As clinicians become increasingly aware of new STAT testing technologies and begin to demand quicker turnaround of more and more analytes, many hospital laboratories have turned to faster pneumatic tube systems for sample transport and dedicated analyzers for use in the near-patient testing environment. However, it is the laboratorian that must weigh all the options—analytical, financial, and operational—when selecting analytical instruments that incorporate new critical care analytes. Hospital administrators expect clinical laboratory scientists to make these decisions based on resources, staffing, reliability of systems, cost, and clinical and operational measures of outcome. While clearly there is a clinical need for certain critical analytes, careful analysis of the logistics and cost issues for these analytes must include numerous details to provide a true picture of overall cost/benefit. Additionally, each group involved in the selection process—the laboratory, management, finance, and direct caregivers—has a different perspective, each of which is legitimate in its own right. The laboratorian’s job is to deliver analytically accurate test results that meet the needs of patients and clinicians. In order to accomplish this, clinical laboratorians must consider the range of available instrumentation, as well as its analytical and operational reliability. In addition, test frequency, sample collection requirements, and the economics of care, including reimbursement policies and budget allowances, must all be considered. This article reviews some of the factors that laboratorians should take into account when deciding whether to include additional analytes on near-patient test systems that also measure blood gases.

What is a Critical Analyte?
In management of clinical laboratory testing, the word “critical” connotes clinical importance and short turnaround time. However, different institutions have different, and sometimes seemingly arbitrary, definitions of what “critical” means. More than a decade ago, AACC’s Quality Assurance Committee recognized the need for a more principled approach to these sometimes-contentious issues and developed a set of guidelines for providing quality STAT laboratory services (9). Although the STAT test list included in the AACC publication needs updating in the light of new analytical and therapeutic approaches that have evolved, the principles behind that list remain valid (Table 1). The use of these criteria, combined with information about the institution’s typical patient population and therapeutic possibilities, can be very useful in deciding which analytes should be classified as urgent and important. In today’s reimbursement and regulatory environment, a new third category called “Responsible and Responsive” may also be needed. This category would take into account the strict clinical requirements noted in the original AACC guidelines, and it adds two new perspectives: laboratory management in today’s health care environment and analytical capabilities of new instruments. In addition, third-party payers may find this new category useful for determining reimbursement policies. In critical care situations, legitimate physician orders and ordering patterns may not always fit the predetermined criteria developed by insurers who have little understanding of critical care analyses.

However, it is the laboratorian that must weigh all the options—analytical, financial, and operational—when selecting analytical instruments that incorporate new critical care analytes. Hospital administrators expect clinical laboratory scientists to make these decisions based on resources, staffing, reliability of systems, cost, and clinical and operational measures of outcome. While clearly there is a clinical need for certain critical analytes, careful analysis of the logistics and cost issues for these analytes must include numerous details to provide a true picture of overall cost/benefit. Additionally, each group involved in the selection process—the laboratory, management, finance, and direct caregivers—has a different perspective, each of which is legitimate in its own right. The laboratorian’s job is to deliver analytically accurate test results that meet the needs of patients and clinicians. In order to accomplish this, clinical laboratorians must consider the range of available instrumentation, as well as its analytical and operational reliability. In addition, test frequency, sample collection requirements, and the economics of care, including reimbursement policies and budget allowances, must all be considered. This article reviews some of the factors that laboratorians should take into account when deciding whether to include additional analytes on near-patient test systems that also measure blood gases.

Blood Gases and Other Critical Care Analytes

Weighing All the Options When Selecting New Instrumentation

ROBERT F. MORAN, PhD, FCCM, FAIC

During the past several decades, pH/blood gas and electrolyte measurements have been among the primary STAT analytes needed to assess the status of critically ill patients. Recent reports have suggested (1–8) that the addition of other analytes to blood gas systems would be advantageous. For example, technology advances have made it possible to include lactate, glucose, and other analytes on the same analytical instruments that perform blood gases. Unfortunately, the issues surrounding this area of laboratory testing are easily blurred in a maelstrom of competing marketing claims. Furthermore, technological feasibility does not necessarily equate with clinical need.
Specific and immediate therapeutic action is based on analyte level. The frequency of need for one quantity is nearly "simultaneous" with others. A single blood specimen is required using analytically related or compatible technology. The cost of treatment vs. no treatment vs. total costs based on the test is significant and related to the test performed. Timeliness is significant, but not critical.

**AACC Test Category 2: Important**
- Analytes are necessary for diagnosis, triage, follow-on therapy.
- Timeliness is a key factor.

**Suggested New Test Category: Responsible and Responsive**
- The quantities are considered clinically related.
- The presence or absence of certain test results is critical, and the test is significant and related to the test performed.
- Timeliness is significant, but not critical.

**AACC Criteria for defining urgent testing**
- An updated list of urgent tests would contain a combination of analytes from the original AACC list along with new analytes that also fit the criteria (Table 2).

**Using the Fundamentals**
Homeostasis, the dynamic balance between opposing systems or within synergistic systems, is a characteristic that can be applied to a number of areas in human physiology, including hematopoiesis, hemostasis, and acid-base/bioenergetic balance. While the individual characteristics of each of these systems can reach a critical state and thus deserve urgent attention by testing facilities, there are three systems that stand out as fundamental homeostatic systems: acid-base, blood gases, and electrolytes as well as the determinants, mediators, and substrates of those systems.

Using the AACC criteria for defining urgent testing, an updated list of urgent tests would contain a combination of analytes from the original AACC list along with new analytes that also fit the criteria (Table 2).

**Suggested New Test Category: Responsible and Responsive**
- The quantities are considered clinically related.
- The presence or absence of certain test results is critical, and the test is significant and related to the test performed.
- Timeliness is significant, but not critical.

**AACC Test Category 1: Urgent**
- Analyte is a cause or effect marker for immediate life-threatening condition.
- Specific and immediate therapeutic action is based on analyte level.
- Timeliness and reliability are crucial.

**Prothrombin (PT)**
- Glucose

The basic blood gas panel includes the most important indicator of oxygenation status for many patients: the oxygen tension of arterial blood (PO_{2} \text{(ab)}) and/or blood oxygen—O_{2}—is present in the air we breathe, and it is this form of oxygen in combination with products of glucose metabolism that fuels cellular mitochondria to manufacture the bioenergetic storage compound adenosine triphosphate (ATP).

Other aspects of oxygenation—oxygen transport, uptake, and utilization—man-"diate measurement of total hemoglobin, oxygen content, and saturation. Also, many clinical situations can justify inclusion of hemoglobin derivatives such as carboxyhemoglobin along with the blood gas determinations.

The addition of potassium to the basic set of measurements is most appropriate in the critical care setting, considering potassium's effect on cardiac efficiency and output. In critically ill patients, parenteral therapy that involves electrolytes also supports the addition of other electrolytes such as sodium and chloride, which are frequently needed in the same timeframe as the blood gases. Ionized calcium may be required in the critical care setting as well, albeit in some cases. Ionized calcium level. The resulting cardiac and neuro muscular effects can have profound impact on patient morbidity.

Table 2. STAT Testing 2000—An Updated List of Urgent Analytes

<table>
<thead>
<tr>
<th>Traditional Urgent Blood Analytes*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Blood Gases: PO_{2}, PCO_{2}</td>
</tr>
<tr>
<td>Hydrogen Ion Concentration: pH (ch+)</td>
</tr>
<tr>
<td>Hemoglobin: Hb or Hct/Packed Cell Volume (PCV)</td>
</tr>
<tr>
<td>Electrolytes: Na+, K+, Ionized Ca++</td>
</tr>
<tr>
<td>Glucose</td>
</tr>
<tr>
<td>Prothrombin (PT)</td>
</tr>
<tr>
<td>Partial Thromboplastin (PTT)</td>
</tr>
<tr>
<td>Platelets</td>
</tr>
</tbody>
</table>

**New Urgent Blood Analytes**
- Base Excess of Blood (BE) or of Extra-cellular Fluid/Bicarbonate
- Activated Clotting Time (ACT)

*Based on AACC Criteria (9)

**Table 3. Important Blood Analytes**

<table>
<thead>
<tr>
<th>All analytes from the Urgent AACC Category 1 list</th>
</tr>
</thead>
<tbody>
<tr>
<td>Urea, Creatinine, Fe, NH_{4}, Bilirubin, Ketones, ALT, AST, Amylase, HCG, Leukocytes, Differential, Fibriogen</td>
</tr>
</tbody>
</table>

**New Important Blood Analytes**
- Oxygen Saturation and Content
- COHb, MetHb
- Lactate
- CK-MB, Troponins T and I

*Based on AACC Test Category 2 (9)

Other analytes such as ionized magnesium, which are analytically feasible and available on some STAT analyzers, may need to be reconsidered for appropriate problems.

**Making the Choices**
In order to make the best choices when selecting urgent care instrumentation, labora-torians need to seek the expertise of a multidisciplinary group: clinicians, scientists, engineers, and marketing staff, as well as economic and regulatory experts. The availability of multiple analytes on the same analytical system certainly provides some real operational and even clinical advantages, but at the same time may require education on issues such as sample processing, costs, availability of the measurements, and billing practices. Table 4 presents some important points to consider when making this decision. Overall, it is important to look at the clinical and operational compatibility of the timing and urgency related test groups when making a decision on the purchase of new critical care instrumentation.

Even considering all of these factors, there are a number of commercially available instruments that meet the clinical and operational requirements for urgent, important, and responsible testing. Most of these systems allow for flexibility based on the needs of a care unit's patient population and specialties, although some systems are more flexible than others.

Another important consideration when deciding on a STAT test menu is what the Health Care Financing Administration (HCFA) allows in terms of test profiles. Laboratorians must consider that the operational convenience of any device may be limited by government regulation. Without the availability of inclusive profiles on a patient-to-patient basis, adding STAT analytes to the test menu could push the limits of operational and economic responsibility, especially when considering some of the third-party reimbursement criteria enforced by HCFA's Office of the Inspector General.
Making It Work

The laboratory testing paradigm continues to shift as clinicians’ needs for faster turnaround time increases, as acceptable sample sizes get smaller, and as technology takes some of the art and science from laboratory measurement and makes it possible to move it outside the laboratory. How are the seemingly incompatible demands of highest accuracy in patient testing reconciled with requirements that seem to push accuracy in the opposite direction? How should laboratorians and clinicians reconcile quality patient care with economic and the requirements of the authorities that pay for the care? These are difficult questions to answer, but if we remain aware of the basic issues, we can better assess individual situations and arrive at workable solutions.

REFERENCES