THE CAUSATIVE ORGANISMS OF BRONCHOPNEUMONIA IN INFANTS IN EGYPT

BY

A. K. ABDEL-KHALIK, M.R.C.P., Assistant Physician; A. M. ASKAR M.R.C.P., Tutor; and MOHAMED ALI, D.T.M.&H., Bacteriologist

(From the Paediatric Department, Faculty of Medicine, Cairo, Egypt)

Every paediatrician is familiar with the lack of therapeutic agents in severe bronchopneumonia and the mixed opinions expressed regarding the use of vaccines. The literature of the last fifteen years is full of encouraging results regarding vaccinotherapy in bronchopneumonia, both experimental (Zinssner, 1929; Barach, 1928; Goodner, 1928) and clinical (Wynn, 1926; Hay, 1927; Lambert, 1926; Forbes and Steinberg, 1931; Cardère, 1930; Fort, 1927; Weill and Dufourt, 1924). However, experience, personal or gained from a careful perusal of the literature, has shown the uncertainty of the results obtained from vaccinotherapy. One of the explanations of these uncertain results obtained by this method of treatment might be that in the preparation of the stock vaccines, no account is taken of the variation in the nature and combination of organisms responsible for the seasonal epidemics from year to year and from country to country. A preliminary step, therefore, before a considered judgement can be passed as to the value of vaccinotherapy in bronchopneumonia in children, would be to identify the organisms responsible for seasonal epidemics in each country and to make the stock vaccines in accordance with the results. It is with this object that an attempt has been made to identify the causative organisms of bronchopneumonia in infants in Egypt.

Methods available

The material for culture was obtained by means of lung punctures during life. Eyre (1910) was the first who tried to examine bacteriologically ‘lung juice’ derived by means of an aspirating needle from the affected lobules. He reported on 164 cases spread over a period of seven years extending from January, 1902, to June, 1909. In some of the cases the lung puncture was made during life, but in the majority it was made after removal of the lungs from the cadaver. Culture specimen taken by lung puncture during life is, however, far superior to culture from the focus at post-mortem examination. This last has been practised by Netter (1892), Mosny (1892), Darier (1909) and Glen Liston (1929), but in this method there is no chance of examining the
cases that survive. Also it is well known that, during the agony of death and immediately after, organisms of the upper passages, bronchi and even of the intestine can invade the lung tissue and appear in the culture although they were not the real cause of bronchopneumonia. Dufourt (1927) has cultured lung juice taken aseptically from the cadaver of children who died without any lung affection and has succeeded in isolating staphylococci and sometimes enterococci and B. coli.

Examination of the sputum is of great help if the search is principally for the tubercle bacillus. But it is unreliable for the organisms that can cause bronchopneumonia, as most of them are normal inhabitants of the upper respiratory passages. Moreover, children before the seventh year of life usually do not spit; they swallow their sputum.

The culture of a swab from the pharynx is also unreliable, because in the pharynx organisms coughed out from the lungs are mixed with those descending from the upper respiratory passages towards the lungs. Therefore, in pharyngeal specimens, it is impossible to be certain if the organisms grown in the culture are the real cause of the bronchopneumonia present.

It seems, therefore, that examination of lung juice taken by lung puncture, during life is the only reliable method for identifying the causative organisms. The culture may prove to be sterile in spite of the presence of bronchopneumonia. Such sterile results have been found in 25 per cent. of Dufourt's cases (1927) and in 90 per cent. of Peyre's cases (1934). We think that this last figure is too high. Probably some difficulty was encountered in hitting the focus.

Technique of lung puncture

Patients were examined clinically and areas on the chest wall where the underlying bronchopneumonia gave most marked physical signs were noted. Skiagrams were taken to confirm the diagnosis and localize the position of the focus. The site of the puncture was chosen according to the clinical and x-ray findings considered together.

Topographically the lungs are divided into upper, middle and lower zones; and the chest wall is divided anatomically into anterior, lateral and posterior surfaces. Cases that showed, for example, middle-zone opacity were punctured in the same zone either through the anterior, lateral or the posterior surface according to the clinical findings. This method of localization is easy and practical, although it sometimes fails. Occasionally, localizing physical signs were absent while the x-ray showed a definite lesion. In some other cases the clinical zonal localization differed from the radiological picture. The presence of the localizing signs over the upper zone of the lung while the skiagram showed middle or even lower zone opacity was common. In such contradiction of findings the x-ray results were always followed.

Operation

Instruments.—

1–2 c.c. all-glass syringe.

2–3 cm. long, soft, 'non-breakable' hypodermic needle with medium-sized bore and long bevel. The long-bevelled is preferable to the short-
CAUSATIVE ORGANISMS OF BRONCHOPNEUMONIA

bevelled needle as it aspirates from a larger area of lung when in position.

The syringes and needles should be thoroughly close-fitting and it is advisable to sterilize them when connected.

Ordinary surgical antiseptic measures should be followed with the following precautions:

- Sterilize the skin with alcohol.
- Rinse the syringe and needle with sterile saline before use.
- No local anaesthetic is needed.

POSITION OF THE CHILD.—Either prone or supine with hands over head to clear the axillary area and abduct the scapula. If the child is restless and strong it is advisable to ask the help of two nurses instead of one.

PUNCTURE PROPER.—After the site has been determined the skin over it is sterilized and then fixed in position by the left hand. The syringe is held in

![Diagram of chest with dark area marked]

FIG. 1.—Anterior surface of the chest. Dark area is practically safe for lung puncture.

the right hand and the needle is pushed through the chest wall to the advisable depth. The piston is now withdrawn and if nothing comes out, the needle is drawn out of the chest while there is a negative pressure inside the syringe. The advantage of the combined withdrawal of the piston and needle is to prevent infection of the pleural cavity and to have the chance of aspirating the focus in case the point of the needle has been pushed beyond the focus.

FAILURE OF THE PUNCTURE MAY BE DUE TO.—
- Failure to hit the focus.
- Aspirating blood from sources other than the focus, i.e. liver, spleen and veins.

DANGERS OF THE PUNCTURE ARE.—
- Haemoptysis. In two cases a severe paroxysm of cough was noted after the operation. In both the contents of the syringes were mixed with blood. In one of them, a five-year-old child, the sputum was tinged.
The second, an infant of about two years, vomited after the cough and the vomit was tinged. Both recovered.

Infection of the pleura. This can be avoided as explained above.

Hitting heart or great vessels. This can be easily avoided, as will be explained later.

Shock from pricking the pleura. This did not occur in a single case.

**DANGEROUS ZONES.**—In order to avoid hitting the heart, great vessels, liver or vertebral column care must be exercised not to introduce the needle in what can be called the dangerous zones. Anteriorly on the right side this dangerous zone lies medial to a line that joins the first intercostal space in the mid-clavicular line with the fifth space in the anterior axillary line. On the left side this line begins as on the right side and descends to the second intercostal space in the mid-clavicular line, then to the third space in the mid-axillary line and ends in the fifth space in the mid-axillary line (see fig. 1, 2 and 3).
Posteriorly the dangerous zone would be medial to a line that starts on either side, above at the fourth space just inner to the medial border of the abducted scapula then drops almost vertically downwards to the eighth space. Above the level of the fourth space the abducted scapula will be in the way. Below the level of the eighth space little lung tissue is left. Between these two lines, above, any enlarged hilar glands at the root of the lung may be punctured; lower down, medial punctures are not advisable as any unexpected lateral move-

Fig. 3.—Left lateral view of same cadaver as fig. 2 with seven needles 3 cm. long introduced perpendicularly to chest wall—on left side—at the anterior and posterior boundaries of the so-called safety zone.

ment of the child—and this cannot be easily prevented—might cause the needle to hit against the bodies of the vertebrae (see fig. 2, 3 and 4).

If the lesion was detected only by x-ray examination with no physical signs, which shows that the lesion is deep in the lung, the needle must be introduced in the mid-axillary line, perpendicular to the surface of the chest, in the intercostal space level with the lesion. This will point towards the hilum of the lung where bronchopneumonia usually starts.

A needle 3 cm. long when introduced in the mid-axillary line perpendicular
to the chest wall in an infant six months old will be quite far from the heart and great vessels; and the point will be near to the hilum of the lung. On the right side any of the upper five intercostal spaces can be chosen, while on the left only the upper three are safe (see fig. 5). In younger infants it is safer to use shorter needles, i.e. 2 cm.

![Fig. 4.—Posterior surface of the chest. Dark area is practically safe for lung puncture.](image)

**Previous investigations**

Other authors proved the safety of lung puncture beyond doubt. C. Robertson Lavalle (1937) in his paper on the treatment of tuberculosis by needle puncture of the lung wrote:

The absolute harmlessness of a puncture performed in the lung has been proved time and again. As long ago as 1917 Dr. Duval presented to the Société de Chirurgie de Paris the results of his first 100 cases of bullet extraction from the lung. With a Kocher's forceps he extracted from the depths of lung tissue, which has already formed a cicatricial mass around the foreign body, bullets as deep as 4-5 inches in the pulmonary parenchyma, and with no after-effects, seeing that the soldiers were discharged after a couple of days. Further, innumerable cases have been recorded bearing witness to Duval's statement at that time: 'The pulmonary parenchyma tolerates the forceps extremely well. Puncture in the lung is just the same as puncturing the gluteal region, the leg, or the arm. Its haemorrhages are insignificant, being either small or limited.'

**Results**

During the winters 1933–1936, 233 cases of bronchopneumonia were examined clinically and radiologically. These were then lung punctured and the material obtained was stained and examined microscopically and cultured on blood-agar plates and in glucose broth, and these media were then examined for organisms after twenty-four, forty-eight and seventy-two hours' incubation at 37° C.
CAUSATIVE ORGANISMS OF BRONCHOPNEUMONIA

Fig. 5.—Anteroposterior skiagram of the chest of a cadaver with nine needles 3 cm. long introduced perpendicularly to chest wall in the mid-axillary lines right 1–5 and left 1–4 spaces. On right side any of the upper five spaces is safe while on the left only the upper three. The fourth is dangerous.

The following are the results.—

<table>
<thead>
<tr>
<th>Organisms</th>
<th>Alone</th>
<th>With Other Organisms</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pneumococci</td>
<td>19</td>
<td>13</td>
<td>32</td>
</tr>
<tr>
<td>Streptococci</td>
<td>20</td>
<td>22</td>
<td>42</td>
</tr>
<tr>
<td>B. Influenza</td>
<td>31</td>
<td>46</td>
<td>77</td>
</tr>
<tr>
<td>Staphylococci</td>
<td>21</td>
<td>46</td>
<td>67</td>
</tr>
<tr>
<td>B. Bordet Gengou</td>
<td>4</td>
<td>2</td>
<td>6</td>
</tr>
<tr>
<td>M. Tetragenus</td>
<td>1</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>M. Catarrhalis</td>
<td>5</td>
<td>25</td>
<td>30</td>
</tr>
<tr>
<td>B. Pyocyaneus</td>
<td>1</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>B. Friedlander</td>
<td>4</td>
<td>7</td>
<td>11</td>
</tr>
<tr>
<td>Diphtheroids</td>
<td>0</td>
<td>8</td>
<td>8</td>
</tr>
</tbody>
</table>

Of the 233 cases examined 51, i.e. 21 per cent., gave no growth on the above media. This probably has been due to difficulty in hitting the focus.
The following table shows the cases caused by more than one kind of organisms and the nature of their combination:

<table>
<thead>
<tr>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
<th>F</th>
<th>G</th>
<th>H</th>
<th>I</th>
<th>J</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pneumococci</td>
<td>19</td>
<td>5</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Streptococci</td>
<td>20</td>
<td>5</td>
<td>17</td>
<td>1</td>
<td>4</td>
<td>3</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>B. Influenzae</td>
<td>5</td>
<td>31</td>
<td>17</td>
<td>5</td>
<td>1</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Staphylococci</td>
<td>2</td>
<td>5</td>
<td>17</td>
<td>21</td>
<td>1</td>
<td>4</td>
<td>3</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Bordet Gengou</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>M. Tetragenus</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>G. Catarrhalis</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>H. Pyocyaneus</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>J. Friedlander</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Diphtheroids</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The following shows the cases caused by three organisms:

**NO. OF CASES**

7. Strept. viridans, B. Influenzae and Diphtheroids.

15 (Total)

The following shows cases caused by four organisms:

**NO. OF CASES**


The following table shows the variability of the rate of incidence in percentage of the causative organisms in the different winters:

<table>
<thead>
<tr>
<th>1932</th>
<th>1934</th>
<th>1935</th>
<th>TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>ALONE</td>
<td>ALONE AND WITH OTHERS</td>
<td>ALONE</td>
<td>ALONE AND WITH OTHERS</td>
</tr>
</tbody>
</table>

| Pneumococci | 16.7 | 27.1 | 12.3 | 17.8 | 3.3 | 9.8 | 10.4 | 17.6 |
| Streptococci | 25.0 | 41.7 | 10.9 | 27.4 | 3.2 | 11.0 | 23.1 |
| Haemolytic | 10.4 | 18.8 | 4.1 | 15.1 | 1.6 | 4.4 | 11.5 |
| Non-haemolytic | 14.6 | 22.9 | 4.1 | 5.5 | 1.6 | 5.5 | 8.8 |
| Viridans | 2.7 | 6.8 | 1.1 | 2.7 |
| B. Influenzae | 10.4 | 18.8 | 13.7 | 42.5 | 26.2 | 60.7 | 17.0 | 42.3 |
| Staphylococci | 4.1 | 25.0 | 15.1 | 35.6 | 11.5 | 47.5 | 11.0 | 36.8 |
| B. Bordet Gengou | 8.3 | 10.4 | 1.4 | 1.4 | 3.3 | 0.6 | 2.2 |
| M. Tetragenus | 2.1 | 1.4 | 1.4 | 1.4 | 3.3 | 0.6 | 2.2 |
| M. Catarrhalis | 4.2 | 2.7 | 15.1 | 4.9 | 26.2 | 2.7 | 16.5 |
| B. Pyocyaneus | 1.4 | 1.4 | 0.6 | 1.5 |
| B. Friedlander | 4.2 | 1.4 | 6.6 | 13.1 | 2.2 | 6.0 |
| Diphtheroids | 2.1 | 9.6 | 2.2 | 4.4 |
CAUSATIVE ORGANISMS OF BRONCHOPNEUMONIA 341

Comment

The above tables show that the pneumococcus (17·6 per cent.) is not the commonest cause of bronchopneumonia in infants. It comes the fourth in frequency after B. influenzae (42·3 per cent.), staphylococcus (36·8 per cent.) and streptococcus (23·1 per cent.). This is quite different from the statistics of other authors. Of the pneumococcal cultures, twenty-seven were typed and the following was the result:

Type I .... .... .... .... 4 cases, i.e. 14·8 per cent.
Type II .... .... .... .... 7 " " 26·0 "
Type III .... .... .... .... 3 " " 11·1 "
Type IV .... .... .... .... 13 " " 48·1 "

Pisek and Pease (1916), Mitchell (1917), Opie (1921) and Thompson, Jr. (1936), gave the following percentages for the different types of pneumococci isolated from cases of bronchopneumonia.

<table>
<thead>
<tr>
<th>Type</th>
<th>PRESENT RESULTS</th>
<th>PISEK</th>
<th>MITCHELL</th>
<th>OPIE</th>
<th>THOMPSON</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type I</td>
<td>14·8</td>
<td>22·9</td>
<td>11·1</td>
<td>7·6</td>
<td>32·1</td>
</tr>
<tr>
<td>Type II</td>
<td>26·0</td>
<td>29·3</td>
<td>11·1</td>
<td>21·9</td>
<td>—</td>
</tr>
<tr>
<td>Type III</td>
<td>11·1</td>
<td>8·3</td>
<td>3·3</td>
<td>5·7</td>
<td>10·7</td>
</tr>
<tr>
<td>Type IV</td>
<td>48·1</td>
<td>39·8</td>
<td>74·4</td>
<td>64·8</td>
<td>57·2</td>
</tr>
</tbody>
</table>

The streptococcus comes third in frequency in the present series. Most authors found it second in frequency in their investigations. B. Influenzae is the commonest organism isolated in the present cases (42·3 per cent.). It has been isolated in pure culture in thirty-one cases of seventy-seven when it has been found. This does not agree with Dufourt's findings (1927). He found it almost always associated with other organisms and found it in pure culture only in one case. The staphylococcus has been met with in 36·8 per cent. of the series. It seems to play a definite pathogenic part in the causation of bronchopneumonia. Dufourt has never been able to isolate it by lung puncture in his cases. He denies its pathogenicity in bronchopneumonia, although he has cultured it from the rhinopharynx and at post-mortem examination from the pus of purulent pleurisy secondary to bronchopneumonia. McGregor (1936) and Smith (1935) came to similar conclusions. They consider that the staphylococcus could produce bronchopneumonia either alone or with other organisms. The B. Bordet Gengou, M. tetragenus, B. pyocyanus and B. Friedlander were rarely met with. The enterococcus has not been encountered in the cultures. This organism has been present in 25 per cent. of Dufourt's cases. The M. catarrhalis, which is said by Duchun (1926) to play a secondary role in the causation of bronchopneumonia, has been met with in 16·5 per cent. of cases and it is concluded that it plays a definite part in the causation of bronchopneumonia. Diphtheroids were cultured from a small number of our cases.

Summary

(1) Lung puncture has been shown to be the best way to isolate the causative organism in bronchopneumonia in early life.
(2) The technique of lung puncture is described in detail and its safety proved.

(3) During the winters of 1932–1936, 233 cases of bronchopneumonia were lung punctured and the material obtained was cultured on blood agar and broth.

(4) Of the 182 positive cases, 106 (58.3 per cent.) showed one organism, fifty-eight (31.9 per cent.) showed two organisms, fifteen (8.2 per cent.) showed three organisms and three (1.6 per cent.) showed four organisms.

(5) The commonest organism found was B. influenzae (42.3 per cent.); then staphylococci (36.8 per cent.), streptococci (23.1 per cent.), pneumococci (17.6 per cent.), M. catarrhalis (16.5 per cent.).

(6) Of the twenty-seven pneumococci typed: four cases (14.8 per cent.) were type I, seven cases (26 per cent.) type II, three cases (11.1 per cent.) type III and thirteen cases (48.1 per cent.) were type IV.

REFERENCES

——, (1924b). Lyon Médical, 58, 35.