

Randomized Trial Interpreting Sputum Quality in a Clinical Laboratory

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The role for laboratory interpretation of microbiologic results remains controversial, and many laboratories leave the interpretation of culture results entirely to physicians. We examined the effects of furnishing a laboratory interpretation of sputum quality on physician decision making. Quality of sputum was determined on Gram-stained smears by using a modification of the criteria of Bartlett (R. C. Bartlett, *Medical Microbiology: Quality, Cost, and Clinical Relevance*, p. 24-31, 1974). A total of 301 poor-quality specimens were randomized either to receive written interpretation of Gram stain results or to a control group for which Gram stain results were reported without interpretation. Physicians were more likely to follow up a poor-quality specimen with a second specimen if they had been furnished an interpretation of the results from the original Gram stain (22 versus 12%; $P = 0.025$). We conclude that laboratory-based interpretation of microbiologic results can improve physician decision making.

Many clinical microbiology laboratories do not pass judgment on the significance of isolates from patient specimens and instead report to clinicians all of their microbiologic findings. This policy leaves the responsibility for interpretation in the hands of physicians and reflects a belief that laboratory personnel, who typically possess limited clinical information about the specimens they process, are ill equipped to pass judgment on the importance of most isolates.

There are both merits and pitfalls to this cautious approach. Clinicians are more familiar than the laboratory staff with their particular patients, but their knowledge of clinical microbiology may be more limited. It is therefore surprising that the reliability of physicians' unaided interpretations of microbiologic results has received little attention.

The present prospective, blinded, randomized study was designed to evaluate the effects that laboratory interpretation of sputum specimen quality has on physician decision making. The reliability of sputum culture in the etiological diagnosis of acute bacterial pneumonia has been questioned on many occasions because of both the high incidence of oropharyngeal contamination and the frequent absence of lower respiratory tract material (1, 5, 18). When significant oropharyngeal contamination is evidenced in the cellular content of Gram-stained sputum smears, most authorities recommend trying to collect second specimens more representative of lower respiratory tract flora (2, 3).

In the present study, poor-quality sputum specimens were randomized either to receive written interpretations of Gram stain results or to a control group for which Gram stain results were reported without interpretation. We then determined whether physicians were more likely to collect repeat specimens if they had been furnished an interpretation of the original Gram stain.

MATERIALS AND METHODS

Patient population. The study population was drawn from inpatients at a 764-bed federally operated medical center that

serves as a major teaching hospital for an affiliated medical school. To be eligible for the study, patients had to have resided in the hospital sometime between 1 September 1986 and 28 February 1987 (6 months). Patients also had to have provided at least three sputum specimens to the microbiology laboratory during this time. We imposed this requirement because we knew on the basis of a previous audit at the study institution that many patients who provided fewer than three sputum specimens were being evaluated for febrile events and had low probabilities of pulmonary infection (H. H. Mizrachi and P. N. Valenstein, Abstr. Academy of Clinical Laboratory Physicians and Scientists, 1986). Since it would not have been appropriate to follow up poor-quality sputum specimens from many of these patients, they were not included in the analysis. This restriction had the effect of excluding many patients with acute bronchopneumonia from the study population, and as a result most patients in the study had infections superimposed upon chronic pulmonary disease.

Sputum quality. The quality of sputum specimens submitted to the laboratory was assessed with Gram-stained smears by using a modification of the rating system of Bartlett (4) that had been used in the laboratory for several years. Smears were scanned at low power (magnification, $\times 100$), and neutrophils and squamous epithelial cells were rated by licensed medical technologists from 0 through 3 according to the following criteria: less than 1 cell per field, 0; 1 to 9 cells per field, 1; 10 to 25 cells per field, 2; more than 25 cells per field, 3. Sputa with a neutrophil grade of 3 and an epithelial cell grade of 0 or 1 were considered good-quality specimens; all other specimens were considered to be of poor quality. By using this rating system in a previous investigation, good-quality specimens were found to have 1.6 times as many pathogenic isolates (*Streptococcus pneumoniae*, *Haemophilus influenzae*, *Staphylococcus aureus*, or members of the family *Enterobacteriaceae*) as poor-quality specimens and 30% fewer isolates from the upper respiratory tract (alpha-hemolytic streptococci and *Neisseria* species).

Randomization. Patients who provided sputum specimens to the laboratory were randomized into either a laboratory interpretation group or a control group that did not receive

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TABLE 1. Repeat specimens obtained after poor-quality sputum specimens with and without laboratory interpretation

Specimen group	No. of specimens		Follow-up rate (%)
	Total	With follow-up	
Interpretation	98	22	22.4
No interpretation	203	24	11.8 ^a

^a $P = 0.025$.

an interpretation of the Gram-stained smear. Randomization was done on the basis of the last digit of a patient's social security number and was begun 2 months before the study period to accustom physicians to receiving interpretations from the laboratory.

When a poor-quality sputum specimen from an interpretation-group patient was received in the laboratory, a gummed label was affixed to the result slip stating that the specimen was contaminated with oropharyngeal material and that a repeat specimen should be submitted. To reinforce the message that culture results might not reliably reflect lower respiratory tract flora, the sputum was not cultured. Only the label and Gram stain results were reported. If a physician called the laboratory for results, technologists were instructed to read the laboratory interpretation warning of oropharyngeal contamination and then to read the Gram stain results.

When a poor-quality specimen was received from a control-group patient, no label was attached to the laboratory report, and culture results were reported along with the Gram stain result. All good-quality specimens were cultured and reported in the same manner as control group specimens. To our knowledge, no physician outside of the laboratory was aware that specimens were being randomized or that physician response to the laboratory interpretations was being monitored.

Follow-up of poor-quality specimens. For each poor-quality specimen received in the laboratory, a record was made of whether a second, follow-up specimen was received within 36 h. If a follow-up specimen was obtained, the physician was considered to have responded appropriately to the fact that the original specimen was contaminated. The proportions of follow-up specimens obtained in the interpretation and control groups were compared by using the two-tailed critical ratio test (8).

RESULTS

Over the 6-month study period, 909 sputum specimens were received in the microbiology laboratory from 399 patients. Sixty-two percent of the specimens were considered to be of poor quality on the basis of Gram-stained smears.

Eighty-five inpatients provided the laboratory with 3 or more specimens during the study period (range, 3 to 20). Together, these patients furnished 504 specimens, of which 301 (60%) were of poor quality. The number of follow-up specimens submitted in response to these 301 poor-quality specimens is shown in Table 1. When a laboratory interpretation was supplied, the follow-up rate increased from 12 to 22% ($z = 2.23$; $P = 0.025$).

The value in obtaining a repeat sputum specimen after an initial poor-quality specimen is shown in Table 2. This table includes data from all patients who had follow-up specimens obtained within 36 h of an initial specimen. Twenty-three percent of sputa obtained after poor-quality specimens were of good quality (95% confidence interval, 14 to 32%).

DISCUSSION

Sputum is invariably contaminated with various amounts of saliva. The use of Gram-stained smears to assess the quality of sputum specimens has received considerable attention as a means for improving the reliability of sputum culture. In 1974, Bartlett proposed that the purity of sputum specimens be rated according to the relative concentrations of polymorphonuclear neutrophils, squamous epithelial cells, and mucus in Gram-stained smears (4). Since his initial report appeared, several others have proposed their own criteria for identifying good- and poor-quality sputum specimens on the basis of cellular content (9, 13, 14, 16, 17, 20, 21). Although the many rating systems in use have been difficult to validate clinically (6, 10), they have intuitive appeal, and several reviewers have warned against basing clinical decisions on culture results from poor-quality specimens (12, 15).

The present study was designed to examine whether the clinical microbiology laboratory should play an active role in interpreting the quality of sputum specimens based on Gram-stained smears. Before this study, our laboratory had routinely reported Gram stain results without interpretation. However, the present study suggests that when the laboratory interprets sputum smear results, physicians are significantly more likely to follow up poor-quality sputa with repeat specimens. This effect was observed even though the information necessary to come to the conclusion that a follow-up specimen was required—the numbers of neutrophils and squamous epithelial cells on Gram-stained smears—was available to clinicians for all poor-quality specimens, even those without a laboratory interpretation. The improvement in the follow-up rate that occurred because of laboratory interpretation was only modest. However, many of the patients who initially contributed poor-quality specimens showed clinical improvement before a repeat specimen could be obtained, obviating the need for follow-up. We therefore believe that the effect we observed was clinically as well as statistically significant.

These results raise anew issues about the proper place for laboratory interpretation of microbiologic data. While it may be convenient from a laboratory standpoint to play a passive role and leave all interpretation to clinicians, in some settings interpretations provided by the laboratory may improve physician decision making. Physicians who order microbiologic tests are a heterogeneous group, and the capabilities of the most able physicians who use the microbiology laboratory should not be an overriding consideration when setting laboratory policy about interpretive reporting. Infectious disease specialists, for example, recognize the technical limitations of most microbiologic tests and are unlikely to benefit from simple interpretive reminders. However, most routine testing is requested by house staff and specialists in other areas of medicine, who may not be as

TABLE 2. Quality of initial and repeat sputum specimens

Quality of specimen:		No. (%) of specimens
Initial	Repeat	
Poor	Poor	65 (77)
Poor	Good	19 (23)
Good	Good	42 (66)
Good	Poor	22 (34)

well informed. The needs of these clinicians also require attention.

Several studies have suggested that physician education fails to improve the use of laboratory tests (11, 19). Salutory effects that have been observed generally do not persist (7), perhaps because the impact of an education program is diluted over time by other demands for physicians' attention. In contrast to most educational efforts, however, laboratory interpretations of test results channel information to the physicians who can make the most use of it and at a time when the information will be the most useful. Further study will determine whether this intervention produces persistent improvements in physician decision making or whether the benefits gleaned from interpretive reporting also show extinction over time.

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