Physician Satisfaction and Emergency Department Laboratory Test Turnaround Time

Observations Based on College of American Pathologists Q-Probes Studies

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Objectives.—To determine the length of time for the components of the emergency department (ED) turnaround time (TAT) study in 1998 and to ascertain physician satisfaction concerning laboratory services to the ED.

Methods.—Using forms supplied by the College of American Pathologists Q-Probes program, participants conducted a self-directed study of ED TAT over a 4-week period. Data requested included various times of day associated with the ordering, specimen collection, laboratory receipt, and result-reporting stages of stat ED TATs for potassium and hemoglobin. Additionally, practice-related questions associated with the laboratory were asked. Participating laboratories also provided a physician satisfaction survey for up to 4 physicians who were users of ED services. Results of both the TAT study and the physician satisfaction survey were returned by mail. Participants were drawn from the 952 hospital laboratories enrolled in the 1998 College of American Pathologists Q-Probes study on ED TAT. The main outcome measures included the components of the ED TAT process, factors associated with decreases in ED TAT, and the results of the physician satisfaction survey.

Results.—Six hundred ninety hospital laboratories (72.4% response rate) returned data on up to 18,230 hemoglobin and 18,259 potassium specimens. Half of these laboratories responded that 90% of potassium tests were ordered and reported in 69 minutes or less, whereas the TAT for 90% of hemoglobin results was 55 minutes or less. Comparison of the components of TAT for both potassium and hemoglobin with similar studies done in 1990 and 1993 showed no change. Factors found to statistically contribute to faster TATs for both tests were laboratory control of specimen handling and rapid transport time. When whole blood specimens were used for potassium determination, TAT improved. Emergency department physicians chose the study-defined lower satisfaction categories of Often, Sometimes, Rarely, and Never for the questions concerning the laboratory being sensitive to stat testing needs (39.1%) and meeting physician needs (47.6%). Many of the physicians surveyed believed that laboratory TAT caused delayed ED treatment more than 50% of the time (42.9%) and increased ED length of stay more than 50% of the time (61.4%) when compared with other specialty users of the ED.

Conclusions.—Laboratory ED TATs have remained unchanged for almost a decade. Emergency department physicians are not satisfied with laboratory services. Although it appears that one issue may relate to the other, the interaction between the laboratory and the ED is quite complex and has been evolving for at least 30 years. Improvement in interoperability between the departments is essential for operational efficiency and patient care. Effective communication channels need to be established to achieve these goals.

may not help the needs of many ambulatory patients who are seeking care for nonurgent problems that they perceive as urgent. A direct impact of these changes is a requirement for the efficient use of laboratory testing that results in timely and effective patient care.

Laboratory testing has also changed since 1965. Laboratories have computerized, replaced, and modernized equipment; optimized transportation systems; and now are automating specimen processing. These changes have allowed laboratories to maintain services in the face of an ever-increasing volume of testing from all areas of the health care system. Also during these years, the location of testing has become more distributed, as point-of-care testing devices now allow quality laboratory work to be performed at many care locations. Despite these improvements, a review of the literature indicates that laboratory test ED TAT has remained at or greater than 1 hour since at least 1965. Additionally, laboratories have difficulty meeting internally set goals for TAT. Until this situation improves, laboratories will have difficulty maintaining credibility that they will meet any consensus ED TAT guidelines.

To study ED TATs, we used the College of American Pathologists Q-Probes program, which is a voluntary quality assurance program that seeks to describe actual laboratory practices by surveying program members. Emergency department TAT was made an early and continuing focus of the program and has been surveyed 3 times. As part of the baseline study in 1990, a survey concerning physicians’ expectations for laboratory TAT was conducted.

From those studies, we observed that the non-Gaussian nature of the distribution of ED TAT dictated the use of frequency-based summary statistics, such as the median or 90th percentile value of the distribution. As an added benefit, the use of these summary statistics limited the impact of data outliers and potential participant data manipulation. Our study of outlier TATs, defined as TATs in excess of 70 minutes, showed that only 28% were caused by the analytic phase of the total testing process; most delays occurred in preanalytic steps associated with specimen collection and transport or postanalytic steps involved with reporting the results. Reoccurring items in all studies included the lack of impact of a passive monitoring program and delays due to computerization, stat laboratories, transport time, potassium specimen type, or the type of collection personnel.

In response to both participants’ requests and our continuing need to monitor the performance of this important quality assurance indicator, we repeated the study for the fourth time in 1998. We report here on the TAT survey results and on a corresponding physician satisfaction survey, compare results with those obtained over the previous 8 years, and suggest changes that can be made to improve performance.

**MATERIALS AND METHODS**

Emergency department TAT was studied using the well-standardized Q-Probes format, which uses only routinely collected unidentified data and is exempt from Institutional Review Board approval. The Q-Probes format supplies survey forms to all members of the program, but receives responses from only those who chose to participate in that particular survey. It is not possible to characterize the nonresponders to a particular survey. Participants in the 1998 College of American Pathologists Q-Probes program were provided with forms to record the order, collection, specimen receipt, and reporting time of day during a 4-week period for the selected ED stat testing samples. Earlier studies showed that the time of day (12 AM to 11:59 PM) or the day of the week a specimen was collected had no impact on TAT. Therefore, to simplify the study, ED specimens having either a potassium or hemoglobin determination ordered individually or as part of a panel and received by the laboratory during the day shift, defined as the shift during which all laboratory tests are performed, usually between 8 AM and 4 PM, were candidates for inclusion. Laboratories were further instructed to select 1 specimen for each test at random times during that shift, but to avoid the first specimen of a shift. Other than these instructions, verification of the selection of truly random specimens was not attempted.

This study used the following intervals and TAT definitions:

- **Order-to-Draw TAT.** The period from the test order to specimen collection.
- **Draw-to-Receipt TAT.** The period from the time of collection to the time of receipt in the laboratory.
- **Receipt-to-Report TAT.** The period from when the specimen was received in the testing laboratory until the result was reported.
- **Draw-to-Report TAT.** The period from the time of collection until the result was reported to the ED.
- **Order-to-Report TAT.** The period from test order to result report.

- **90% Completion TAT.** When order-to-report TAT values are arranged from shortest to longest, the 90% completion time represents the TAT within which 90% of tests are completed.

As part of the Q-Probes program, participants provide general demographic information on affiliation (municipal, federal, and nonfederal), bedsize, institution type (private, independent, other, and type of government facility), location (urban, suburban, rural, and federal), and teaching status. Participants were also asked 10 questions concerning general TAT practices and 9 questions on TAT goals and definitions. They were also provided a physician questionnaire consisting of 8 questions: responder’s specialty, definition of TAT starting and ending times, expected TAT for potassium and hemoglobin tests, and 4 questions concerning satisfaction with laboratory performance. Participants were asked to have 4 physicians who were routine users of ED laboratory services respond to the questionnaire. We requested that they have responses from an ED physician, internist, surgeon, and pediatrician, if possible.

Laboratories were asked to define TAT goals as the percentage of specimens they expected to report within the number of minutes they would allow. As an example, a draw-to-report TAT goal could be expressed as 90% (of specimens completed) in 30 minutes. We requested from the laboratories goals for TAT intervals starting with the order, draw, and laboratory receipt times and all ending with the report time, independent of existing laboratory definitions. Lastly, we asked which of the above time intervals participants used as an internal goal.

Additionally, we surveyed the physicians about their perceptions of laboratory ED services. They were asked to use a 6-point scale for responses: Always (>95% of the time), Usually (76%–95%), Often (51%–75%); Sometimes (26%–50%); Rarely (5%–25%), and Never (<5%). We questioned them on the following 4 points: Is the laboratory sensitive to the stat needs of clinicians, does the laboratory meet the stat needs of clinicians, does laboratory TAT delay treatment in the ED, and does laboratory TAT lengthen ED length of stay?

Data received were analyzed using SAS (SAS Inc, Cary, NC). Descriptive statistics, including means, medians, ranges, standard deviations, and frequencies, were calculated. The TAT process was modeled to find significant variables used analysis of variance (ANOVA). For modeling, the 90% completion time from the time of order to reporting for hemoglobin and potassium were the dependent variables, and personnel collecting the specimen, if the test was performed in a stat laboratory, extent of computerization, if TAT was monitored, means of monitoring TAT, specimen type...
(potassium only), means of transporting the specimen to the laboratory, affiliation, bedsize by groups (0, 1–150, 151–300, 301–450, 451–600, and ≥600), institution type, location, and teaching status were the independent variables. A variable was significant when \( P \leq 0.05 \).

RESULTS

Six hundred ninety of 952 hospital laboratories that were mailed surveys provided TAT data on 18,230 hemoglobin and 18,259 potassium specimens, for a response rate of 72.4%. Of these, 26.8% were teaching institutions, 47.0% were located in cities, 23.6% described their location as suburban, and 28.9% were rural. Of the 661 laboratories providing bedsize information, most (32.2%) were located in institutions with between 151 and 300 beds; those with fewer than 151 beds constituted the next largest group (30.6%). Of the remainder, 19.4% had between 301 and 450 beds, while 17.9% had more than 450 beds. Nearly all (96.5%) the institutions were located in the United States, with the remainder located in Canada, Australia, the United Kingdom, Brazil, Spain, and Thailand.

Hemoglobin and potassium TAT distributions found in 1998, expressed as the intralaboratory 90% completion time, are shown in Figure 1. Table 1 shows the participants’ ability to meet their 1 selected TAT goal for 1998 and previous years.

Modeling results for hemoglobin and potassium TATs by ANOVA are shown in Table 2. Good models were produced for both analytes and were remarkably similar. Significance of the factors is shown in Table 3, with the significant factors marked with an asterisk. We observed the following concerning the significant factors found (except as noted, the factor observed applies significantly to both analytes):

- About half (51.5%) the specimens were collected by laboratory personnel and these had the fastest TATs. Emergency department personnel, who were responsible for collecting most of the other half (47.0%), had next fastest time, which was about 10 minutes slower.
- The extent of computerization was significant, but the results were difficult to interpret owing to the number of possible combinations concerning the responsibilities placed on laboratory and hospital information systems and their interconnections.
- For affiliation, both nongovernmental and nonfederal sites had about the same TATs. Federal sites were about 30 minutes slower in TATs.
- The bedsize groups showed a linear increase in TAT by approximately 15 minutes from lowest to highest bedsize group.
- Rural locations had the fastest TATs, followed by city (about 8 minutes slower), suburban (13 minutes slower), and then federal sites (about 15 minutes slower).
- Just less than 50% of participants used a stat or ED laboratory to perform the tests, and it was not a significant factor in determining TAT.
- Specimen type, introduced in the potassium model only, had the longest 90% completion TAT when serum was the specimen type. An improvement of 8 minutes was found when laboratories (n = 228) used plasma and 22 minutes when whole blood (n = 13) was the potassium specimen type.
- Means of transport was a significant factor only for hemoglobin; those 15 institutions that had a laboratory in the ED had the fastest TAT (49 minutes). Clinical staff

![Figure 1. Distribution of intralaboratory hemoglobin and potassium 90% completion turnaround times. The top of each box corresponds to the 25th percentile and the bottom to the 75th percentile. The top line ends at the 10th percentile and the bottom line ends at the 90th percentile. The dotted line in the box indicates the median turnaround time for the component.](image)

| Table 1. Percent Institutions Meeting Internal Turnaround Time (TAT) Goals |
|-----------------------------|---------------------|---------------------|---------------------|
|                             | 1993 (Large Hospital) | 1993 (Small Hospital) | 1998                |
| Hemoglobin TAT              |                     |                     |                    |
| Order to reporting*         | 16.2                | 7.2                 | 31.0               |
| Draw to reporting           | 24.0                | 37.6                | 9.3                |
| Receipt to reporting        | 35.8                | 44.1                | 46.6               |
| Potassium TAT               |                     |                     |                    |
| Order to reporting*         | 5.5                 | 3.5                 | 18.8               |
| Draw to reporting           | 15.2                | 21.3                | 0.8                |
| Receipt to reporting        | 22.9                | 20.1                | 2.0                |

* Order time was not collected in 1990.
was next fastest (55 minutes), and mechanical tubes with convenient or inconvenient ports had a TAT of about 1 hour.

Responses were obtained from 1937 physicians from 552 of 690 institutions. The maximum number of responses possible was 2760, yielding a response rate of 70%. The bedsize distribution of the institutions associated with responding physicians was essentially the same as the overall respondent population. Most responding physicians classified their specialty as Emergency Medicine (49.0%), followed by Primary Care or Internal Medicine (19.8%), Surgery (11.9%), Pediatrics (11.1%), and Other (8.2%).

Summary responses of our physician satisfaction survey are shown in Figure 2. Emergency department physicians, primary users of ED laboratory testing, frequently cited the lower satisfaction categories of Often, Sometimes, Rarely, and Never for the questions concerning the laboratory being sensitive to stat testing needs (39.1%) and meeting physician needs (47.6%). Many respondents felt that laboratory TAT caused delayed ED treatment more than 50% of the time (42.9%) and also increased ED length of stay more often than half the time (61.4%).

Laboratories most commonly (41.1%) defined TAT as time of receipt in the laboratory to time of report (internal processing time), followed by ordering of tests to result reporting (27.0%), and specimen collection to reporting (18.2%); the remainder cited a variety of other combinations of starting and ending times. The corresponding definitions for starting and ending times by physicians are shown in Figure 3.

**COMMENT**

Results of the physician satisfaction survey (Figure 2) indicate concerns by ED physicians with laboratory services when compared to other specialty groups. Physicians are faced with increasing changes in how patients perceive the role of the ED. Their time with patients is decreasing, as the health care system tries to accommodate more patients per hour. It is only natural that ED physicians try to optimize the effectiveness of their environment while minimizing the impact on their time. They perceive, and have perceived for at least 5 decades, that laboratory test TAT hinders this process. What follows are our observations on future strategies that may improve the quality of care ED patients who have laboratory tests receive.

Table 4 contains a summary of the important ED TAT components for the various Q-Probes studies. It is evident that ED TAT has not improved during the years shown. Table 1 demonstrates that most laboratories do not meet their internal goals for ED TAT, although they have improved from the 1990 and 1993 studies. It is particularly significant that laboratories have improved their ability to meet internal goals for order-to-reporting TATs, the most common clinician definition for TAT,\(^4\) but this improvement has only reached 31% for hemoglobin and is still less than 20% for potassium. To put these data in a historical perspective, Reiber\(^5\) reported an ED TAT for an undefined laboratory test of 55 minutes in 1965. In 1983, ED draw-to-report TAT was reported to have a mean of 86 minutes for a chemistry panel containing potassium and 38 minutes for a complete blood count containing hemoglobin, comparable to the TATs observed today.\(^6\) The inability of laboratories to meet physicians’ expectations was first reported by Hilborne et al\(^11\) and then again in the 1990 Q-Probes study.\(^14\)

A striking result of the physician satisfaction survey is the perception by 61% of ED physicians, versus 47% overall (Figure 2), that laboratory TAT extends ED length of stay always, usually, or often. While this study did not look at the relationship between TAT and ED length of stay, studies conducted over the last 20 years have helped us understand and optimize the delivery of emergency medicine and delineate the contribution of the laboratory in that process. In 1978, Cue and Inglis\(^8\) reported on the operation of EDs located in 20 hospitals in Washington,
DC, and noted that that average laboratory test TAT was also 55 minutes. They found the most common reasons for test delays were linked to collecting and transporting specimens, queuing the tests on an emergency basis, and communicating results to physicians, responses that are remarkably similar to results we have observed in this and past studies. Six years later, Heckerling provided a description of ED length of stay factors at Rush-Presbyterian-St Luke's Medical Center in Chicago, Ill, and noted that of those patients who did not have a laboratory test or radiographic study, 80% were discharged from the ED within 2 hours, whereas only 42% having blood tests and 57% having radiographic studies were discharged in that amount of time. In 1989, Saunders et al published a detailed computer model of ED operations, showing that the length of time in seeing the initial caregiver is a key factor toward reducing ED length of stay. The model shows that laboratory, radiology, or any other testing has a potential impact on ED length of stay only when the stay exceeds an hour. Recent studies using point-of-care devices have not demonstrated a relationship between laboratory test TAT and ED length of stay. Multi-institution studies are needed to define this complex and poorly understood relationship.

Another result from the physician satisfaction survey is the increased number of ED physicians (42% vs 33% overall, Figure 1) who believe laboratory TAT delays treatment always, usually, or often, an observation of concern. Although increased ED length of stay may be a cause for decreased patient satisfaction, unless it prevents others from access, it is most likely not related to care. Treatment delays, however, can directly relate to the quality of care. Again, this study did not look directly at the relationship of treatment and laboratory testing, but others have. Sands et al noted that in a general ED population of 960 patients having laboratory testing performed, test results affected patient disposition (admission or release) only 10.7% of the time. Based on this and other similar observations, guidelines need to be developed and accepted on the appropriate use of laboratory tests in the ED. Reducing the burden of unnecessary testing will help both ED and laboratory personnel provide timely care when it is needed and will not impact patient outcome. Rutledge et al provided a suggested reflex testing protocol for use in the ED for evaluating abdominal pain. Expanding this process to other conditions and diseases, as well as formally accepting the process of both developing and implementing these guidelines, will reduce the patient care burden.

While the laboratory generally is well regarded for being sensitive to stat testing and physician needs, the ED physician rankings are lower than other specialties. We speculate the continued increased in the number of stat or ED laboratories is a response to a perceived need that stat testing is better served in a dedicated laboratory. Brennan and Gaudiosi described large improvements in ED TAT after introducing a dedicated and optimized ED laboratory. Previous Q-Probes studies have shown these improvements are not universally realized. This study also notes no improvement from a stat or ED laboratory. In a 1996 Q-Probes study, Steindel and Novis investigated causes of outlier TATs, those that exceed 70 minutes, and found ED laboratories were a factor in excessive TAT. These results supported earlier observations that satellite testing laboratories are subject to a queuing effect that results in excessive TATs when the limited capacities of the analytic systems in those laboratories are exceeded. We recommend that an institution contemplating a stat laboratory first undertake a thorough evaluation of the timeliness of laboratory results, the factors causing delays, and solutions to effect improvement. Saxena and Wong described results in their institution that produced simple, satisfactory improvements in the preanalytic and postanalytic phases of the laboratory testing process and avoided development of the more costly alternative, an ED laboratory. Also, when testing volumes overwhelm their existing equipment, laboratories may want to look at their equipment mix and consider adding supplemental analytic processing equipment to augment testing and help prevent formation of long testing queues.

An example of the continued laboratory sensitivity to stat testing needs is the introduction of pneumatic tube systems. In the 1990 ED TAT study, only a few sites used tube systems, and their TAT was slower than the median. It was suggested that many of the early tube systems might not have optimized port locations. The 1993 study indicated that those that did have convenient port locations had faster TATs, both overall and for tube systems. Supporting this observation, Keshgegian and Bull have shown that their pneumatic tube system resulted in faster TAT by reducing transport time. The present study found that pneumatic tube system use had increased to almost half of the participants, but their TATs were slower than average and independent of their tube system design classification. We suspect the present increases in TAT from laboratories using these systems results from delays such as personnel not posting or removing many specimens promptly. Optimizing the effectiveness of tube systems requires more than just installation, but rather encompasses thorough and thoughtful overall system design.

The increasing use of point-of-care testing can be related to our observed physicians’ definition of laboratory TAT (Figure 3). Most physicians feel the testing process starts on physician request and ends when they get the results. Many ED physicians, however, have a TAT definition more closely approximating that of the laboratory, that is, from the time of order to the receipt of the result. Point-of-care testing theoretically allows the physician the ability to shorten the time between request and results to just the analytic processing time, as the ability to test immediately exists. It is the recent introduction of whole blood analysis for many analytes using point-of-care devices that is of interest to ED physicians. These devices have been shown to have acceptable accuracy and precision when properly used, while potentially providing rapid TAT. This, and previous ED TAT studies, show that when a whole blood specimen is used for potassium determination, the TAT approximates that of hemoglobin. A similar effect is observed when plasma is used. Countering the potential improvement in TAT is the observation that point-of-care testing devices and ED laboratories have been reported to add to the workload of busy ED personnel.

One can view the factors influencing TAT as being of 2 broad types: those that one can control and those that one cannot. Institution factors are ones that are not under the control of service providers. An institution cannot change bedsize, affiliation, and location without essentially becoming a new entity, in practice if not in name. All of these factors were found to be significant in determining ED
TATs and most likely are surrogates for more specific causative factors, such as staffing levels, governance, case mix, or geography as it impacts transport time. Process factors are under the control of both the laboratory and the ED and should be the focus of quality improvement initiatives. Significant factors appearing in this and previous studies include the nature of the collection personnel, the extent of computerization for hemoglobin only, and the method of specimen transport to the testing site. These factors have appeared in previous studies. In past studies the impact of computers was clearer. We suspect that common use of computers and the multiple ways institutions use them has obscured our ability to interpret the results. Since clear reasons for prolonged TATs do not exist, representatives from the ED, laboratory, nursing services, and any other appropriate intrainstitutional departments need to review changes in the overall flow of ED specimens in their institutions. Fernandes and Christenson applied the technique of continuous quality improvement to study 1993 ED length of stay in Canada's St Paul's Hospital, Vancouver, British Columbia, and found that laboratory and radiographic tests were not the root cause of delays, but a symptom they could correct. Rinderer conducted a similar continuous quality improvement study, which identified unexpected factors that, when corrected, resulted in decreases in length of stay, whereas several expected factors did not.

To improve TATs to fulfill clinicians' goals requires complete and long-term commitment to the process of continuous improvement. Laboratorians must plan appropriate changes, make these appropriate changes, gather information on the effect of the changes, act on the information about the changes, and then repeat the same 4-step process over and over again. There is no single fix for slow TAT, as there is when a replacement instrument is purchased for an inaccurate and imprecise laboratory method, nor is there a turnkey approach of adding a total solution from one vendor. Rather, the solution lies in having the entire hospital staff, under the leadership of the laboratorians, develop a single organizational quality strategy to undertake improvement on a daily basis. One of the first steps toward improving TAT is to develop a schematic of...
all the steps in the laboratory total testing process, and then to overlay all possible changes that can be implemented in an orderly fashion at each of these steps. Over a number of years, these suggested changes, as well as other less obvious changes, must be implemented with TAT goals clearly in mind. Changes must be considered for staffing and personnel scheduling, equipment purchase and use, and work flow patterns and processes within the hospital as well as within the clinical laboratory for each of these steps. Some examples of improvements, such as installation of pneumatic tubes, front-end automation, higher throughput analyzers, whole blood or plasma analysis, automatic verification of results, and optimization of computer systems, have been advocated and validated. Old habits, practices, and protocols must be investigated, and reasonable changes must be instituted in the name of improved TAT. For example, laboratories have always interrupted routine testing with stat analysis, but this process must be questioned, as stat testing not only disrupts workflow and delays results, but also leads to errors. In many situations, it is far faster to perform both routine and stat testing with the priority of stat testing, thereby simplifying laboratory processes at the same time TAT is improved. Another approach may be to consider point-of-care laboratory quality control practices with far fewer false-run rejections for central laboratory testing. Hospitals have implemented well-staffed remote stat laboratories or have embraced bedside glucose testing because clinicians have urged huge investments in these technologies in the name of rapid testing. Investment in a single institutional quality strategy for central laboratory TAT improvement must occur in equipment, staffing, and the physical plant, as there not only will be significant financial payback, but also increased physician and patient satisfaction.

In this article we document many common themes that have persisted at least since 1965. A complex relationship exists between the laboratory and the ED. Mutual frustration may exist between laboratory and ED personnel. The same issues are investigated on what appears to be a recurring cycle of once a decade. It is also apparent that after each cycle one seems to reach the same conclusions, but behavior is not changed. Our Q-Probes studies indicate that universal simple solutions do not exist and the only
effective solutions take time. All parties must meet, perhaps within the context of a formal continuous quality improvement study, to find causes and systems responsible for delays that are unique to their individual situation. Staff members need to substitute the time they are spending internally dealing with their frustrations with working together to find and satisfactorily implement solutions. Once these improvements are implemented, the work is not done. Continual monitoring and addressing of new issues must occur or the process of continual improvement will collapse. Health care delivery is facing too many complex changes for the laboratory-ED axis to continue having resolvable conflicts.

References
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