A recent Ministry of Health Report (1949) gives a tentative figure for the general population in Britain of 0.5 to 1%, but this almost certainly understates the frequency, for Record and McKeown (1950) report an incidence of 0.59% for major malformations of the central nervous system alone.

It would therefore seem that the congenital malformation rate in viable babies of women previously sterile is similar to that of the population in general, and this probably irrespective of the method of treatment. This is supported by a recent paper by Grant (1951), who found six abnormal babies among 457 born to women previously sterile, a rate of 1.3% against the rate of 2% in his general obstetric service.

With regard to the second point of view, it was thought desirable to see whether any support could be offered by this investigation to a theory that there is a sterility-abortion-malformation sequence due presumably to "defective germ-plasm."

There is certainly an increased incidence of abortion in women previously sterile, but this investigation has shown no proportional increase in congenital abnormalities in foetuses of more than 28 weeks' maturity. However, Hertig and Livingstone (1944) have repeatedly demonstrated a high incidence of pathological ova and foetal anomalies in abortions. It may also be significant that Schultze (1949) has been quoted, although without specific reference, as having reported that previous sterility is a much more common finding in women aborting with abnormal than with normal ova (58% against 31.2%). There is therefore a possibility that there is an increased incidence of foetal abnormalities in women previously sterile, but it is not apparent; and in fact these abnormalities thereby account for the high abortion rate in these women.

The possibility of a sterility-abortion-malformation sequence thus remains to be refuted or confirmed.

Summary

Sterility should be regarded as a legitimate complaint when no pregnancy occurs within one year of uncontracepted married life.

The overall conception rate in 700 couples seen on account of primary sterility was 46.3%, so far as could be ascertained by a limited follow-up. If all of the women had been followed to the menopause the actual rate would probably have exceeded 50%.

In only one-half of the successes at the very most does it seem reasonable to ascribe the conception to medical treatment, the remainder being due to time and chance. The high rate of spontaneous cure should be borne in mind when evaluating the results of any form of treatment.

Among the women previously sterile who became pregnant the abortion rate was double that given for spontaneous abortion; the ectopic rate was also significantly increased.

The incidence of congenital malformations in foetuses of more than 28 weeks' maturity was not increased, but the high abortion rate might be due to foetal anomalies.

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NOTES ON CUIRASS RESPIRATORS

BY

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The experience of recent years has made it apparent that considerable preparation must be made for dealing with outbreaks of poliomyelitis in this country if the victims are to benefit from advances in knowledge of the disease and its treatment. In this disease the correct use of mechanical aids to respiration is important as a means not only of saving life but also of resting a partially paralysed but very vital group of muscles. For this purpose there is nothing to compete with the cabinet respirator as regards efficiency, but for convalescent patients still requiring some respiratory assistance a type of respirator which makes nursing and physiotherapeutic care easier is very desirable; in this connexion the possibilities of cuirass-type respirators require investigation.

The early models of cuirass respirators were described in the M.R.C. Report, published in 1939, and were thought to be promising. Since that date respirator development in this country has been curtailed by the war, and is only now getting into its stride again. Work has, however, continued in America and Sweden, and we describe below two representative types—one American and one Swedish—which have been tested. These tests are a continuation of investigations previously reported (Bourdillon *et al.*, 1950).

Two Types in Use

Cuirass respirators are of two types: first, those which completely surround the trunk, and, secondly, those in which a light "shell" (or chest-piece) is applied to the front of the chest and abdomen. Both types of respirator have to be airtight on the body, and negative pressure is applied intermittently. The two respirators described below are of the second type, in which the upper edge of the shell rests on the upper ribs or clavicles; the respiratory movement produced is of the lower ribs and diaphragm, the latter being pulled down by the outward suction effect on the upper abdominal wall. Expiration depends on the recoil of the chest and abdomen after the suction phase.

THE MONAGHAN RESPIRATOR

The Monaghan respirator* consists of six graded sizes of chest-piece (ranging in size from infant's to large adult's), a pump unit, a positive pressure breathing unit, and a battery unit (Fig. 1).

The Chest-pieces.—These are made of transparent acrylic resin, with rubber cushions round the edge to provide an air-tight seal. The

FIG. 1.—The Monaghan respirator.

cushions are made of sponge rubber enclosed in an air-tight outer skin, which can be inflated if necessary to improve the fit.

The Pump Unit.—This is a light and portable unit in which the pump is driven by a small 12-volt D.C./A.C. motor, with an adjustable governor to control the speed. The pump is a piston type with an outlet at each end of the cylinder, and will therefore run two

chest-pieces simultaneously but in opposite phase; for this purpose the pump unit is fitted with two independent hose connexions and two sets of controls and pressure gauges. The pump unit can also be used to give both negative and positive pressure to the cuirass and face mask respectively. It is important to note that the pressure gauge on this machine is calibrated in mm. Hg, instead of the customary cm. H₂O (1 mm. Hg=1.36 cm. H₂O).

The Positive Pressure Unit can be connected to the other end of the pump by plugging into the hose connexion, and can then be used to deliver oxygen or oxygen/air mixtures to the patient via an anaesthetic mask or tracheotomy tube at a controllable positive pressure. The positive pressure phase in the mask thus coincides with the negative pressure phase in the chest-piece, and so reinforces the pressure differential during the inspiratory phase. The gas delivered to the patient can be either oxygen from a cylinder or room air drawn in through a filter. The construction of the unit is such that only clean filtered air, unmixed with air from the pump, reaches the mask, so that there is no possibility of contamination of the inspired air with lubricant.

The Battery Unit.—This incorporates a 12-v. lead-acid accumulator and a built-in trickle charger. It may be left permanently connected to the pump unit, and will take over the running of the respirator automatically and without interruption in the event of supply failure.

THE KIFA RESPIRATOR

The KIFA respirator† consists of four different sizes of chest-piece, from child's to large adult's, and a pump unit. Also provided is a gantry, the use of which is described below (Fig. 2).

The Chest-pieces are made of aluminium alloy, thick enough to be very robust but none the less sufficiently flexible to be bent inwards at the edges when necessary to adapt them to fit the patient closely. The seal round the edge is a rubber tube of about 2 in. diameter, similar to a motor-cycle inner tube. This is intended to be used only partially inflated, so that it rolls with the movement of the chest-piece and thus avoids rubbing.

The Pump Unit is of generous capacity, with a 1/6 h.p. A.C. motor, having an ample reserve of power. It is exceptionally silent in use, and is very well built. An alarm device rings a bell if the pressure falls below a pre-set level; the alarm device is, however, rendered inoperative when positive pressure is used. In the event of power-supply failure the pump can be operated by means of a handle, which can be brought into use in a few seconds.

FIG. 2.—The KIFA respirator.

Use and Performance

INDICATIONS

Cuirass respirators may be used for almost any type of patient, and, indeed, if extensive or intensive physiotherapy or nursing care for the limbs is needed there is no more satisfactory method, especially if the patient is a respiratory cripple. There are also satisfactory reports of the use of these respirators in cases with a tracheotomy (Peterson and Ward, 1948; Wilson, 1951).

When considering the use of a cuirass respirator for a patient, we have found the following points of importance. First, it is essential that no overt respiratory tract infection or atelectasis is present. As will be discussed in greater detail below, cuirass respirators give less ventilation than the cabinet type, so that a relatively slight respiratory complication may necessitate a return to the cabinet respirator. Because of this it is wiser not to use the cuirass respirator until after the end of the acute period, when the liability to respiratory complications is decreasing (Wilson, 1951). Secondly, the patient should preferably have some respiratory ability of his own, since not only is the ventilation better and the reserve greater if the patient can co-operate actively with the machine, but transfer to the cuirass respirator is much simpler. In addition, there is less danger in the unlikely event of a seal leaking. (The alarm bell fitted to the KIFA is, of course, an important safeguard.) However, if the above points are borne in mind the cuirass respirator may be found suitable even for a patient with total respiratory paralysis.

When transferring a patient from a cabinet respirator to one of the cuirass type, we have found it wise to try the new respirator for only 20 minutes on the first day, and thereafter to increase the period by an hour daily, since the different action of the cuirass respirator may at first cause progressive discomfort.

APPLICATION TO THE PATIENT

With the patient lying flat in bed or on the stretcher of the cabinet respirator the largest chest-piece which can be made to surround the trunk snugly should be selected. In the KIFA the aluminium shells should first be bent inwards, so that when applied to the patient's chest they hug the sides of the body firmly. The Monaghan shells, on the other

*Manufactured by J. J. Monaghan Co. Inc., Denver, Col., U.S.A. English agent: Electronic and X-ray Applications Ltd., 17, Pennant Mews, Kensington, London, W.8.

†Manufactured by Kirurgiska Instrument Fabriks Aktiebolaget, Stockholm, Sweden.

hand, are more flexible, and so require to be pulled in on to the patient's trunk by means of the two elastic straps across the back. The leather strap of the KIFA is needed only if positive pressure is being used in the cuirass. The chest-piece will usually seal without any difficulty as soon as the pump is switched on, but the pneumatic pressure inside the rubber seal may have to be adjusted by means of the inflator provided. The negative pressure will pull the shell down on to the patient at each stroke, the travel being often as much as half an inch. In order to prevent sores it is important that the clothing under the shell shall not become wrinkled, and we have found that a stockinet singlet is best. Care should also be taken to see that the lower edge of the Monaghan does not cause redness or chafing over the iliac crest; the occurrence of this has prevented some patients from using the Monaghan. The down-and-up movement of the KIFA can be restricted to some extent by the gantry, which consists of two adjustable legs supporting a horizontal bar to which the shell can be clamped. Some movement of the shell must be allowed or the seal will not be airtight. The comfort of the KIFA respirator is considerably improved when the gantry is in use.

The performance of these respirators in terms of tidal volume for a given negative pressure cannot equal that of a cabinet respirator. For example, on some subjects, using either KIFA or Monaghan, it is impossible to produce a tidal volume greater than 500 ml., even though the negative pressure amounts to 35 cm. H₂O (26 mm. Hg). On the same subjects a cabinet respirator may give a tidal volume of as much as 1,000 ml. at a negative pressure of only 20 cm. H₂O. However, for lower pressures the differences are not so marked, and at a negative pressure of 15 cm. H₂O the figures on these subjects are 300-500 ml. for the cuirass type as against 700 ml. for the cabinet respirator. Thus, for patients who are convalescent and not entirely without respiratory power these respirators may be quite suitable. If the chest-piece can be made to fit comfortably the cuirass respirator may also be used for the chronic case with severe paralysis and wasting, since the need for ventilation has become much less than normal.

If in practice a negative pressure of 15 to 20 cm. H₂O does not give sufficient ventilation for a patient in a cuirass respirator there is usually little to be gained by increasing the negative pressure further, and, indeed, to do so may be harmful. Severe pulmonary emphysema of the anterior portions of the lungs, with dilatation and fragmentation of the alveoli, has been reported in such circumstances (Plum and Wolff, 1951). Should the patient not obtain adequate ventilation in the cuirass he should be returned to a cabinet respirator.

Discussion

Sufficient has been said of these cuirass respirators to indicate that, though of great value and convenience in certain cases, they are not so efficient as cabinet-type breathing machines as regards the ventilation produced. Nevertheless, their development shows interesting possibilities, and sufficient should be available for special cases. The operation of the Monaghan by a 12-volt battery is an enormous advantage when a patient with respiratory paralysis requires transportation, since the whole machine with a patient in it can be conveyed easily in an ambulance. Further, in slight cases of respiratory paralysis the limited assistance of the cuirass may be sufficient to tide the patient over a short period of respiratory difficulty.

Our clinical experience of the use of these cuirass respirators is limited, but we have used them both on children and adults, on patients in the acute stage, and on convalescent patients requiring only periodic or partial assistance with respiration. We have found that, though they are not as yet able to take the place of the cabinet-type respirator, they are certainly useful in selected cases.

Summary

The advantages and disadvantages of the cuirass type of respirator are reported.

The Monaghan and KIFA types are described.

Such machines are useful in certain cases of respiratory paralysis, particularly in the convalescent stage, where the full use of a cabinet respirator has become unnecessary and burdensome.

Further improvements in design may be hoped for.

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NEUROLOGICAL COMPLICATIONS ASSOCIATED WITH INSECTICIDES AND FUNGICIDES

BY

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This paper describes several cases of polyneuritis that occurred in men and women who had been using a certain insecticide preparation for treating woodworm. The insecticide is a proprietary preparation, the exact formulation of which is unknown, but which contains *ortho*- and *para*-dichlorobenzene, D.D.T., and pentachlorophenol.

Cases 1 to 5 had a peripheral neuritis, and Case 2 had, in addition, a retrobulbar neuritis. In Cases 6 and 7 retrobulbar neuritis developed a few days after using the insecticide.

Cases 1 and 2

Case 1.—A butcher, aged 42, attended the out-patient department in December, 1949, complaining of tingling in the feet and hands for the past nine months. Previous illnesses were irrelevant and there was no family history of polyneuritis. On examination a slight sensory loss in the fingers and toes to pin-prick and cotton-wool was noted, but otherwise there was no abnormal physical sign. His blood count was normal and there were no signs of anaemia. A test meal showed a normal acid curve. He was treated with vitamin B₁ without any improvement, and three months later he brought his wife to hospital with the same symptoms.

Case 2.—The wife of Case 1, aged 39, had begun to notice symptoms of tingling in both hands and feet, with slight instability in walking and a feeling of tightness round the waist and paraesthesiae in this area. Her symptoms had developed in November, 1949—that is, eight months after those of her husband—and were generally more severe. From January to May, 1949, she was treated with vitamin B₁ and a course of dimercaprol without improvement.

They were admitted to hospital and investigations were repeated on their acid curves and blood counts without any abnormality. Examination of their food and water supply for lead and arsenic revealed nothing abnormal. A pyruvate-tolerance test showed abnormal tolerance (see Table). In

Pyruvate Tolerance Test

	Fasting	After 60 Minutes	After 90 Minutes
Case 1	0.69 mg.	0.93 mg.	0.97 mg.
" 2	0.82 "	1.43 "	2.04 "

Expressed as mg. of pyruvic acid per 100 ml. of blood. Maximum normal values do not exceed 1.4 mg./100 ml. Thus, only Case 2 is definitely abnormal.