INCUBATOR FOR INFANTS UNDERGOING SURGERY*

BY

P. P. RICKHAM and JEAN M. JENKINS

From the Alder Hey Children's Hospital, Liverpool

For the last six years all infants operated upon in the Neonatal Surgical Unit at Alder Hey Children's Hospital have been nursed in incubators during the immediate pre- and post-operative period. The infants are nursed at a constant temperature of 85° F. (29.5° C.). Draughts and sudden changes in temperature are thus prevented and the infants can be nursed naked. The rate and type of respiration can be constantly watched, the abdomen can always be inspected and the child can move freely and unrestrained by clothing. If necessary he can be nursed in a definite concentration of oxygen, which is important in cases with pulmonary collapse, pneumonia or abdominal distension. The infants are nursed in an atmosphere of 100% humidity, which, in our experience, is the most important single factor in the prevention of post-operative pulmonary complications, as it liquifies the sticky pulmonary secretion, thus preventing blocking of the bronchi and pulmonary collapse (Rickham, 1957a).

It has been shown by O'Brien, Hansen and Smith (1954) that newborn infants nursed under the atmospheric conditions described above have an insensible water loss less than half that of infants nursed at room temperature and humidity. The high atmospheric humidity not only reduces water loss to a marked degree, but it also makes any metabolic balance studies which may be carried out much more accurate, since at a temperature of 88° F. (31° C.) and 100% humidity the daily water loss remains constant at 13.8 g. per kg. of body weight (Rickham, 1957b).

Nursing in incubators is even more important for premature infants undergoing surgery than for full term babies. Premature infants stand a fall in body temperature very badly and require to be nursed at incubator temperatures of between 90° and 95° F. (32° to 35° C.). Any marked drop in body temperature in premature infants undergoing surgery predisposes to sclerema, the development of which may prove fatal (Rickham, 1957c).

Experience gained in the nursing of surgical newborn babies during the last 10 years has shown that the incubators in use for premature infants in medical paediatric practice are not very suitable for newborn babies undergoing operations. These children should be brought to the operation table in an incubator and should after operation be lifted off the table and returned to the incubator. Procedures such as examinations, obtaining blood samples, setting up intravenous infusions, sucking out the pharynx, passing stomach tubes, endotracheal intubation and artificial respiration should be carried out in the incubator with the minimum disturbance of the infant. An incubator which is employed to transport babies to and from the operating theatre must be provided with oxygen supply and drip stands.

A number of infants admitted to the unit for operation have been submitted to balance studies necessitating careful intake and output estimations and accurate daily weighing. Considerable disturbance was caused to the babies by these investigations when ordinary incubators were in use.

It was decided to modify a standard incubator so that it would fulfil the requirements mentioned above. The Mark IV incubator made by Messrs. Oxygenaire, Ltd., London, was chosen for this purpose. The modified incubator has now been in use for several months and has proved very satisfactory.

The Mark IV incubator contains no electric motor, air circulation being produced by thermal convection. The absence of a motor eliminates many causes of mechanical breakdowns. Apart from the usual humidifying mechanism, a built-in atomizer (Fig. 1) permits the raising of the atmospheric humidity to 100% within a few minutes. Warm dry air circulates behind the front panel preventing misting due to humidity and allowing the infant to be watched at all times. Even with an oxygen inflow of 6 litres per minute the oxygen concentration in the incubator cannot rise above 35%; with the usual practice of allowing 1½ litres per minute, the concentration is 26%. There is a slight positive

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FIG. 1.—Rear view showing atomizer in centre and receptacle for urine on left side. Note adjustable drip stands and oxygen cylinder carrier.

FIG. 2.—Front view showing large sliding doors. Plastic cradle is suspended from weighing machine. Note metal buckles at edge of plastic cradle.

FIG. 3.—Infant nursed in semi-sitting position on adjustable backrest.

pressure in the incubator, so that opening it does not cause air to rush in.

In the modified surgical model the front panel is composed of two horizontally sliding doors, which when open give the widest possible access. The groove in which the sliding doors run is just below the level of the tray on which the infant lies so that the infant can be handled without discomfort to the nurse's arms.

The child is nursed on a plastic, radio-translucent cradle, which can be tilted into Trendelenburg's and anti-Trendelenburg's positions. Six metal buckles are fixed along the edge of the cradle and it is thus possible to immobilize the baby in various positions by tying the limbs to the buckles (Fig. 2). In order to nurse the infant in a semi-sitting position, which may be necessary for such conditions as hiatus hernia, an adjustable backrest is incorporated (Fig. 3). Radiographic pictures are taken by placing the photographic plate underneath the plastic cradle on a metal tray which can be pulled out through a hinged panel situated on the left side of the incubator. In order to facilitate accurate placing of the cassette beneath the infant, the metal tray is divided into numbered squares corresponding to numbers painted on the side of the plastic cradle. The cassette is fixed securely to the tray with the aid of a metal bar attached to two rubber suction pads (Fig. 4).

On the right side of the incubator there is a hinged

FIG. 4.—Left side panel. Metal tray pulled out and radiographic cassette fixed in position by metal band suction pads. Note drip feed aperture.

panel 6 in. in height (Fig. 5). With this flap open, various procedures can be performed. On admission the infant is placed into the incubator with his feet pointing towards this panel. When an intravenous infusion is set up in the ankle the child's feet are pulled out of the incubator through this opening (Fig. 6).

FIG. 5.—Right side panel showing large hinged flaps with deep slots guarded by plates cut into upper border.

FIG. 6.—Intravenous infusion is set up in internal saphenous vein at right ankle.

FIG. 7.—Endotracheal intubation.

FIG. 8.—Artificial respiration given by endotracheal intubation.

Following the operation the infant is put back into the incubator with the head pointing towards the flap. Procedures such as emergency intubation (Fig. 7) and putting up of scalp vein infusions are thus easily carried out. Prolonged positive pressure artificial respiration is facilitated by passing the oxygen tubes through the deep slots cut into the hinged flap (Fig. 8).

There are four holes for suction drainage tubes along the lower edge of each side panel. The urine of male infants is collected by fixing a piece of Paul's tubing around the penis and passing it through an opening in the metal panel at the back of the incubator to a receiver.

The incubator is provided with two adjustable drip-stands fixed one to either side and an oxygen

cylinder carrier slung beneath the bottom shelf (Fig. 1).

The infant can be weighed in the incubator without much disturbance by suspending the cradle on which he lies from an accurate weighing machine placed on top of the upper lid (Fig. 2).

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