The Aetiology of Pneumonia Associated with Measles in Bantu Children*

A. G. WESLEY, M.B., CH.B. (CAPE TOWN), M.R.C.P. (EDIN.), D.C.H. (LOND.), J. B. SUTTON, M.B., B.CH. (RAND), M.MED. (RAD.D.) (CAPE TOWN) AND A. J. WIDRICH, M.B., B.CH. (RAND), F.C.P. (S.A.) (PAED.), *Departments of Paediatrics and Radiology, University of Natal and King Edward VIII Hospital, Durban*

SUMMARY

Antemortem and postmortem lung puncture aspiration was performed in Bantu children with pneumonia associated with measles.

The superinfecting organisms were commonly Staphylo-coccus pyogenes, **but from one-third of the patients Gram-negative organisms were cultured. These organisms were rarely sensitive to ampicillin or streptomycin. Antibiotic therapy should be tailored accordingly.**

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Acute pneumonia in Bantu children often fails to resolve rapidly on treatment. This poor response to therapy is highlighted in the patient with pneumonia associated with measles.

Cultures taken from nose, throat, sputum and trachea do not necessarily reflect the causative bacteria in lower respiratory tract infection.[1-4] The latter technique (cultures from the trachea) is more reliable than the others,[5] but difficult in children.

A study has been made of organisms present in the lungs of these children by culture of specimens obtained by percutaneous lung aspiration puncture (LAP).

MATERIAL

Twenty-two Bantu children with measles and pneumonia were studied on admission to the Fever Wards at King Edward VIII Hospital, Durban. In some patients a dose of antibiotic had been given before LAP.

A further 5 cases were studied postmortem. The time lapse between death and LAP varied from 10 minutes to $3\frac{1}{2}$ hours. All cases had received antibiotics for some days before death.

The age range of the patients was 5 months to 4 years.

Method of LAP

The lung aspiration was performed with a sterile 5-ml glass syringe and 18-gauge needle. The site of the LAP was selected over the area of maximal clinical signs, taking care to avoid mediastinum, liver and diaphragm.[6,7]

The skin over the area was prepared with a phenol or iodide solution.

Two millilitres of serum broth was drawn into the syringe. The needle was advanced rapidly into the thorax to a depth of 2 - 3 cm and withdrawn immediately, nega-tive pressure being applied throughout the procedure. Thus the lung aspirate was drawn directly into the serum broth. Chest radiographs were done after the procedure.

Postmortem specimens were obtained by puncture into each axilla, using the same technique. In addition, 5 ml of heart blood was obtained.

A drop of lung aspirate was placed on two sterile glass slides, another drop in Loewenstein-Jensen media and the remainder of the syringe contents were replaced in the serum-broth culture bottle. The postmortem cardiac blood was placed in glucose broth media.

Bacteriological Methods

The Department of Microbiology, University of Natal, received the specimens without delay and the following procedure was undertaken:

1. The lung aspirate in serum broth was subcultured into thioglycollate broth media and then plated onto blood agar and MacConkey agar. All cultures were incubated both aerobically and anaerobically for 48 hours before being discarded.

The Loewenstein-Jensen media were incubated for 6 weeks: any growth was stained by Ziehl-Neelsen stain for acid-fast bacilli.

2. Blood cultures in glucose broth were incubated aerobically and anaerobically for 48 hours and then plated onto blood agar and MacConkey agar. They were not discarded until 21 days of negative growth.

3. Antibiotic sensitivities were done on oxoid sensitivity agar with mast rings.

4. The slides made from lung aspirates were stained with Gram and with Ziehl-Neelsen stains.

RESULTS

Organisms Cultured (Table I)

Antemortem: In 68% of cases positive culture was obtained. The commonest organism cultured was coagulase-positive staphylococcus (10 cases). *E. coli* (6 cases), *Proteus morgani* (1 case) and *Streptococcus viridans* (4 cases) were also cultured.

Postmortem: All 5 cases yielded growth from LAP, and in the 2 cases where the blood culture was positive at least one organism matched that cultured from the lung. *Pseudomonas* species occurred in 4 of the 5 cases, *E. coli* in 2, coagulase-positive staphylococcus in 2 and *Streptococcus viridans* in 1.

TABLE I. ORGANISMS CULTURED

	Antemortem	Postmortem	
	LAP	LAP	Blood
Total cases	22	5	5
Negative culture	7	0	2
Pure growth*	11	3	1
Mixed growth	4	2	2
Staphylococcus	10†	1	1
E. coli	6‡	2	2
Pseudomonas	1§	3§	2
Strep. viridans	3	1	0
Proteus morgani	1	0	0

* 1 organism only.
† 8 in pure growth.
‡ 2 in pure growth.
§ Pure growth.

Antibiotic Sensitivity

Table II shows the antibiotic sensitivities of the organisms. Of the 12 coagulase-positive staphylococci, 5 were insensitive to penicillin. Of the 8 *E. coli*, only 1 was sensitive to ampicillin and 2 to streptomycin. No pseudomonas organism was insensitive to both gentamycin and carbenicillin.

TABLE II. ANTIBIOTIC SENSITIVITY

			Organisms		
	Staph. (12)	E. coli (8)	Pseudo-monas (7)	Strep. viridans (4)	Proteus morgani (1)
Penicillin	7	—	—	2	—
Cephalosporin	12	7	0†	4	0
Cloxacillin	12	—	—	2	—
Ampicillin	—*	1	0	—	—
Streptomycin	—	2	0	—	0
Kanamycin	—	6	0	—	1
Gentamycin	—	8	5	—	0
Carbenicillin	—	—	4	—	1

* Sensitivity not done.
† Insensitive.

Gram and Ziehl-Neelsen Slides

These proved unhelpful as it was not possible to identify the organisms sufficiently accurately. Culture was, therefore, necessary. Organisms were shown on slides in 7 (33%) cases only. In 5 cases where the slides were negative, the LAP cultures were also negative.

Relationship of Mortality, Organisms and Nutrition

Of the 22 cases who were studied during life, 9 died (41%). From Table III it can be seen that the mortality was higher in those with Gram-negative infections, with mixed infections and with malnutrition.

The causes of death of children in this series were

TABLE III. MORTALITY AMONG PATIENTS WITH ANTEMORTEM CULTURES

	Survived	Died
Total	13	9
Poor nutrition	3	5
Fair nutrition	10	4
Gram-positive	6	3
Gram-negative	3	3
Single organism	7	3
Mixed organisms	0	4

cardiac failure (2), encephalitis (1), pneumonia within 2 days of admission (5) and chronic staphylococcal pneumonia (1).

Complications of Procedure

This occurred in 7 cases (32%). A single immediate haemoptysis occurred in 2 children. In 5 cases (23%) pneumonothorax followed the procedure; 2 were symp-

tomless; and in 2 an underwater drain hastened recovery. In the fifth case delay in detecting symptoms contributed to death.

DISCUSSION

The high mortality of measles in a malnourished population has been well described.[8-10] There was need to know the pattern of superinfection in such cases, to tailor antibiotic treatment more effectively.

Organisms obtained by sputum or tracheal secretion culture may be oropharyngeal organisms,[1,2] and their relationship to lower respiratory tract infection is equivocal. But organisms cultured from a lung aspirate must have been present in the lower respiratory tract.

LAP is, however, not without hazard, but in a condition with a high mortality rate, it was felt that LAP was justified. Undoubtedly, precise knowledge of the superinfecting organism(s) was invaluable and saved lives. Reported complications following LAP have been massive pulmonary haemorrhage, reflex cardiac arrest,[11,12] haemoptysis and pneumothorax, the last occurring in up to 22% of cases.[13,17] The latter two complications were also encountered in this series.

LAP was an effective tool: in 68% of cases bacteria were isolated. The success rate in other series has been 17 - 92%.[3,6,13-15,17,18] Negative cultures may be due to faulty bacteriological methods, to sampling an area of lung remote from infection, or the pulmonary pathology may have been purely viral.

The pattern of bacterial infection in this group of children was not predictable from other studies of childhood pneumonia, with or without measles, but might have been from postmortem blood cultures from kwashiorkor children.[19] Factors which influence the occurrence of pathogens in disease include the socio-economic circumstances and the location of the population in question, and the time of study.[13]

Notably absent from this study were *Diplococcus pneumoniae*, haemolytic streptococcus and *Haemophilus influenzae*. These organisms were the commonest pathogens in other measles and non-measles series.[3,6,13,16,17,20-24] It is unlikely that the culture technique for the former two organisms was inadequate, but the methods employed were not directed specifically towards *H. influenzae*. In some instances, therefore, this fastidious organism may have been missed.

Only 2 Gram-positive organisms were obtained from these patients. Coagulase-positive staphylococcus was the most common superinfecting bacterium. This organism is a frequent secondary invader in viral disease.[18,25]

Streptococcus viridans, an oropharyngeal organism, does invade the lower respiratory tract of diseased lungs[1,26] but it is not thought to be pathogenic in this site. It has been found previously in the lungs of measles patients[23,24] and it is just possible that it may cause disease in malnourished patients.[27]

One-third of the bacteria cultured from the living patients were Gram-negative. When *H. influenzae* is excluded, this incidence is far in excess of that in other series,[6,14,21] except where patients with other debilitating diseases were studied.[13]

Postmortem cultures have in the past been regarded as unreliable. However, it has been shown that any redistribution of bacteria at the time of death is not sufficient to obscure the true bacterial picture.[28] In the 5 cases cultured after death either *E. coli* or *Pseudomonas* species was isolated. In 2, coagulase-positive staphylococcus was also present. Antibiotics administered before death probably altered the bacterial flora of the lungs, and thus the organism cultured might not have been the original aetiological agent. But the knowledge that *E. coli* and pseudomonas have been obtained in pure growth before treatment makes it likely that they were the original culprits.

Antibiotics sensitivities showed that almost half the staphylococci were resistant to benzylpenicillin G, but were sensitive to cloxacillin and cephalosporin. Further, the high percentage of cases with Gram-negative superinfection indicated the necessity for a second antibiotic. These organisms were rarely sensitive to streptomycin or ampicillin, but were sensitive to gentamycin. This information should assist in the selection of antibiotics for ill or malnourished Bantu children.

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