Improving Quality of Patient Care in an Emergency Department

A Laboratory Perspective

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Key Words: Clinical pathology; Management and administration; Clinical chemistry

DOI: 10.1309/DGXYTH0VNTTQRQHD

Abstract

The purpose of our study was to improve the quality of care in an emergency department (ED) as measured by length of stay (LOS), total turnaround time (TAT) for laboratory result reporting, and the blood culture contamination rate. Data were included for patients who had at least 1 of 5 laboratory tests performed as part of their care. The study was conducted in 2 phases. First, phlebotomy was performed by a dedicated phlebotomist or nonlaboratory personnel. The second phase added a dedicated laboratory technologist. There was a significant reduction in total TAT for all tests (at least 46 and 75 minutes in the respective interventions), and blood culture contamination rates dropped from 5.0% to 1.1%, although the overall LOS did not change. Estimated cost avoidance is more than $400,000 annually. Quality of care in an ED is improved when samples are collected by a dedicated phlebotomist, but overall LOS does not change.

Laboratory specimen quality and the rapid transmission of results are important factors in patient safety and reducing health care system expenses. Increasing health care costs and decreasing reimbursements have prompted hospitals to focus on developing strategies to reduce waste.[1,2] A common approach has been to decentralize phlebotomy. Eliminating positions that have duplicate skill sets was thought to result in a net savings of labor costs; however, the quality of specimens sent to the laboratory for testing has decreased since hospitals have moved to decentralized phlebotomy.[3] Furthermore, consolidating phlebotomy services at individual locations (ie, having nurses collect samples in the emergency department [ED]) may increase turnaround times (TATs) and negatively impact length of stay (LOS).[4]

The reduction of dedicated phlebotomists is occurring at a time when the annual number of patient visits to an ED in the United States is on the rise. According to the ED summary of the National Hospital Ambulatory Medical Care Survey, between 1994 and 2004, the number of ED visits increased 18.0%, from 93.4 million to 110.2 million visits annually, while the number of hospital EDs in the United States decreased by approximately 12.4%.[5] These trends have likely contributed to higher diversion rates, more crowded waiting rooms, and compromised patient care.[6]

We hypothesized that patient care quality indicators, including laboratory specimen quality (as indicated by blood culture contamination rates), TATs for laboratory test results, and LOS in the ED would decrease if specimens were drawn by a dedicated phlebotomist compared with samples collected by nonlaboratory personnel (ie, nurses and physicians). In addition, we hypothesized that the reduction

in blood culture contamination would result in cost savings, even if new positions were required.

Materials and Methods

A baseline and 2-arm intervention, prospective, observational study was performed on the data for patients who had at least 1 of 5 laboratory tests (CBC count, chemistry panel [CPBASIC], prothrombin time [PT], troponin, or blood culture) performed as part of their care. Contamination rates and laboratory result reporting times were reviewed in all cases. Our goal for total TAT (collection of the sample to reporting of the result, excluding blood culture results) was less than 1 hour. Ideally, collection and transport could be accomplished in 20 minutes. The remaining 40 minutes would encompass laboratory testing time.

Blood culture contamination data are collected quarterly in our hospital and reported by department and collection personnel identifiers. A blood culture was considered contaminated if 1 or more of the following organisms were identified in only 1 of a series of blood culture specimens: coagulase-negative *Staphylococcus* species, *Propionibacterium acnes*, *Micrococcus* species, "viridans"-group streptococci, *Corynebacterium* species, or *Bacillus* species. A blood culture series was defined as 1 or more specimens collected serially within a 24-hour period to detect a bacteremic episode.[7] Assuming a charge/cost ratio of 1.5:1 and correcting for inflation, the current incremental cost of a false-positive blood culture for patients admitted to hospital is estimated to be $5,765.[8]

Baseline Data

Baseline TAT (for collection, transport, testing, and total time) data from nonlaboratory staff working 2:00 PM to 10:00 PM were collected for 6 months before the intervention. Blood culture and LOS data were collected only during the time of each intervention.

Intervention 1

A phlebotomist dedicated to the ED randomly collected specimens on the weekday evening shift (2:00 PM-10:00 PM) for 3 months. Patient volumes are highest for our ED during this shift. The phlebotomist's TATs were compared with baseline TATs. The TAT is composed of 3 distinct periods, described subsequently. TAT data were determined by using time stamps manually entered or recorded by the laboratory information system (LIS). The initial time recorded by the LIS is the time the order is placed. The next time recorded is manually entered and reflects the time written on the tube by the collector at the time of collection. The period between order and collection is shown in **Table 1** as the collection time. The transport time is the difference between the time written on the tube at collection and the time the sample is received by the laboratory and is calculated by the LIS. Testing time is the time between sample receipt and reporting the result. The total time is calculated by the LIS from the time the order is placed until the time the result is reported. The 90th percentile for each period and the total TAT were analyzed for 4 tests: CBC, CPBASIC, PT, and troponin. The numbers in parentheses in Table 1 represent the 90th percentile TAT, in minutes, for specimen collection, transport, laboratory testing, and total

Table 1
Time From Specimen Order to Reporting of Results for Selected Emergency Department Requests*

	Collection	Transport	Testing	Total Time	*P*†	*P*‡
CBC count						
Baseline	57	46	44	122		
Intervention 1	26 (15)	27 (30)	30 (33)	66 (63)	<.001	<.001
Intervention 2	13	17	16	43	<.001	
Chemistry panel						
Baseline	54	45	45	122		
Intervention 1	30 (15)	32 (26)	34 (40)	76 (67)	<.001	<.001
Intervention 2	12	16	23	47	<.001	
Prothrombin time						
Baseline	63	45	63	141		
Intervention 1	28 (16)	26 (26)	50 (51)	88 (83)	<.001	<.001
Intervention 2	13	20	30	63	<.001	
Troponin						
Baseline	52	48	94	167		
Intervention 1	21 (11)	36 (35)	74 (64)	119 (110)	<.001	<.001
Intervention 2	12	20	39	78	<.001	

* Collection time is the period between order and collection; transport time, the difference between the time written on the tube at collection and the time of sample receipt in the laboratory; testing time, the period from sample receipt until the result is reported; and total time, from order placement until the result is reported. The numbers in parentheses represent the 90th percentile turnaround time (TAT) for specimen collection, transport, laboratory testing, and total TAT for the last month of Intervention 1. Times are given in minutes.
† Baseline compared to intervention 1.
‡ Intervention 1 compared to intervention 2.

DOI: 10.1309/DGXYTH0VNTTQRQHD

TAT for the last month of intervention 1. A Student *t* test was performed to determine statistical significance. The *t* test was 2-tailed, unpaired with unequal variances.

The ED database regularly collects time stamps to track and improve performance of patient LOS. Separate times are recorded for patient arrival, time to physician evaluation, completion of the physician evaluation, and, finally, disposition (discharge or admission). Collectively, these time points reflect the total LOS. We were able to retrospectively collect these data to determine if there was a correlation between which personnel collected the laboratory specimens and the time stamps. A Student *t* test was performed to determine statistical significance.

Finally, the blood culture bacterial contamination rate was monitored for specimens collected by the phlebotomist and by all nonlaboratory personnel during this period. Blood culture bacterial contamination data for nonlaboratory personnel are not separated by shift but include all shifts during the study period. The Fisher exact test was used to determine whether contamination rates were significantly different when specimens were collected by the phlebotomist vs nonlaboratory personnel.

Intervention 2

In intervention 2, we expanded the study to include all aspects of intervention 1 (ie, a phlebotomist dedicated to the ED collected specimens on the weekday evening shift [2:00 PM-10:00 PM] and a medical technologist was stationed in the laboratory to only receive and track all ED specimens for a 10-day period. These data were compared with baseline and intervention 1 laboratory result reporting times. The 90th percentile TATs, LOS data, and blood culture bacterial contamination rates were monitored as in intervention 1.

Results

Intervention 1: TAT Data

There was a statistically significant reduction in TAT from request to completion for all monitored tests collected by the phlebotomist compared with baseline ($P < .001$) **Figure 1** (Table 1). We were, however, unable to reach our target to complete TAT of 60 minutes on all 4 tests.

Intervention 2: TAT Data

There was a statistically significant reduction in time from request to completion for all 4 tests performed by the phlebotomist compared with baseline (Table 1 and Figure 1). The addition of a medical technologist stationed in the laboratory to receive and supervise processing of the specimens from the ED resulted in a further reduction in TAT compared with intervention 1 ($P < .001$). During intervention 2, we were able to reach our target goal for TAT for 2 tests, CBC count and CPBASIC, but the 90th percentile for PT and troponin were more than 60 minutes.

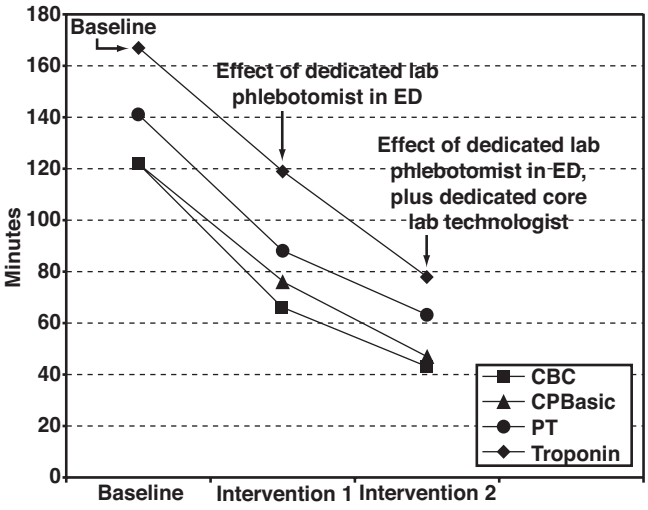

Figure 1 Effect of a dedicated laboratory phlebotomist in the emergency department (ED) and dedicated core laboratory technologist on the turnaround time for selected laboratory tests. Times shown represent the 90th percentile total turnaround time from order to result reporting. CPBASIC is a chemistry panel; PT, prothrombin time.

Blood Culture Bacterial Contamination Rates

Blood culture bacterial contamination was significantly reduced for phlebotomist collection vs baseline (1.1% and 5.0%, respectively; $P = .001$) **Table 2**. The rate of 1.1% for phlebotomist collection was not significantly different from the average phlebotomy rate for the hospital (1.3%).

Cost Analysis

Blood culture data stored in the electronic medical record for a 6-month period encompassing the study demonstrated that a total of 2,986 blood cultures were collected in the ED. Thus, in the ED, there are an estimated 5,972 blood cultures collected annually. In addition, data stored in the electronic

Table 2
Blood Culture Bacterial Contamination Rates

Collection Staff	No. of Blood Cultures		Contamination Rate (%)
	Contaminated	Total	
Nonlaboratory	129	2,576	5.0
Laboratory	3	278	1.1

$P = .0011$; Fisher exact test.

DOI: 10.1309/DGXYTH0VNTTQRQHD

medical record and mined from baseline data after the study showed that approximately 75% of patients who had blood cultures drawn in the ED were ultimately admitted. The phlebotomist was only capable of drawing 50% of the samples during the shift. Therefore, we need at least 2 phlebotomists and 1 laboratory technologist (on each shift) to completely cover this service 24 hours a day, 7 days a week. Assuming blood culture contamination rates of 5.0% and 1.1% for nonlaboratory personnel and phlebotomists, respectively, and an inpatient expense of approximately $5,765[8] per incident, the projected annual cost savings to our system is estimated to be $445,523.80. Total annual labor costs of $561,506.40 to implement this proposal include 8.4 full-time equivalents (FTEs) for phlebotomists at $13.49/h (2.0 FTEs each for day, evening, and night shifts and 2.4 FTEs for weekends and 25% benefits) and 4.2 FTEs for medical technologists at $24.44/h (1.0 FTE each for day, evening, and night shifts and 1.2 FTEs for weekends and 25% benefits) **Figure 2**. This proposal provides coverage 24 hours a day, 7 days a week, with enough phlebotomy personnel to eliminate the requirement for specimen collection by nonlaboratory personnel and a full-time technologist in the laboratory dedicated to testing ED specimens. Even if it is assumed that only 50% of patients who have blood cultures drawn in the ED are admitted (vs our estimated 75%), this program can still be implemented with a positive balance of a little more than $100,000).

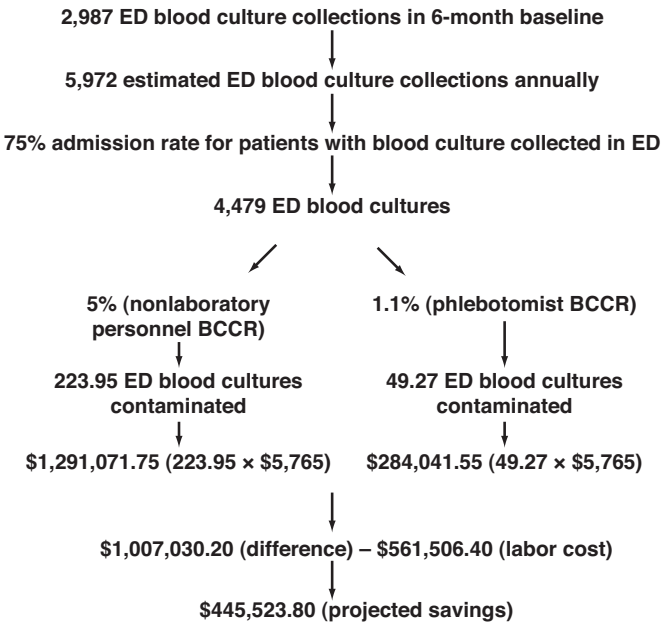

Figure 2 Projected cost savings of having a dedicated laboratory phlebotomist in the emergency department (ED) and dedicated core laboratory technologist in relation to reducing the blood culture contamination rate (BCCR).

LOS Data

The time from arrival to being seen by a physician was decreased on average by 24 minutes (P =.003) in intervention 1 and 48 minutes (P = .007) in intervention 2 when patients' laboratory specimens were collected by the phlebotomist as compared with nonlaboratory personnel on the same shift. However, the total evaluation time by the physician and the total LOS were similar among the 2 groups.

Discussion

As the aging population increases, the workload of ancillary services such as the laboratory will also increase. Because laboratory results provide approximately 60% to 70% of the objective information used in clinical decision making,[9] it is reasonable to assume that the increased volume burden on laboratories may result in increased result reporting times and, perhaps, even increased LOS.

Having closer contact with the ED helped us identify previously unrecognized laboratory problems in specimen result reporting. Even with our interventions, the total TAT for troponin remained longer than the National Academy of Clinical Biochemistry goal of less than 1 hour.[10] Further investigation demonstrated that results were delayed on average 30 minutes for critical troponins vs noncritical troponin tests. Recognizing that critical laboratory results require documentation to meet the Joint Commission National Patient Safety Goal 2A, we initiated process modifications to the reporting algorithm for critical results to address these delays.

Specimen integrity is a major preanalytic concern facing laboratories. A high blood culture contamination rate, for example, burdens the laboratory with unnecessary testing, results in longer hospital stays, and contributes to unnecessary antibiotic therapy for patients.[8] In our hospital, the EDs collect 25% to 33% of all blood culture specimens, making them the largest driver of the overall contamination rate for the hospital. Despite efforts to continuously provide in-service education to nonlaboratory staff on proper phlebotomy technique, our blood culture contamination rates have remained unchanged for years. We believe this may reflect high turnover rates in nursing personnel and the multitasking nature of their role. It must be noted that this study was performed at a single institution, and system inefficiencies with respect to nonlaboratory personnel education and training observed in our system may be more easily overcome in another.

This study has some additional limitations. First, a patient selection bias cannot be excluded; however, post hoc interviews did not reveal a difference in the acuity of the conditions of patients from whom specimens were drawn by the phlebotomist vs nonlaboratory personnel. Second, the blood culture contamination data at our hospital are collected

DOI: 10.1309/DGXYTH0VNTTQRQHD

bimonthly and by location. Therefore, we were unable to separate contamination rates for nonlaboratory personnel by shift. Thus, it is possible that rates for one shift may be worse than the rates for another shift; however, it is unlikely because high contamination rates among specimens obtained by nonlaboratory personnel are consistent with rates from nonlaboratory personnel at our sister hospital and also consistent in our ED over the years.

We have shown that placing laboratory personnel in the ED to collect specimens decreased the laboratory total TATs for 4 tests, blood culture contamination, and the time to be seen by an ED physician. In addition, when a technologist in the laboratory dedicated to receiving ED samples was added in intervention 2, the total TATs decreased further. Usually, in our laboratory, specimens from all locations in the hospital are processed together, but in intervention 2 study specimens from the ED were separated from all other specimens, which facilitated their processing (ie, they were prioritized above other specimens). It is interesting that with only the addition of a laboratory technologist in intervention 2, a difference in collection times between intervention 1 and intervention 2 was noted. Initially, the phlebotomist had a lack of knowledge of ED processes and difficulty being recognized as part of the ED team. When we reanalyzed the data to include only the last month of intervention 1, we found that 90th percentile collection times were similar to those for intervention 2 (Table 1).

The cost avoidance for reduced blood culture contamination alone is $445,523.80. Therefore, by adding just 1 phlebotomist per shift, a hospital can improve the quality of patient care and reduce costs. In our study, the phlebotomist working a shift in the ED was only capable of collecting 50% of the specimens; however, the total TATs of the 4 tests were still statistically significantly impacted.

In addition, we have shown that the use of LOS statistics as overall monitors of efficiency may be flawed because small improvements made in patient care may not reflect a decrease in total LOS if other inefficiencies exist. During our interventions, for example, we realized that improving total TAT for laboratory result reporting decreased only the time to be seen by a physician but did not have an effect on the total LOS. The reason for the observed difference in time to be seen by a physician remains unclear, despite our attempts to identify patient selection bias, but may be related to the use of triage protocols including these common laboratory tests in our ED.

Although total LOS did not change, it is likely that other factors may delay patient disposition despite laboratory improvements. The availability of hospital beds and consultative services, including radiology and cardiology, also has a significant impact on the LOS that simply decreasing laboratory result TATs will not address. This study, to our knowledge, is the first example of an attempt to address a central problem in ED congestion by introducing a laboratory phlebotomist. Future studies, performed at multiple ED centers, are needed to validate these correlations and cost estimations.

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Acknowledgments: There were contributions made by several individuals without whom this project could not have been completed. They include Terry Reese, phlebotomist; Brenda Moore, MT(ASCP), medical technologist; and the nursing personnel of the Emory Crawford Long Emergency Department, especially Valerie Sweigart, RN. Additionally, we thank Deonne Jackson, MT(ASCP), for compiling the blood culture contamination data.

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DOI: 10.1309/DGXYTH0VNTTQRQHD