Twelve Years' Experience With Bronchopulmonary Dysplasia

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ABSTRACT. A retrospective study of 299 successive infants who were ventilated for respiratory distress syndrome (RDS) showed that 62 (21%) developed radiographic stage IV bronchopulmonary dysplasia (BPD). The largest, most mature, and least ill infants tended to survive without developing BPD; the smallest, least mature, and most ill infants tended to die without developing BPD. The patients who developed BPD tended to be intermediate in terms of weight, maturity, and severity of disease; they required longer exposures to elevated oxygen and assisted ventilation than patients who did not develop BPD. The data suggest that in addition to varying individual susceptibility (primarily degree of immaturity and initial severity of disease), elevated oxygen is more important than mechanical ventilation in the pathogenesis of BPD. Pediatrics, 59:839-846, 1977, BRONCHOPULMONARY SYNDROME, RESPIRATORY DISTRESS SYNDROME, RESPIRATORY THERAPY, PULMONARY DISEASE, PULMONARY OXYGEN TOXICITY.

In 1967 Northway, Rosan, and Porter described a chronic lung disease that appeared in certain infants with respiratory distress syndrome (RDS) who were treated with mechanical ventilation and elevated inspired oxygen. This disease, which was called bronchopulmonary dysplasia, has subsequently been observed by many investigators and described under a variety of names, including bronchopulmonary dysplasia, pulmonary fibroplasia, chronic pulmonary disease, respirator lung disease, and other descriptive terms. The majority of cases described are similar to those that were described initially: newborns with RDS who require assisted ventilation and high concentration of inspired oxygen. Exceptions have been reported, however, with changes that suggest bronchopulmonary dysplasia (radiographically or pathologically or both) in infants not exposed to elevated oxygen tension for extended times in infants not subjected to mechanical ventilation, and in infants with underlying diseases other than RDS.

The pathogenesis of bronchopulmonary dysplasia (BPD) is a matter of dispute, although there is widespread agreement that iatrogenic factors, specifically endotracheal intubation, mechanical ventilation, and elevated oxygen, play an important role. The relative importance of each of these is uncertain; some studies suggest that elevated oxygen is implicated more strongly than mechanical ventilation and some suggest the opposite. These discrepancies suggest that factors additional to mechanical ventilation and oxygen are involved in the occurrence of BPD. Such factors could include degree of maturity and severity of underlying disease, as suggested by Bomsel.

This retrospective study of a large and partially

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homogeneous group of infants was done to answer these questions of pathogenesis, and specifically, the contributions of individual susceptibility and factors related to respiratory support.

**PATIENTS AND METHODS**

**Criteria for Selection**

Patients selected for study included all infants born during the 12-year period between January 1962 through December 1973 who had RDS as their primary diagnosis by both clinical and radiographic standards, and who required mechanical ventilatory assistance with endotracheal tube in place for at least 24 hours. The techniques of assisted ventilation were intermittent positive pressure ventilation (IPPV), with and without positive end-expiratory pressure, and continuous positive airway pressure (CPAP). Mask ventilation and negative pressure ventilation (each used with only a few patients during this time period) were not counted as mechanical ventilation.

**Chart Review**

The medical histories, physical examinations, and face sheets of these infants were reviewed to ensure that the primary diagnosis was RDS, which was generally manifested by expiratory grunting, nasal flaring, subternal and intercostal retracting, and hypoxia in room air. Patients with other causes of neonatal respiratory distress were excluded.

The items listed in Tables I-V also were recorded from the charts when available. Manual bagging when an endotracheal tube was in place was counted as mechanical ventilation. Peak ventilatory pressure was defined as the highest ventilator pressure setting used for a duration of at least an hour. The relatively large size of the middle oxygen concentration range (40% to 79%) was necessitated by practical considerations. Survival duration was noted to a cutoff date of May 1, 1975.

**Radiographic Review**

Of the patients who met the aforementioned criteria, the original chest radiographs were available for 213. The radiographs of 53 patients were available on microfilm; these were examined using a microfilm viewer (Recordax Motomatic MPG-GL). No photographic records were available for 33 patients (radiographic reports were reviewed for each of these).

The initial film was examined to confirm the radiographic diagnosis of RDS, and the radiographic severity of RDS was graded on a scale of increasing abnormality from zero to five. The time at which the initial film was made varied from a few minutes of life to 24 hours; most were done between one and four hours of age.

The radiographic stage of BPD (I through IV) was noted for each patient using the criteria of Northway et al. For this study a patient was scored as having BPD if he exhibited characteristic radiographic changes and survived 30 days or more (stage IV BPD). Because of the radiographic similarity between the later stages of BPD and the Wilson-Mikity syndrome, the radiographic (and clinical) course of each patient was scrutinized to exclude such cases.

**Statistical Methods**

The statistical methods used were analysis of variance to evaluate the relative effects of ventilation and oxygenation, and the chi-square and the two-tailed Student t test to examine differences between groups. A probability value of $P < .05$ was accepted as significant.

**RESULTS**

Three hundred patients met the criteria of this study; the records for one patient were lost, which left 299 patients. Certain characteristics of the study group are shown in Table I.

The population of the study group by year is shown in the left side of Table II. A marked increase in total patients was noted over the latter three years, particularly during 1973. Review of nursery censuses and practices indicates that this increase was related both to an increase in number of patients and to changes in criteria for placing infants on assisted ventilation. These changes occurred gradually after October 1970 when CPAP was introduced. Increased liberality in administering assisted ventilation with CPAP appears to have created a degree of inhomoge-
TABLE II
Survival by Year of Total Study Group and of Patients with Bronchopulmonary Dysplasia Stage IV

<table>
<thead>
<tr>
<th>Year of Birth</th>
<th>All Patients Studied</th>
<th>Cases of BPD (IV)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Total</td>
<td>Living</td>
</tr>
<tr>
<td>1962</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>1963</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>1964</td>
<td>13</td>
<td>6</td>
</tr>
<tr>
<td>1965</td>
<td>23</td>
<td>7</td>
</tr>
<tr>
<td>1966</td>
<td>20</td>
<td>3</td>
</tr>
<tr>
<td>1967</td>
<td>22</td>
<td>8</td>
</tr>
<tr>
<td>1968</td>
<td>16</td>
<td>10</td>
</tr>
<tr>
<td>1969</td>
<td>21</td>
<td>8</td>
</tr>
<tr>
<td>1970</td>
<td>28</td>
<td>9</td>
</tr>
<tr>
<td>1971</td>
<td>41</td>
<td>21</td>
</tr>
<tr>
<td>1972</td>
<td>42</td>
<td>20</td>
</tr>
<tr>
<td>1973</td>
<td>11</td>
<td>18</td>
</tr>
<tr>
<td>Total</td>
<td>299</td>
<td>141</td>
</tr>
</tbody>
</table>

neity in the last three years of the study group.

Sixty-two patients (21% of the study group) developed BPD. Of these, 38 survived and 24 died; 19 died during their initial hospitalization at 30 to 226 days of age. Five died of cardiopulmonary disease after discharge at 100 to 1,237 days of age. The mean age at death was 180 days.

The mean age of surviving patients with BPD is 2,055 days (range 563 to 2,849). The mean age of patients surviving without BPD is 1,411 days (range 498 to 4,599). Patients who died without developing BPD survived an average of seven days (range 1 to 96).

The number of BPD cases per year (Table II) did not vary decidedly, although the fractional incidence among ventilated infants apparently decreased in 1973.

Patients were separated into three groups: patients who survived without BPD, patients with BPD, and patients who died without BPD. Living and dead patients with BPD were grouped together because they did not differ significantly, except for the respiratory factors shown in Table III.

The most frequent complications of maternity, labor, and delivery are shown in Table IV. Chi-square tests showed that none of these factors was predictive of survival or development of BPD.

Table V shows the means, ranges, and standard deviations of the clinical and respiratory variables. The three groups of patients differ significantly in regard to most variables. Values of several variables were not recorded for some patients.

In examining peak ventilator pressure, it should be noted that a volume-cycled respirator was used intermittently with 11 patients; when this apparatus was used the pressures reached are unknown. Twelve patients were ventilated with CPAP alone; of these only one patient developed BPD.

TABLE III
Significant Differences Between Surviving and Dead Patients with BPD

<table>
<thead>
<tr>
<th>Variable</th>
<th>Mean Value, Range, Standard Deviation (σ)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Surviving (38 Patients)</td>
</tr>
<tr>
<td>Duration of endotracheal intubation (hr)</td>
<td>443</td>
</tr>
<tr>
<td></td>
<td>93–2,345</td>
</tr>
<tr>
<td></td>
<td>σ = 438</td>
</tr>
<tr>
<td>Duration of assisted ventilation (hr)</td>
<td>395*</td>
</tr>
<tr>
<td></td>
<td>80–2,012</td>
</tr>
<tr>
<td></td>
<td>σ = 400</td>
</tr>
<tr>
<td>Duration of exposure to 80% to 100% oxygen (hr)</td>
<td>100</td>
</tr>
<tr>
<td></td>
<td>0–623</td>
</tr>
<tr>
<td></td>
<td>σ = 125</td>
</tr>
<tr>
<td>Duration of exposure to 40% to 79% oxygen (hr)</td>
<td>346</td>
</tr>
<tr>
<td></td>
<td>44–973</td>
</tr>
<tr>
<td></td>
<td>σ = 263</td>
</tr>
</tbody>
</table>

*Data could not be determined for one patient.
TABLE IV
MAJOR COMPLICATIONS OF PREGNANCY, LABOR, AND DELIVERY (NUMBER OF PATIENTS)

<table>
<thead>
<tr>
<th>Complication</th>
<th>Survivors Without BPD</th>
<th>Patients With BPD</th>
<th>Patients Who Died Without BPD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maternal diabetes mellitus</td>
<td>5</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Family history of diabetes</td>
<td>2</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>History of previous premature delivery or spontaneous abortion</td>
<td>16</td>
<td>14</td>
<td>24</td>
</tr>
<tr>
<td>Rh factor sensitivity with rising maternal titers</td>
<td>4</td>
<td>3</td>
<td>5</td>
</tr>
<tr>
<td>Toxemia or pre-eclampsia</td>
<td>4</td>
<td>0</td>
<td>4</td>
</tr>
<tr>
<td>Maternal fever at time of delivery</td>
<td>4</td>
<td>3</td>
<td>7</td>
</tr>
<tr>
<td>Premature (&gt; 24 hr) rupture of membranes</td>
<td>7</td>
<td>7</td>
<td>15</td>
</tr>
<tr>
<td>Abruptio placentae, partial or complete</td>
<td>9</td>
<td>8</td>
<td>19</td>
</tr>
<tr>
<td>Placenta Praevia</td>
<td>6</td>
<td>10</td>
<td>11</td>
</tr>
<tr>
<td>Cesarean delivery</td>
<td>29</td>
<td>24</td>
<td>33</td>
</tr>
<tr>
<td>Breech delivery</td>
<td>9</td>
<td>4</td>
<td>22</td>
</tr>
</tbody>
</table>

The respiratory data as presented permit no assessment of the relative effects of the respiratory variables (intubation, ventilation, and oxygen) on the development of BPD. Analysis of variance showed all three factors to be significant in predicting occurrence of the disease. An analysis of variance that deletes patients who died before three days of age (the earliest changes suggesting chronic disease never appeared before three days) showed that BPD was predicted by total duration of oxygen above 40%, and not by duration of intubation or assisted ventilation.

Infants who developed BPD without lengthy exposure to high oxygen concentration were examined as a group. Fourteen infants developed BPD after less than 24 hours of 80% to 100% oxygen; four received no oxygen in this range. These patients were more numerous in the latter years, with 9 of the 14 born in 1972 and 1973. In comparison with the 48 other patients with BPD, the only significant differences were lower birth weights (mean 1,332 gm, with mean of 1,963 gm for the other BPD patients; \( P < .001 \)) and gestational ages (mean 30.7 weeks as compared with 33.7 weeks for the other BPD patients; \( P < .001 \)).

Efforts to identify exact time-concentration relationships between oxygen, ventilation, and the development of BPD were unsuccessful because of wide patient variability and difficulty in identifying radiographically and clinically exactly when BPD appeared.

DISCUSSION

Two aspects of the pathogenesis of BPD are discussed in this study: the contributions of individual susceptibility and of iatrogenic factors, specifically oxygen and assisted ventilation.

Individual Susceptibility

Observations on factors that could influence individual susceptibility to the development of BPD have been scanty. Philip\(^7\) suggested that relatively immature newborns may be more apt to develop BPD and presented cases that supported this contention. Banerjee et al.,\(^11\) on the other hand, found no association between gestational age and the development of chronic lung changes. In the larger series of Bomsel,\(^3\) patients with lower birth weights and gestational ages had an increased incidence of BPD, and the incidence in survivors increased with radiographically more severe RDS.

In the current study, three groups of patients were examined: patients who survived without developing BPD, patients who developed BPD, and patients who died without developing BPD. On several clinical variables these three groups seemed to form a spectrum. The patients who survived without BPD tended to be larger and
<table>
<thead>
<tr>
<th>Variable</th>
<th>A—Survivors Without BPD (103)</th>
<th>B—Patients With BPD (62)</th>
<th>C—Patients Who Died Without BPD (134)</th>
<th>Significant Differences</th>
<th>P &lt; .05</th>
<th>NS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Birth weight (gm)</td>
<td>2,136</td>
<td>1,821</td>
<td>1,573</td>
<td>A × B</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(680–4,026)</td>
<td>(822–3,473)</td>
<td>(652–3,969)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>σ= 674</td>
<td>σ= 590</td>
<td>σ= 567</td>
<td>A × C</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Estimated gestational age (wk)</td>
<td>34.3</td>
<td>33.0</td>
<td>31.4*</td>
<td>A × B</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>24–40</td>
<td>25–40</td>
<td>24–40</td>
<td>A × B</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>σ= 3.3</td>
<td>σ= 3.1</td>
<td>σ= 3.1</td>
<td>B × C</td>
<td></td>
<td></td>
</tr>
<tr>
<td>One-minute Apgar score (units 0-10)</td>
<td>6.3†</td>
<td>5.9‡</td>
<td>5.0§</td>
<td>A × C A × B</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>1–10</td>
<td>0–9</td>
<td>0–10</td>
<td>B × C</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>σ= 2.4</td>
<td>σ= 2.4</td>
<td>σ= 2.7</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>RDS Severity on first radiograph (units 0-5)</td>
<td>2.3</td>
<td></td>
<td></td>
<td>2.9</td>
<td>3.2</td>
<td>A × B</td>
</tr>
<tr>
<td></td>
<td>0–5</td>
<td>1–5</td>
<td>1–5</td>
<td>A × C</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>σ= 1.0</td>
<td>σ= 0.9</td>
<td>σ= 1.3</td>
<td>B × C</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Age assisted ventilation begun (hr)</td>
<td>33.1</td>
<td>31.7</td>
<td>17.3</td>
<td>A × C A × B</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>0.6–224</td>
<td>0.1–108</td>
<td>0–147</td>
<td>B × C</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>σ= 26.3</td>
<td>σ= 23.3</td>
<td>σ= 20.6</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Peak ventilator pressure (cm water)</td>
<td>30.0†</td>
<td>37.9#</td>
<td>42.9**</td>
<td>A × B</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>8–55</td>
<td>14–60</td>
<td>24–80</td>
<td>A × C</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>σ= 10.1</td>
<td>σ= 7.9</td>
<td>σ= 8.7</td>
<td>B × C</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Duration of endotracheal intubation (hr)</td>
<td>141.7</td>
<td>546.8</td>
<td>141.1</td>
<td>A × B B × C</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>28–861</td>
<td>93–3,245</td>
<td>24–771</td>
<td>B × C</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>σ= 125</td>
<td>σ= 427</td>
<td>σ= 137.8</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Duration of assisted ventilation (hr)</td>
<td>126.9</td>
<td>512.3†</td>
<td>137.8</td>
<td>A × B A × C</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>25–821</td>
<td>80–2,012</td>
<td>24–748</td>
<td>B × C</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>σ= 121</td>
<td>σ= 409</td>
<td>σ= 132</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Duration of 80% to 100% oxygen (hr)</td>
<td>26.9</td>
<td>144.9</td>
<td>87.8</td>
<td>A × B</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>0–144</td>
<td>0–1,083</td>
<td>0.5–617</td>
<td>A × C</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>σ= 28</td>
<td>σ= 195</td>
<td>σ= 90</td>
<td>B × C</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Duration of 40% to 79% oxygen (hr)</td>
<td>99.3</td>
<td>604.3</td>
<td>56.9</td>
<td>A × B</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>16–436</td>
<td>44–3,640</td>
<td>0–625</td>
<td>A × C</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>σ= 69</td>
<td>σ= 639</td>
<td>σ= 94</td>
<td>B × C</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Duration of 22% to 39% oxygen (hr)</td>
<td>188.0</td>
<td>974.3</td>
<td>20.5</td>
<td>A × B</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>9–1,278</td>
<td>0–11,106</td>
<td>0–1,120</td>
<td>A × C</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>σ= 229</td>
<td>σ= 1,608</td>
<td>σ= 107</td>
<td>B × C</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*132 patients.
†89 patients.
‡44 patients.
§105 patients.
||102 patients; could not be evaluated in one patient because of bilateral pneumothorax.
¶95 patients.
#60 patients.
**124 patients.
††61 patients.

More mature at birth with less severe disease as reflected by Apgar score, radiographic severity of RDS, age requiring assisted ventilation, and peak ventilator pressure. The patients who died without BPD tended to be at the opposite end of the spectrum; they were the smallest and most immature with the most severe illness as reflected by the indexes noted. The patients who did develop BPD formed a distinct group that tended to be intermediate between these extremes.

Although the variance of these measures is large enough within each group that predicting the course of a single patient would be unwarranted, it does appear that birth weight, maturity, and severity of disease at least partially define susceptibility to BPD. The mechanism for this is
not clear. It may be simply that the patients who
develop BPD are “borderline babies” who are
healthy and mature enough to survive, but ill
and 80% to 100% oxygen. These infants differed
from the other patients with BPD only in that they
were significantly smaller and more immature
and were born in more recent years. This suggests
that less mature newborns are more susceptible to
the agent or agents that cause BPD than can be
accounted for by the tendency of immature
newborns to require more oxygen and ventilation
than their more mature counterparts.
This suggestion, however, does not correlate
completely with the decreased incidence of BPD
in the final year of this study. The reason for the
decreased incidence in 1973 is not obvious. It is
probable that increased liberalty in placing
patients on assisted ventilation skewed the study
population. It also is possible that earlier use of
ventilatory assistance and increased use of CPAP
in favor of IPPV was beneficial in decreasing
BPD; thus some patients, who might not have
otherwise survived, lived to develop BPD, but
many more survived without the disease. These
possibilities are being investigated.

Iatrogenic Factors

There continues to be controversy about
iatrogenic causes of BPD: the major etiologic
contenders are endotracheal intubation, mechanical
ventilation, and elevated inspired oxygen. Morbid effects of endotracheal intubation have
been described, as have effects of mechanical
ventilation which appear distinct from those of
oxygen in some reports. Toxic effects of high
oxygen concentration have been observed in vitro
with neonatal respiratory epithelium and in
animal models, including infant lambs in
which ventilation with air was without toxic
effect. Pulmonary ultrastructural changes after
exposure of newborn mice to high oxygen
concentrations are very similar to changes in the
lungs of children who died with BPD. Furthermore,
there is an impressive body of clinical data
that suggests at least an association between
oxygen therapy and the development of BPD.
Most clinical studies, including this one, show
an impressive correlation between the development
of BPD and the exposure of patients to
considerable respiratory support. It is an unfortu-
nate characteristic of BPD that extensive respira-
tory support is both a probable cause of the
disease and its major therapy, so that it is difficult
to separate respiratory support as a cause from an
effect of the disease. It is also vexing that the
disputed factors of respiratory support—intuba-
tion, ventilation, and oxygen—are administered
by and large concomitantly, which renders isol-
ation of individual effects difficult.
In this study, intubation, ventilation, and
oxygen exposure were all significantly predictive
of the development of BPD. To reduce statistical
variance that could be extraneous, patients who
died before three days were discounted. With this
adjustment, duration of supplemental oxygen
over 40% concentration significantly predicted
the occurrence of BPD, whereas duration of
intubation and ventilation did not. This finding
suggests that oxygen may be of relatively greater
etiologic importance than intubation and ventila-
tion. It also is compatible with the data that
indicate that intubation and ventilation act as
permissive factors that allow oxygen to reach and
damage the lung (as may be the case with CPAP
in a lamb model). This study confirms the previous observation that any patient who received 80% to 100%
oxygen for more than about six days (144 hours)
either developed BPD or died. Any patient in
this study who was exposed to 436 hours (about 18
days) of 40% to 79% oxygen, or 1,278 hours (about
53 days) of 22% to 30% oxygen, died or developed
BPD. The 14 infants who developed BPD after 24
hours or less exposure to 80% to 100% oxygen
received significantly more 22% to 79% oxygen
than patients who did not develop BPD. These
data suggest a reciprocal relationship between
oxygen concentration and duration of exposure in
the development of BPD. Quantifying this rela-
tionship, however, was not possible because of
other influential factors, such as the effect of
maturity.

Taghizadeh and Reynolds have suggested that
high ventilator pressures (35 cm H2O or greater
for two days or more) are implicated in the
development of BPD. In our study, peak pressures
were recorded rather than durations of ventila-
tion above a particular pressure. Thus the data
from the two studies are not directly comparable,
although they may be roughly parallel. Our data
suggest that peak pressures reflect the severity
of the underlying pulmonary disease, with high
pressures required for patients who are more
severely ill as judged by other measures. Patients
who developed BPD did have higher peak pres-
sures than those who survived without BPD, but had lower peak pressures than those who expired without the disease. A contribution of high ventilator pressure in the development of BPD is possible, but our data do not suggest it more strongly than the other clinical variables.

CONCLUSIONS

This study does not resolve the controversy about the etiology of BPD, but the data presented suggest that elevated oxygen is relatively more important than endotracheal intubation and assisted ventilation. Individual factors of maturity and severity of lung disease also appear to play important roles. These observations represent statistical trends; the lack of individual specificity suggests that other determinants are involved. Such determinants could include the biochemical maturity of the lung, the type of ventilation used, infection, or other unconsidered factors.

REFERENCES


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CHARLES DICKENS'S DESCRIPTION OF HIS VISIT TO A FREE SCHOOL IN CINCINNATI IN 1842

Charles Dickens (1812-1870) was among the first of several English writers who visited the United States during the 1840s and 1850s. The description below of his visit to a free school in Cincinnati was included in his American Notes which Dickens wrote in 1842 upon completion of his six months' visit to our country.

Cincinnati is honorably famous for its free schools, of which it has so many that no person's child among its population can, by possibility, want the means of education, which are extended, upon an average, to four thousand pupils annually. I was only present in one of these establishments during the hours of instruction. In the boy's department, which was full of little urchins (varying in their ages, I should say, from six years old to ten or twelve), the master offered to institute an extemporary examination of the pupils in algebra; a proposal which, as I was by no means confident of my ability to detect mistakes in that science, I declined with some alarm. In the girl's school, reading was proposed; and as I felt tolerably equal to that art, I expressed my willingness to hear a class. Books were distributed accordingly, and some half dozen girls relieved each other in reading paragraphs from English history. But it seemed to be a dry compilation, infinitely above their powers; and when they had blundered through three or four dreary passages concerning the treaty of Amiens, and other thrilling topics of the same nature (obviously without comprehending ten words), I expressed myself quite satisfied.

It is very possible that they only mounted to this exalted stave in the Ladder of Learning for the astonishment of a visitor; and that at other times they keep upon its lower rounds; but I should have been much better pleased and satisfied if I had heard them exercised in simpler lessons, which they understood.1

Noted by T. E. C., Jr., M.D.

REFERENCE