260,000 | 1.14   | 6:00                             | 12.00 | 290,000 | 1.12   |
|            | V      | 7:02     | 11.75 | 303,000 | 1.16   | 5:53                            | 12.25 | 273,000 | 1.10   | 6:03                             | 12.00 | 337,500 | 1.21   |

W.B.C.T.—Whole blood clotting time (average of 3 determinations)—in minutes and seconds.

P.T.—Prothrombin time (average of 3 determinations by one-stage method)—in seconds.

P.C.—Platelet count

P.A.I.—Platelet Adhesive Index

A—Arterial

V—Venous

## STUDENT RESEARCH ON MALIGNANT NEOPLASMS OF LYMPHOID TISSUE

A statistical survey was carried out last summer at the Toronto Western Hospital on the primary malignant neoplasms of lymphoid tissue. The following conditions were included in the survey: lymphosarcoma, Hodgkin's sarcoma, reticulum cell sarcoma, and lymphatic leukemia.

### Method of Study

All patients who were admitted to Toronto Western Hospital with any of the above conditions in the last 5 years were included. These case records were analysed for presenting symptoms, time between apparent onset and diagnosis, symptomatology, effect of treatment, and survival rates. It is beyond the scope of this article to present all the findings. One of the more interesting findings was that in this series (110 cases), the incidence of

lymphosarcoma in females was twice that of males. The most effective palliative measure was found to be X-ray therapy. As an overall picture, these conditions, particularly lymphosarcoma and chronic lymphatic leukemia presented an extremely varied picture, with some patients surviving up to 18 years and living in considerable freedom from the disabling symptoms of the disease for most of these years.

Though no startling new discoveries were made nor a wonder-cure found, the survey proved to be a very profitable experience for me and I hope will be useful to the hospital and other physicians in presenting the picture of these conditions and analysing the advances in management which were achieved in the last 5 years.

George Kutas, '62  
Department of Hematology  
Toronto Western Hospital  
Summer of 1961

*Continued on Page 145*

only a few of the findings have been discussed, it is hoped that the material will indicate why autoimmunity has become a significant concept in modern immunological research.

As for the future, one may well speculate on the role autoimmunity may play in the collagen diseases, the field of tissue grafting, and cancer research.

It must be remembered that this phenomenon is a disease of tissue "suicide" where the external environment plays a minor role in the development of its many symptoms.

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# Historical

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Dr. Walter Bapty, Meds '06, reminisces on some of the early teachers and procedures around the Medical School.

George Hodge was a general practitioner who became Associate Professor of Medicine. He was the best type of family physician. Kindly and understanding, I shall always remember him as he came to our home. There were no telephones in those days so it had to be a personal message given to him by my father on his way to work. Or, if the call was at night, my father had to dress and make the journey on foot to his home and office on Queens Avenue.

Dr. Hodge was of medium build, of fair complexion with blue eyes. He wore a full beard, always well trimmed, as was a common custom at that period. He was held in high esteem by the students who appreciated his lectures on diseases of the nervous system, his book of reference being *Allchin*.

In his early years, he lived and practised in Mitchell, Ontario, leaving there to do

post-graduate study in Vienna. He then came to London, Ontario, taking over the office of Dr. Arnott. The dates of these moves I do not know but he was our family doctor in the '80's. In Vienna, he spent much of his time in Surgical Wards and had hopes of engaging in surgery in his general practice, but an early infection of his hand, the right I believe, led him to spend more of his time on internal medicine. I have seen him do a circumcision on a young child in a private house and this he did well and quickly.

He died a comparatively young man of aneurysm of the abdominal aorta, I was told probably related to his early infection of the hand.

He was a shining light in the profession and set a high standard of conduct and ethics for himself and for his students. Perhaps his kindly bedside manner has permeated to his students, enabling them to give courage and inspiration to countless patients.

Walter O. Bapty, M.D., '06

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## Book Reviews

**The Cardiac Arrhythmias:** by Brendan Phibbs, 128 pages, C. V. Mosby Co., St. Louis, 1961, \$7.50.

This book is written for the student and the general practitioner who have previously considered the interpretation of the electrocardiogram too difficult to master. Although only one small part of the vast field of cardiology is covered, the stimulus to the reader may be enough to push him further into a larger aspect of this field at a later date.

The content of the book is divided into five sections. Before launching into the normal E.C.G. one can quickly review the anatomy of the conduction system of the

heart. The abnormal ECG of the common arrhythmias is the content of the main chapter of the book. Each arrhythmia is described in detail with reference to accompanying ECG tracings which enable the reader to understand the interpretation of the arrhythmias without any confusion. After the chapter on clinical diagnosis, which is very brief because the author maintains that it is at best inaccurate, there are exercises for those who wish to put their knowledge to the test.

For the student or the physician who desires an introduction into the complex field of electrocardiology this is an excellent primer and a short night's reading.

Jim Clapperton, '63



**Atlas of Clinical Endocrinology:** by H. Lissner and R. F. Escamilla, 499 pages, 165 plates, 2nd ed. The C. V. Mosby Company, Saint Louis, 1962. \$23.00.

Written by two men with vast clinical experience in endocrinology, this atlas is a concise and largely pictorial presentation of endocrine disorders and related syndromes. Detailed discussion of physiology, biochemistry, pathology and experimental work are left to the textbooks, while complete management of the patient involved, from diagnosis to therapy and prognosis, is provided for the physician.

The contents are organized according to the endocrine organs. Each individual condition is presented under several headings and sub-headings including: Definition, Symptoms, Physical Signs, Laboratory Procedures, Differential Diagnosis, Treatment, and Prognosis, with further subdivisions of Symptoms and Signs into *Important* and *Less Important*, Laboratory Procedures into *Valuable* and *Tests of Interest*, and Treatment, which includes commonly used preparations with suggested dosage schedules, into *Important* or *Early* and *Late*. Points under each heading are numbered according to their relative importance. Each condition and, often, those from which it must be clinically differentiated are illustrated by photographs of patients. Tables, graphs, and pictures of pathological specimens and X-rays are numerous. References provide direction to more detailed information about each disorder.

The twenty page Appendix not only collects the normal values for the laboratory tests suggested in endocrine diagnosis and the useful preparations which highlight endocrine therapy, but it also has many valuable tables and graphs of behavioral and physical growth and development. An extensive index adds to the value of this atlas.

The atlas is a heavy book, measuring 11" x 8 $\frac{1}{2}$ " x 1" with a hard cover. The paper is of a high quality which provides

for the best presentation of the 165 plates, including 3 colored plates, without unduly compromising the reader's comfort by glare. The printed text, set out in double columns with adequate spacing in a clear type of ample height, combines with the numbering of points under headings to provide a concise and rapidly readable coverage of the topics.

For the medical student, who is burdened by the complicated chemistry and pathology of endocrinology, the clarity of presentation of an often confusing field provides a good clinical and visual background. However, the price of the book, high because of the numerous plates, is likely to be beyond the means of most students. Besides the major endocrine disorders which are of the most interest to the medical student, the many rare oddities that are included make this of more value as a medical library reference book than as a basic student manual. Unfortunately, too, the pictorial presentation of material has precluded the inclusion in this book of such a major endocrine disorder as Diabetes Mellitus.

This second edition follows the first by only five years. New plates have been added and old ones rearranged. Many minor syndromes have been added, while some major sections have been largely rewritten. More stress is placed on recent developments in the genetic sex field. Treatment and laboratory investigations have been brought up to date. References have been enlarged to include major writings from 1955 to 1961.

The Foreword by Dr. E. P. McCullagh, Chief of the Section of Endocrinology and Metabolism at the Cleveland Clinic, commends this book to the clinician. It fulfills its purpose of being an atlas of clinical endocrinology in which the authors share their vast experience with endocrine problems with the reader by bedside teaching.

Beryl A. Chernick, '62

# News and Views

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## REPORT ON C.A.M.S.I. FORUM, "THE NEED FOR EUGENICS?"

The Annual CAMSI Forum was held in the Medical School Auditorium on the evening of March 7, 1962. Moderator of this panel on "The Need For Eugenics" was Dr. J. C. Rathbun, Professor of Pediatrics. The four panel members were Dr. L. L. De Weber, Assistant Professor of Pediatrics; Dr. H. L. Soltan, Assistant Professor of Genetics; Dr. B. Goldberg, Psychiatrist, Children's Psychiatric Research Institute; and Mr. K. J. Duncan, Sociologist of the U.W.O. Department of Economic and Political Science.

To begin, Dr. Rathbun presented a definition: "Eugenics now signifies the study of agencies under social control, which may improve or impair the racial qualities of future generations, either physically or mentally".

For Dr. De Veber, eugenics consists of two aspects. One, the heroic aim to improve the whole race; two, the piecemeal genetic engineering on the individual level. Despairing that Democracy permits the legislation prerequisite to achieve the first aim, he advised that we counsel the individual, thus educating the public in eugenic matters. Some specific examples of these are Rh incompatibilities and hemophilia. As heterozygous genotypes of all known debilitating recessive characteristics comprise upwards of 50% of the population, restriction of breeding would scarcely be acceptable. Even less heroic measures are

chimerical, because agreement upon which traits to exclude, upon means for eradicating these and enforcing the plans is impossible.

Continuing the thought that the scientific basis for eugenic measures is too nebulous and impractical, Dr. Soltan stressed that virtually all our knowledge concerns the negative results of single gene effects. For while we might, theoretically, with very austere restrictions, eliminate about one-half of the incidence of inborn errors, still, the mutation rate would replace these genes to some extent and we would never be able to relax our exhaustive screening of the population, an expensive and tedious pastime.

Interesting historical background was given by Mr. Duncan, who reminded us that over the past hundred and seventy-five years, there had been eras of frantic Malthusean concern for overpopulation interspersed with periods of anxiety amongst the upper class that the poor were to overrun the earth or that the gene-pool was being weakened by allowing all of the people who previously used to die because of some defect now manageable before they could reproduce to breed. Even to-day, there is a wide-spread tendency to regard the poorer class as the cause in themselves of such social ills as crime and unemployment and illiteracy (although it must be admitted that preventing them from reproducing would not solve these problems). We do exercise various eugenic practices either indirectly, as in marriage

selection, institutionalization of criminals and mentally ill patients, or directly, by having laws for the sterilization of mental defectives (23 states and 4 Provinces have them) and habitual criminals as in England.

To round off the discussion, Dr. Goldberg posed some of the questions he has to deal with as a physician: Should you sterilize the mentally defective, a woman with previous mentally defective children; or a woman who has previously had severe postpartum depressions? Or should a person with known serious genetic anomalies be sterilized? Finally, there is the notable success of animal breeders in obtaining breeds for temperament, intelligence or physique. Why do we not try these techniques?

In the question period following, several interesting points were mentioned. One possible avenue for experimental work in the positive direction is controlled artificial insemination. This procedure has such exciting possibilities that it is indeed surprising that it has not yet been attempted!

The obvious answer to the argument that it is too costly, complicated, and ineffectual to try to screen the population before they reproduce, is to let them all reproduce. Then, when they have defective children, we will simply dispose of them as Jonathan Swift suggested in his essay, "A Modest Proposal". The Greeks, too, were aware of the advantages of this practice.

But, ultimately, the issue is determined by the extent of popular or legislative support for the idea. As there was no

statement made by the group concerning the need for a more intensive eugenic program, it might be assumed they deemed it unnecessary. The meeting was successful in elucidating the many facets of the problem, and in providing an awareness of the tremendous obstacles to be surmounted.

Ross Laing, '64

### OSLER SOCIETY BANQUET

The annual Osler Society Banquet was held on Friday, March 9th, in Somerville House with Dr. E. G. D. Murray as guest speaker and new Honorary President for the coming year. The Oslerian address delivered by Dr. Murray consisted of reflections and short anecdotes about men who have been concerned with Medical research and who have, in varying degree, built something in the structure of medicine. The speaker was introduced by Catherine Cole and thanked by Bruce McDonald.

The recipients of keys and scrolls were Catherine Cole, Stuart Klein, David McCourtie, Bruce McDonald, Paul Mackenzie, William McLeish, Robert Moffat and Dick Redinger.

Newly elected officers of the Osler Society are as follows: Honorary President, Dr. E. G. Murray; President, David Burk; Vice-President, Albert Yuzpe; Secretary, Gloria Burk; Treasurer, Stephen Blizzard; Editors of the Osler Bulletin, Carol Ann Reed, Albert Barber; Osler Librarian, James Dewar.

Carol Ann Reed, '63

### THE ETIOLOGY OF MENTAL RETARDATION

The following is a report on a Symposium on "The Etiology of Mental Retardation",

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sponsored by the Faculty of Medicine, University of Western Ontario, and the Children's Psychiatric Research Institute, held in London, Ontario, March 14, 1962. The co-chairmen were Dr. M. L. Barr, Professor of Microscopic Anatomy, and Dr. G. E. Hobbs, Professor of Psychiatry and Preventive Medicine, U.W.O.

The topics discussed were arranged to correspond with the chronological development of the child, from conception to early childhood. The first speaker for the afternoon, Dr. D. E. Zarfes, Superintendent, Children's Psychiatric Research Institute, spoke on "The Problem of Mental Retardation and its Practical Aspects". He stated that mental retardation is a symptom and not a pathological entity, and an adequate definition is the arrested or incomplete development of the mind measured by an Intelligence Quotient more than 1 standard deviation below normal or less than 85. The incidence of mental retardation is probably around 1-3% of the general population. Dr. Zarfes suggested that a good practical clinical classification involves the grouping of causes into prenatal, perinatal, and postnatal categories. He stated that in discussing mental retardation with parents, one should avoid such terms as "idiot", "moron", and "imbecile", and speak in terms of mild, moderate, and severe mental retardation. Dr. Zarfes concluded by noting that the medical profession and the community at large are rapidly becoming enlightened with new ideas on the prevention of mental retardation and on better care and earlier recognition of the mentally retarded child.

Dr. W. C. McMurray, Assistant Professor of Biochemistry, U.W.O. Medical

School, discussed "The Biochemical Genetics", of mental retardation. He emphasized the fact that 2-4% of all severe mental defectives have biochemical factors as their basis, and that there is a rapidly increasing interest in the field at the present time. Dr. McMurray explained how mental retardation may arise from a genetic enzyme defect, and how such a defect may arise from a faulty gene. The enzyme defect produces mental retardation by causing the accumulation of metabolites above the metabolic block, or by the accumulation of abnormal metabolites from alternative metabolic pathways formed. He discussed briefly some of the general diagnostic and clinical features of the known biochemical lesions producing mental retardation, with special emphasis on "Citru-  
linuria", recently discovered in his department. Dr. McMurray concluded by stating that many more biochemical defects will likely be found, and what is most needed at the present time, is diagnosis of those we have.

Dr. D. H. Carr, Assistant Professor of Anatomy and Microscopic Anatomy, spoke on "The Genetics of Mongolism". He stated that the etiology of Mongolism became known in the last three years, with the arrival of modern methods of chromosome study. He explained how the chromosomes of the cell are stained and photographed, and arranged in the "Karyotype" (numbering and pairing of chromosomes by an internationally accepted system). Dr. Carr stated that the Mongol appears to have three chromosomes in the 21 position of the karyotype, and is therefore "trisomic". This occurs, it is thought, by the phenomenon known as "non-disjunction", which is a failure in the separation of the

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chromosomes, at cell division. Finally, Dr. Carr noted that "partial Mongolism" could occur, in which case, the child could possess a "body mosaic" type of arrangement of cells with normal and Mongol cell areas interspersed. The significance of this is that the patient may appear clinically as a Mongol, but possess normal intelligence. The converse is also possible.

"The Gestational and Perinatal Factors" of mental retardation were discussed by Dr. D. P. Swartz, Assistant Professor of Obstetrics and Gynecology, U.W.O. Dr. Swartz explained in detail, the possible obstetrical factors that might result in brain damage, and he classified these into prenatal and perinatal categories. He emphasized the fact that the most important single cause is prematurity, and the next three, anoxia, trauma, and hemorrhage. He suggested that the contribution of traumatic obstetrics to mental retardation will be decreased only by realizing the problem, by teaching modern preventive obstetrics, and by practicing a philosophy of preventive medical care.

The next speaker, Dr. G. K. Hinton, Pediatric Neurologist, War Memorial Children's Hospital, spoke on "The Organic Postnatal Causes", of mental retardation. Dr. Hinton stressed the importance of these factors by stating that they are easily preventable if recognized. The postnatal causes include: (1) fever, convulsions and coma of varied etiology, which account for the largest percentage; (2) encephalitis; (3) accidents; (4) meningitis; (5) a miscellaneous group including mainly epilepsy, tumors, and hydrocephalus. Dr. Hinton concluded his lecture by suggesting that

reduction of the 11% of mental retardation due to the above factors requires early diagnosis, adequate treatment, and possible modifications of our present management. He also stated that further investigation into the fever, convulsion and coma group is indeed necessary.

Dr. B. Goldberg, Psychiatrist, Children's Psychiatric Research Institute, discussed "The Postnatal Psychogenic Causes" of mental retardation. These include cultural-familial factors, environmental deprivation emotional disturbances, psychosis, and an idiopathic group.

Dr. D. E. Zarfes concluded the symposium by discussing "The Preventive Measures and the Management of Mental Retardation". He emphasized the need for specialized clinics which can function in diagnosis of the underlying pathological processes if possible, and the dynamics of all factors involved, and in the education and guidance of the family. It can also assist in the day to day management of the child, helping the family to understand the child's behavior in the light of the physical and social pathology involved. He stressed the necessity for careful handling of the family in the proper management of the child because the sympathetic understanding of the family is a primary requirement. The family doctor should make use of the specialized clinic, but his main function is concerned with the management of the patient at the community level, and especially with the medical treatment of the child, and assistance and advice to the family.

Lawrence W. Burt, '63

# Abstracts

## NEEDLE BIOPSY OF THE PROSTATE: A REVIEW OF 346 BIOPSIES

Fortunoff, S.: *The Journal of Urology*, February, 1959.

Malignancy in the prostate should be suspected when rectal examination reveals a nodule, induration, asymetry or fixation of the gland. Diagnostic measures must also include serum alkaline phosphatase, serum acid phosphatase and skeletal X-rays. Confirmatory evidence is obtained by removing adequate prostatic tissue for histologic study.

Open perineal biopsy is the most accurate diagnostic procedure, but it necessitates prolonged hospitalization, greater risks, and a loss of sexual potency in a high percentage of patients. Trans-urethral prostatectomy only produces a periurethral biopsy which is far removed from the primary site of cancer in the posterior lobe.

Prostatic needle biopsy in 286 suspicious cases showed adenocarcinoma in 85. Another 17 were still suspect after negative biopsy reports and were diagnosed by other means. Thus, this study showed an accuracy of 80.9% in the diagnosis of prostatic malignancy by needle biopsy.

A modified Vim-Silverman needle was inserted distal to the muco-cutaneous junction and guided into the prostate by a gloved finger in the rectum, the needle tract having been anesthetized with Xylocaine. The needle may be inserted repeatedly.

Complications occurred in 3.5% of cases. They included four bladder punctures, mild rectal bleeding, hematuria, and acute urinary retention owing to benign prostatic hypertrophy.

In the author's estimation, prostatic needle biopsy is a safe, quick, and reliable method of making a tissue diagnosis of adenocarcinoma prior to initiating therapy.

Bruce McDonald, '62

## MASSIVE LOBAR EMPHYSEMA IN INFANTS:

### DIAGNOSIS AND TREATMENT

Mercer, R.D., Hawk, W. A., and Darakjian, G.: *Cleveland Clin. Quart.*, 28: 270, 1961.

Massive lobar emphysema in infants can be readily diagnosed but requires emergency surgical treatment. The condition is probably much more common than the literature would suggest.

Three typical cases were presented by the authors and discussed in some detail. Diagnosis was made on history, physical examination and study of roentgenograms. Respiratory distress which developed within the first few weeks of life as well as dyspnea, wheezing, grunting, coughing, and cyanosis were suggestive. The physical findings were those of emphysema, namely diminished breath sounds, hyperresonance, etc., on the diseased side. Roentgenograms were characteristic.

The paper also stressed the differential diagnosis of such a condition which included congenital cystic disease of lung, pneumatocele, spontaneous pneumothorax, localized emphysema, generalized obstructive emphysema, aspiration of foreign body, hyaline membrane disease, diaphragmatic hernia or eventration, and cyanotic congenital heart disease.

In lobar emphysema, obstruction of the air passages is the basic etiological factor but is not always apparent. The presence of stenosis of the bronchus leading to the involved lobe was demonstrated in the 3 cases under discussion. Other causes described in the literature included hypoplasia of bronchial cartilages, valves or folds of bronchial mucosa, alveolar fibrosis, and pressure on the bronchus from abnormal blood vessels.

In each instance, the treatment consisted of surgical removal of the involved lobe and was considered to be lifesaving.

Robert Moffat, '62

The research library of the Institute of Experimental Medicine and Surgery of the University of Montreal has suffered extensive losses owing to destruction by fire.

In attempting to rebuild their library, they would like to enlist the assistance of the readers of University of Western Ontario Medical Journal and ask them to send them all available reprints of their work, especially those dealing with ENDOCRINOLOGY and STRESS.

At the same time, they wish to point out that their permanent mailing list was also destroyed, hence they shall be able to send reprints of their own publications only to those of our readers who write for them.

Hans Selye, Professor and Director,  
Institute of Experimental Medicine  
and Surgery, University of Montreal,  
P.O. Box 6128, Montreal 26, Canada.



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# Drug-Induced Deformities

DONALD REID, '64

## INTRODUCTION

For many years, investigators have succeeded in producing congenital malformations in mammalian embryos by exposing their mothers to various chemical and physical agents called "teratogens", during pregnancy. The problem has recently become prominent because of the discovery that thalidomide is extremely teratogenic to human beings. Each teratogen usually produces a characteristic array of defects, presumably depending on the particular metabolic pathway that is interfered with at the given stage of development.

There are many drugs in medical use today that are known to be teratogenic to animals, including adrenaline, androgens, antileukemic agents, corticosteroids, estrogens, insulin, penicillin in combination with streptomycin, posterior pituitary extracts, progestins, salicylates, oxytetracycline, tetracyclines, thalidomide and tolbutamide. Of these, the estrogens, androgens, progestins, thalidomide and antileukemic agents like aminopterin are known to be teratogenic in man as well.

## Specificity of Action

### In Experimental Teratogens

From most animal experiments it would seem certain that the teratogens act in specific ways to produce characteristic patterns of abnormality. Since different agents can produce different patterns of abnormality, this implies that they either act at different times in the development or on different phases of the developmental process. The significance of the time factor is indicated by the observation that X-rays caused primarily ocular and cerebral abnormalities when administered on the ninth day of gestation in the rat, but caused primarily skeletal defects when given on the fourteenth day. Furthermore, since Vitamin A deficiency in rats acts during the same period to produce entirely different defects, it is clear that the two agents, X-rays and Vitamin A deficiency, exert their effects on different mechanisms or on different phases of the metabolism of the embryo.

Little is known about the specific developmental mechanisms involved. Kalter and Wakany suggest that the action of the agent can be such as to create shortages of essential material, the need for which is cumulative. The metabolic rates being higher in some areas than in others, the

shortage of materials would be felt sooner and more acutely in the more active areas. As the shortage continues, even areas of less intensive metabolic activity will eventually be affected, producing more generalized deformities. F. C. Fraser proposes such factors as death of certain groups of cells, mitotic aberrations, altered cell migrations, and tissue movements.

The general types of malformations produced depend largely on the stage of embryonic development. Usually malformations are not produced in organs that have completed their development at the time when the agent is given. Fraser states that the stage at which the development of a particular organ is most likely to be deranged by a teratogen may be at a time when organogenesis is proceeding rapidly or at some earlier stage, perhaps even before there is visible primordium of the organ. In addition, it has been suggested that the frequency of the malformations produced by the teratogen varies with such factors as maternal weight, position of the embryo in the uterus, and the genetic makeup.

### Thalidomide as a Teratogenic Agent

#### A. Pharmacological Actions

Kunz et al characterized thalidomide as a central nervous system depressant in



## —Drug-Induced Deformities—

1956. They reported that thalidomide induced sleep in mice. However, the criterion for this effect was arbitrarily selected as a fifty per cent reduction in the spontaneous motor activity. Thalidomide failed to produce loss of the righting reflex, overt symptoms of central nervous system depression, or toxicity in doses of four grams per kilogram. Somer, in 1960, demonstrated that thalidomide increased the barbiturate-induced sleeping time and potentiated the catatonia produced by chlorpromazine and reserpine in mice. Jung revealed that it induced sleep in man with potency and effectiveness equal to that of secobarbital.

The usual sedatives, hypnotics and even the tranquilizers in appropriate doses produce loss of the righting reflexes in animals. Thalidomide is of particular interest because it lacks this effect in laboratory animals, but nevertheless it is an effective sleep-inducing agent in man with a potency comparable to that of the short-acting barbiturates. In animals, it does not produce hyperactivity in small doses. Respiratory depression in rats is not noted. This drug potentiates the central nervous system depressants and antagonizes the central stimulants.

Thalidomide was developed in West Germany and was marketed under the name "Contergan". It was first brought out as an anticonvulsant drug in epilepsy. Soon it was found to be useless in this condition but it was found to cause sleep. Then it was sold as a sleeping tablet, as a sedative, and as a tranquilizer. The drug was manufactured by the ton and sold without prescription. It was thus readily available to all segments of the population.

B. Effect of Thalidomide on the Foetus

Early in 1962, there was a sharp increase in the incidence of infants born with severe malformations of the extremities. The outstanding feature was phocomelia. Phocomelia literally means "seal extremities". In phocomelia the bones between the hand and the shoulder are defective and the hands or rudimentary fingers arise directly

from the end of the affected bone as the flippers of a seal.

The first two such cases were presented by Kosenow and Pfeiffer as an exhibit at the German Pediatric Meeting in Kassel in 1960. These pediatricians reported that there was no hereditary factor found, nor was any blood incompatibility demonstrated, and no chromosomal abnormality was detected. This exhibit did not seem to attract much interest.

Phocomelia has long been known as a rare malformation but usually only one limb is affected. In September 1961, Wiedemann reported the first series of thirty-three such children and delineated the clinical syndrome. As in most malformations the severity varies, but the pattern is markedly specific. The essential feature of the abnormality concerns the long bones of the extremities. The prehensile grasp is lost. The hand arises directly from the distal end of the affected bone. The radius is absent and both the radius and ulna are defective. In some extreme cases the radius, ulna and humerus are lacking and the hand arises from the shoulder. Both sides are affected, but not usually with the same severity. The legs may be affected in the same manner. In most instances, however, the deformity of the legs is less severe. The tibia fails to form. The fibula also may not form and the femur may be short. The hip girdle is not fully developed and there is a dislocation of the hip with external rotation of the stub of the femur. The feet are externally rotated. Polydactyly and syndactyly of the toes are common. In the extremely severe cases, the arms and the legs are completely missing. In some instances, the external ear is missing and the internal auditory canal is abnormally low. There is some disagreement over the amount of hearing loss, but it would appear that in most cases the hearing loss is minimal. Unilateral facial paralysis is relatively common in phocomelia. Fortunately the vast majority of these children are of normal mentality.

Pfeiffer and Kosenow noted that a mid-line facial hemangioma on the forehead which extended over the nose to form a "moustache" on the upper lip was almost pathognomonic of the syndrome. A saddle nose is also reported to be common. These latter features diminish and tend to disappear as the infant grows.

In some instances, usually in the severe cases, the internal organs are affected. Malrotation of the gut occurs with duodenal stenosis. Anal atresia may also be present. Asplenia may occur, and the musculature of the uterus may be so affected as to make a bihorned uterus. A variety of cardiac malformations have been described, but these do not fall into any specific pattern. Some of the more frequent are hypoplasia of the aorta, defects of the auricular and the ventricular septa, all forms of transposition of the great vessels, tetralogy of Fallot, and pulmonary stenosis. Other miscellaneous malformations include pylorospasm, esophageal atresia, anencephaly, microcephaly, eye malformations, and nasal obstructions. Twenty per cent of pregnancies end in stillbirths.

Pfeiffer and Kosenow found no similar traits among the relatives and no consanguinity among the parents. Chromosomal analysis of twelve patients showed no chromosomal aberrations either in the number or in the form of the chromosomes. In one interesting study, four pairs of dizygotic twins were affected, but the twins did not have equal malformations. From these observations, the investigators thought that the causative factor was exogenous and acted during the critical phase of development—that is, between the third and the sixth week of pregnancy. Although this critical time was similar to that of German measles, viral infection was ruled out by the steady increase in the number of patients over a two year period and also by the distribution. Spearheaded by Inez,

a prominent German pediatrician, lengthy questionnaires were sent out to all the parents of the deformed children in West Germany. The evidence immediately became overwhelming that thalidomide was the teratogenic agent in phocomelia.

### Experimental Evidence

There is now definite evidence to show that thalidomide does cause severe malformations in the extremities of experimental animals. Gruenthal showed that the drug passes through the placenta of rabbits. Distillers Ltd. of England have reproduced the malformations in rabbits by feeding the drug to pregnant animals. Murray produced phocomelia in rats by giving enormous doses to pregnant rats.

### Conclusions

In the future, it is imperative that new drugs useful to persons of all ages and which enter the blood stream be screened for teratogenic action. Large scaled experimental studies with animals are essential. Further protection can be offered to the pregnant woman by only administering those drugs which are absolutely essential for the normal development of the foetus and the maintenance of material health.

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# Psychosomatic Medicine

"For this is the great error of our day  
that physicians separate the soul from the body."  
Plato

P. GLORIA BURK AND ROSS LAING

Danger! Highly provocative material!  
Keep out!

Such is the aura surrounding this topic. With very few exceptions, the only people who are sufficiently aware of the problem are psychiatrists and psychologists. *Noli me tangere* has long been the prevalent attitude towards this contentious subject and the dichotomy between mind and body is still maintained in practice, if not in precept also.

Just what is psychosomatic medicine anyway? Well, it is not, as you might surmise from the amount of time given over to its teaching, a rare and obscure specialty. Indeed, quite contrariwise, its concepts encompass the whole of medicine. Psychosomatic medicine can be defined as an approach, by the clinician, to the whole integrated individual. This approach attempts to understand all disease as a product of both emotional and physical factors. Rosenbaum (7) writes that when he tried to set up a course in psychosomatic medicine at the University of Cincinnati, the professor of medicine informed him quite bluntly that "all this was well and good, but all the patients on his medical wards were truly sick people!" The author then goes on to state that he made a serious mistake "in failing to take into account the cardinal rule in the teaching of psychosomatic medicine, namely, that the particular approach and attitude towards the practice and teaching of medicine by an experienced clinician is a function of his total personality, and any attempt to change such an approach and attitude requires the same degree of patience, understanding and skill as would be required to change any pattern of behaviour." So, obviously the best way to integrate these concepts, is to present them to the medical students.

The very fact that a separate designation exists for the psychosomatic diseases emphasizes the unfortunate tendency we have of ignoring the most fundamental and significant aspect of physiology, namely that any organism is an integrated whole and cannot be regarded as having a body functioning separate from psychic influences. How has this dichotomy arisen? Traditionally, problems of mind or psyche have been taboo for the so-called true scientist on the grounds that knowledge so obtained was not empirically valid, being dependent solely on the subjective interaction of subject and observer. But now we are slowly realizing that it is just as vital to treat a patient's psyche as his physical impairment. Nevertheless, the inertia retarding the acceptance of psychological knowledge, as it would pertain to medicine, is terribly frustrating to those who believe in its essentiality and efficacy in the understanding and treatment of disease.

If we examine for a moment, our medical education to date, it becomes readily apparent that it has been remarkably deficient in providing us with an opportunity to get to understand peoples' complaints in terms of their whole personality. The result is that doctors are loath to diagnose a patient's disorders as being psychosomatic. Some ideas of the inability or reluctance of doctors to diagnose illness as being psychosomatic may be gained from the following. (8)

In a study from the Mayo Clinic, Macy and Allen report that of a group of 235 patients diagnosed there as suffering from chronic nervous exhaustion (a typical American euphemism for psychoneurosis) 94% were found to be accurately diagnosed at the end of a six year period. These patients were diagnosed by the

costly elimination method and it was noted that 200 of these patients had had the grand total of 289 separate operations. This may be good business, but it's bad medicine.

Similarly, Bennett (8) in another study of 150 psychiatric patients who had been previously treated for organic disease, found that they had had 240 operations. With psychotherapy 80 recovered and 28 improved.

As we have seen above, the cause of this inability to properly diagnose and treat the patient with psychosomatic illness lies with our medical education. Having accumulated a working knowledge of Anatomy, Bacteriology, Pharmacology, Pathology, Biochemistry and Physiology plus laboratory and x-ray techniques, we are still unable to understand the patient's emotional problems. So systematized and compartmentalized has medical knowledge and its teaching become, that doctor's thinking too, has become channelized, so that our method of diagnosis and treatment is oriented primarily towards the removal of symptoms, and little or no effort is made to comprehend the psychological processes that underlie and aggravate the disease. The patient is little more than a vehicle for interesting symptoms.

But, progress has been made, if only in a limited way. The medical profession is now in general agreement that at least certain diseases have both a physiological and psychological component. These are designated as the psychosomatic diseases. They include (4) peptic ulcer, ulcerative colitis, some menstrual disorders, bronchial asthma, hypertension, rheumatoid and other forms of arthritis, frigidity, to mention a few. There are still many conflicting views on the details of etiology of these diseases. Let us examine a few examples:

#### **Asthma**

Psychiatrists and medical clinicians are generally agreed that (4) "The primary

pulmonary feature in asthmatic breathing is obstruction to the smallest air passages". What they cannot agree on is the etiology of the lesion. A text book of medicine (4) states the following etiological factors:

- 1) Allergy to inhaled antigens
- 2) Respiratory infection
- 3) A combination of the above

It concedes that the autonomic nervous system, histamine and serotonin may be implicated in the pathogenesis. Emotional factors are mentioned only as possible precipitators of attacks in persons already suffering from the disease.

Yet, there are those psychiatrists who feel, that not only must the emotional stimuli and an unstable autonomic nervous system be present for allergens to cause the syndrome asthma, but in certain cases asthma can be caused by emotional factors alone (3). In fact, one interesting hypothesis advanced by a member of the psychoanalytical school is as follows: asthma could be regarded as a ". . . retention analogous to the holding back of the stool by the anal neurotic," "a holding back of air breathed in, instead of retaining the stool." This is, of course, an over simplification of a complex psychoanalytical theory. It is stated merely to point out the divergence of thought on this topic.

#### **Anorexia Nervosa**

Anorexia Nervosa is a syndrome of psychogenic undernourishment that, fortunately, is relatively rare. It usually involves young women and its etiology (4) is stated as involving persons usually severely emotionally disturbed (a) often with a history of incompatibility with their parents or (b) frequently with a story of some sort of sexual difficulty.

This same text goes on to say, "rejection of food represents a sort of suicidal tendency." Again some psychiatrists would disagree (1). Blitzer et al feel that the self destructive wish is not usually present.

These patients have no desire to end their life, but rather, have equated food with all sorts of symbolic meanings (love, security, prohibited desire, oral impregnation, to mention a few). Understanding the symbolic meanings leads to an explanation of the patients behaviour.

The medical text goes on to say that, "since the emotional disorder precipitating this disease is usually severe and potentially self destructive, these patients should be treated with the full co-operation of a psychiatrist."

The association between the patient's personality and the type of illness he is prone to is suggestive of a causative relation, but absolute proof is lacking. An interesting possibility is syphilis.

If syphilis has been contracted by sexual intercourse, then there are certain obvious conclusions we can make about the person. In the first place, he or she lacks discretion to the extent that they cannot refrain from coitus with a partner whose sex life is not known or is obviously promiscuous. Why does a person not exercise caution in picking his sexual partner? How can the patient be taught the need for more circumspection in these matters? Instead of solving these problems, treatment consists of penicillin intramuscularly.

The following quotation exemplifies a serious lack in our approach to diagnosis and treatment of disease. (8)

"The senior author learned quite forcibly that understanding illness and treating sick people consists of something more than a knowledge of disease. Some twenty years ago, shortly after he had entered clinical medicine through the doors of pathology, he was consulted by a young woman whose headaches were of an obscure origin. With pathological knowledge and scientific zeal, he vigorously proceeded to investigate, by means of physical examination and laboratory studies, her various

organs and tissues. After a lumbar puncture, her condition worsened, with more severe headaches, plus intestinal disturbances, and pain in her back. Finally the family's patience was exhausted and they dispensed with such services, calling in the old family physician who knew what the young scientist had not attempted to discover. The patient's only brother, to whom she was closely attached, and who acted as head of the family, was intending to marry. Thus her illness was an expression of her disapproval and when this was pointed out to her, she promptly recovered."

Part of the approach to the diagnosis of illness in any patient should be an attempt by the practitioner to answer the following questions(6):

- 1) What sort of person was the patient before he became ill?
- 2) Why, out of all the days in his life, did he fall ill on the day he did?
- 3) Why did he become ill in the particular way he did?

From the answers to these three questions, a diagnosis of psychogenic disorders may be made without first subjecting the patient to a full battery of unwarranted diagnostic procedures. At the same time, treatment commences immediately because the patient begins to realize that his problems are responsible for his symptoms. This diagnosis could not have been made if the doctor had failed to keep foremost in his mind the sick person rather than the disease process.

Now 2000 years later, Plato would still say,

"For this is the great error of our day . . . that physicians separate the soul from the body."

*Continued on Page 181*

# Iatrogenic Disorders

A. ALBERT YUZPE, '64

## INTRODUCTION

The term "Iatrogenic Disorders" refers to adverse effects induced by the physician in caring for his patients. These may not only be the direct injuries that may result from therapeutic and diagnostic measures, but also the hurt that can be inflicted by words or actions. The term generally carries with it the connotation of an untoward effect that could have been avoided by exercise of reasonable care and knowledge on the part of the physician.

## GENERAL CONSIDERATIONS:

At first consideration one may tend to regard such a disorder, or disorders, with a certain amount of apprehension. The question arises: why is it that a physician whose goal is to prevent disease, or cure it, should in treating one condition induce a second undesirable one? The answer to this lies mainly in the following:

- (i) Sequellae to drug therapy;
- (ii) Therapeutic procedures which produce undesirable long term sequellae;
- (iii) Injudicious statements on the part of the physician, misdiagnosis or incorrect prognostication;
- (iv) Adverse and paradoxical effects of drugs.

## I. SEQUELLAE OF DRUG THERAPY

Every drug, in sufficient therapeutic dosage, is toxic to someone; and thus, any patient is potentially subject to the development of an iatrogenic disorder during the course of treatment. The sequellae can appear as:

### (1) Allergies

These reactions are commonly no different from hypersensitivity reactions of other types and include rashes, asthma, and the symptoms of serum sickness.

Organs and organ systems affected may be:

- (i) Skin — morbilliform, urticarial & maculopapular rashes being commonest;

- (ii) Blood — changes in the formed elements;
- (iii) Nervous system — delirium;
- (iv) G.I. tract — nausea, vomiting, diarrhea, abdominal pain.

### (2) Intoxications

This includes such disorders as hypervitaminosis A, Vitamin D poisoning, atropine & chronic iodide poisoning.

Hypervitaminosis A usually results from the ingestion of large amounts of vitamin A in the treatment of various skin, eye, ear, renal, and gynecological problems.

The iatrogenic results in this case may involve:

- (i) CNS—headaches, diplopia, increased intracranial pressure;
- (ii) Locomotor System — calcification of some areas & decalcification of others
- (iii) Skin—alopecia, exfoliation, seborrhea hemorrhagic dermatoses;
- (iv) Other changes—hemorrhagic manifestations, hepatomegaly, splenomegaly, leukopenia, and anemia.

### (3) Metabolic and Endocrine Derangements

Steroid therapy has become widely employed in modern medical practice, often times with great success. It has, however, at the same time resulted in a variety of iatrogenic disorders due to its injudicious use. These affect:

## —Iatrogenic Disorders—

- (i) *CNS*—causing nervousness, insomnia, changes in mood or psyche and psychopathies of the manic-depressive or schizophrenic type;
- (ii) *Electrolyte Metabolism*—causing sodium retention and potassium loss;
- (iii) *Calcium Metabolism*—causing osteoporosis, fractures and low calcium tetany;
- (iv) *Blood*—hypercoagulability causing thromboembolic complications including pulmonary embolism;
- (v) *Endocrine Glands*—causing amenorrhea, alteration in thyroid function, adrenal and pituitary suppression, pancreatic lesions, aggravation of underlying diabetes mellitus or hypertension, hirsutism, and loss of scalp hair;
- (vi) *Gastro-Intestinal Tract*—causing peptic ulceration. Abrupt cessation of steroid therapy leads to withdrawal symptoms. (Other examples of metabolic and endocrine derangements, other than those caused by steroids, are: hypothyroidism—caused by phenylbutazone, cobalt, PAS; gynecomastia—caused by estrogens, digitalis; deficiency syndromes—caused by folic acid, vitamin B12, isoniazid, etc.).

### (4) Complications of Antibiotic Therapy

Iatrogenic disorders in this category include:

- (a) Resistance;
- (b) Alteration of flora;
- (c) Superinfection;
- (d) Interference with antibody formation;
- (e) Pseudomembranous enterocolitis;
- (f) Tracheobronchitis.

### (5) Complications of Blood Transfusions

In this group, iatrogenic disorders include:

- (a) Infectious Hepatitis;
- (b) Hemochromatosis;
- (c) Gram—negative infections;
- (d) Hemolytic reactions;
- (e) Malaria;
- (f) Citrate Intoxication.

### (6) Addiction & Habituation

Injudicious administration of addictive drugs, by physicians, has caused many patients to become drug addicts, with serious consequences to themselves both from a legal and a medical point of view. The therapeutic use of opiates in acute situations rarely leads to drug addiction, since most doctors realize their potential danger, and thus, only prescribe them when they are absolutely justified in doing so. These drugs are then used only for a minimal length of time. Despite this fact, some patients may still develop an addiction to one of these opiates, especially morphine. However, this is not the case with the barbiturates. Numerous barbiturate addictions still occur, mainly because physicians fail to recognize the fact that barbiturates are addicting drugs. These physicians prescribe barbiturates far in excess of their requirement.

There is, however, a situation in which doctors deliberately prescribe opiates in a way that inevitably leads to addiction, but this as a rule is done as a beneficial act. The case in point is a patient with terminal, inoperable cancer, to whom the denial of pain relief would be inhumane. In such cases, the patient may become addicted to morphine or one of its synthetic substitutes. This type of iatrogenic addiction is frowned upon by some in the profession. E. R. Bloomquist, a noted authority on drug addiction, has said, "When a physician decides to use potentially addicting drugs to relieve pain, he employs a sacred and marvellous right. He also assumes tremendous responsibilities." The physician must decide whether the patient really needs narcotics, or whether personal atten-

tion, discussion, encouragement, and the use of physical therapy or regional anesthesia would be a better choice for subduing pain or allaying anxiety. Analgesics should be chosen to fit a particular case. Short acting narcotics, used frequently over a two or three week period, can lead to physical addiction. Therefore, long acting analgesics, which do not permit tolerance to build up so rapidly, should be employed where applicable.

#### (7) Systemic Complications of Topical Dermatologic Therapy

- (i) Boric acid intoxication;
- (ii) Salicylic acid poisoning;
- (iii) Phenol poisoning;
- (iv) Mercurial poisoning;
- (v) Estrogenic effects.

#### (8) Undesirable Side Effects

##### (a) *Teratogenic Effects*

A number of drugs have been found to cause teratogenic effects if administered in sufficient dosage at a precise period during gestation. These drugs include: Antileukemic drugs; estrogens; androgens, progestins; thalidomide.

(b) *Hemorrhage and Purpura*, caused by—  
Anticoagulants, quinidine, salicylates, etc.

(c) *Eighth Nerve Damage*, caused by—  
Streptomycin; dihydrostreptomycin; Neomycin; Polymyxin.

(d) *Jaundice*, caused by—  
Chlorpromazine; methyl testosterone; thiouracil.

(e) *Hematologic Abnormalities*, caused by—

- (1) Anticonvulsants such as Mesantoin, & Tridione;
- (2) Antihistamines such as Phenergan & Pryribenzamine;
- (3) Antimicrobial agents such as Arsenobenzol, & Chloramphenicol;

(4) Antithyroid agents such as Thiouracil & Tapazole;

(5) Sedatives such as Sedormid, & Amidopyrine;

(6) Spasmolytics such as Diparcol, & Pronestyl;

(7) Gold preparations, Phenylbutazone, & Nitrophenols, etc.

(f) *Urinary Calculi*

(g) *Acute Tubular Necrosis.*

As every drug is toxic to someone, the list of undesirable side effects is obviously inexhaustible; and the preceding list in no way covers all eventualities.

## II. THERAPEUTIC PROCEDURES WHICH PRODUCE UNDESIRABLE LONG-TERM SEQUELLAE

- (1) Multiple immunizations;
- (2) Potentially sensitizing, immunizing biological products;
- (3) Chemicals added to food;
- (4) Flouridation;
- (5) Radiation Sequellae.

Infants and children with a history of exposure to ionizing radiation show an increased incidence of hematologic abnormalities, cataracts, hypoplasia of dental enamel, delayed dentition, congenital abnormalities, genetic mutations and malignant disease).

Various organs in the adult are often involved with significant complications. The undesired effects, as they affect these different organs are, namely, radiation pneumonitis, nephritis, enterocolitis, esophagitis, pericarditis, myelitis, as well as mucous membrane and bone marrow changes.

## III. INJUDICIOUS STATEMENTS, MISDIAGNOSIS, OR INCORRECT PROGNOSTICATION

Studies have shown that there is considerable overdiagnosis of such conditions as



## Iatrogenic Disorders

amebiasis in patients who are merely suffering from some functional gastrointestinal disorder. Multiple food allergies are often diagnosed on the basis of positive skin test alone.

Perhaps the commonest and yet the most serious iatrogenic disorder of this type is heart disease, diagnosed on the basis of electrocardiographic studies or the presence of a heart murmur. These patients have no cardiac symptoms or disability until their attention is suddenly focused on the heart by some word or action of the physician. This problem is aggravated by the fact that:

(i) More and more people are undergoing routine physical examinations;

(ii) People are under considerable stress during these examinations, which often causes tachycardia or increased blood pressure on a purely physiological basis;

(iii) Modern health surveys which frequently include E.C.G. and chest X-rays as routine tests, increase chances for erroneous diagnosis of heart disease based on changes in heart shadow.

Thus, we are having more and more opportunities for the discovery and misinterpretation of various unimportant changes in otherwise healthy subjects.

Ill-considered and unjustified remarks are also important factors in the etiology of iatrogenic disorders. Even the most stoic of all patients displays some degree of fear and concern. His anxiety can be aggravated by either too serious a demeanor, or a flippant remark, or an impressive conference. How often has the word "leukopenia", heard by a patient, been misinterpreted by him to be leukemia?

#### IV. ADVERSE AND PARADOXIC EFFECTS OF DRUGS

In recent years, physicians have become aware of the fact that placebos can at times produce striking subjective and objective

toxic effects, as well as demonstrate remarkable therapeutic power.

The preceding statement is well exemplified in a double-blind trial using Hydroxychloroquine sulfate. The study was performed by the Cooperating Clinics Committee of the American Rheumatism Association. In reviewing the undesirable signs and symptoms, 58% of patients who received the drug developed pruritis, whereas 38% of the patients who received the placebo had similar effects. Furthermore, in patients who received the drug, 53% developed headache; 49% developed abdominal pain; and 37%, tinnitis. In the placebo group: 48% developed headache; 47% developed abdominal pain; and 37%, tinnitis.

Thus, from this study, we see that many unforseen iatrogenic disorders develop when even the most innocuous drugs are used.

#### CONCLUSION

Are iatrogenic disorders preventable?

T. R. Harrison answers this question fully when he says, "Even if it were possible to achieve the goal—a generation of flawless physicians with infallible judgment and infinite wisdom—there would be the patients who still have uncanny capacity for misinterpreting the most innocent remarks, and the most cautiously expressed opinions. In the end, iatrogenic illness is largely a matter of incomplete knowledge and fallacious judgment on the part of the physician conjoined with the fears and anxieties of the patient. So long as Medicine remains an art, iatrogenic illness will remain."

In my opinion, the chief hope for diminishing the incidence of these disorders is through a wise and cautious approach to his problems on the part of the physician, and a greater appreciation by him of the mood and attitude of the patient.

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# Mass Immunization

DAVID M. P. THOMSON, '64

## INTRODUCTION

Since Jenner established the principle of vaccination over a century and a half ago, immunization has been one of the more efficient methods devised for protecting man and animals from disease. Under ideal conditions it converts a susceptible man to a resistant man, permitting him to move wherever and whenever he chooses, carrying his protection with him. Unlike chemoprophylaxis, immunization frees him from having to take a drug regularly with the risk of the supply running out or the mental hazard of forgetting to use it. No longer must he periodically flee an epidemic area, hoping that he has left in time. These gains, unparalleled in preventive medicine, have saved millions of lives and freed millions from panic or from chronic fear.

### 1. MASS VACCINATION PROGRAMMES

Recently the President of the U.S. announced to the Press that over the next three years the U.S. Public Health Service would carry out mass immunization against Diphtheria, Pertussis, Tetanus, Smallpox and Poliomyelitis. Nearly all European countries carry out Mass Vaccination, but methods vary a great deal. In some, short campaigns are organized by the Central Health authority with mobile teams, and in others by permanent local services.

In order for a programme of total mass vaccination to be a success the following should be incorporated into the programme:

#### 1. *A Centralized Health System:*

This will ensure:

- (a) uniformity in the execution of programmes
- (b) continuity of control which, to be effective, includes:
  - (1) Laboratory control of the quality, effectiveness, and safety of vaccines and sera.
  - (2) Epidemiological control of the effectiveness of sera and vaccines in large scale use.
  - (3) Control of the number and periodicity of immunizations.

#### 2. *Registration:*

Personal records of immunization are desirable, and it is essential that they should be readily available in respect to tetanus. Recent suggestions for ensuring a

readily available record of tetanus immunization are bracelets and tatoos. Another setup for general registration would be double registration of vaccinations with the family keeping one record which must be produced whenever the children come for a new vaccination; the other record being kept in the child health centres.

#### 3. *Financing of Vaccination Programme:*

The central and local authorities bear the costs in countries where vaccination is compulsory.

#### 4. *Health Education and Mass Vaccination:*

Although the subject of voluntary or compulsory vaccination is controversial, it may be said that, ideally, a vaccination programme should be carried out with the full understanding and co-operation of everyone concerned, even when vaccination is compulsory. The most decisive factor in the success of a mass vaccination campaign is the health education of the public, provided the health educators themselves are suitably specialized and have thorough knowledge of teaching methods so that they can suit the method to the circumstances. Although there is no universally applicable method of health education, a careful study of conditions should be made, and the health education programme should be adapted to them. Among the most important local conditions to be taken into account are the economic situation, religious and social customs, and the attitude of the inhabitants to the health problem in question. Some of the methods which could be used are the following:

Those programmes in which the individual takes no active part and are for that reason of limited effectiveness (e.g. lectures, films, television, features, etc); Those programmes in which the individual takes active part are more effective but more time consuming (e.g. discussion groups, committees, and interviews (7)).

## II. IMMUNIZATION PROCEDURE:

Immunization procedure is a dynamic subject in need of constant evaluation. Although to-day the various programmes are basically similar, there is still considerable difference in the recommended time for vaccination. In planning any programme one must consider foremost the importance of establishing resistance to all possible infections as early in life as is reasonably possible. The use of complex antigen mixtures rather than individual antigens has received more attention since the work of Zoeller and Ramon, and physicians now generally accept the dictum that combined antigens should be employed whenever possible. (1)

The main reasons are:

- (1) Programmes are more successful when the number of injections and visits are reduced to a minimum.
- (2) Emotional disturbances are decreased with fewer injections.
- (3) Period of time necessary to establish immunity is shortened.

### Recent Contributions To Preventive Vaccination:

#### (1) *Vaccination against Tuberculosis:*

B.C.G. is still the vaccine most commonly used against Tuberculosis, although studies are being carried out using other materials. B.C.G. should be given to:

- (1) Contacts of cases who are tuberculin negative.
  - (2) Persons with occupational exposure.
  - (3) Residents of areas of high incidence.
- B.C.G. should not be given to tuberculin positive individuals.

#### (2) *Vaccination against Poliomyelitis:*

At present, two distinct types of poliomyelitis vaccine are available, both capable of conferring active immunity; they are formaldehyde-inactivated vaccine (Salk), and live attenuated vaccine (Sabin).

#### A. Immunization with inactivated vaccine (Salk)

##### Advantages:

1. Considerable experience has already been acquired with this type of vaccine.
2. It gives approximately 70% protection against paralytic disease to the vaccinated individual.
3. There is no danger of infection from the vaccine with the careful methods of preparation and testing now established.
4. Reactions are insignificant, and any which occur are usually to the penicillin which is included.

##### Disadvantages:

1. There is no definite information of the duration of immunity or how often it is necessary to vaccinate.
2. Although it gives good individual protection against paralysis, it does not protect the individual from infection of the gastro-intestinal tract; thus transmission of poliovirus through the population is not prevented.
3. It does not assure 100% protection from the disease.
4. It requires multiple inoculations.
5. It does not produce sufficient immunity in face of epidemics.
6. It is still debatable whether there is any hope of eradicating poliomyelitis by this kind of vaccination in its present form.

#### B. Immunization by Orally Administered Live attenuated Vaccine (Sabin)

##### Advantages:

1. It is made from an attenuated virus free from paralytogenic properties, which sets up in the individual a Gastro-Intestinal-Tract infection thus producing im-

munity form Gastro-Intestinal Tract and Central Nervous System infection.

It therefore provides a means of preventing disease in the individual and also controlling the transmission of natural poliovirus in the population. This means that control of infection can be achieved without 100% immunization.

2. Since it is given by mouth and can be administered by non medical personnel, its use is cheaper than that of an injected vaccine.
3. There is some transfer of the vaccine virus from person to person; thus, by immunizing one person of a household others may be infected and obtain immunity. This is perhaps a dubious advantage because of the danger of mutation to a more virulent strain.

#### Disadvantages:

1. The extent of immunity and its duration is unknown.
2. Other viruses of the Gastro-Intestinal Tract can interfere with the growth of the live attenuated virus. Therefore, it is necessary to saturate whole communities at a time of year when other enteric viruses are not prevalent.
3. There is some danger that the virus may not remain entirely free from paralytogenic properties when it is excreted by the vaccinated individual; among contacts, mutation to a more virulent form might occur. (3, 10).

Only this fall the Surgeon General's advisory committee made the following recommendation that "the use of Type 3 vaccine in mass campaigns be limited to preschool and school age children. Plans for mass programs using Type 1 and 2 vaccines in all age groups should continue. Furthermore, Type 3 vaccine is still indicated for use among adults in high risk groups, which include tourists of hyperendemic areas and persons residing in epidemic areas." (17)

This recommendation resulted from eleven cases following Type 3 vaccine, all of which could not be assumed to be coincidental. They occurred in the age group from 16-52 years with eight among persons over thirty years of age. The clustering of the intervals from vaccine feeding to onset in the 2-3 week period suggested a vaccine relationship. The incidence, assuming all cases to have been vaccine induced, was only eleven cases among more than thirteen million fed. (17)

#### (3) Vaccination against Influenza:

The most important problem in the manufacture of influenza vaccine is the constant antigenic variation in the virus. Routine inoculation of whole general populations is not feasible. Protection should be given to those with a greater risk of complications (e.g. pregnant women, the aged) or death and those engaged in essential community services. Immunization should be repeated with the specific vaccine well before an expected epidemic.

#### (4) Vaccination against Typhoid and Paratyphoid:

In spite of the fact that vaccine against typhoid fever has been used for a long time, no strictly controlled trials were carried out until recently. On the basis of present knowledge, vaccination against typhoid is advisable in places where the disease is endemic and for persons subject to unusual exposure through occupation or travel.

The effectiveness of vaccination against paratyphoid fever has never been satisfactorily proven. (7)

#### (5) Vaccination against Brucellosis:

A vacuum-dried live vaccine is at present being used in the Soviet Union. Since the introduction of mass vaccination in the Soviet Union, the over all incidence of brucellosis has declined by some 60%. (7)

#### (6) Vaccination against Diphtheria, Tetanus and Whooping-Cough:

Vaccines against diphtheria, tetanus and

pertussis may be advantageously used in combined form for immunization in early childhood.

(7) *Pertussis:*

A good pertussis vaccine gives 80-90% protection for several years. It should be used early, since up to 70% of deaths from pertussis occur in the first year of life and the fatality is particularly high under the age of six months. The reason for this is that passive transfer of naturally acquired immunity from mother to baby does not occur. It should not be used to vaccinate school-age children because of the serious reactions which may occur.

**Hazards:**

(1) Mild local or general reactions occur in 50-70% of children but are not contra-indications.

(2) *Pertussis Vaccine Encephalopathy:*

After contrasting the risk of pertussis vaccination with the risk of the disease itself, so long as the incidence of pertussis remains high, the risk of encephalopathy (less than one/million) should not be considered a contra-indication to vaccination. When the incidence of pertussis has been reduced to a level will assume greater prominence in the low level by vaccination, the risk of vaccination will assume greater prominence in the minds of parents. Under these conditions, the occurrence of a case of encephalopathy with all its tragic consequences might receive great publicity and turn parents against vaccination.

It is clear that if one injection of pertussis vaccine causes Central Nervous System symptoms no more injections should be given to the child. On purely general grounds, children with a previous history of repeated convulsions should not be inoculated nor should children suffering from other illnesses be inoculated until they have recovered. (2)

(3) *Provocation Poliomyelitis:*

There is some evidence of an association between the localization of paralysis in poliomyelitis and the site of recent toxoid or vaccine injection. During a poliomyel-

itis epidemic, routine (I.M.) or (S.C.) injections of toxoids and vaccines might be limited to children less than six months.

(8) *Tetanus:*

Tetanus Toxoid is an excellent antigen capable of producing good and lasting immunity. Protection against tetanus should be established and maintained in all persons at all times. This is important in view of its effectiveness in prophylaxis against tetanus and in view of the possibility of sensitivity to horse serum in unimmunized persons who may need antitoxin.

(9) *Diphtheria:*

Diphtheria Toxoid produces good immunity after the recommended number of doses and there are few side effects. Adults not previously immunized should have a Shick test to detect sensitivity to Toxoid. Reimmunization at convenient times throughout the life of an individual is strongly recommended.

(10) *Small Pox:*

The control of smallpox has been so successful that physicians and patients have become complacent in regard to vaccination and maintenance of immunity. Routines should be established for revaccination in order to assure continued immunity. Revaccination every five years is advisable. The best time for initial vaccination is during the first year of life. In infants, the constitutional reaction from the first vaccination is usually much less than in older children and adults, and the risk of complications is practically eliminated. All contacts of cases should be revaccinated.

**Hazards:**

(1) Generalized Vaccinia and Secondary Vaccinia. Vaccination against smallpox is contra-indicated for children with eczema or dermatitis and for household contacts of children with these conditions.

(2) Post vaccinal encephalitis does occur, but rarely.

(3) Local reaction is not a contra-indication. (14)

### III. IMMUNIZATION PROGRAMME RECOMMENDED:

#### 1. Primary Immunization:

| Age          | Visit | Vaccine   |
|--------------|-------|---|
| 3 months     | 1     | P.D.T. (Pertussis, Diptheria, Tetanus) and Poliomyelitis vaccine. |
| 4 months     | 2     | P.D.T. and Poliomyelitis vaccine.                                 |
| 5 months     | 3     | P.D.T. and Poliomyelitis vaccine.                                 |
| 6 months     | 4     | Small pox.  |
| 12-18 months | 5     | P.D.T. and Poliomyelitis vaccine.                                 |

#### II. Routine Recall (Booster Injection):

|                              |   |   |
|------------------------------|---|---|
| 2-4 years                    | 6 | Poliomyelitis                           |
| 5 years (School Entry)       | 7 | Smallpox revaccination                  |
| 8-9 years                    | 8 | D.T. and Poliomyelitis revaccinate.     |
| 14 years (High School Entry) | 9 | D.T. and Polio<br>Smallpox revaccinate. |

—Revaccinate for Diptheria, Tetanus, Poliomyelitis and Smallpox thereafter at convenient intervals and/or when exposed.

N.B. Immunization for children born in the fall should probably be started at two months of age because of the danger of immediate exposure to Pertussis.

### IV. SUMMARY

There is no need to speculate on the future of immunization. We must now be prepared to accept no half-truths in immunization. We must correctly determine the value for man of agents now in use and those to be provided in the future.

Vaccination presents sociologic as well as scientific problems. It will do little for the future of immunization to prepare excellent vaccines, test them for safety and efficiency, and then not insure that they are adequately used. A paramount problem in immunization in the future, and one for which we must all share responsibility, is to get vaccines into the people who need them.

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# Fluoridation:

## A Review of the Literature

ANNE FANNING, '63

### INTRODUCTION

Dental disease affects virtually every man, woman, and child in Canada. Because it is seldom a cause of death, and because manifestations of the disease are not always obvious, the magnitude of the problem is often overlooked, not only by the layman, but by the physician. A recent survey in the city of Toronto showed that 20% of the two year olds, 80% of the public school children, and 98% of 19 year olds had active tooth decay.

### THE TOOTH

The tooth consists of a core of nerve fibers and blood vessels called pulp. This is surrounded by dentin, a mineralized ground substance containing embedded collagen fibers. Canals which contain the processes of odontoblasts, the dentin forming cells, run from the inner to the outer surface. The crown of the tooth is covered with a thin cap of enamel, a non-cellular, highly mineralized tissue of ectodermal origin. The enamel is 95% inorganic  $\text{Ca}_3(\text{PO}_4)_2$  in the form of hydroxyapatite crystals. The deepest cells of the foetal enamel organ differentiate to ameloblasts, and produce enamel. The cytoplasm of the ameloblasts undergoes changes; adjacent to the basement membrane it first becomes granular and then produces the homogeneous enamel material. Opinions vary as to whether the homogeneous material should be considered a secretion of the ameloblasts or a transformation of their cytoplasm.

### DENTAL CARIES

A dental cavity is a lesion of the hard tissues of the teeth. The lesion begins in a crevice on the outer surface of the enamel. Food debris sticks here and acts as a substrate for the metabolism of bacteria abundant in the mouth. The acid products of bacterial action decalcify the enamel. The organic matrix undergoes proteolysis following the initial decalcification.

### MANAGEMENT:

The classical approach to dental caries

has been two fold:

#### 1. Preventive:

a) dietary controls—by decreasing the carbohydrates in the diet, the substrate for bacterial enzymatic action is thereby reduced. Thus, the harmful organic acids are less abundant.

b) Cleansing—the brushing of teeth immediately after eating removes the particles from between teeth and from crevices. Organic acid already formed is diluted and washed away.

#### 2. Active Treatment: The filling of dental cavities.

As evidenced by the Toronto statistics, the classical approach is not adequate. Public education is an aid to prevention, but there is an element of the population which does not respond. Traditional methods of treatment are described in dental reports as "stop gap". The greatest hope for improved dental health in the future lies in active public health preventive programs.

**PROPOSAL: THAT FLUORIDES BE ADDED TO THE PUBLIC WATER SUPPLY AT THE LEVEL OF ONE PART PER MILLION (PPM) PARTS OF WATER, IN ORDER TO REDUCE DENTAL CARIES.**

### HISTORY:

In 1892, Sir James Critchton—Browne suggested that lack of Fluoride in the diet might account for the high rate of tooth



decay in London, England. But for almost forty years his suggestion went unexplored. In 1908, Dr. Frederick McKay, a Denver dentist, became interested in brownish blemishes, or mottling on teeth. He undertook to check six thousand persons in ten states and two countries. His work led to two significant discoveries:

1. There was "something" in the drinking water of certain towns which caused differences in tooth enamel.
2. Persons with mottled teeth had fewer cavities than those whose teeth were unmottled.

In 1939, M. C. Smith of the University of Arizona discovered that the "something" in the drinking water which caused mottling and also reduced dental caries was the Fluoride ion.

#### MECHANISM.

There are two mechanisms by which the Fluoride ion is thought to reduce dental decay.

1. If the ion is available to the ameloblasts, producing enamel in late foetal life and childhood to the age of 15 years, it is substituted for the OH- group in the apatite crystal to produce Fluorapatite. This structure is less soluble in acids. The resistance of Fluorapatite enamel to acids produced in the mouth has been proved experimentally with deciduous teeth of children from Fluoride and non-Fluoride areas (Finn and Demarco, 1956).
2. Fluoride ions in the drinking water may inhibit bacterial glycolysis which results in the production of organic acids. Hence, the rate of decay would be reduced not only in those exposed to the Fluoride ion from birth, but in adults as well.

#### ACCUMULATED EVIDENCE:

H. T. Dean and his associates have added vast amounts of evidence to the files in favour of Fluoridation. In 1953, he correlated the Fluoride content in the water with the mottling of teeth. He stud-

ied 5824 white children in 22 cities. Where the Fluoride content was greater than 4 ppm, Fluorosis, a brownish discolouration of the teeth accompanied by pitting, was severe. In areas with 2.5-3.5 ppm of Fluoride ion in the drinking water, teeth were chalky white and dull at eruption and took on a brown stain with age. In areas with 1 ppm or less there was no clinically significant mottling.

At the same time, Dean, McKay, Bunting and others were studying the relationship between mottled teeth and dental caries. In 1939, Dean reported a study of 1581 children in two cities with Fluoride level of 1.7-1.8 ppm, and two cities without significant Fluoride levels. He included only those who had used the water supply from birth. It was found that children in the low Fluoride communities had three times the amount of dental caries observed in the Fluoride communities.

In 1949 and 1943, Dean observed in a clinical study of 7257 white children ages 12-14 that a striking reduction of caries (about 65%) was associated with a Fluoride content of approximately 1.0 ppm. At this concentration there was no Fluorosis of aesthetic significance.

Hundreds of studies have been carried out in communities throughout the world, all drawing similar conclusions. The most immediate to our attention is the Brantford, Sarnia, Stratford study. In June 1945, studies of dental caries in children of Stratford, (1.6 ppm Fluoride), Brantford, (Fluoridation initiated in June 1945), and Sarnia, (a city having negligible amounts of Fluoride in its water supply and no program of Fluoridation), were begun. Periodic examination for decayed, missing or filled (D.M.F.) permanent teeth in children of different age groups was carried out by the Department of National Health and Welfare.

Both the number of children caries-free and the mean number of D.M.F. teeth per child were similar in the cities of Brantford and Sarnia, at similar age groups in

1948. Stratford, on the other hand, had a higher caries-free rate, and lower mean D.M.F. teeth per child level. By 1955, Brantford statistics were reaching the desirable picture which Stratford presented. Thus, we can conclude that the addition of 1.0 ppm Fluoride to Brantford water supplies reduced the dental caries rate to levels near those of Stratford with its natural Fluoride supply. On the other hand, Sarnia dental caries rate showed no reduction over the seven years.

### THE OPPONENTS OF FLUORIDATION:

The opponents of Fluoridation of the communal water supply are a small but vociferous minority. They are an interesting group who base their arguments on scientific evidence, religious beliefs, and reaffirmation of democratic civil liberties.

Scientists presented evidence of the dangers of Fluoridation to the Ontario Commission, headed by Morden. Almost every disease entity was, in one brief or another, blamed on Fluorides. Cryolite workers who receive a daily intake of twenty times the recommended level of 1.0 ppm. show symptoms of musculo-skeletal disease only. These include skeletal Fluorosis and a secondary macrocytic anaemia due to bone marrow involvement. McCauley and McClure in 1954 made a study of the effect of Fluoride in water on skeletal development in children where levels were 3.5-6.2 ppm. These children were ages 7 to 14 years and life long residents of the areas. Studies of right hand and wrist X-rays for carpal ossification and skeletal age ratings were done on an age and sex specific basis and were well controlled. There was no consistent relationship between skeletal development and Fluoride content. Similar studies have eliminated Fluoride in the cause of arthritis, hypertension, heart disease, renal damage, bone fractures, abnormalities of height and weight, deafness, cataracts, thyroid disease, biliary and urinary calculi, cancer and cirrhosis.

The possibility of an overdose in the drinking water is suggested by the anti-Fluoridationists. At the levels of 1.0 ppm. the consumption of 1000 mgm. of  $H_2O$  daily includes 1/1000 of a mgm. of Fluoride. Lethal levels are 4-10 gm. retained. It is obvious that sickness due to water overloading would develop long before Fluoride poisoning due to overdosage.

Errors in the pro/Fluoridation statistics are pointed out by P.R.N. Sutton in his book entitled *Error and Omissions in Experimental Trials*. He asserts that the statistical methods employed in Fluoridation studies were naive and full of errors. It is true that any statistical data is more reliable if the results have been obtained by blind testing. However, this is well nigh impossible in such an extensive study where the city water supply is the vehicle of the tested drug. It need not be added that there is no test more objective than that of determining the presence or absence of dental caries.

Religious sects oppose Fluoridation on the grounds that if God had wanted Fluoride in the water, He would have put it there.

The most effective argument against Fluoridation is that put forward by those who see its institution as a step against civil liberties. The following statement was made to the Morden Commission by G. G. Tew; "The ordinary and time-honoured relationship of physician and patient is that the physician advised, but it remained optional with the patient to accept or reject the proffered advice. If a physician subscribes to this principle, how then can he logically advocate mass medication or Fluoridation?" Legal advisors and witnesses to the Morden Commission held that any mass medication which is to the public good cannot be held as a threat to their civil liberties. Finally, the Morden Commission recommended "that legislation be

*Continued on Page 192*

# News and Views

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## SIR STANFORD CADE

Third and fourth year students were privileged to hear the eminent British surgeon, Sir Stanford Cade, at rounds and clinics, and were unanimously impressed with his forceful personality, his wealth of knowledge and experience, and his views on controversial medical questions. It was perhaps of even greater value to be able to hear "Some Reflexions on Cancer" presented in the Undergraduate Lecture Series to a mixed audience of the laity and the medical profession. The challenge of this type of audience should not be minimized; how to answer the questions of the former while maintaining the interest of the latter is a formidable task.

Sir Stanford successfully met the needs of each group. For the citizen of London and the undergraduate student, he outlined what is known about this "biological aberration"; the roles of predisposing fac-

tors, infection, heredity, sex, and age. His presentation was emphasized by statistics and examples from his personal experience. He anticipated common queries and answered them conscientiously and concisely.

For those medically oriented, Sir Stanford's speech was valuable in an entirely different fashion. Intermingled with well known medical facts were comments such as "I never talk about cure. I prefer to talk about control," and "I have no use for observation . . . It has no curative value". He apologized for being unable to define cancer satisfactorily, saying that although we do not know what cancer is, we do know what it is not. Certainly these are challenges for all of us. An even greater challenge to any doctor lies in the questions asked about cancer by friends and by patients. Sir Stanford's insight into how to answer these question with the correct proportion of fact and philosophy will serve as a guide to all of us.

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## Book Reviews

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**Practical Anesthesiology:** Artusio and Mazzia 318 pages, C. V. Mosby Co. \$7.75.

This book is easily read and well illustrated. It is designed for medical students and general practitioners and its approach to anesthesiology is primarily clinical.

The first section deals with basic con-

siderations including both anatomical and physiological discussions, with a description of the general and local anesthetic agents. A section follows concerning the preanesthetic evaluation and preparation of the patient, and the operative risks involved with different agents in varied situations. In the third section, the authors

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outline the stages and planes of general anesthesia, management of airway, ventilation, and vital signs. A fourth section deals with techniques of administration and runs the gamut from the drop method with diethyl ether through the anesthetic machine with endotracheal intubation to spinal anesthesia. The final section describes the special considerations in anesthesiology, with very valuable information on a variety of subjects including prevention and management of complications of general and local anesthesia, anesthesia for emergency surgery, and medicolegal aspects concerning anesthesia.

Each chapter has a good bibliography and the illustrations are excellent. This book is valuable reading both for medical students and physicians.

**Primer of Clinical Measurement of Blood Pressure:** Burch and De Pasquale, 121 pages, C. V. Mosby Co., St. Louis, 1962, \$5.50.

This book summarizes the principles, techniques, and precautions involved in recording blood pressure. Emphasis is placed on the accuracy of the diastolic and systolic readings. The authors terminate their remarks with the statement that "—No data is better than wrong data".

The history of the recording of blood pressure traces the development of methods from direct measurement in animals, by Hale, in 1773, to the methods of the present day. In the review of the physiology, the factors of cardiac output and peripheral resistance are considered as the primary determinants. The actual measure-

ment of blood pressure in clinical practice is discussed stressing the theory, technique, sources of error and the variable factors to be learned. The chapter on normal values is important because the statistics aid in differentiating the pressures which stray from the mean. Reference to diagnostic applications is narrow in scope, due to omission of certain disease processes which indirectly affect the blood pressure.

An elementary, but concise, discussion of the most commonly used instrument in the physician's bag.

**Early Detection and Diagnosis of Cancer:** O'Donnell, Day, Venet, 280 pages, C. V. Mosby Co., St. Louis, 1962. \$12.00.

"This book is not a definitive treatise or reference work on the subject and all its ramifications." With this in mind, the authors have placed their emphasis on the detection and the diagnosis of cancer rather than its treatment which is mainly handled by specialists. In this book, cancers which are common and accessible are discussed in detail. The minority of cancers which do not meet these criteria are omitted. The interesting illustrations and visual aids are very relevant and enable the reader to summarize the written descriptions at a glance.

The cancer problem is introduced with brief statistics indicating its importance as a major public health challenge. In the chapter on the cancer detection exam, the modifications of the general physical examination and history are pointed out. As with any examination, the importance of detailed records is stressed. The body of the book is a systematic discussion of the

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skin, head & neck, breast, uterus & female genital tract, stomach, colon & rectum, urinary tract & male genitalia, and the blood forming organs. These topics are described under epidemiology, etiology, pathology and steps in the diagnosis of

cancer of these areas.

This excellent book definitely fills a vacuum because it is concise and authoritative. The practical principles described can not but help the physician make an early diagnosis.

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enacted empowering municipalities to Fluoridate their water supplies". The Morden report should be read by all physicians as well as those layment interested in the question of Fluoridation. Not only does it present the evidence on both sides in an unbiased fashion, but it includes an assessment of the civil liberties problem in the light of present democratic political philosophy.

### THE ALTERNATIVES

Several Alternatives to the Fluoridation of Communal water supply have been suggested:

1. Fluoride mouth washes have been shown to reduce dental decay to a limited extent. However, as indicated above for full effect Fluoride must be ingested and must be available to the enamel forming cells prior to tooth eruption.
2. Stannous and Sodium Fluoride dentifrices have been produced but have the same drawbacks as the mouth wash.
3. Food articles such as milk may be used in the future but at present, the technical problem of how to incorporate it in milk has not been solved.
4. Fertilizers have been suggested as a vehicle for Fluoride; however in the soil

Fluoride forms Calcium Fluoride,  $CaF_2$ , which is almost insoluble and therefore not available to the growing plants.

5. Home Fluoridation units are too costly.
6. Fluoride tablets must be given in daily doses for at least the first eight years of life. There are few studies reported but some are in progress presently. A May 1962 article in the *Globe and Mail* entitled "peaceful Fluoride" outlines a trial in Essen, Germany where Fluoride tablets were given to school children at the cost of 12c per month. Less than 1% of the parents in the city refused to participate. The estimated cost of Fluoridating a city's water supply is 25c per person per annum.

### CONCLUSION:

Tooth decay is a mammoth problem. Preventive measures are necessary in order to reduce the incidence of the disease. Fluoridation of communal drinking water is a safe, inexpensive, and effective way of achieving this end.

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