

# Routine laboratory assessment of postoperative chest infection: a prospective study

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**SUMMARY** Postoperative chest infection was studied prospectively in 73 patients in order to evaluate standard laboratory methods of sputum examination and to relate the results to the patients' clinical state and to antibiotic therapy. When a culture medium selective for haemophilus was used in addition to unselective media, homogenisation of the specimen gave no advantage. Laboratory and clinical findings usually corresponded well. Profuse growths of *Streptococcus pneumoniae* or *Haemophilus influenzae* were clearly associated with clinical evidence of chest infection but other Gram-negative bacilli and *Staphylococcus aureus* much less so. Coliforms were more prominent after antibiotic therapy.

Sputum bacteriology has had a bad reputation with some microbiologists and clinicians because of the poor correlation between laboratory findings in expectorated samples and clinical features of chest infection. Improvement may be sought by refinement of techniques of specimen collection and by elaboration of laboratory methods. Bolder procedures such as pertracheal aspiration have given good results but are unlikely to gain popularity outside specialist units. More sophisticated laboratory techniques such as those using fluorescent antibodies are not yet available to most routine laboratories.

The results of culture can be improved by liquefying the sputum (Rawlins, 1953) and by culturing the dilutions of the liquefied sample (Dixon and Miller, 1965). The use of selective media also improves results (Baber, 1969). We report here a prospective study of chest infection in adults treated by elective operation. We also compare our routine laboratory procedure, which uses selective as well as non-selective media, with a liquefaction and dilution technique.

## Patients and methods

Seventy-three patients were treated by elective operation, mostly abdominal, by the same surgical team between October 1974 and September 1975.

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The mean age was 57 years (range 27 to 88). They were assessed clinically from the day before operation (when all were free from evident chest infection) to the tenth day after operation or to the day of discharge, whichever came first. These observations, which were not disclosed to the laboratory until the investigations were complete, were made by a member of the surgical team who was not responsible for the day-to-day care of the patients. Patients with evidence of chest infection were also examined radiologically.

The clinical findings were graded as 0 (no clinical or radiological evidence of infection), 1 (minor evidence, few physical signs), 2 (clear evidence but no consolidation), and 3 (frank pneumonia).

## SPUTUM EXAMINATION

Samples of sputum were collected daily or the fact was recorded that no sputum had been produced; when possible, physiotherapists assisted in sample collection. The appearance of the sputum, mucoid or purulent, was recorded as described by Miller (1963). Unsatisfactory specimens, for example, evident saliva, were discarded. The specimens were then examined by two procedures.

### 1 Routine method (without homogenisation)

Microscopy (Gram stain) of selected portions, purulent when present.

Culture of selected portions on:

- (a) blood agar with two optochin discs
- (b) MacConkey bile-salt agar

- (c) heated (chocolate) blood agar containing bacitracin 10 units/ml (Baber, 1969), selective for haemophilus and other Gram-negative bacilli.

## 2 Homogenisation method with *N*-acetyl-L-cysteine (Woodhams and Mead, 1965)

### Microscopy (Gram stain)

- Culture (i) neat, on media (a), (b), and (c) above  
(ii) diluted 1:1000 on media (a) and (c).

## LABORATORY ASSESSMENT

### Smears

The average number of leucocytes seen in several representative fields was recorded in both methods. The morphology and profusion of organisms were recorded, special care being taken to note predominance of one or more varieties. Cultural growth was graded as  $\pm$  (scanty: colonies present but separated in primary pool and not extending beyond first spread), + (moderate numbers: separate colonies but extending beyond the first spread), and ++ (confluent in the primary pool and extending to the final spread).

Organisms were regarded as *non-significant* (commensals such as viridans streptococci, neisseria, diphtheroids, *Staphylococcus albus*, and also other organisms except when profuse); or *significant*, ie, profuse growth (++) of pneumococcus, haemophilus, *Staph. aureus*. Gram-negative bacilli other than haemophilus (*Proteus*, *Escherichia coli*, *Pseudomonas*, *Klebsiella*, etc.). Profuse isolates of haemophilus were tested for dependence on X and V factors; all were *H. influenzae*.

## Results

One hundred and thirty-seven sputa were examined by both methods. The microscopic findings correlated well with the results of culture. Organisms seen to be numerous in direct smears (by both methods) grew profusely in culture. Irregularities in the isolation of organisms, as demonstrated by May (1953) when non-liquefied sputum was plated on a non-selective medium, did not occur with our routine combination of selective and non-selective media. When significant organisms were detected by the homogenisation method they nearly always appeared significant also by the routine method. Neither method had a clear advantage over the other (Table 1).

Of the 73 patients studied, 20 without clinical evidence of chest infection produced no sputum. Three with chest infection could produce no sputum. In the remaining 50, representative sputum samples

Table 1 Comparison of sputum examination directly and after homogenisation

	Microscopy	Culture
Homogenisation better	7	9
Direct examination better	11	7
No difference	119	121
Total	137	137

were compared with the corresponding clinical grade, and an average of 2.7 samples were examined per patient. The relationship of sputum production, purulence, and bacteriological findings to the clinical grade of the patient at the time of obtaining the specimens is shown in Table 2. Where there was a clear change of either clinical grade or bacteriological findings during the observation period in a given patient, a second entry for that patient has been made in this table.

There was good, though not absolute, agreement between laboratory and clinical findings. Not surprisingly, almost all patients who produced no sputum lacked clinical evidence of chest infection. However, 10 patients without other evidence of chest infection produced purulent sputum but only two of them yielded growths of pathogens assessed as significant on the criteria described above. Of the patients with chest infection (all clinical grades), significant growths of pathogens were obtained from most purulent sputa (27/30). Significant growths were also obtained from five mucoid specimens, two of which were from patients who had already received antibiotics.

The results of examining sputum from patients who had not received antibiotics during the preceding week are shown in Table 3. As expected, non-significant growths were obtained from most of the uninfected patients but also from five with clinical chest infection (though none of these was in the most severe grade). Where the growth was significant the pathogen was usually (in 18 of 23 specimens) pneumococcus and/or haemophilus, and only one of these cases lacked associated clinical signs of infection. *Staph. aureus* was present as the sole pathogen in only three specimens, and Gram-negative bacilli (other than haemophilus) in only one; none of these was from a patient with pneumonia (grade 3).

When antibiotics had already been given (Table 4) there were no isolations of pneumococcus and/or haemophilus as the sole pathogen. In five infected cases they were isolated with either another Gram-negative bacillus or *Staph. aureus*. In six cases, however, heavy growths of coliform bacilli were found in fairly pure culture. This supports the view that such organisms frequently colonise the respiratory tract of patients receiving antibiotics.

Table 2 Sputum purulence in relation to clinical infection

Clinical chest infection (grade)	Sputum results				
	No sputum	Mucoid		Purulent	
		Non-significant growth	Significant growth	Non-significant growth	Significant growth
0 (no signs)	20	6	1	8	2
1	2 (1)	3	2 (1)	1 (1)	11 (4)
2	0	0	2	2	7 (4)
3	1	0	1 (1)	0	9 (2)
Total infected	3 (1)	3	5 (2)	3 (1)	27 (10)

( ) had preceding antibiotic

Table 3 Bacteriological findings in sputum before antibiotic therapy

Clinical chest infection (grade)	Sputum results						
	No sputum	Growth not significant	Significant, ie, profuse growth of:				
			Pneumococcus and/or haemophilus		GNB	Staph. aureus	GNB and Staph. aureus
			Alone	with GNB and/or Staph. aureus			
0 (no signs)	20	14	1	0	0	1	1
1	1	3	5	2	0	1	0
2	0	2	2	1	1	1	0
3	1	0	7	0	0	0	0
Total infected	2	5	14	3	1	2	0

GNB = Gram-negative bacilli

Table 4 Effect of previous antibiotics on sputum flora

Clinical chest infection (grade)	Sputum results					
	No sputum, or commensals only	Pneumococcus and/or haemophilus	Pneumococcus/haemophilus plus GNB and/or Staph. aureus	GNB	Staph. aureus	GNB plus Staph. aureus
0 (no signs)	0	0	0	0	0	0
1, 2, and 3	2	0	5	6	1	0

GNB = Gram-negative bacilli

## Discussion

The aims of this study were to evaluate methods for bacteriological examination of sputum available to all laboratories, and to assess the clinical significance of organisms commonly regarded as pathogens in chest infections after surgical operations.

Homogenisation and dilution of sputum is undoubtedly advantageous when only non-selective culture media are used. But the combination of a

medium selective for haemophilus with non-selective media, as used routinely in our laboratory, abolishes this advantage provided that care is taken to select purulent portions of the specimens. The chocolate plate with bacitracin demonstrates haemophilus very well even when it is obscured by other organisms on blood agar. Optochin discs, as used in many laboratories, facilitate the recognition of pneumococci. The MacConkey plate, though less important, helps to distinguish between different types of

coliforms when they are numerous.

The comparison of ward and laboratory results was encouraging in that there was a close, though not invariable, association between the sputum findings and the clinical and radiological signs in the chest after operation. In most cases, clinical evidence of chest infection, whether minor or major, was associated with profuse growth of pneumococcus or haemophilus or both. Other Gram-negative bacilli and *Staph. aureus* were rarely associated with infection in patients who had not received antibiotics.

Factors which predispose surgical patients to develop chest infection were recently discussed by Laszlo *et al.* (1973). Antibiotic treatment of post-operative chest infection is generally indicated only in severe cases. It should be directed initially against pneumococcus and haemophilus, but, if possible, the sputum should be examined microscopically before treatment is started.

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