

Do Positive Anaerobic Culture Results Affect Physicians' Clinical Management Decisions?

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Background. Aerobic and anaerobic cultures from body fluids, abscesses, and wounds are ordered routinely. Prior studies have shown that the results of anaerobic blood cultures do not frequently lead to changes in patient management.

Methods. We performed a retrospective chart review to determine whether positive results of anaerobic tissue and fluid cultures (excluding blood) affect physicians' treatment approaches. Of 3234 anaerobic cultures, 174 unique patient admissions had positive cultures and met inclusion criteria.

Results. Only 18% (n = 31) of patient charts with positive cultures had documented physician acknowledgment (90.3% of acknowledgments by infectious diseases physicians), with 9% (n = 15) leading to change in antibiotic regimens based on results. Seventy percent of all patients received initial empiric antibiotics active against anaerobes. Of the remaining 30% (inappropriate, unknown, or no empiric coverage), 1 regimen change was documented after culture results were known.

Conclusions. Given the lack of management change based on results of anaerobic wound cultures, the value of routine anaerobic culturing is of questionable utility.

Keywords. anaerobic culture; body fluid culture; physician behavior.

Clinicians routinely order aerobic and anaerobic cultures when obtaining specimens from body fluids, abscesses, and deep wounds. Once specimens are collected, clinicians choose their initial, empiric antimicrobial regimen based on the likely pathogens at the site of infection, often selecting a broad-spectrum drug, or combination of drugs, to cover both aerobic and anaerobic organisms. Once culture results are available, the initial regimen may be refined to target the recovered pathogens. However, it is not clear that results translate into modifications. We investigated whether positive results of anaerobic cultures from body fluids/wounds/abscesses/bones affected clinician decisions about treatment, and hence whether the practice of routinely processing these specimens for anaerobic culture is a cost-effective use of microbiology laboratory resources.

There have been multiple retrospective cohort studies in academic and community hospitals, both in the United States and abroad, which reviewed the impact of routine aerobic and

anaerobic blood cultures on choice of definitive regimens. Many of these studies show that results of anaerobic blood cultures infrequently lead to changes in patient management, because recognition of the presence of clinical risk factors for anaerobic bacteremia has already led to inclusion of anaerobic coverage in the initial, empiric antimicrobial regimen [1–3]. Salonen et al [4] evaluated the impact of positive anaerobic blood culture results and found that 57% of the patients with positive cultures were already on appropriate treatment, 33% of patients had their treatment modified based on the culture results, but approximately 20% of patients with positive anaerobic blood cultures still did not have their treatment appropriately altered when results became available. The authors concluded that a selective approach in obtaining anaerobic cultures only from patients with a high pretest probability may result in cost-effective care and appropriate management [4]. Other studies have come to similar conclusions regarding lack of cost effectiveness of routine anaerobic blood cultures and recommend more selective testing [5, 6].

In contrast, some investigators have concluded that there is benefit in obtaining routine anaerobic blood cultures, because some of their study patients who were not considered at high risk of anaerobic infection grew clinically significant organisms only in the anaerobic cultures [7]. In addition, they argue that routine anaerobic blood cultures may actually be cost effective, to ensure coverage of anaerobes, if present, and to narrow spectrum if results are negative [8]. After extensive literature review, we found no prior studies addressing anaerobic cultures from specimens other than blood.

Received 16 August 2016; editorial decision 24 October 2016; accepted 27 October 2016.

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DOI: 10.1093/ofid/ofw236

METHODS

This study, approved by the Rutgers Health Sciences Institutional Review Board, was a retrospective chart review of all adult in-patients (age ≥ 18 years) who had positive anaerobic cultures from specimens other than blood in 2012. The Robert Wood Johnson University Hospital (RWJUH) Microbiology Laboratory provided a list of all the nonblood anaerobic cultures from January 1, 2012 to December 31, 2012. These included cultures from tissue, wounds, drainage from abscesses, bone, pleural fluid, ascitic fluid, synovial fluid, tympanic fluid, and cerebrospinal fluid (CSF). Anaerobic cultures are routinely performed on all wound and body fluid specimens (with the exception of joint fluid and peritoneal dialysis fluid) received in a sterile container and on others if an order is received by the microbiology laboratory at the discretion of the physician. Swab specimens for anaerobic culture must be transported in an anaerobic transport device, whereas tissues or body fluids are sent to the laboratory in sterile containers at room air in a biohazard bag. All anaerobic specimens are inoculated to prereduced (ie, anaerobic) culture media and cultured using Anoxomat Anaerobic Culture system (Advanced Instruments Inc., Norwood, MA). The RWJUH laboratory routinely incubates anaerobic culture specimens for 48 hours unless longer incubation is specifically requested by the ordering clinician based on a high index of suspicion for slow-growing anaerobic bacteria such as *Propionibacterium* species. This laboratory protocol is based on an internal quality assurance review that was later validated by an internal RWJUH study, which showed that a longer duration of incubation did not significantly increase the yield of anaerobes [9].

Culture data collected included specimen source, organism identification, and time to final report of anaerobic culture. For analysis, if a patient had multiple positive anaerobic cultures, they were grouped together if they were from the same culture site within 2 days and from the same admission. However, if cultures were collected from the same patient on multiple admissions, each admission was counted as a separate patient for data analysis.

Laboratory data and physician orders were obtained from our electronic medical record (EMR). During the period of this study, physicians at RWJUH had not yet begun to enter daily notes into the EMR, so the On-Base EMR system, which gives access to the scanned paper chart, was used for all other elements of data collection, including patient demographics (Table 1), assessment of clinician acknowledgment of positive culture results in daily progress notes, and changes in clinical management based on the results. Data collected included demographics (age, sex), comorbidities, the medical service the patient was admitted to during their inpatient stay, initial antibiotic regimen, acknowledgment in the chart of positive anaerobic culture results, changes in regimen based on results, and

Table 1. Patient Demographics

Characteristics	No. (%)
Age (mean)	55
Male	74 (48)
Comorbid Conditions	
Diabetes mellitus	34 (22)
Cancer	44 (29)
Abdominal pathology	38 (25)
Ob/Gyn	8 (5)
Microbiology	
Monomicrobial	118 (77)
Polymicrobial	36 (23)
Concomitant-positive aerobic culture	5 (3)

whether or not Infectious Diseases consultation was obtained. Anaerobic cultures were considered acknowledged by physicians if culture results were documented in the “Laboratory/Microbiology” or “Assessment/Plan” sections of the physician progress note.

RESULTS

Culture Data

During the study period, a total of 3234 body fluid/tissue cultures were collected from 1997 patients, and only 205 (6.3%) cultures were positive from 172 patients during a total of 180 hospital admissions. Twenty-six charts were excluded—21 charts of patients less than 18 years of age and 5 charts of patients who had their culture specimens collected as outpatients. A total of 174 cultures from 154 patient charts were included in the analysis.

Of the positive cultures, the highest yield was from abscesses (Table 2). The majority of anaerobic-culture positive abscesses were from intra-abdominal (76%, $n = 44$) or pelvic (12%, $n = 7$) sites. Pleural fluid specimens had the lowest yield of anaerobes (3 positive of 755). The average number of days it took to report final anaerobic culture results in the EMR was 4.5 days (range, 1–8 days), with the majority being reported in 3–5 days. Only 1 specimen, which grew *Peptoniphilus asaccharolyticus* (formerly *Peptostreptococcus*), took 12 days to final report. The majority of cultured anaerobes were *Bacteroides* species and *Prevotella* species (Table 3).

Table 2. Anaerobic Culture Positivity by Source

Specimen Type	No. of Anaerobic Cultures	No. of Positive Anaerobic Cultures	Percent Positive
Abdominal cavity fluid	336	20	6%
Wound/tissue/biopsy	1236	84	7%
Pleural fluid	755	3	0.4%
Abscess	308	58	18.8%
Miscellaneous*	599	40	7%

*Drainage fluid, tympanocentesis fluid, synovial/joint fluid, bone, bile, pelvic fluid, vitreous fluid, lymph node, gallbladder, appendix, gastric fluid, pericardial fluid, placenta, amniotic fluid, aspirate, other fluid not otherwise specified.

Table 3. Anaerobes Recovered

Bacteria	No. of Isolates
<i>Bacteroides</i> species	85
<i>Clostridium</i> species	14
<i>Fusobacterium</i> species	4
Mixed anaerobic flora	4
<i>Peptoniphilus asaccharolyticus</i>	5
<i>Peptostreptococcus</i>	6
<i>Porphyromonas gingivalis</i>	2
<i>Prevotella</i> species	43
<i>Propionibacterium acnes</i>	1
<i>Streptococcus constellatus</i>	1
<i>Tissierella praeacuta</i>	1
<i>Veillonella</i>	3

Patient Chart Data

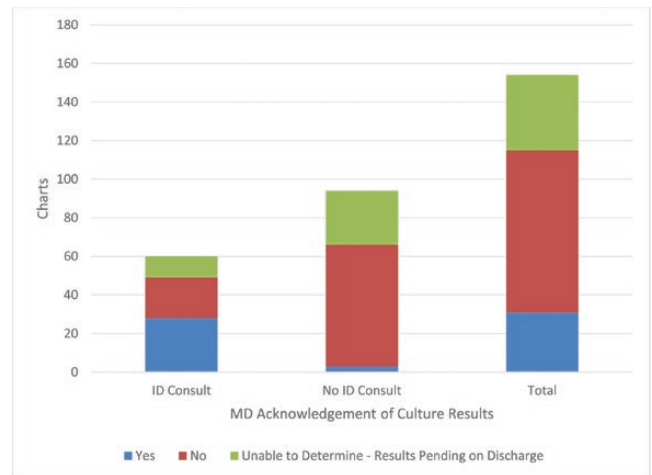
The vast majority (73%) of patients who had positive anaerobic nonblood cultures were on a surgical service (general surgery, surgical oncology, orthopedics, or gynecology). Of the 154 patients with positive cultures included in the analysis, 39 (25%) were discharged before reporting of culture results in the EMR, so it was not possible for physicians to acknowledge the positive cultures in progress notes during the hospitalization or to act on the results. However, of the 115 patients whose culture results were reported before discharge, only 31 had their cultures acknowledged by physicians (27%), mostly by infectious disease consultants (28 of 31 cases) (Chart 1), and only 15 of these cases had antibiotics changed based on the results. For 14 of 15 cases where antibiotics were changed, antimicrobial spectrum was narrowed. In the remaining case, antibiotic coverage was broadened. There were no antibiotic regimen changes in cases without physician acknowledgement.

Most patients were started on empiric antimicrobials that included anaerobic coverage (n = 115, 75%) before culture results. For the remaining 25% of patients, the culture result led to regimen change in only 1 patient.

DISCUSSION

This study demonstrates that positive anaerobic body fluid/tissue culture results infrequently affected physicians' treatment decisions. The majority of patients whose wound/fluid cultures grew anaerobes were already receiving empiric treatment with a regimen that was active against the anaerobes that ultimately grew, and very few antibiotic regimens were changed when definitive results became available. In addition, as a consequence of the time required for growth and identification of anaerobic species, final anaerobic culture results often only became available after patients had already been discharged, thereby not allowing physicians to acknowledge or tailor antibiotic regimens in the inpatient setting.

Our study suggests that there is little utility of routine anaerobic tissue/body cultures, because clinical management does not change based on the results. This finding may have

**Chart 1.** Acknowledgment of positive anaerobic culture results stratified by those patients with and without ID consultation.

major implications for laboratory-resource use and cost-saving practices. The RWJUH Microbiology Laboratory uses the Anoxomat standard system to grow anaerobic cultures. Patients are charged approximately \$58.00 per anaerobic culture using CPT code 87076. This suggests a significant opportunity for cost reduction. For example, in this study, pleural fluid specimens had low yield for anaerobes; and because the 3 patients who had positive anaerobic pleural fluid cultures were already on empiric antibiotics with anaerobic activity before the results, antibiotics were not altered. Eliminating 755 anaerobic cultures of pleural fluid alone could have potentially saved \$43 790 in addition to the microbiology laboratory technicians' time.

Our results suggest that eliminating routine anaerobic cultures and having a more selective approach may be cost saving. This selective approach should be based on (1) known yield of anaerobic cultures from different body sites and (2) clinical situations in which culture results would be likely to change clinical management and potential patient outcomes. One example would be performing anaerobic culture of CSF in a patient with a ventriculoperitoneal shunt, given the recognition of *Propionibacterium* as a significant pathogen in that setting. The key to such an approach is open communication between the requesting clinician and the microbiology laboratory.

This study has several limitations. We reviewed written progress notes for documentation that physicians acknowledged culture results. This approach may have underestimated awareness of results. With paper charts, all components of the progress note, including laboratory values, must be entered manually. Therefore, it is possible that physicians would not bother to document a finding that did not affect patient management (eg, positive anaerobic culture on a patient already receiving an antimicrobial that has anaerobic coverage). On the other hand, with the EMR, results of laboratory tests are often

inserted into a progress note via keyboard shortcuts, rather than by deliberate review of each individual result. If we were to repeat this study today, it would be difficult to assume that every laboratory value that was pasted was actually reviewed by the physician.

Another potential limitation is the premise that a lack of documentation or lack of change of antibiotics is equivalent to lack of utility of results, and therefore that cultures are not useful. One example would be that the positive anaerobic culture influenced the physician not to narrow the initial empiric antibiotic regimen to cover only the aerobes.

An additional limitation is that many patients were discharged before results were reported. It is unknown whether physicians may have changed antibiotics after discharge when the results became available at an outpatient encounter.

Finally, the low percentage of positive cultures may be a reflection of our institution's overzealous physicians, who may order cultures routinely when fluid is sampled for any reason (ie, therapeutic thoracentesis), regardless of whether there is any suspicion of infection. In addition, we were not able to differentiate the specific type of specimen that was sent to the laboratory—swab (anaerobic transport) versus tissue or fluid (exposed to air), which may affect the culture yield.

An additional caveat in assessing the relevance of any study report to current practice relates to the rapid changes in technology within the hospital and laboratory settings. Since this study was performed, in addition to the switch to EMR documentation of progress notes, our laboratory has implemented new methodologies for organism identification (matrix-assisted

laser desorption ionization-time of flight), which should allow for more rapid reporting of results.

CONCLUSIONS

More studies are needed to evaluate whether results of anaerobic cultures from specimens other than blood impact patient outcomes (ie, hospital length stay, readmission rates, and morbidity/mortality). If the findings are consistent with our results, we would question the utility of routinely performing anaerobic cultures on most nonblood specimens.

Acknowledgments

Potential conflicts of interest. All authors: No reported conflicts.

All authors have submitted the ICMJE Form for Potential Conflicts of Interest. Conflicts that the editors consider relevant to the content of the manuscript have been disclosed.

References

1. Chandler MT, Morton ES, Byrd RP Jr, et al. Reevaluation of anaerobic blood cultures in a Veteran population. *South Med J* **2000**; 93:986–8.
2. Iwata K, Takahashi M. Is anaerobic blood culture necessary? If so, who needs it? *Am J Med Sci* **2008**; 336:58–63.
3. Morris AJ, Wilson ML, Mirrett S, Reller LB. Rationale for selective use of anaerobic blood cultures. *J Clin Microbiol* **1993**; 31:2110–3.
4. Salonen JH, Eerola E, Meurman O. Clinical significance and outcome of anaerobic bacteremia. *Clin Infect Dis* **1998**; 26:1413–7.
5. Ortiz E, Sande MA. Routine use of anaerobic blood cultures: are they still indicated? *Am J Med* **2000**; 108:445–7.
6. Saito T, Senda K, Takakura S, et al. Anaerobic bacteremia: the yield of positive anaerobic blood cultures: patient characteristics and potential risk factors. *Clin Chem Lab Med* **2003**; 41:293–7.
7. Grohs P, Mainardi JL, Podglajen I, et al. Relevance of routine use of the anaerobic blood culture bottle. *J Clin Microbiol* **2007**; 45:2711–5.
8. Rosenblatt JE. Can we afford to do anaerobic cultures and identification? A positive point of view. *Clin Infect Dis* **1997**; 25(Suppl 2):S127–31.
9. Hameed N, Kirn TJ, Weinstein MP. Clinical utility of incubating anaerobic cultures 2 versus 5 days. In: IDweek 2013; Philadelphia, PA; Abstract #1423; **2014**.