The freedom from complications in the whole series is remarkable, although the epidemic did not appear to have been one of a milder type than usual, as indicated by the cases which were not inoculated.

Observations of Attenuation

The following conditions were observed to be attendant on the use of the serum:

1. Lower temperature, fewer constitutional disturbances, quicker recovery.
2. The rash is noticeably different. It is much more discrete, rather more ham- or copper-coloured. It persists a long time on the face and is not so profuse or well marked on the trunk and limbs.
3. There was at first a suspicion that the incubation period is delayed; the rash appeared slow to come out, even for measles. This suspicion was not borne out by subsequent observations. We had, in fact, been prepared to accept the view that the serum conferred some degree of immunity when used before infection. The steady curve of the incidence graph does not support this. The inoculation of fifty boys on the same date might be expected to produce a definite flattening of the incidence curve if temporary immunity was a result of inoculation.

The real problem in aiming at attenuation in this type of school is to select the right moment to give the serum. The ideal from the treatment point of view would be the certain infection of the largest number from the first case. In a preparatory boarding school it would probably be wise to use serum without delay.

There is no reaction to the injection. It is well to give it before bedtime. There is some stiffness locally some four hours after injection, and a few boys were allowed to stay in bed for breakfast. Two patients had chicken-pox concurrently with measles.

In all cases with ear symptoms of deafness, discomfort, or pyrexia the drum is incised as soon as any bulging is observed. If the fluid evacuated has passed the serous stage we are disappointed at not having been earlier in intervention. The importance of the early treatment of middle-ear inflammation is not sufficiently insisted upon in the standard works on medicine used by medical students. It is worth recording in this connexion that in fifteen years' experience of measles epidemics in this school we have never had a case of mastoid infection requiring operation.

Conclusions

The use of adult serum has a marked effect in attenuating the disease and in decreasing the incidence of complications.

In the epidemic here recorded there was no evidence of temporary immunity resulting from the use of the serum. Early treatment of middle-ear infection by incision of the drum will greatly reduce the risk of mastoid infection.

The *Transactions of the Twenty-third Annual Conference of the National Association for the Prevention of Tuberculosis*, which was held last July in Bristol, have now been published from Tavistock House North, Tavistock Square, London, W.C.1, as a paper-covered volume of nearly 200 pages (price to booksellers, 6s. 9d.; sold privately at 7s. 6d.). The main subjects discussed were propaganda and publicity methods, preventive institutions, with special reference to open-air schools, and the equipment and activities of a tuberculosis dispensary.

THE VALUE OF CONTINUOUS NEGATIVE PRESSURE IN SURGERY

BY

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The use of suction to remove blood, pus, and other exudates in throat, abdominal, and neurological surgery is now well established. Through a bronchoscope or oesophagoscope no other method would be possible; in brain surgery it is essential to keep a bloodless operative field with the minimum of trauma to the tissues. For such purposes suction pumps are required which will remove a large quantity of fluid quickly, while the amount of noise such a pump produces is of minor importance because it is only used in an operating theatre for relatively short periods. There are many excellent pumps for these purposes which work by pedal, electric, and water power.

Suprapubic Drainage

Although the Harris operation is accepted as an advance in suprapubic prostatectomy, an attempt at the immediate closure of the bladder is advocated by only a small proportion of surgeons owing to the risk of reactionary haemorrhage and the difficult and constant after-treatment necessary. The large-calibre indwelling catheter required is very liable to give rise to a severe urethritis, which later may lead to stricture formation. Suprapubic drainage is regarded as much safer, especially in the hands of the majority of surgeons. Can, therefore, the disadvantages of suprapubic drainage be removed? There are roughly two ways of treating a suprapubic cystotomy. The urine can overflow through and around a tube, to be collected by a suprapubic box. The main advantage of this method is that the apparatus is so simple, but the disadvantages are many. Macalpine (1932) pointed out that overflow drainage of the bladder predisposes to perivesical extravasation, which contributes to toxæmia in a patient whose excretory function is usually already damaged. He has shown that post-operative uræmia and sloughing of the wound are often the result of overflow drainage of the bladder: "the fundamental fault is the saturation of the perivesical structures before any of it arrives on the surface of the abdomen." He supported his assertions by experimental and clinical evidence, and also by the marked improvement in his results since he used suction drainage. Although suprapubic wounds frequently heal well without the use of suction, especially in private patients in good condition, I have also been convinced of the improvement in the morbidity and mortality resulting from the use of suction suprapubic drainage. I have based my opinion on a number of cases at the Liverpool Royal Infirmary and other cases treated elsewhere during the last three years. Furthermore, if a suprapubic box is used early it has to be applied with firm pressure in order to prevent leakage; such pressure causes much pain in a recent wound, which becomes oedematous and gaping, thus also predisposing to infection and violating Hilton's principle of rest to a healing wound. The other alternative of allowing the urine to soak into repeated large dressings and the bed is an "incomparable disgrace to modern surgery."

Problem of Suprapubic Suction Drainage

Even in 1914 Chetwood described an electric suction pump operated by a 1/12 horse-power motor; this apparatus

also included a pressure gauge with a regulating device. Although this elaborate machine worked well I think it was too cumbersome and expensive to be tried by others. In 1916 Churchman described a rotary electric suction pump, but very few details are given about its use. A most ingenious apparatus was also devised by Davis (1916); this was introduced into the Liverpool Royal Infirmary by Professor R. E. Kelly, but it was soon given up because it leaked. The apparatus consisted of a large glass bottle which was exhausted by a vacuum pump: the vacuum was gradually reduced by a very fine capillary tube, thus producing negative pressure for a long time. Various hydrostatic pumps (Jordan, 1936) have been used even longer, but most of them are cumbersome, and they have usually been discarded because they have failed to carry over clots. I was amazed to find that a pressure of at least 10 cm. of mercury is necessary to be certain of bringing urine and blood clot through a tube with a 3/8-inch internal bore: this fact explains why the Cathcart type of pump is quickly abandoned. The Bunsen aspiration pump which is fixed to a cold-water tap is powerful enough, but it can only be used in a hospital bed specially fitted up, because the noise of running water would disturb patients. With this type of pump the rate of suction is far in excess of what is required if enough pressure is obtained, for the rate of suction increases with the amount of negative pressure according to the rate of water flow from the tap. An excessive rate of aspiration tends to cause unnecessary gurgling in the wound, cooling of the bladder, and accumulation of urinary deposits in the tube unless irrigation is arranged. However, the great advantage of this type of pump is reliability, unless the water supply fails or fluctuates.

The problem is therefore the removal of only about 50 oz. of urine in twenty-four hours, but it is mixed with blood clot and possibly diluted with a variable quantity of irrigating fluid. Suction should start *immediately* after the operation and be continued for at least three days; by that time one hopes that the perivesical tissues have become walled off and the wound has had a chance of healing under a dry dressing. Macalpine advised aspirating every quarter of an hour, removing about 1/2 oz. of urine each time. Although theoretically this should keep the patient dry, allowance has to be made for coughing, change of posture, and the unavailability of the nurse every quarter of an hour, so continuous aspiration is better. I also have the impression that there is less bleeding from a bladder which is kept empty.

For the last few years I have been trying to construct a satisfactory negative pressure apparatus, because I believe the lack of one is the reason why suprapubic suction drainage of the bladder has not been widely adopted. A serviceable apparatus should be capable of producing any degree of negative pressure up to 25 cm. of mercury, with an adjustable suction rate: the rate of suction required is very much less than that of the usual electric pump. The difficulty has been to construct a pump which possesses qualities of being reliable, almost silent, easily portable, compact, and preferably capable of working on both the direct and alternating main electric current so that it can be used anywhere suitable for nursing patients.

Methods of Applying Suction to the Bladder

It is important to keep the bladder almost dry and yet avoid any possibility of the mucosa being drawn against the end of the tube—that is, atmospheric pressure must prevail in the bladder by arranging for a down draught of air. This is usually secured by having a right-angled

glass suction tube fitting loosely in the rubber bladder-drainage tube; the glass tube must be slightly shorter than the rubber tube. Another excellent method (Macalpine, 1932) is to pierce the rubber tube with a silver cannula or a long exploring needle, which also must not reach the end of the rubber tube. Whichever method is used lateral eyes are necessary in the distal end of the rubber tube: the second method is better when a very small rubber drainage tube can be used. Irrigation of the bladder is easily arranged by allowing a mild antiseptic solution to enter through the air inlet tube or a tube incorporated in the rubber drainage tube—for example, Marion's tube. One may prefer to pass the irrigating fluid per urethram. Irrigation at the rate of about one drop per second certainly hinders clot formation and the deposition of phosphates in the tube, but it makes the urinary output estimation more difficult. This estimation is, however, more of prognostic than of therapeutic value. It is difficult to say at present whether the irrigated cases did slightly better than the non-irrigated ones, but I think they do.

Empyemata

In 1890 Bülow advised siphon drainage of the chest because he considered that steady removal of pus and a steady intrapleural pressure caused less shock and assisted expansion of the lung. Immediate open drainage appears to have been the accepted method of draining empyemata until the work of Graham and Bell for the Empyema Commission emphasized the dangers of the open pneumothorax in synpneumonic empyemata (Morrison Davies, 1930).

Closed drainage does not necessarily mean intercostal drainage, but it implies that negative pressure is present in the drainage tube. An absolutely gas-tight junction between the tube and the chest wall is essential for successful production of closed drainage if a water seal or some other hydrostatic (McEachern, 1933) method of producing negative pressure is used. Intercostal drainage certainly makes it easier to obtain a gas-tight junction, but the small tube it entails prevents the proper drainage of thick pus and fibrin. Roberts (1935) stated that repeated aspiration through a needle is inferior to closed drainage because the cavity cannot be emptied of fibrin, also the filling up of the cavity between aspirations fails to reduce toxæmia and to allow the lung to expand. Moreover, repeated aspirations every forty-eight hours distress a patient, and especially so if infection of the chest wall occurs.

Closed drainage has many advantages over open drainage. The danger of the open pneumothorax, before the fixation of the mediastinum, is obviated. This applies especially in children, in bilateral cases, and in the synpneumonic streptococcal empyemata with thin pus. The negative pressure in the pleural cavity assists lung expansion, and therefore shortens the period of drainage required.

Closed drainage suffers from the disadvantage that the patient may pull out the tube, but this can be prevented by suturing the external flange of a Tudor Edwards (1931) tube to the skin and then using strapping to prevent the tube slipping through the external flange. In narrow intercostal spaces the pressure of large drainage tubes may cause necrosis of the adjacent ribs. It is better to resect a rib in all cases to ensure adequate drainage by a large tube, because rib resection need not prevent successful closed drainage. If a faulty siphon apparatus or a water seal is used fluid may be sucked into the chest, but

surely this is a fault of the apparatus and not of the principle of closed drainage.

The usual method of closed drainage operation is to pierce the chest wall with a trocar and cannula, followed by the introduction of a Pezzar catheter. Although Bettman's thoracotome (1933) enables a larger catheter to be introduced, I have mentioned the advisability of rib resection in most if not all cases. The "flapper" tube (Bohrer, 1934) is far too dependent on the gas-tight junction between it and the chest wall to be effective; also it can only cause negative intrapleural pressure during inspiration.

The Tudor Edwards drainage tube is probably the best because it is large enough to drain thick pus and it possesses an internal flange which greatly helps to maintain a gas-tight junction. If the chest wall is tightly closed round the tube and perhaps reinforced by a collodion-and-wool dressing there will be very little leakage. If, however, the tube is connected with a water seal the slightest leak will cancel all the negative pressure, which as a rule is a few inches of water only during inspiration and coughing. I have therefore tried the effect of a more constant negative pressure with my suction apparatus. A constant pressure can be maintained by placing a large bottle, the volume of which is considerable compared with that of the pleural cavity, between the suction apparatus and the large drainage tube. A constant intrapleural negative pressure of 30 mm. mercury should keep the diseased lung practically at rest in the expanded condition. So far I have not treated enough cases to give statistics, but it appears very satisfactory. I believe that in the past we have been afraid to apply sufficient negative pressure to the pleural cavity. I have also had the opportunity to apply 30 mm. mercury pressure to the pleural cavity after

3. I have tried to point out that suction needs analysing into its components of pressure and the volume evacuated with respect to time, in order to suit the particular purpose required.

I have to thank all the surgical staff of the Liverpool Royal Infirmary for allowing me to try out the above methods on their cases. I am also much indebted to Mr. J. L. Mayhook, B.Sc., A.I.C., for his untiring efforts in designing and constructing the pumps that have been used. The present one, which has proved most satisfactory, is a gear pump worked by a universal 1/16 horse-power motor with a pressure gauge graduated up to 30 cm. mercury. The pressure can be adjusted to the required amount by a blow-off device incorporated in the pressure gauge, while the rate of suction is controlled by a rheostat.

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BENZEDRINE: A REVIEW OF ITS TOXIC EFFECTS WITH THE REPORT OF A SEVERE CASE OF ANAEMIA FOLLOWING ITS USE

BY

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Benzedrine is the name given to a synthetic drug (β -phenylisopropylamine) chemically allied to adrenaline and ephedrine and comparable to them in its pharmacological effects. Prinzmetal and Bloomberg (1935) introduced it into the treatment of narcolepsy, as they had found it to be much more effective than ephedrine in this condition. Guttman and Sargent (1937) recently reported further observations on benzedrine of an experimental and therapeutic nature which had been collected since the preliminary communication on this subject from the Maudsley Hospital by Peoples and Guttman (1936). Their investigation was mostly confined to the action of benzedrine on the cardiovascular system and the psychological changes observed. Benzedrine produces a general psychological stimulation, and subjectively this is shown by increased confidence and initiative, and ease in making decisions, but is sometimes combined with a feeling of restlessness. They describe the psychological effects in detail, and further state that medical colleagues and others who have themselves taken benzedrine have found it of definite value in such tasks as lecturing or taking an examination. Their experience is that mild depression accompanied by retardation is the most favourable of all psychological disorders for benzedrine therapy. In conclusion, they warn against the possibility of addiction and are already aware that the drug is obtained without medical supervision. At present benzedrine may be purchased without prescription. As they say, this seems inadvisable with a drug the properties of which have still to be fully investigated. They emphasize the fact that the therapeutic indications for the use of benzedrine, apart from the treatment of narcolepsy, have not yet been formulated exactly.

Anderson and Scott (1936) have reported the cardiovascular effects of benzedrine. The patients selected for

A portable continuous negative pressure apparatus.

a lobectomy had been performed by Mr. Hugh Reid for the first week after operation. During this time there was no effusion and practically no bleeding, while the general condition of the patient was excellent. I believe that this pressure helped to prevent collapse of the remainder of the lung with the necessary sequel of pleural effusion or empyema. This complication of lobectomy was discussed at a recent meeting of the Association of Surgeons, but no effective preventive measure was suggested.

Summary

1. The value of suction suprapubic and closed empyema drainage has been confirmed.
2. An attempt has been made to construct a suitable negative pressure apparatus for the after-treatment of suprapubic cystotomy, empyema, and lobectomy.