feature was the confidence shown by the patients in the machine and the immediate relief of respiratory distress, apprehension, and agitation.

The machine appears to have many advantages. The simplicity of its operation appealed to the nursing staff. It is electrically powered and mains-operated, and consequently not dependent on cylinder-gas supplies for operation. The effective triggering mechanism allows the machine to assist the patient's spontaneous efforts, yet the machine takes over completely during apnoea. It is claimed that, being a volume-limited respirator, it can compensate for changes in compliance by automatically altering the delivered pressure to maintain a pre-set tidal volume. Inspiratory and expiratory times are adjustable independently of each other. Tidal volumes as low as 20 ml. can be delivered, so that the respirator can be used to ventilate children and infants artificially. The monitoring system sets off an alarm buzzer on mechanical failure of the respirator and on pressure build-up or leakage in the circuit. It also operates if expiration or inspiration is unduly prolonged, in which event the electrical power to the respirator is automatically cut off.

The disadvantages we encountered were few. The degree of humidification is not controllable. During suctioning of the trachea the drop in pressure too easily sets off the alarm buzzer. No battery operation or hand-pumping facilities are available if the mains power supply fails. However, a hand-operated bellows can be easily connected to the side tube of

the tracheostomy connexion. The respirator does not provide negative pressure during the expiratory phase.

Summary

Patients in partial respiratory paralysis can be artificially ventilated by using a patient-triggered respirator.

The details of such a respirator used by us are described.

Case reports are presented of two patients who were artificially ventilated with this machine; one a patient with paralytic poliomyelitis and the other with polyneuritis who had partial respiratory paralysis. Both these patients were first tried without success on respirators providing controlled ventilation alone.

The effectiveness of the respirator used and its advantages and disadvantages are discussed.

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Rapid Estimation of Urea in Whole Blood with Urastrat

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Urastrat (Warner; Urograph in the U.S.A.) is a commercial "stick" test for the estimation of urea in a sample of serum or plasma.

The stick is dipped into 0.2 ml. of serum for 30 minutes. The serum passes up the stick by capillary action and the urease in the stick reacts with the serum urea to produce ammonia; this diffuses further up the stick and reacts with bromo-cresol green to produce a blue coloured column. The height of this column is proportional to the serum-urea concentration: the column height can be measured, or be compared with the manufacturer's chart.

A drawback to Urastrat is that it cannot be used on whole blood. The viscosity of the sample is critical in this procedure, and the viscosity of blood is different from that of plasma; also the erythrocytes impede capillary action. This paper describes a satisfactory modification to enable whole-blood urea to be estimated with Urastrat.

Method

Reagents.—(1) Urastrat. (2) Sedimenting solution: to one 5-ml.-size phial of phytohaemagglutinin M(Difco) is added 5 ml. of a 1% solution of dextran of molecular weight approxi-

mately 500,000 (dextran 500 (Pharmacia) was used) in isotonic saline, 200 I.U. of lithium heparin, and 0.1 ml. of 1:1,000 merthiolate. This solution has the viscosity of plasma (1.7 approximately, as measured with an Ostwald viscometer). It is stable in the refrigerator for two to three months.

Procedure.—0.1 ml. of the sedimenting solution is put into a tube measuring 10 by 7.5 mm., and 0.1 ml. of whole blood added. The blood may be fresh venous or capillary, heparinized, oxalated, or from sequestrene bottles. The tube is gently "flicked" to ensure thorough mixing and is then left undisturbed for 10 minutes. During this time rapid agglutination takes place and the erythrocytes form a firm "button" at the bottom of the tube, leaving a clear supernatant. Urastrat is gently lowered into the mixture and the reaction is allowed to proceed at room temperature for 30 minutes $\pm$ 1 minute, in the usual way. When the reaction is complete the urea concentration is calculated by comparison with the maker's chart. As Urastrat is manufactured in the U.S.A. the chart is calibrated in blood urea nitrogen. It is therefore necessary to multiply the figure corresponding to the height of the column by 4 to calculate the true blood urea—multiply by 2 to convert from blood urea nitrogen to blood urea (mg./100 ml.) and by 2 because of the 1+1 dilution of the original blood. The sedimenting solution can also be used to dilute plasma of high urea concentration. The manufacturers recommend Versatol (a control serum of known urea concentration) for this purpose, but this entails unnecessary calculation.

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Results

The calibration of Urastrat was confirmed by the use of standard solutions of urea made up in the sedimenting solution. It is desirable to assay one or more controls (using standard solutions of urea in dextran) with each batch of analyses. The Table shows a comparison of urea analyses on blood and plasma by different methods. The Chart shows a comparison of blood-urea estimations by this procedure and by the standard AutoAnalyzer method, which is not a urease method but depends on the colour given by urea with diacetyl monoxime.

Comparison of Blood Urea Analyses by Different Methods

AutoAnalyzer	Urastrat and Undiluted Plasma	Urastrat, Plasma, and Sedimenting Solution	Urastrat, Whole Blood, and Sedimenting Solution	Urastrat, Plasma, and Versatol
23	20	< 30	< 30	25
40	45	40	40	55
150	> 150	160	160	160
380	> 150	360	360	370

Comparison of blood urea (mg./100 ml.) as measured by AutoAnalyzer and estimated by modified Urastrat procedure (see text).

It can be seen that this modified method gives a result for blood urea comparable with that of a standard analytical method to within $\pm 20\%$. A just-visible blue colour occurs with a blood urea of about 30 mg./100 ml., and maximum height of coloured column occurs with a blood urea of 300 mg./100 ml. If a Urastrat blood-urea test is to be done when a higher result is expected then an initial dilution of 1 + 3 is suitable.

Discussion

In order to use whole blood with Urastrat it was necessary to find a dilution reagent that caused rapid and complete agglutination of erythrocytes, that had the same viscosity as plasma, and that had no effect on the chemical reaction. The following agents were investigated: (1) Fibrinogen (Armour): this produced only a weak agglutination at a concentration giving correct viscosity. (2) Polyvidone: although sedimentation was rapid, agglutination was poor and the erythrocytes were resuspended on adding the Urastrat stick. (3) Dextran: this gave very rapid sedimentation but poor agglutination. (4) Phytohaemagglutinin M(Difco): both sedimentation and agglutination were excellent, but the viscosity at suitable concentration was approximately 1.0.

Accordingly, dextran and phytohaemagglutinin were mixed as described, with the addition of heparin to act as an anti-coagulant for fresh blood, and merthiolate as a preservative.

Comparisons have been made of serum urea estimated with Urastrat and with standard laboratory methods. Logan (1963) measured the height of the blue column (which in our opinion introduces a spurious accuracy) and found that the Urastrat method was not accurate (confidence limits $\pm 27\%$). Grabener (1963) found Urastrat of value for the diagnosis of azotaemia, with a similar scatter of results to those presented here: he diluted serum of high values by adding normal serum. Tárnoky (1964) also found that direct reading from the chart was better than calculation by measurement of the column height: he recommends its use as an emergency procedure.

We consider that Urastrat is excellent for emergency use. Employment of the dextran-phytohaemagglutinin-heparin sedimenting solution increases the range of the test.

With this sedimenting solution, and using the method described, a blood-urea analysis can be done at the bedside, in the out-patient department, in the casualty department, or in the surgery, the result being obtained in 45 minutes. The cost in reagents per 50 tests was: Urastrat sticks 50s., sedimenting solution 40s. 7d.

Summary

A mixed solution of dextran, phytohaemagglutinin, and heparin, when added in equal proportions to whole blood, causes rapid firm agglutination of erythrocytes.

Urastrat can be used with this mixture as with serum, and rapid blood-urea estimations are possible with an accuracy of $\pm 20\%$ within the range 30–500 mg./100 ml.

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