Derivation and Validation of Guidelines for Stool Cultures for Enteropathogenic Bacteria Other Than Clostridium difficile in Hospitalized Adults

Tilman M. Bauer, MD
Ajit Lalvani, MRCP
Jürgen Fehrenbach, MD
Ingrid Steffen, MD
John J. Aponte, MD
Roberto Segovia, MD
Jordi Vila, MD
Gabi Philippczik, MD
Bernhard Steinbrückner, MD
Ian Bowler, MRCPath
Manfred Kist, MD

Context The yield of in-hospital stool cultures performed more than 72 hours after admission is low, and a commonly used policy dictates that laboratories reject these cultures to save costs. However, enteropathogenic bacteria other than Clostridium difficile (EPB) may cause nosocomial illness that would be missed by use of such a “3-day rule.”

Objective To develop guidelines for hospital use of stool cultures that are sensitive to clinically relevant cases of sporadic and epidemic nosocomial diarrhea.

Design Five-part study that incorporated a derivation sample based on retrospective chart review and a prospective cohort study (including cost savings analysis), and a validation sample based on retrospective chart review.

Setting Four European academic health care centers.

Patients Derivation sample: 1735 adult inpatients from whom 3416 stool cultures were obtained during a 19-month period (1995-1997) and 68 adult inpatients for whom EPB were grown from stool cultures during a 10-year period (1988-1998); validation sample: 65 patients with sporadic isolation of EPB (1993-1998), 56 patients involved in 2 nosocomial Salmonella outbreaks (1992 and 1997), and 330 patients who had stool cultures performed (1998).

Main Outcome Measure Performance of derived criteria in detecting pathogenic bacteria and outbreaks and reducing total number of stool cultures performed.

Results Stool cultures grew EPB in 3.3% of samples obtained ≤72 hours after admission and 0.5% of samples obtained thereafter (P<.001). Isolation of EPB >72 hours after admission was not associated with clinical symptoms or signs but was associated with community-acquired diarrhea (24%), age 65 years or older with pre-existing comorbid disease (25%), neutropenia (13%), HIV infection (10%), and non-diarrheal manifestations of enteric infections (16%). Twelve percent were asymptomatic carriers. These characteristics were used to create criteria for selecting patients for whom stool cultures would be indicated. These criteria were applied post hoc to a series of 1025 stool cultures; the number of stool cultures would have been reduced by 52% and no clinically significant cases would have been missed. Annual savings to a 355-bed institution would be approximately $7800 for reagent costs and 75 hours of technician time. In the validation samples, only 2 patients of 65 who had EPB would not have been identified, and neither required treatment. If the 3-day rule had been applied, 52 cases would not have been identified, 28 of which required antibiotic treatment.

Conclusion Our modified 3-day rule for use in selecting cases for stool culture is sensitive to sporadic and epidemic cases of nosocomial diarrhea in hospitalized adults.

JAMA. 2001;285:313-319 www.jama.com

See also Patient Page.
out the United States would result in savings of $20 million to $73 million (data for 1990 and 1996, respectively).6,7 This policy is now receiving increasing attention in Europe.3,8,9

Nosocomial diarrhea is most frequently an adverse effect of antibiotic administration or enteral tube feeding or a consequence of Clostridium difficile infection.10 However, “conventional” pathogens such as Salmonella, Yersinia enterocolitica, or Campylobacter may cause sporadic nosocomial diarrhea11 and nosocomial outbreaks.12,13 Prompt detection of such episodes would be compromised by the strict application of the 3-day rule. Therefore, exceptions to this rule such as immunosuppression4 and suspected outbreaks14 have been proposed. Neither modification has been evaluated as to its practicability, safety, and economic impact. Moreover, the definition of “immunosuppression” varies widely, and nosocomial outbreaks may be difficult or even impossible to suspect on clinical grounds.15,16 Therefore, we sought to develop a modified 3-day rule with precise criteria for performance of stool cultures in hospitalized patients and to test whether this modified 3-day rule would allow cost savings without negatively affecting patient care.

METHODS

Study Centers and Microbiological Methods

The University of Freiburg Hospital is an 1800-bed secondary and tertiary care center and includes a 355-bed department of internal medicine with approximately 19000 admissions and 121000 inpatient hospital days per year. The University Institute of Medical Microbiology and Hygiene performs approximately 2900 stool cultures in hospitalized patients per year, of which 74% are from the department of internal medicine.

Stool samples are routinely plated onto Endo agar, Leifson agar, and cefsulodin-irgasan-novobiocin agar. Additionally, 2 enrichment media for Salmonella species (Kauffmann broth and selenite broth) are inoculated and subcultivated after 24 hours on Endo agar, Rambach agar, and brilliant green agar. Cefsulodin-irgasan-novobiocin agar plates are incubated at 30°C for 48 hours, and all other media are incubated at 37°C for 24 hours. Samples submitted for the investigation of diarrheal flora are also inoculated onto blood-free selective Campylobacter agar (incubated at 37°C for 48 hours under microaerophilic conditions). Yersinia cold enrichment in saline (at 4°C for 7 days) is performed when clinically indicated. Enterohemorrhagic and enteropathogenic Escherichia coli are searched for when clinically indicated by means of a verotoxin enzyme-linked immunosorbent assay (Premier EHEC Test Kit, Meridian Diagnostics, Cincinnati, Ohio) and serotyping, respectively. Organisms analyzed for the purpose of this study were Salmonella species, Shigella species, Campylobacter species, Yersinia species, enterohemorrhagic and enteropathogenic E coli, and Vibrio species. Clotstridium difficile–toxin A/B is determined by an enzyme-immune assay (Ridascreen, R-Biopharm, Darmstadt, Germany).

The independent evaluation was performed in 3 European secondary and tertiary academic health centers: University Hospital Basel, Basel, Switzerland (900 beds, 1300 stool cultures from hospitalized patients per year), Hospital Clinic, Barcelona, Barcelona, Spain (900 beds, 1200 stool cultures per year), and the Oxford Radcliffe Hospitals NHS Trust, Oxford, England (1380 beds, 3700 stool cultures per year). These institutions had no standard culture criteria in place at the time of the study and none routinely used empirical treatment for nosocomial diarrhea. Patients with Salmonella or Shigella infection are generally treated with antibiotics; patients with Campylobacter or Yersinia infections are treated on an individualized basis. Because the study was observational with patient confidentiality maintained, the University Hospital Freiburg institutional review board waived the requirement for informed consent.

Study Design

The study comprised 5 parts (TABLE 1). Part 1 was performed to provide baseline information about the practice of ordering stool cultures and stool culture yield among adult (≥18 years) patients at the University of Freiburg Department of Internal Medicine. All stool cultures and tests for C difficile toxin (for comparison purposes) performed between November 1995 and October 1996 were analyzed retrospectively. Data collected included patient identification number and date of admission, date of stool specimen, number of specimens obtained during admission, and microbiological results.

Part 2 was a 7-month prospective survey in adult medical inpatients for whom stool cultures had been ordered by ward staff, conducted to identify patient characteristics that were predictors of stool culture positivity. In addition to the data obtained in part 1, patient charts were reviewed on the day their sample was received by the laboratory. Data evaluated included a recent family history of diarrhea or recent travel outside of Europe, the presence of nausea or vomiting, 8 or more bowel movements per day, temperature exceeding 38°C, and presence of abdominal pain or tenderness.

Part 3 was a retrospective chart review designed to identify risk factors for stool culture positivity in hospitalized adults. All patients from any hospital department with a stool culture growing enteropathogenic bacteria other than C difficile over a 10-year period (April 1988–October 1996 and June 1997–October 1998) were reviewed. Data obtained were the same as those in part 1, plus the day of onset of diarrhea, reason(s) for performing stool culture, preexisting comorbidity, use of immunosuppressive drugs, and peripheral neutrophil count on the day the stool culture was performed.

In part 4, criteria for the performance of stool culture were defined and applied post hoc to the data of part 2. Part 5 consisted of an independent validation of the criteria at 3 different institutions. We assessed the sensitivity of the criteria by performing 4- to 6-year
reviews of all stool cultures growing enteropathogenic bacteria other than *C. difficile* from hospitalized patients (analogous to part 3). We also studied the impact of our criteria on the detection of nosocomial *Salmonella* outbreaks that had occurred in 2 study centers. We evaluated the efficiency of our proposed criteria by retrospectively determining the percentage of stool cultures that would not have been submitted under the premises of the criteria during a consecutive 2-month period.

Definitions

Comorbidity was defined as any preexisting disease that resulted in permanently altered organ function, eg, cirrhosis, end-stage renal failure, chronic obstructive pulmonary disease, active inflammatory bowel disease, leukemia, or hemiparesis due to cerebrovascular accident. **Immunosuppression was defined as human immunodeficiency virus (HIV) infection, leukemia, malignant lymphoma, plasmacytoma, cirrhosis, diabetes mellitus, end-stage renal failure, and use of cytotoxic or immunosuppressive drugs or corticosteroids at dosages equivalent to or greater than 20 mg/d of prednisone.** Nosocomial diarrhea was defined as the onset of 3 or more soft or liquid bowel movements at least 72 hours after admission, and neutropenia as a peripheral neutrophil count of less than 0.5 × 10⁹/L. The yield of stool culture was defined as the proportion of stool cultures growing enteropathogenic bacteria other than *C. difficile* that had not been previously reported in that patient, ie, first positive reports. The cost of reagents needed for the processing of an average negative stool culture was calculated on the basis of 100 consecutive negative stool cultures and amounted to $6.90 (EUR 4.62). Technician time required for the processing of an average negative stool culture was estimated at 4 minutes.

**Statistical Methods**

Comparisons of proportions were done using the χ² or Fisher exact test where appropriate. Positivity rates from parts 1 and 2 were combined using the Mantel-Haenszel method. Heterogeneity of positivity rates between study periods was evaluated using the χ² test for interactions.

### RESULTS

**Yield of Stool Cultures From Hospitalized Adults (Parts 1 and 2)**

During the 12-month and 7-month periods of parts 1 and 2, 2391 and 1025 stool cultures were analyzed, respectively, of which 21 (0.9%) and 13 (1.3%) yielded first positive results of enteropathogenic bacteria other than *C. difficile*. These positivity rates do not differ significantly (P = .21), and therefore results of parts 1 and 2 were combined for the purpose of the following analyses. A total of 3416 stool cultures from 1735 patients (mean age, 49 years; 49% men) during 1820 admissions were included. First positive results were obtained from 34 stool cultures (1.0%): *Salmonella* species in 17, *Campylobacter* species in 10, *Yersinia* species in 6, and enterohemorrhagic *E. coli* in 1 case. Eighty-five percent of first positive results were obtained from the first specimen from a given patient, the remainder from the second (5%) or third (10%) specimen.

A total of 2818 stool cultures (82.5%) were collected more than 72 hours after admission (FIGURE). The yield of SC>3d was more than 6-fold lower than parts 1 and 2.

<table>
<thead>
<tr>
<th>Table 1. Study Design*</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Part of Study</strong></td>
</tr>
<tr>
<td>Derivation</td>
</tr>
<tr>
<td>2</td>
</tr>
<tr>
<td>3</td>
</tr>
<tr>
<td>Validation</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>5b</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>5c</td>
</tr>
</tbody>
</table>

*Ellipses indicate not applicable.

©2001 American Medical Association. All rights reserved.
Figure. Distribution of Stool Cultures and Yield for Enteropathogenic Bacteria Other Than Clostridium difficile According to Day of Hospitalization

<table>
<thead>
<tr>
<th>Day of Hospitalization</th>
<th>No. of Stool Cultures</th>
<th>Yield, %</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-3</td>
<td>598</td>
<td>3.3</td>
</tr>
<tr>
<td>4-8</td>
<td>764</td>
<td>0.7</td>
</tr>
<tr>
<td>9-31</td>
<td>1519</td>
<td>0.6</td>
</tr>
<tr>
<td>&gt;31</td>
<td>535</td>
<td>0</td>
</tr>
</tbody>
</table>

Data represent stool cultures collected during the combined 19-month period of study parts 1 and 2 (n=3416).

Table 2. Characteristics of Patients in Whom Enteropathogenic Bacteria Other Than Clostridium difficile Were Isolated More Than 3 Days After Admission (n = 68)*

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>No. (%) of Patients</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nosocomial diarrhea</td>
<td></td>
</tr>
<tr>
<td>Age &gt;65 years</td>
<td>17 (25)</td>
</tr>
<tr>
<td>with preexisting comorbidity</td>
<td></td>
</tr>
<tr>
<td>Neutropenia‡</td>
<td>9 (13)</td>
</tr>
<tr>
<td>HIV infection</td>
<td>7 (10)</td>
</tr>
<tr>
<td>Community-acquired diarrhea§</td>
<td>16 (24)</td>
</tr>
<tr>
<td>Nondiarrheal manifestation of enteric infection§</td>
<td>11 (16)</td>
</tr>
<tr>
<td>Asymptomatic carrier§</td>
<td>8 (12)</td>
</tr>
</tbody>
</table>

*Based on 10-year retrospective chart review (part 3 of the study). HIV indicates human immunodeficiency virus.
‡Defined as neutrophil count <0.5 x 10^9/L.
§Diagnosed more than 72 hours after admission when samples had not been provided within the first 3 days or when the first sample was negative.
§§Mesenteric lymphadenitis, acalculous cholecystitis, fever of unknown origin, polyarthritis, erythema nodosum.

Table 3. Proposed Guidelines for Stool Cultures in Hospitalized Adults (Modified 3-Day Rule)*

- Obtain stool culture in the presence of:
  - Community-acquired diarrhea (if onset =<72 h of admission)
  - Nosocomial diarrhea (if onset >72 h of admission) AND at least 1 of the following:
    - Age <=65 years with preexisting comorbidity
    - HIV infection
    - Neutropenia
    - Suspected nosocomial outbreak
    - Suspected nondiarrheal manifestations of enteric infections
- Maximum of 2 repeat examinations in a given patient

*For definitions of preexisting comorbidity see the “Methods” section. For definitions of neutropenia and suspected nondiarrheal manifestations of enteric infections, see Table 2. HIV indicates human immunodeficiency virus.

Table 4. Proposed Criteria for Stool Cultures and Cost Savings (Part 4)

- Exemption of immunosuppressed patients
- Additional 3-day rule with and without the exclusion of immunosuppressed patients

Definition of Criteria for Stool Cultures and Cost Savings (Part 4)

We defined criteria for stool cultures in hospitalized adults that would have identified all positive non-C difficile SC>3d obtained during the 10-year period of part 3 (Table 3). These criteria and the traditional 3-day rule with and without the exemption of immunosuppressed patients were retrospectively applied to the patient series of part 2 to compare their impact on laboratory workload and the ability to identify sporadic cases of nosocomial diarrhea due to enteropathogenic bacteria other than C difficile (Table 4). Immunosuppression (as defined in the “Methods”) was present in 224 of 341 patients (65.7%) examined more than 72 hours after admission, accounting for 74.4% of processed SC>3d. A total of 119 patients (34.9%) fulfilled 1 of our proposed criteria, accounting for 307 (36.7%) of SC>3d. Submission of only those samples would have increased the yield of SC>3d from 0.8% to 2.0%. All first positive results would have been detected with the exception of a 45-year-old patient who had undergone renal transplantation and had C difficile–associated diarrhoea with an isolate of uncertain pathogenicity (Y enterocolitica biovar 1 without virulence plasmid pYV).24

Reagent costs and technician time saved by omitting 63.3% of SC>3d in the Freiburg 355-bed department of internal medicine would amount to approximately $7800 (EUR 5200) and 75 hours annually, equivalent to total savings to the hospital of approximately $10500 (EUR 7000) annually. Based on US cost estimates, the total reagent cost and technician time savings would be approximately $10300 and 356 hours annually.

Independent Evaluation of Criteria (Part 5)

Four- to six-year reviews of positive stool cultures from hospitalized medical and
surgical patients were performed at university hospitals in Basel, Barcelona, and Oxford. Over a total cumulative period of 14 years during which an estimated 27,000 stool cultures from hospitalized patients were collected, 65 patients were identified in whom enteropathogenic bacteria other than C difficile were grown from SC>3d (Table 5). Only 1 patient each from Basel and Barcelona was not covered by the criteria: a 45-year-old woman following bone marrow transplantation in whom Y enterocolitica was grown from a culture obtained 4 days after recovery from neutropenia; and a 60-year-old man with cirrhosis and melena with Campylobacter species grown 4 days after admission. Neither patient required treatment. Conversely, the unmodified 3-day rule would have missed 52 patients with nosocomial diarrhea related to enteropathogenic bacteria, 28 of whom required antibiotic treatment.

A series of 168 and 162 consecutive stool cultures obtained from hospitalized patients over 2-month periods were reviewed in Basel and Barcelona, respectively (Table 5). The percentage of SC>3d collected that could have been avoided by application of the criteria was 47% and 62%, respectively.

**Effect of Criteria on Detection of Outbreaks**

Two food-borne nosocomial Salmonella outbreaks were analyzed. The Basel outbreak of 1992 with S enteritidis affected 42 patients over 21 days, and the Barcelona outbreak of 1997 with Salmonella species of group C2 involved 14 patients over 17 days. In both outbreaks the first 5 cases occurred on 5 nonadjacent wards and therefore they were not suspected by ward staff. The outbreaks were recognized by the microbiology laboratory after isolation of the second nosocomial Salmonella strain within a short period. Had the 3-day rule been applied, the outbreaks would have been suspected at the earliest after the second case on a given ward, which was the sixth case in both outbreaks. This would have resulted in a delay of detection of at least 1 and 9 days, corresponding to 6 and 34 excess patient-days of diarrhea in Basel and Barcelona, respectively. Under the premises of our modified 3-day rule, 79% and 64% of patients, respectively, would have had stool cultures even in the absence of a suspected cluster. Therefore, both outbreaks would have been detected after the third case. In Basel, this would not have delayed recognition because cases 2 through 5 occurred on the same day. The Barcelona outbreak would have been diagnosed 4 days later, causing an excess of 10 patient-days of diarrhea.

**COMMENT**

Our study demonstrates a low yield of stool cultures obtained from hospitalized patients, confirming previous reports from the United States and various European countries. At the Freiburg University Hospital, enteropathogenic bacteria other than C difficile are grown from 0.5% of cultures obtained more than 3 days after admission, compared with a 10-fold higher yield of tests for C difficile-toxin A/B. Thus, testing for C difficile infection and consideration of noninfectious causes such as antibiotic-associated or osmotic diarrhea should be the first steps in the evaluation of nosocomial diarrhea. However, enteropathogenic bacteria other than C difficile may cause nosocomial diarrhea sporadically in elderly or immunosuppressed patients or during hospital outbreaks.

We designed a comprehensive list of criteria for stool cultures that would have identified all positive cultures in hospitalized patients over a 10-year period. Retrospective application of the criteria to a consecutive series of 1023 stool cultures showed that more than half of the cultures from hospitalized patients could have been avoided, resulting in substantial cost and time savings. Time savings were calculated based on laboratory time only and do

---

**Table 4. Theoretical Impact of Stool Culture Guidelines on Cultures Processed and Detection of Enteropathogenic Bacteria**

<table>
<thead>
<tr>
<th>Guideline</th>
<th>Total Stool Cultures, No. (%)</th>
<th>SC&gt;3d, No. (%)</th>
<th>Positive Yield, No. (%)</th>
<th>Enteropathogenic Bacteria Detected, %</th>
</tr>
</thead>
<tbody>
<tr>
<td>All stool cultures</td>
<td>1025 (100)</td>
<td>836 (100)</td>
<td>13 (1.3)</td>
<td>100</td>
</tr>
<tr>
<td>Original 3-day rule</td>
<td>189 (18.4)</td>
<td>0</td>
<td>6 (3.2)</td>
<td>46</td>
</tr>
<tr>
<td>Original 3-day rule plus SC&gt;3d</td>
<td>805 (78.5)</td>
<td>622 (74.4)</td>
<td>12 (1.5)</td>
<td>92</td>
</tr>
<tr>
<td>Original 3-day rule plus SC&gt;3d in patients with proposed indications†</td>
<td>496 (48.4)</td>
<td>307 (36.7)</td>
<td>12 (2.4)</td>
<td>92</td>
</tr>
</tbody>
</table>

†Based on 7-month prospective series (study part 2). SC>3d indicates stool cultures performed more than 3 days after hospital admission. For definition of immunosuppression, see the “Methods” section.

**Table 5. Evaluation of Sensitivity and Efficiency of Proposed Criteria**

<table>
<thead>
<tr>
<th>Center (Study Period)</th>
<th>SC&gt;3d Positive/Period (SC&gt;3d/Year)</th>
<th>Cases Not Identified by Criteria, No.</th>
<th>Total No. of Stool Cultures†</th>
<th>SC&gt;3d, No. (%)</th>
<th>SC&gt;3d Not Covered by Criteria, No. (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Basel (1993-1998)</td>
<td>19/6 y (3.2)</td>
<td>1</td>
<td>168</td>
<td>120 (71)</td>
<td>56 (47)</td>
</tr>
<tr>
<td>Barcelona (1995-1998)</td>
<td>32/4 y (8.0)‡</td>
<td>1</td>
<td>162</td>
<td>133 (82)</td>
<td>83 (62)</td>
</tr>
<tr>
<td>Oxford (1995-1998)</td>
<td>14/4 y (3.5)</td>
<td>0</td>
<td>ND</td>
<td>ND</td>
<td>ND</td>
</tr>
</tbody>
</table>

†Consecutive series of cultures processed in November and December 1998.

‡Fourteen of 32 patients were affected by a nosocomial Salmonella outbreak. Excluding those 14 patients, the number of SC>3d per year would be 4.5.
not reflect potential savings realized by clinicians and nurses. The independent evaluation of this modified 3-day rule at 3 European university hospitals confirmed its excellent safety profile and potential for cost savings.

Sporadic bacterial diarrhea may occur after nosocomial exposure to enteropathogenic bacteria other than C difficile or following their overgrowth during antibiotic treatment in previously asymptomatic carriers.25 We found 2 distinct forms of immunosuppression to be associated with an increased risk for this occurrence: chemotherapy-associated neutropenia and HIV infection. Exempting all other patients with immunosuppression from the 3-day rule as suggested previously would greatly reduce if not eliminate the economic impact of the culture policy without increasing its yield. A third and hitherto unrecognized group of patients at risk is persons aged 65 years or older with preexisting comorbidity. The omission of SC>3d in all patients aged 65 years or older would have impaired patient safety: 18 cases of sporadic nosocomial bacterial enteritis in elderly patients at the Freiburg University Hospital would have been missed over a period of 10 years. On the other hand, no diagnosis of nosocomial diarrhea due to enteropathogenic bacteria other than C difficile in patients aged 65 years or older without preexisting comorbidity was identified in the retrospective analyses performed in 4 centers, comprising approximately 50,000 stool cultures from hospitalized patients.

Our review found that nosocomial diarrhea accounted for only half of the positive SC>3d, and community-acquired diarrhea was the second largest group. This may be due to delayed diagnostic workup and negative initial cultures: up to 3 specimens may be necessary to detect 99% of pathogens.1,3 A third group of conditions yielding positive cultures at any time after admission are nonidiopathic manifestations of enteric infection, such as mesenteric lymphadenitis, acalculous cholecystitis,20 or extra-abdominal signs such as reactive arthritis, erythema nodosum, or pyrexia of unknown origin.21 Finally, stool cultures on selective medium for Listeria species may be indicated when a Listeria infection or a food-borne outbreak is suspected.

Outbreaks of nosocomial bacterial enteritis27 may cause high morbidity and mortality rates12 and require rapid recognition and treatment.28 They are readily recognized clinically when a large percentage of patients is affected.28 However, episodes with low attack rates may be identifiable only by the microbiology laboratory when an identical pathogen is isolated from 2 or more seemingly sporadic cases of nosocomial diarrhea.13,16,29-31 The detection of such outbreaks will inevitably be delayed by any kind of laboratory rejection policy. The original 3-day rule would have significantly delayed the recognition of the 2 outbreaks we analyzed. It is probable that further nosocomial transmission and spread of the outbreak would have occurred during this delay. In contrast, our modified 3-day rule addresses this problem by routinely allowing for stool cultures in compromised patients who are likely to develop symptomatic intestinal disease and require antibiotic treatment.33 The delay in the laboratory-based recognition of these outbreaks would have been minimized and no vulnerable patients requiring antibiotic treatment would have been missed.

In conclusion, we have defined criteria for stool cultures in hospitalized patients that greatly reduce the laboratory burden of stool culture, yet provide rapid diagnosis for patients at increased risk of nosocomial bacterial gastroenteritis. Our criteria are based on readily available patient characteristics and can be applied easily by ward staff ordering cultures. The applicability of these criteria to other centers can be assessed by simple surveys. Inclusion of these criteria into hospital guidelines and teaching programs may help refine test ordering patterns by physicians, as has successfully been shown for previous stool culture policies.14 Laboratory expenses can thus be limited in an era of increasing cost constraint without compromising individual patient care.

Author Affiliations: Department of Internal Medicine II (Drs Bauer, Feilenbach, and Philippczik) and Institute of Medical Microbiology and Hygiene (Dr Steinbrücker and Kist), University Hospital, Freiburg, Germany; Nuffield Department of Clinical Medicine, University of Oxford (Dr Lalvani), and Department of Microbiology, John Radcliffe Hospital (Dr Bowler), Oxford, England; Bacteriological Laboratory, University Hospital Basel, Basel, Switzerland (Drs Steffen and Frei); and Departments of Microbiology (Dr Vila), Gastroenterology and Hepatology (Dr Segovia), and Epidemiology and Biostatistics Unit (Dr Aponte), Hospital Clinic, IDIBAPS, University of Barcelona, Barcelona, Spain.

Author Contributions: Dr Bauer participated in study concept and design, acquisition of data, analysis and interpretation of data, drafting of the manuscript, and critical revision of the manuscript for important intellectual content. Dr Lalvani participated in acquisition of data, analysis and interpretation of data, drafting of the manuscript, and critical revision of the manuscript for important intellectual content. Dr Steffen participated in acquisition of data, analysis and interpretation of data, critical revision of the manuscript for important intellectual content, and statistical expertise. Drs Vila, Frei, and Bowler participated in acquisition of data, critical revision of the manuscript for important intellectual content, and administrative, technical, or material support. Dr Kist participated in study concept and design, acquisition of data, critical revision of the manuscript for important intellectual content, administrative, technical, or material support, and supervision of the study. Acknowledgment: We are obliged to Hubert E. Blum, MD, Department of Medicine, University Hospital, Freiburg, Germany, for stimulating contributions to the study design, data interpretation, and the manuscript. We thank the medical and nursing staff of the Department of Internal Medicine II and the technical staff at the Institute of Medical Microbiology and Hygiene for their cooperation and Ellen Weber for secretarial assistance.

REFERENCES
7. Siegel DL, Edelstein PH, Nachamkin I. Inappropri
ate testing for diarrheal diseases in the hospital. JAMA. 1990;263:979-982.