Original Articles

A Follow-Up of the Survivors of Mechanical Ventilation in a Paediatric Intensive Care Unit

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Accepted: 9 October 1981

Abstract. Fifty-eight long-term survivors of mechanical ventilation have been traced and examined for evidence of auditory, visual, behavioural, developmental and central nervous system abnormalities. There were four children with serious neurological or intellectual handicaps, the causes of which did not seem to be related to deficiencies of their ventilator treatment but rather to events preceding ventilation or to the disease which had necessitated ventilation. There were an additional eight children who may have some intellectual damage. The occurrence of convulsions or hypoxic episodes during or preceding the period of treatment was significantly more common among the 12 children with a poor outcome, than those with a good outcome.

Key words: Ventilation — Intermittent positive pressure — Intensive care — Infants — Neonates — Brain damage

Methods of Respiratory Support and Ventilation

The criteria for starting mechanical ventilation in this heterogeneous group in the course of 7 years have varied considerably. In some cases this depended on clinical indices, but most often the decision was influenced by deteriorating blood gas values. The techniques of respiratory support and ventilation have changed and evolved during this time and have been described in greater detail elsewhere [12–14].

In many instances mechanical ventilation was preceded by other methods of respiratory support, e.g. oxygen enrichment of the inspired gases, chest physiotherapy, or endotracheal intubation and suction with or without continuous positive airways pressure (CPAP). In some cases, where respiratory assistance was required post-operatively, ventilation was continued from the time that surgery was completed. All mechanical ventilation in the intensive care unit was carried out via nasal endotracheal tubes except, on rare occasions, when this was impossible, and then oral endotracheal or tracheostomy tubes were used. All the long-term endotracheal tubes were 'Portex' PVC 'Blue Line' tubes and the tracheostomy tubes were the Aberdeen Great Ormond Street pattern made by 'Franklyn'.

Nasal intubation was nearly always preceded by a brief period of oral intubation with a latex armoured tube to control the airway. The nasal tube was cut to length, for small infants, by reference to Coldiron's chart relating head circumference to the distance between the nares and the mid-trachea [15]. The endotracheal tube was then connected by means of a 7-mm Penlon 'Oxford' connector to a Newcastle breathing circuit [12] which was attached to the infant's head by an arrangement of sticking-plaster and plastic adhesive tape [12] which provides an extremely secure method of tube fixation. In the cases

Introduction

The results of mechanical ventilation in infancy have been reported in several studies [1–11] but most investigations have been related to the treatment of neonates suffering from the respiratory distress syndrome (RDS). The results of using mechanical ventilation in treating a wider range of diseases and age groups have been reported less frequently [8].

This paper presents the results of a follow-up survey of the survivors of mechanical ventilation who were treated in a paediatric intensive care unit over a period of 7 years.
which required a tracheostomy the same breathing circuit was used, connected by means of a polycarbonate tapered fitting [16].

In most cases the Newcastle Infant Ventilator [12, 13] was used to provide intermittent positive pressure ventilation (IPPV). This is a fluid logic driven ventilator which is able to deliver a constant volume of sterile, completely humidified gas with a known oxygen content. On a few occasions a T-occluder system was used.

The duration of IPPV in the group of survivors varied from three hours to seven weeks, with a mean time of 5 days. During this time the level of ventilation was assessed using capillary blood gas samples and, more recently, the level of oxygenation has been monitored using skin PO2 electrodes. Tracheal aspirates were cultured three times a week and great care taken not to contaminate the endotracheal tube during suction. All the small infants who required ventilation were nursed in IMI Infant Care Centres (Becton Dickinson UK, Ltd.) which incorporate overhead infra-red heaters.

The decision to wean the patient from IPPV was made on clinical, radiological and biochemical grounds and at this stage the breathing circuit was connected to a large flow of gas of the same quality as before, usually with the addition of various levels of CPAP. Progress was assessed clinically and by changes in serial blood gas values. At no time was the endotracheal tube removed before the infant had demonstrated an ability to breathe reliably for several hours. This allowed mechanical ventilation to be restarted, if necessary, without delay. After extubation the infant was often placed in a head-box to provide increased oxygen and humidity in the inspired gas.

**Patients**

The authors' intensive care unit is a referral centre for neonatal and paediatric surgery, excluding cardiac surgery. It opened in September 1971 and takes a high proportion of surgical cases but it also admits some medical referrals.

During the seven years up to September 1978, there were 966 admissions to the intensive care unit, including some re-admissions. The numbers and types of cases are shown in Table 1, together with the numbers dying in each category. 132 infants, whose ages ranged from a few hours to 7 years, were ventilated. Four children were ventilated during two separate admissions, so that a total of 136 episodes of ventilation were involved. At the start of ventilation, 111 (81%) of the children were neonates. The numbers of children ventilated each year (September to September) varied from 23 in the second year to 15 in the sixth year and the yearly mortality rate varied from 87% in the first year to 27% in the sixth year (Fig. 1).

This improvement occurred entirely within the neonatal group.

Sixty-six children were discharged from hospital after being ventilated but eight of these subsequently died, leaving 58 long-term survivors, and these cases are the subjects of this follow-up survey.

All the 58 long-term survivors were traced and 48 were examined in a special clinic; the remaining 10, most of whom had moved away from the region, were

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**Table 1. Numbers and types of admissions to the intensive care unit 1971–1978**

<table>
<thead>
<tr>
<th>Diagnosis</th>
<th>Numbers in group</th>
<th>Deaths</th>
<th>Ventilated</th>
<th>Deaths</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tracheo-oesoph. Fistula</td>
<td>73 (8%)</td>
<td>21 (29%)</td>
<td>20 (27%)</td>
<td>11 (55%)</td>
</tr>
<tr>
<td>Cong. Diaph. Hernia</td>
<td>24 (2%)</td>
<td>13 (54%)</td>
<td>19 (79%)</td>
<td>11 (58%)</td>
</tr>
<tr>
<td>Exomphalos</td>
<td>34 (6%)</td>
<td>15 (28%)</td>
<td>21 (39%)</td>
<td>9 (43%)</td>
</tr>
<tr>
<td>Intestinal obstruction</td>
<td>298 (31%)</td>
<td>48 (16%)</td>
<td>26 (9%)</td>
<td>17 (65%)</td>
</tr>
<tr>
<td>Miscellaneous surgical</td>
<td>420 (43%)</td>
<td>34 (8%)</td>
<td>18 (4%)</td>
<td>10 (56%)</td>
</tr>
<tr>
<td>Medical non-respiratory</td>
<td>15 (2%)</td>
<td>4 (27%)</td>
<td>2 (13%)</td>
<td>1 (50%)</td>
</tr>
<tr>
<td>Medical respiratory (RDS)</td>
<td>11 (1%)</td>
<td>4 (36%)</td>
<td>10 (91%)</td>
<td>4 (40%)</td>
</tr>
<tr>
<td>Medical respiratory (non-RDS)</td>
<td>71 (7%)</td>
<td>3 (4%)</td>
<td>20 (28%)</td>
<td>7 (35%)</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>966</td>
<td>142 (15%)</td>
<td>136 (14%)</td>
<td>70 (51%)</td>
</tr>
</tbody>
</table>