ANAESTHESIA FOR GASTRIC OPERATIONS

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The ideal anaesthetic for the various operations upon the stomach has not yet been found. Any method employed should fulfil the following conditions and should provide :

A. Good relaxation of the muscles of the abdominal wall and of the peritoneum. This makes exposure of the upper abdominal organs easy, and facilitates closure of the wound. Relaxation in general anaesthesia is due to depression of the motor centres in the anterior horn cells of the spinal cord which initiate impulses maintaining muscular tone. As the rectus and transversus abdominis are accessory muscles of respiration, their tone persists in planes of third-stage anaesthesia which produce complete flaccidity of the skeletal muscles of the limbs. Moreover, as the posterior fascial sheath of the rectus and transversus muscles is fused with the parietal peritoneum in the upper abdomen, these muscles must be loose when the peritoneum is sutured. Relaxation is aided in all methods of anaesthesia by raising the knees six inches off the table, and by flexing the head.

B. Quiet breathing. This makes the manipulations of the surgeon easier because movements of the diaphragm and intercostal muscles cause movements of the upper abdominal viscera proportional to the activity of the breathing. Conversely, the rising and falling of the diaphragm, and hence respiratory exchange, may be interfered with by packs and retractors.¹

C. Protection from shock and circulatory depression. There are many nerve endings and plexuses in the upper abdomen, stimulation of which by traction, packing, etc., can cause shock. For this reason, upper abdominal operations cause more shock than lower.

D. Minimal disturbance of respiratory function. Anaesthetic agents can cause (a) chemical irritation with excess mucus production, e.g., ether ; (b) depression of the muscles of respiration which favours post-operative hypoventilation and atelectasis, e.g., high spinal and intercostal blocks ; (c) depression of the cough reflex, e.g., deep ether and heavy premedication.

E. Minimal interference with body chemistry. Here ether is the chief offender of the commonly used anaesthetics. It depresses liver and kidney function, makes the bowel atonic, and causes nausea and vomiting after operation.

In addition to satisfying the surgeon by attention to the above points, the aim should be to give the patient an anaesthetic that is as free as possible from unpleasantness both before and after operation. Finally, the anaesthetic must not endanger life nor add to post-operative complications.

Preliminary Examination

This should be carried out, where possible, before the day of operation, since estimation of the general condition of the patient is the first step in assessing him as an anaesthetic and surgical risk. After that comes an estimation of the tone of the muscles of the anterior abdominal wall. Flaccid muscles can be easily relaxed whereas a tight powerful belly wall will demand the use of the most potent drugs and techniques.

Respiratory function requires special notice. The existence of a productive cough is more important than the elicitation of adventitious sounds with the stethoscope, as when it is present before operation it is most important to see that sputum is not allowed to collect in the bronchial tubes after operation.

The state of the blood, heart and vessels must be evaluated. Here, again, the reactions of the patient to the ordinary activities of life give more useful information than the presence of physical signs. When the haemoglobin is below 50 per cent., or when the systolic blood pressure is less than 100 mm. Hg., high spinal analgesia is likely to be hazardous. A low haemoglobin level may call for transfusion before, during or after operation. The condition of the liver and kidneys must not be forgotten, while the state of the teeth and the degree of patency of the nares may influence the method of intratracheal intubation. Finally, the emotional make-up of the patient together with his reactions to previous operations must be investigated so that proper premedication can be ordered.

Pre-anaesthetic Preparation and Medication

The patient should be in hospital 48 hours before operation so that he may become familiar with his surroundings and undergo any investigations that may be necessary. Glucose given at this time will help to combat any post-operative ketosis and should be taken in substantial amounts

Smoking should have been given up at least three weeks before operation as there is evidence that the non-smoker has a much greater chance of avoiding post-operative lung complications than the moderate or heavy smoker.² The patient should be instructed in deep breathing and shown how to expand the lower chest ; he will then co-operate more readily in the 'shake-up' treatment after operation and lower his chances of post-operative pulmonary morbidity.

The evening before operation a sedative such as medinal gr.x will usually ensure a sound sleep, while omnopon gr. 1/6 and scopolamine gr. 1/300 given one hour before operation is a good routine premedication. Patients over 60 may become unco-operative with scopolamine and usually do better with atropin gr. 1/75. If the patient is to have cyclopropane, two or three grains of nembutal should be given by mouth one and a half hours before operation, with atropin hypodermically. Nembutal depresses the respiratory centre less than omnopon or morphine and helps to prevent cardiac arrhythmias.³

Agents and Methods

Many techniques of administration are available and several agents may be used either alone or in combination the one with the other. General anaesthetics may be given by inhalation or by vein, while local analgesics can be used to produce spinal or regional blocks.

A. Inhalation

Guedel has described four stages of general anaesthesia :

1. Analgesia.
2. Delirium.
3. Surgical anaesthesia.
4. Respiratory paralysis.

Surgical anaesthesia is further sub-divided into four planes.

The first plane commences with the onset of regular breathing, and during it there is progressively decreasing eyeball activity.

The second plane is initiated by the eyeballs coming to rest in the centre of the palpebral fissure. The laryngeal reflex, active in plane I, is quiescent in plane II.

Commencing intercostal paralysis marks the onset of plane III, the paralysis being complete at the bottom of this plane. Intercostal paralysis is accompanied by the thoracic respiratory movements gradually lagging behind abdominal movement.

The fourth plane lasts from the onset of complete intercostal paralysis, to respiratory arrest. Breathing in this plane is entirely diaphragmatic.

Upper abdominal operations usually require plane III anaesthesia for their successful management, if ether is used. Occasionally plane IV may produce better conditions. Controlled breathing with cyclopropane, of course, implies descent into stage IV. Maximal depth is required while the surgeon is making his initial exploration, immediately after opening the abdomen, and again when he is making his final inspection and during the suturing of the peritoneum. A lighter plane may often be satisfactory during the freeing of the stomach and duodenum, and during the anastomosis, but at all times the abdomen must be quiet and there must be no pouting of bowel which cannot be easily controlled by a light pack.

A theoretical knowledge of the stages and planes of anaesthesia is important, but the anaesthetist is there to produce satisfactory operating conditions for the surgeon, regardless of the plane of anaesthesia required to produce these conditions.

From the anaesthetic point of view the shorter the time the patient is in deep anaesthesia, the better will his post-operative condition be.

Ether is the best agent for use by the occasional anaesthetist, and although it is usually preceded and may be accompanied by gas and oxygen from a machine, the open method of administration need not be frowned upon and should not be entirely neglected. Robust and obese patients may sometimes be more easily subdued with 'a rag and bottle' than by a machine. The Oxford Vaporizer is a useful device for maintaining ether anaesthesia. The gas-oxygen-ether sequence may be advantageously given in a closed circuit with carbon dioxide absorption. This benefits the patient by conserving his body heat and moisture ; it facilitates quiet breathing because of the lower alveolar CO₂ tension, and economizes gases. Ether is well tolerated by most patients and its margin of safety is wide. While muscular relaxation is usually good, breathing is reasonably tranquil. On the other hand, deep ether anaesthesia, especially if maintained during a long operation, has many disadvantages which include upset of the body chemistry, pulmonary irritation, cardiovascular depression, slow recovery from anaesthesia, and nausea and vomiting after operation. The deeper the plane the greater are the post-operative circulatory and pulmonary complications. It should therefore be replaced whenever possible.

The important thing about good inhalation anaesthesia is an adequate airway and this is best obtained in gastric operations by the passage of an intratracheal tube, either blindly through the nose, or under direct vision through a laryngoscope, via the mouth. The latter route is usually preferable

as a larger tube can be passed which makes for quieter breathing. The new Portex plastic tubes sizes eight to ten are very satisfactory for oral intubation as they will not readily kink. Preliminary topical analgesia of the larynx, carried out with Macintosh's spray, makes intubation easier, and once the tube is in place, laryngeal spasm ceases to play any part in the anaesthesia.

Cyclopropane possesses many advantages for operations in the upper abdomen, such as quiet breathing, freedom from irritation of the respiratory tract, and the rapidity with which induction and recovery take place. In third-plane anaesthesia, diaphragmatic breathing is not exaggerated as it is with ether. Prolonged nausea and vomiting rarely follow cyclopropane, while the renal and hepatic functions return to normal at the end of the anaesthesia. Shocked patients do well with it⁴ and it has been recommended for use after haemorrhage. It is very useful in cases blanched from haematemesis.⁵ Its disadvantages are its uncertain power of producing muscular relaxation and its sensitizing effect on the cardiac automatic conductive tissue, this being still further increased by the presence of adrenalin. The addition of small quantities of ether vapour greatly aids relaxation, while it minimizes cardiac irregularities. Capillary oozing is increased in light cyclopropane anaesthesia, because it causes an increase in the systolic blood pressure together with peripheral vaso-dilatation. These changes are not present however when the anaesthesia is deepened. It has been shown that circulatory complications, which may persist into the post-operative period, such as tachycardia, alteration in the blood pressure or cardiac arrhythmia, or shock, are more frequent after cyclopropane than after ether, even in healthy subjects.⁶ On the other hand, the respiratory morbidity is less than with either ether or spinal analgesia.⁷ The pneumonia rate was less than one-third of that seen after ether in a large series of upper abdominal cases.⁶

Arrhythmias are most common in sthenic and neurotic adults between 15 and 50.⁸ They can be minimized by using evipan or thiopentone for induction. They usually take the form of ventricular extrasystoles and may show clinically either as a bigeminal pulse or as a total irregularity. A-V nodal rhythm can occur, but is undetectable by the finger and stethoscope and there is no evidence that it is dangerous. Ventricular extrasystoles associated with cyclopropane anaesthesia are probably of a reflex nature involving the hypothalamus, and commonly appear at about the level of respiratory arrest, i.e., when the alveolar concentration of cyclopropane is 20 to 30 per cent.

Higher concentrations, such as 50 to 70 per cent., abolish the irregularity in the majority of cases. In spite of the bizarre character of the pulse there is no evidence of myocardial depression, except in the presence of anoxia. The combination of deep cyclopropane anaesthesia with anoxia is very dangerous. Arrhythmia is more dangerous in ascent from than in descent to deep anaesthesia. A moderate slowing of the pulse can be regarded as a normal response, but a bradycardia below 50 a minute will probably develop either into an arrhythmia or into a ventricular tachycardia with a pulse rate of over 200, if cyclopropane is further pushed.

Controlled breathing is a useful technique in gastric surgery and can be easily employed with cyclopropane. It can be produced by either of two methods or by a combination of the two. The patient's carbon dioxide can be lowered by pressure on the breathing bag during inspiration, with the soda lime in circuit, i.e., by hyperventilation, until the alveolar, and thus the blood carbon dioxide, is no longer in sufficient amount to stimulate the respiratory centre, and spontaneous breathing ceases. By the second method, the respiratory centre is deliberately depressed by pre-operative omnopon and pentothal, and cyclopropane is given until breathing stops. After this interchange of gases is then kept up by regular manual compression of the breathing bag so that the frequency and depth of respiration is under the control of the anaesthetist. Guedel states that every patient can be relaxed completely with cyclopropane if controlled breathing is used to push sufficient cyclopropane into his tissues. Providing he is kept fully oxygenated and his arteriolar-capillary refill time does not unduly lengthen, Guedel believes that no harm will come to him. This is an extreme view and may be a true one, but I feel that in the present state of our knowledge a more conservative attitude should be adopted and every effort made to keep the cardiac action normal in rate and rhythm. I prefer to augment relaxation, should this be necessary, by the addition of curare or a little ether, rather than push the cyclopropane to the arrhythmic level.

The type of patient likely to develop arrhythmia is the type that may show emergence delirium or great restlessness immediately following the operation. This is little influenced by morphine but is readily controlled by subemetic doses of apomorphine as recommended by Rovenstine and Hershey, who inject intravenously 1.5 to 2 mgm. (gr. 1/44-1/32). Occasionally patients who have had deep cyclopropane anaesthesia become shocked on their return to the ward, and may need intravenous fluid. Cyclopropane shock is less

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Cross-section of part of the anterior abdominal wall, showing the method of making deep injections within the rectus sheath.

frequent if the high oxygen tension of the respired gases during operation is gradually and not suddenly reduced. This can be accomplished by admitting air to the circuit for some time before the end of the operation, and also by giving oxygen to the patient after he leaves the theatre, gradually reducing the amount. Dripps²⁶ has recently shown that this hypotension may be due, at least in part, to the following mechanism. During anaesthesia, the shallow breathing characteristic of deep cyclopropane results in the accumulation in the blood of an abnormally high amount of carbon dioxide. On the patient's return to the ward breathing deepens as the anaesthetic level lightens, and this results in the washing out of the accumulated carbon dioxide and so removes its hypertensive effect.

The most useful signs of anaesthesia with this gas are the degree of activity of the respiratory centre, the state of the peripheral circulation, and the degree of muscular relaxation. Cyclopropane can be combined with spinal analgesia, with abdominal field block, or with curare, in which case the depth at which arrhythmias occur need not be reached, while consciousness is quickly regained so that the patient can be stirred up soon after operation.

Trilene

While this agent has no place as a complete anaesthetic producing relaxation for upper abdominal operations, it is a useful supplement to regional or spinal analgesia in combination with nitrous oxide. It has the advantage that it is not explosive, should the surgeon be using the diathermy machine. Minimal amounts only should

be used, so that cardiac irritation and anomalies of respiration do not occur. It must not be used together with adrenalin, nor must it be used together with soda lime in a closed circuit.

B. Intravenous

Pentothal sodium is not irritant to the respiratory tract, and produces only moderate changes in body chemistry. Furthermore, with a free airway, respiration is quiet. It is, however, seldom adequate for gastric surgery when used alone, as the large doses required to produce relaxation cause too much respiratory and post-operative depression. Combined with nitrous oxide and plenty of oxygen (20 to 50 per cent.) pentothal may be satisfactory for quick operations in debilitated or asthenic patients.

It forms a pleasant induction to general anaesthesia and can be used to give a short period of relaxation if this is required quickly during the operation. Many of these dyspeptic gastric patients are edentulous and lend themselves after preliminary topical laryngeal analgesia to intubation through a laryngoscope after the injection of about 0.5 gm. of pentothal, followed immediately by cyclopropane or ether. Pentothal combines well with abdominal field block and with spinal analgesia, especially if gas and oxygen are added, but I prefer to use cyclopropane to supplement these techniques.

C. Spinal Analgesia

This method is indicated in strong, muscular patients, and in some with active pulmonary tuberculosis, bronchiectasis or acute bronchitis.

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Extensive abdominal field-block. The dots mark the sites of puncture along the lateral margin of the rectus sheath; the dotted lines the subcutaneous infiltration.

Analgesia must reach to the fourth or fifth dorsal roots so that the spinal nerves supplying the skin and muscles of the anterior abdominal wall may be blocked, as well as the rami communicantes carrying visceral impulses from the upper abdominal organs. The higher the level of analgesia the greater the risk of circulatory depression and post-operative pulmonary complications. Traction on the stomach and mesentery may cause nausea and retching by reflexes involving the vagus nerves, and for this, as also for psychological reasons, it is desirable to combine light general anaesthesia with the high spinal block. Cyclopropane is to be preferred in this case, as with it anoxia is minimized, and should the spinal analgesia be short-lived, the production of quiet breathing and relaxation can be taken over more easily and safely than by pentothal sodium.

During spinal analgesia the blood pressure must be charted regularly. In cases where shock is anticipated an intravenous drip can be set up. Methedrine is useful to combat hypotension, while the continuous adrenalin drip⁹ works well in patients who are not receiving cyclopropane.

Hypobaric nupercain can be used according to the techniques of Howard Jones¹⁰ or W. Etherington Wilson,¹¹ while Lake's method is a good one for operations lasting up to one hour.¹² Heavy nupercain will also give good results.

The following are useful specimen techniques for use in a well built man of average height.

(a) *Light Nupercain—Howard Jones technique*

The solution used is 1:1500 nupercain in 0.5 per cent. saline, having a sp.g. of 1.003. Success depends on the displacement of c.s.f. by a large volume of analgesic solution, together with gravity keeping the solution in the desired part of the subarachnoid space. Injection of 15-17 c.c. of solution warmed to body heat is made between the second and third lumbar vertebrae, with the patient in the lateral position on a level table. He is then turned prone for five minutes so that his posterior nerve roots receive a soaking in solution. Taking care to keep the head low, he is once more turned to the supine position and the table tilted head down 10°. This should give a block to T-4-5 which should last from 1½ to 3½ hours.

(b) Heavy Nupercain

This is 0.5 per cent. nupercain in 6 per cent. glucose solution, the sp.g. being 1024. Puncture is made in the interspace between the second and third lumbar vertebrae with the patient in the lateral position and the spine inclined 5° head downward. The dosage is 2.2-2.4 c.c. using a little barbotage. Following the injection the patient is placed on his back with the spine still tilted in a 5° Trendelenburg position, so that excess solution will pool in the region of the fourth and fifth thoracic roots. No steep tilt is allowed for 15-20 minutes.

The introduction by Lemmon of his method of serial or continuous spinal analgesia¹³ was a valuable addition to the technique of spinal analgesia. By its use the effects of procain, the least toxic of all spinal analgesic drugs, can be maintained for as long as may be necessary, while the risks of over—or under—dosage are abolished. Extra equipment is needed and there are some technical difficulties to be overcome, but it is a useful method which should be used more frequently.¹⁴

D. Regional Analgesia

This may be used alone, or in combination with light general anaesthesia to improve relaxation and lessen the amount of general anaesthetic necessary. It may take the form of abdominal field block,¹⁵ ¹⁶ posterior intercostal block,¹⁷ lateral intercostal block¹⁸ or rectus sheath block. In the absence of general anaesthesia, splanchnic block is required in addition.

Regional analgesia is the method of choice in poor-risk patients, but is time-consuming. The technique requires practice and in the obese may be difficult to accomplish faultlessly. In the hands of experts, good operating conditions are regularly obtained, but the anaesthetist employing the method occasionally will not always obtain such good results. If regional analgesia is to be used with a general anaesthetic, this is induced before the injections are commenced, but in the absence of general anaesthesia the patient must be well tranquillized beforehand with omnopon or omnopon and membutal. Extra omnopon can be given in the theatre in doses of gr. 1/6 intravenously. The legs and arms must be comfortably secured to prevent the patient from moving.

Regional analgesia of the upper abdominal wall entails the blocking on each side of the lower six dorsal nerves, which convey both motor and sensory fibres; while analgesia of the upper abdominal viscera involves blocking of the splanchnic plexuses, either by the surgeon from the

front,¹⁹ or by the anaesthetist from the back²⁰ ¹⁷. The dorsal nerves can be reached in their subcostal grooves, four finger-breadths from the spinous processes¹⁷ or in the mid-axillary line.¹⁸ Five to ten c.c. of analgesic solution being injected into the vicinity of each nerve.

The technique of abdominal field block has been well described by Labat,¹⁵ Finsterer¹⁶ and Maingot.²¹ Tovell and Hinds²² describe a useful and simple method which combines light cyclopropane anaesthesia with a costoiliac block on each side. The analgesic solution is deposited beneath the deep fascia at points two inches apart along lines running from the ensiform, below the ribs and along the flanks to the anterior superior spines. Finally, injections are given into each rectus muscle. Each one of this series of injections consists of 10 c.c. of 1 per cent. procain solution with 1 : 40000 cobefrin.

Another good procedure is to aid the poor relaxation afforded by a light general anaesthetic by injections into the rectus sheath on each side of 50-100 c.c. of 1 : 1000 solution of anethaine (Figs. 1 and 2). Five or six injections, each of 15 c.c. of solution, are placed in the rectus sheath close to its outer border where the dorsal nerves enter it. The highest injection is just below the ensiform, and the lowest is half-way between the umbilicus and the pubis. At least one injection should be made between the tendinous intersections,²³ of which there are usually three, one just inferior to the ensiform, one level with the umbilicus, and the third midway between the other two. A wider zone of relaxation is produced if in addition a costoiliac block is performed. Solution is deposited deep in the muscular planes, as the nerves run between the internal oblique and transversus muscles. Anethaine 1 : 1000 solution lasts longer than procain but is more toxic, and 300 c.c. should not be exceeded, physically handicapped patients receiving much less. The addition of 0.25 c.c. of 1 : 1000 adrenalin to the 300 c.c. makes the agent last longer and reduces toxicity.

Regional analgesia is very useful in operations for repair of perforated ulcers and in wounds involving the upper abdomen. In these cases the addition of light general anaesthesia, especially cyclopropane, is often preferable to the large doses of omnopon, etc., which may be needed in its absence.

Curare

This is a crude extract containing numerous alkaloids, d-tubocurarine being the only one used in anaesthesia. It has one action and that is to paralyse skeletal muscle by blocking impulses at

the myoneural junction. Two brands are on the market, Intocostin (Squibb) and Tubarine (B.W. & Co.). Tubarine is a buffered solution made up so that 1 c.c. contains 10 mg. of d-tubocurarine which is variously stated to be the equivalent of from 30 to 70 units of intocostin.

Prostigmin is the not too efficient pharmacological antagonist of d-tubocurarine, a dose in the order of 10 mg. being necessary to combat the apnoea of overdosage. As prostigmin is a powerful vagotonic drug, atropin gr. 1/50 should be given at the same time.

Tubarine has no general analgesic or depressant action in the absence of hypoxia, nor is the cardiovascular system influenced with reasonable dosage. Bronchospasm may sometimes occur, especially if the dosage of d-tubocurarine is too small, or the plane of anesthesia too light, and it is probable that the condition will yield to further d-tubocurarine or to a greater depth of anaesthesia.

Excretion is fairly rapid, thus making an intravenous drip unsatisfactory, except as a means of keeping the patient topped up following an intravenous injection of a dose sufficient for full curarization. It is probably unwise to give an initial dose more than 15 mg. Further amounts can then be given as required.

As d-tubocurarine produces salivation, atropin should be given beforehand.

Clinical uses. With the patient intubated and stabilized at the upper border of plane II, stage 3, from 10-15 mg. should be intravenously injected five minutes before the peritoneum is opened. The method of general anaesthesia may be pentothal sodium with gas, oxygen and, perhaps, minimal trilene; cyclopropane; or light gas, oxygen ether. In the last case, the dose of d-tubocurarine should not exceed 10 mg. in the first instance. Relaxation will last about 40 minutes, and can be prolonged by subsequent injections of approximately half the initial dosage. These amounts are of course reduced in aged, ill or very young patients. It is most important to stress that while the patient is under the influence of d-tubocurarine, and this may extend for some time after he has left the operating theatre, his respirations must be augmented by rhythmical pressure on the breathing bag. Only in this way can he be spared the twin insults of hypoxia and carbon dioxide accumulation. It will usually be found advisable to gain relaxation for closure of the peritoneum by the use of a little ether or cyclopropane, rather than by the further injection of the depressant d-tubocurarine, so near the end of the operation.

In those cases in which no intracheal tube is in use, the intravenous injection of 5-10 mg. of d-tubocurarine will often cause a troublesome

laryngeal spasm to subside. Should post-operative bronchoscopy become necessary for the relief of atelectasis, it can be greatly facilitated by the injection of 10-15 mg. of d-tubocurarine together with 0.5 to 1 g. of pentothal sodium.

As the use of this new drug extends so do its disadvantages become more apparent. There is evidence that the rate of post-operative atelectasis is increased by its use. Shock after operation has been reported and has caused deaths. It has been accused of causing increased bleeding. Slow regurgitation of stomach contents into the respiratory tract, due to the abnormal relaxation of the oesophagus has also been seen. Massey Dawkins has reported that the death rate greatly exceeds that following the use of chloroform. It is possible that some of these disasters are due to unwise use of a new drug, but their occurrence emphasizes the need for great care and knowledge when d-tubocurarine is used. The presence of myasthenia gravis is an absolute contraindication to the use of this drug.

For further information about curare the reader is advised to consult the Discussion reported in the Proceedings of the Royal Society of Medicine vol. xl; number 10. August 1947.

Factors Influencing the Choice of Anaesthetic

Each anaesthetic agent and method varies in its capacity to upset the function of both normal and pathological organs, and no single agent is satisfactory for routine use. The type of patient, including his physique, habits and general health, may vary, as also the nature and probable duration of the operation.

Good relaxation is the first essential and is therefore the most important factor governing the choice of anaesthetic technique. The ultimate choice depends on the amount of relaxation demanded by the surgeon and the price one is prepared to pay for it.²²

Fit men who are at the same time tough and muscular, usually do well with spinal analgesia and cyclopropane light general anaesthesia. Healthy patients of both sexes with average physique, can be managed well with cyclopropane and minimal ether if necessary; with gas oxygen ether; or with rectus sheath block, abdominal field block or intercostal block combined with either of these methods of general anaesthesia. The type with flabby abdominal muscles does well with cyclopropane in concentrations which do not affect the heart. Finally, the poor-risk case, lacking in muscular tone and vitality, can often be carried along with continuous pentothal

and gas and oxygen with the addition of a small amount of cyclopropane or ether if necessary. Otherwise abdominal field block with anterior splanchnic block may give the patient his best chance of ultimate recovery.

Duties of the Anaesthetist during the Operation

A. Administration of an anaesthetic producing good relaxation and quiet breathing.

B. Intermittent aspiration of the stomach via a Ryle's tube inserted through the nose before the patient leaves the ward. Before the clamp is applied, the tube is pulled clear into the proximal part of the stomach. This intermittent aspiration avoids the spillage of gastric contents when the stomach is opened, while the presence of the tube post-operatively prevents distention.

C. Observation of the general condition of the patient. A chart should be kept of the blood pressure and pulse-rate, so that the rate of flow of an intravenous drip, if used, can be related to the condition of the patient's cardiovascular system. Thus shock can be detected in its early stages and proper measures used in time to combat it.

Prevention and Treatment of Post-operative Pulmonary Complications

Primary atelectasis results from bronchial obstruction and is due to secretions which have not been removed by cough, either because of their abnormal amount and consistency or because of inefficient cough and ciliary action. Less frequent causes of bronchial obstruction are vascular congestion of the bronchial mucosa, and bronchospasm.

Causes of excessive bronchial mucus are pre-existing disease, e.g., bronchitis, smoker's cough, etc.; inspiration of saliva, vomitus, or infected material from pyorrhoea alveolaris; and finally irritation of mucous membranes by anaesthetic agents such as ether, or of appliances such as endotracheal tubes, pharyngeal airways or stomach tubes, etc.

Bronchial obstruction results in absorption of gases from alveoli distal to the point of obstruction, with consequent patches of atelectasis which may range in size from isolated lobules, to a whole lobe. If obstructing mucus is removed early, either by cough or suction, the collapsed areas will re-expand. If not, there is the likelihood of infection with the production of patchy bronchopneumonia, and more rarely of lung abscess or bronchiectasis.

Incomplete expulsion of mucus results from pain in the wound interfering with cough. This

is one reason why post-operative pulmonary complications are more frequent after upper than after lower abdominal operations. It is interesting in this connection that transverse incisions are less painful than longitudinal ones and are followed by fewer post-operative pulmonary complications.

Sedative drugs given before or after operation depress the cough reflex, as do the long acting anaesthetic agents.

Hypoventilation of the lungs, i.e., shallow breathing, predisposes to atelectasis as it interferes with the expulsion of mucus. Causative factors here are splinting of the diaphragm by tight binders, and reflex ascent and immobility of this muscle so frequently seen after operation on the upper abdomen, and sedative drugs and prolonged muscular atony due to long acting general and regional anaesthetic agents.

Diagnosis

A chest complication is suggested if a rise of temperature occurs in the first four or five post-operative days, in the absence of other obvious cause. The presence of excess mucus in the air passages may be audible, while auscultation in the suprasternal notch may give useful information as to the presence of excess mucus in the bronchial tree. If the condition progresses, other signs of collapse appear such as rapid pulse, dyspnoea, cyanosis, and even mediastinal displacement. The radiologist may find it difficult to differentiate patchy collapse from bronchopneumonia.

Prevention

Avoid operations in patients suffering from infections of the upper respiratory tract.

Avoid overdoses with sedative drugs.

Try to plan the technique so that the patient is awake and coughing and breathing well and able to be propped up as soon after operation as possible.

After operation, the trachea and main bronchi should be sucked out and the mouth and nasopharynx cleared of secretions.

Before consciousness is regained the foot of the bed should be elevated and the patient placed on his side, so that gravity aids removal of secretions. After consciousness is regained the 'shake up' ritual must be zealously employed. This consists in gentle but firm encouragement of the patient, every hour, to cough, to take a dozen really deep breaths and to change position from back to right side to back to left side, and so on. The lateral position aids aeration of the uppermost lung.

Cough is made less uncomfortable if the belly is firmly supported by either the patient's or the

nurse's hands. If the pain caused by coughing is acute, extra morphine can be given, but only with the full understanding that until its effects wear off, cough and deep breathing will be in abeyance unless the sister is constantly nagging the patient.

To be effective the shake up treatment must be conscientiously carried out, and this depends on the ward sister. An occasional exhortation to clear the throat or to take a deep breath and move a little in the bed, is not enough. The post-operative patient does not like the frequently repeated disturbance, but it may save him from much discomfort, and even chronic ill-health, later on.

Treatment

The shake up drill must be continued. Nosworthy has recommended an occasional clout on the chest wall overlying the area of collapse, with the object of dislodging a mucus plug.

If these methods fail, and suprasternal auscultation indicates the presence of excess secretion, a Magill tube should be passed into the trachea after topical laryngeal analgesia with 10 per cent. cocaine or 2 per cent. amethocain hydrochloride. Either the blind nasal, or the direct laryngoscope method may be employed. Through the Magill tube a rubber catheter or a large ureteric catheter with a curve near its tip, can be inserted into the

trachea and into the right bronchus. By suitable positioning of the patient, and manipulation of the tube it may be possible to intubate the left bronchus. Suction through the catheter will effect the removal of a quantity of mucus, with immediate benefit to the patient. The procedure can be carried out in the patient's bed. The insult to the laryngeal and carinal reflexes produces a cough which in itself is most beneficial. The whole procedure may require to be repeated several times.

The most severe cases which do not benefit from this tracheobronchial aspiration via an endotracheal tube, must be bronchoscoped. Since the introduction of curarine, this need not be so distressing to the patient as heretofore. The addition of 15 mgm. of d-tubocurarine to 0.5 gm. of pentothal sodium injected intravenously, enables bronchoscopy to be performed easily and without discomfort, so that plugs of mucus may be aspirated under direct vision. The application of equal parts of 1 : 1000 adrenalin and 2 per cent. amethocain hydrochloride to the bronchial mucosa, via the bronchoscope, will reduce vascular congestion and pulmonary ventilation in certain cases.

Chemotherapy should be commenced if symptoms persist in spite of the treatment outlined above. Sulpha drugs have no beneficial effect on atelectasis, but are helpful in preventing the collapsed areas from becoming infected.

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'In all demonstrative sciences the rules are certain and infallible ; but when we apply them, our fallible and uncertain faculties are very apt to depart from them, and fall into error. We must, therefore, in every reasoning form a new judgment, as a check or control on our first judgment or belief ; and must enlarge our view to comprehend a kind of history of all the instances, wherein our understanding has deceived us, compared with those wherein its testimony was just and true.'

A Treatise of Human Nature. DAVID HUME.