Objective: To determine whether simply being made continually aware of the hospital costs of daily phlebotomy would reduce the amount of phlebotomy ordered for nonintensive care unit surgical patients.

Design: Prospective observational study.

Setting: Tertiary care hospital in an urban setting.

Participants: All nonintensive care unit patients on 3 general surgical services.

Intervention: A weekly announcement to surgical house staff and attending physicians of the dollar amount charged to nonintensive care unit patients for laboratory services during the previous week.

Main Outcome Measure: Dollars charged per patient per day for routine blood work.

Results: At baseline, the charges for daily phlebotomy were $147.73/patient/d. After 11 weeks of residents being made aware of the daily charges for phlebotomy, the charges dropped as low as $108.11/patient/d. This had a correlation coefficient of −0.76 and significance of $P=0.002$. Over 11 weeks of intervention, the dollar amount saved was $54,967.

Conclusion: Health care providers being made aware of the cost of phlebotomy can decrease the amount of these tests ordered and result in significant savings for the hospital.

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The use of laboratory tests has been rapidly increasing over the past few decades to the point where phlebotomy is a substantial proportion of hospital expenditure, and much of it is unwarranted. Many institutions have implemented interventions to reduce the amount of laboratory tests per patient. Interventions with significant results have been to (1) modify computerized ordering systems to limit options (T. Rosenbloom, MD, MPH, Department of Biomedical Informatics, Vanderbilt University, written communication, March 2007), (2) not allow tests to be ordered on a recurring basis, necessitating daily re-evaluation; (3) install pop-up reminders of what seem to be redundant tests; (4) require clerical justification for each test ordered by the ordering physician, and (5) unbundle tests so each specific value must be ordered separately (T. Rosenbloom, MD, MPH, Department of Biomedical Informatics, Vanderbilt University, written communication, March 2007).

When ordering tests, most providers are unaware of the charge incurred to the patient. One study showed no significant difference in test ordering behavior when displaying charges for ancillary services at the time of ordering. However, other studies have shown quite the opposite. One performed in a teaching hospital, when combining computer-based intervention with lectures on economic implications of laboratory testing, showed a 3-year savings of close to $2 million.

Moreover, no adverse effects have been associated with reducing the number of laboratory tests performed. Across multiple studies, there has been no difference in readmission rates, transfer to intensive care unit, length of stay, diagnoses, or mortality when laboratory tests have been significantly decreased.

At our particular hospital, we had the same problem of unnecessary phle-
botomy orders for our postsurgical patients. Many patients were ordered to have complete blood cell counts and chemistry panels for days after their operation, even when they were recovering well. The habit of daily laboratory test ordering was perpetuated by senior residents who asked for the “lab list” from their junior counterparts without offering much instruction as to when these laboratory tests are actually warranted. Additionally, surgical residents currently have no way of knowing the costly effects of these ordering habits.

Potential solutions aimed at busy surgical house staff are few. Our particular hospital had both bundled and unbundled options for ordering tests, though the bundled option was used far more frequently. Attempting to change the hospitalwide computer system was unrealistic, and many of the interventions shown to have influenced behavior in previous studies had already been implemented, but with seemingly less effect. Any kind of senior oversight of laboratory test ordering was also not realistic on a surgical service since the senior members of the team are in the operating room. This differs significantly from an internal medicine service. A series of lectures on the subject is also difficult for the same time-constraint reasons.

Given the success of alerting physicians of the monetary costs of their actions, this seemed potentially the most effective and efficient intervention for changing the behavior of busy surgical residents. The hypothesis was that simply being made continually aware of the hospital costs of daily phlebotomy would, over time, reduce the amount of phlebotomy ordered for nonintensive care unit surgical patients.

Table. Dollars per Patient per Day and Cost Savings

<table>
<thead>
<tr>
<th>Week</th>
<th>$/Patient/d</th>
<th>Weekly Cost Savings, $</th>
</tr>
</thead>
<tbody>
<tr>
<td>Baseline</td>
<td>147.73</td>
<td>2149</td>
</tr>
<tr>
<td>Week 1</td>
<td>140.02</td>
<td>7805</td>
</tr>
<tr>
<td>Week 2</td>
<td>142.40</td>
<td>1524</td>
</tr>
<tr>
<td>Week 3</td>
<td>126.30</td>
<td>5400</td>
</tr>
<tr>
<td>Week 4</td>
<td>122.80</td>
<td>5599</td>
</tr>
<tr>
<td>Week 5</td>
<td>141.23</td>
<td>1541</td>
</tr>
<tr>
<td>Week 6</td>
<td>141.46</td>
<td>1267</td>
</tr>
<tr>
<td>Week 7</td>
<td>118.62</td>
<td>6957</td>
</tr>
<tr>
<td>Week 8</td>
<td>108.11</td>
<td>9667</td>
</tr>
<tr>
<td>Week 9</td>
<td>122.21</td>
<td>6941</td>
</tr>
<tr>
<td>Week 10</td>
<td>118.93</td>
<td>7805</td>
</tr>
<tr>
<td>Week 11</td>
<td>118.83</td>
<td>6156</td>
</tr>
<tr>
<td>Total</td>
<td>54967</td>
<td></td>
</tr>
</tbody>
</table>

The study was a prospective observational and interventional study approved by the institutional review board. Consent was waived, as there was no direct intervention in patient care. There are 3 general surgical services at Rhode Island Hospital. Baseline monitoring of laboratory test ordering took place daily for an initial observational period of 2 weeks. The data were collected by printing a daily patient list for each service, which included the complete blood cell count and chemistry panel, if obtained, for each patient. These particular tests were studied since they are the only laboratory test values that appear on the printable patient census system at our hospital. If a test for a value such as hemoglobin was ordered individually, without the rest of the complete blood cell count, this would appear as such on the patient census but not be counted as a complete blood cell count for purposes of the study. However, this occurrence of individual “unbundled” orders was exceedingly rare among the providers studied.

Test values then counted from the printed census were number of patients on the floor, number of complete blood cell counts for these patients, and number of chemistry panels for these patients. The charges submitted to these patients’ providers for daily laboratory services could then be quantified based on values obtained from the hospital billing department. The dollar amounts charged for these particular tests were as follows: complete blood cell count, $56; total chemistry panel 7, $169.09 (M. McAlister, Billing Department, Rhode Island Hospital, oral communication, July 2007).

The study intervention was a weekly announcement to surgical house staff and attending physicians, during an educa-

The outcome measure of dollars per patient per day decreased over the course of the intervention, with a correlation coefficient of −0.76 (P = .002). The lowest weekly value reached was $108.11/patient/d, a decrease of 27% from baseline charges. The lowest overall charges per week were $25 311. The cost savings per week were calculated as the baseline dollars per patient per day minus the actual dollars per patient per day times the number of patients for that week. The decrease in weekly charges started at $2149 at the beginning of the intervention and went as high as $9667 in 1 week toward the end of the intervention. This number may not correlate directly with the primary outcome of dollars per patient per day since the number of patients varied from week to week. Added up consecutively, the total cost savings over the course of the intervention amounted to $54 967 over 11 weeks (Table).

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The weekly value of dollars per patient per day did not decrease every week, although the overall trend was highly significant ($P = .002$). There were 2 weeks where the value increased significantly from the week prior. These weeks coincided with the interns switching services; thus, the population hearing the weekly announcement was different from the prior 4 weeks (Figure).

**Figure.** Weekly value of dollars per patient per day for all services.

Several studies in the past have shown that physician ordering behavior, specifically phlebotomy, can be affected by different interventions. All of these prior studies have incorporated multiple different interventions in an effort to decrease the amount of unnecessary tests ordered. In this study, we focused on simply providing the economic implications of wasteful ordering habits, specifically regarding phlebotomy. This study successfully showed that even without technical and time-consuming interventions, test ordering behavior can be greatly reduced by making health care providers aware of costs. Moreover, the cost of instituting this intervention was negligible, adding to its efficacy. There is, at least in the United States, a disconnect between health care providers, consumers, and the cost of the service. Neither the patient nor the provider is usually aware of the costs involved in their care, since this aspect is overseen by third parties. Patients may only become aware of the costs after their hospital stay, and providers, especially on the resident level, may never know the cost of care provided. With health care costs rising out of control, perhaps routinely informing providers of costs would decrease overall expenditure, as occurred in this study.

However, it may be argued that cost does not equal charge, and this study measured only charges, not reimbursement or true cost. The prior studies cited on reducing blood work used either a percentage of reduction in tests ordered or Medicare reimbursement rates to estimate cost savings. Understanding that reimbursement rates of hospital services are highly variable, we chose to use charges as a standard measurement since they were easy values to obtain and were specific to our hospital. The calculated cost savings would certainly be lower if Medicare reimbursement rates were used instead of charges, but our patients had a multitude of third-party providers. Thus, we did not feel Medicare rates would be applicable to our patient population as a whole.

The limitations of this study are admittedly its short interval and the inability to prove sustainability. The prior studies mentioned that achieved a reduction in phlebotomy had interventions that lasted for years. This study shows that the same effect can be obtained by a much shorter and cheaper intervention. If practice patterns can be changed in a few weeks, perhaps lengthier efforts to achieve the same goal are not necessary. It does remain unclear how long the intervention used would be effective or even whether the same results could have been achieved within an even shorter period.

Probably the greatest weakness of this study is the lack of follow-up data. Since the intervention occurred from February to May, the study population of interns completely changed 1 month after study completion. Looking at laboratory test ordering habits several months after the intervention would not yield any useful information since the providers ordering phlebotomy then were not around during the time of intervention. Thus, there was really no good way of measuring durability after the intervention.

Finally, it is very likely that the results of this study are actually an underestimate of the cost savings in reducing phlebotomy. Gathering data by printing a daily census meant that only a single blood draw could be counted for a given patient for that day. There were likely some patients who had more than 1 blood draw during a 24-hour period. Additionally, this study had no way to account for the cost of any intervention based on the results of the phlebotomy values. It is very common for electrolyte replacement to be ordered for patients with normal or slightly subnormal values, the clinical significance of which is debatable. The cost of these electrolyte replacements could not be assessed by this study but is likely to be significant.

Health care providers are often unaware of the costs of the care they are providing. Phlebotomy is a significant cost during an inpatient admission, and much of it is unwarranted. Practice patterns, specifically phlebotomy ordering, can be significantly reduced by providers knowing the economic cost of medical decision making. Perhaps making the cost of procedures or tests more immediately available to those ordering them would result in more judicious ordering. This could then result in savings for the hospital and health care system as a whole.

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**Author Contributions:** Study concept and design: Stuebing. Acquisition of data: Stuebing. Analysis and interpretation of data: Stuebing and Miner. Drafting of the manuscript: Stuebing. Critical revision of the manuscript for important intellectual content: Miner. Statistical analysis: Stuebing. Administrative, technical, and material support: Stuebing. Study supervision: Miner.
Modern Day Bloodletting

Is That Laboratory Test Necessary?

The practice by surgeons of bloodletting or phlebotomy to “rebalance the body’s humors” dates back to at least Egyptian times. Some have speculated that not even George Washington was spared, having been bled to death by the lancets and leeches of his aggressive doctors. Fortunately, the practice was abandoned in the late 19th century, when it was finally accepted to have no medical benefit. Today, therefore, the term phlebotomy usually refers to the drawing of blood for diagnostic rather than therapeutic purposes. Unfortunately, the pervasive, unnecessary testing that is currently ordered, particularly in our teaching hospitals, sometimes rivals the volumes prescribed by our bloodletting ancestors. These wasteful habits raise major economic issues.

Wasted medical spending has been estimated to account for as much as one-third of the $1.5 trillion the United States expends annually for medical care, and inappropriate, redundant, or unnecessary tests and procedures have been suggested to encompass the biggest area of such waste.1 Although concern over frivolous lawsuits and, thus, the need to practice “defensive medicine” is a major reason for ordering procedures that are not clearly based on need, many believe that the fact that neither the health care provider nor the patient are aware of the price tag for the test may also be a culprit. Stuebing and Miner admit that they have no longer-term follow-up data to assess the durability of their approach. Although some reports have suggested that similar educational programs have shown only short-lived effects,2 I believe that such simple, low-cost, and readily repeatable interventions provide one of the most easily applied strategies for influencing clinicians’ test and medication requesting behavior. In our own unit, for example, I was amazed to observe how unaware clinicians are regarding the sometimes more than 10-fold difference in cost between essentially identical medications (eg, ciprofloxacin vs levofloxacin) and the major changes in prescribing behavior that occurred following posting of patient charges for commonly ordered medications at care unit work stations.

In summary, Stuebing and Miner have presented convincing evidence that cost consciousness can provide a potent weapon for reducing some of the wasteful medical spending that contributes to our overall health care bill, which currently is twice as much per person as that of most industrialized countries.

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