A Novel Approach to Managing Hemolyzed Specimens

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ABSTRACT

Hemolyzed specimens continue to cost the laboratory time and money. However, the core laboratory at Georgia Regents Health System, Inc. has instituted a novel approach to managing this problem. The purpose of this study was to determine whether the laboratory's new approach had a significant impact on the turn-around time (TAT) and cost of processing hemolyzed and non-hemolyzed specimens in the laboratory. The investigators queried the laboratory information systems for hemolyzed and non-hemolyzed specimens categorized as routine or STAT from the core laboratory and calculated statistical differences between the groups with respect to TAT and cost.The investigators found a statistically significant difference in the time it takes to process STAT hemolyzed specimens versus non-hemolyzed specimens with the new approach. Because of the new approach, hemolyzed specimens were actually processed as fast as, or faster than non-hemolyzed specimens in the core laboratory.

ABBREVIATIONS: GRU - Georgia Regents University, GRSU - Georgia Regents Health System, TAT - Turn-around time, LIS - Laboratory Information System, RT - Report Times, TSC - Technical Staff Cost

INDEX TERMS: Blood specimen collection, Hemolysis, Blood Chemical Analysis, Blood Specimen Collection, Specimen Handling, Time Factors, Laboratories, Hospital, Clinical Laboratory Information Systems, Workflow

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INTRODUCTION

Hemolyzed specimens continue to plague the medical laboratory costing precious time and money to patient safety and care. Pretlow et. al (2008) found that hemolyzed specimens caused deviations in turn-around times (TAT).[1] When a hemolyzed specimen was discovered, laboratory staff had to wait for another specimen to be submitted to replace the compromised specimen that had already been logged into the department.[1] Waiting for a replacement specimen often caused a longer TAT. According to this study, most of the hemolyzed specimens came from the emergency department, ironically the department in which timing was most critical. Jones et. al (1997) showed that hemolysis was a common cause of specimen rejection in the chemistry laboratory because of the effect it has on the concentration of several analytes.[2] The investigators rejected 60% of the specimens for hemolysis, which was five times more than the second most common reason for rejection, insufficient specimen quantity.[2] Carraro et. al (2000) found that the cost of encountering hemolyzed specimens was masked under the fact that

laboratory test results must be accurate and valid, even if it meant rejecting bad samples, awaiting new replacements, and restarting the process.[3]

The core laboratory of Georgia Regents Health System Inc. (GRHS) (formerly Georgia Health Sciences Health System Inc.) has begun a new approach to monitor and alleviate the impact of suboptimal specimens on the time and cost of testing. The managing of suboptimal specimens was formally the duty of the personnel in specimen receiving. However, they (receiving personnel) would often not follow-up on obtaining new specimens to replace suboptimal draws. Eventually, this lack of follow through led to quality assurance problems such as lost specimens and longer TAT.

The new approach has taken the responsibility of processing suboptimal specimens from personnel in receiving and given it to the technical staff running the chemistry automated-line (LabCell by Siemens) connected to their Siemens Advia 1800s. One technologist, called the "driver" is responsible for verification, calling criticals, and calling suboptimal specimens to the nursing staff on the floors. The driver is assisted by the "specimen manager" who is responsible for pulling the specimen log 3 to 4 times a shift. Together, these technical staff members monitor the automated-line for problematic specimens and immediately make nursing staff aware of critical results and suboptimal specimens.

There are studies that document the effects of hemolysis on chemistry analytes, such as potassium and hemoglobin.[4] As well, there are studies that discuss the rate of hemolysis as it relates to the emergency department, nurse phlebotomy techniques, and TAT; these often relate to failure to follow procedures with poor handling or inappropriate storage of samples.[5,6] The purpose of this novel study was to determine if GRHS's approach to handling suboptimal specimens resulted in any difference in the average report times and average technical staff costs of hemolyzed versus non-hemolyzed specimens.

This study asks two questions: what is the mean report time it takes to process routine and STAT specimens (hemolyzed and non-hemolyzed) with the new approach in the core laboratory, and what is the cost of technical staff in relation to the time it takes to process a hemolyzed specimen versus a non-hemolyzed specimen? For the purposes of this study, hemolyzed specimens were specimens in which the red cell membranes have ruptured and the contents of red cells have spilled into the surrounding fluids, causing the serum to appear red to the eye. Non-hemolyzed specimens were specimens in which the red cell membrane is still intact and no rupture has occurred; thus, the serum appears amber to the eye. Report time was the time it took for the specimen to be processed and reported and was derived by subtracting the time the specimen was received in the laboratory from the time the final report was entered into the laboratory information system (LIS). Processing is synonymous with the Report time and includes all procedures, preanalytical, analytical, and post analytical. Routine specimens are specimens that need to be processed and reported as soon as possible within the next few hours. On the other hand, STAT specimens should be processed within 60 minutes. The hypothesis is that there is no significant difference in the mean-time that it takes to process routine and/or STAT non-hemolyzed specimens versus routine and/or STAT hemolyzed specimens with the new approach of the core laboratory. In addition, there is no significant difference in the cost of technical staff to process hemolyzed specimens.

MATERIALS AND METHODS

This novel study took place in the core laboratory at GRHS, a major medical center in the Central Savannah River Area. The Internal Review Board (Human Assurance Committee) of GRU approved this study before any data was collected. This project was not considered human subjects research as defined by federal regulation in that the project involved the use of unlinked or anonymous data or specimens. There were no controls or experimental groups. The laboratory information system allowed investigators to obtain data based on specimens that had previously been processed in the laboratory. The investigators pulled the number of hemolyzed and non-hemolyzed specimens that were routine as well as STAT from the LIS database along with the times the specimen was accessioned into the LIS and the time the final result was reported. The researchers determined the effects of hemolyzed routine and STAT specimens in relation to mean report times as opposed to non-hemolyzed specimens (routine and STAT). The processing time included all preanalytical, analytical, and the post-analytical procedures of

entering results into the LIS. For hemolyzed specimens, the time it took to complete the preanalytical procedures was extended due to the need to contact the nursing staff, who had to then draw another specimen, and resubmit that specimen to the laboratory. Moreover, the investigators compared the cost of technical support (for laboratory personnel only) incurred due to the extended processing time. The study used specimens designated for chemistry testing only.

Blood specimens that were submitted for chemistry tests during a period of one month were included in the study. The cost of technical staff consisted of the average technologist's estimated hourly wage multiplied by the time it took for them to process a hemolyzed specimen versus their salary multiplied by the time it took to process a non-hemolyzed specimen. The measure used for time was only the information taken from the LIS. This included when the hemolyzed specimen was logged into the laboratory and when the final result was entered into the LIS; included in this time were all activities performed by the "driver" to obtain a new specimen. Technologists were not watched or timed as they were processing these specimens live.

The investigators used student t-tests to analyze the statistical differences between individual group means for technical costs and report times. A p-value of 0.05 or less was considered significant.

RESULTS

The investigators calculated the mean report time and technical cost, standard deviation, and coefficient of variance for the routine non-hemolyzed, routine hemolyzed, STAT hemolyzed, and STAT non-hemolyzed specimens. Table 1 shows the total numbers of hemolyzed and non-hemolyzed specimens included in the study. Note that the numbers of routine specimens were significantly larger than the total number of STAT specimens; therefore only a percentage of routine specimens equivalent to the observed percentage of STAT specimens were used to perform all statistical calculations. This meant that 164 routine specimens were statistically compared to 149 STAT specimens. Table 1 also compares the average report times and the average technical staff cost for each of the groups of specimens. Interestingly, hemolyzed STAT specimens were reported in the shortest amount of time (53.45 minutes) and cost the least to process ($24.29). Results for non-hemolyzed routine specimens took the longest to report (65.62 minutes) and cost the most ($29.82).

Table 1. This table shows the mean report times (RT) and technical staff costs (TSC) in dollars for all groups.

Group	Number of Specimens	Avg. RT Minutes	Avg. TSC @$27.26/hr
1-Hemolyzed STAT	119	53.45	24.29
2-Hemolyzed routine	31	57.03	25.91
3-Non-hemolyzed STAT	30	56.33	25.60
4-Non-hemolyzed routine	133	65.62	29.82

In order to find out if there were any statistical differences in the times it took to process different groups of specimens, we compared various groups to each other by subtracting the means of the report times for each group. (Table 2) The t-statistic between group means is also reported along with the p-value. The only groups that showed a significant difference in report times were the STAT hemolyzed group compared to the routine non-hemolyzed ($p = 0.0002$). The STAT non-hemolyzed group compared to the routine non-hemolyzed showed a significant difference ($p = 0.0187$). However, when performing multiple comparisons, the accumulation of errors may be enhanced; using a correction method (Bonferroni), the STAT non-hemolyzed group compared to the routine non-hemolyzed group showed no significance difference. There was no significant difference in the time it took to report the results of STAT hemolyzed specimens and routine hemolyzed specimens ($p = 0.5908$) or STAT non-hemolyzed specimens ($p = 0.6331$). Similarly, there was no significant difference in the time it took to report the results of routine hemolyzed specimens and STAT non-hemolyzed specimens ($p = 0.9325$) or routine non-hemolyzed specimens ($p = 0.0743$).

The statistical difference between the average cost for technical staff to process the various specimens was determined as well as the t-statistic and the p-value. (Table 3) Just like the differences in report times, only the cost of the technical staff to process the STAT hemolyzed specimens compared to the routine non-hemolyzed ($p = 0.0001$) showed a statistical difference. Before error correction, there appeared to be a

significant difference between the cost of STAT non-hemolyzed specimens versus routine non-hemolyzed specimens (p = 0.0188). However, after applying the Bonferroni correction, there was no significant difference in the costs for processing these groups.

Table 2. This table shows the mean differences in processes times; the t- and p-values for all comparisons are presented. Hem refers to hemolyzed specimens. Nonhem refers to nonhemolyzed specimens. Degrees of freedom = 1. *When performing multiple comparisons, the accumulation of errors is enhanced. After using a correction method (Bonferroni), STAT nonhem vs. Routine nonhem showed no statistical difference.

Group Comparisons	Mean Report Time Differences (minutes)	t-value	p-value
STAT hem vs. Routine hem	-3.58	-0.54	0.5908
STAT hem vs. STAT nonhem	-2.882	-0.49	0.6331
STAT hem vs. Routine nonhem	-12.17	-3.81	0.0002
Routine hem vs. STAT nonhem	0.70	0.09	0.9325
Routine hem vs. Routine nonhem	-8.59	-1.80	0.0743
STAT nonhem vs. Routine nonhem	-9.29	-2.37	0.0187*

DISCUSSION

This retrospective study shows that there was no significant difference in the report times and technical cost for the majority of the individual groups of data; therefore the null hypothesis is accepted showing that the core laboratory's new approach to managing suboptimal specimens is successful in that the report time and cost of processing hemolyzed samples is, for the most part, the same as the report time and cost for processing non-hemolyzed samples.

Where there was a statistical difference between groups, it involved the report time and cost for the non-hemolyzed routine specimens compared to the STAT hemolyzed specimens (see Table 1 and 2). This is an expected result since the average TAT for routine specimens should be significantly longer than for any STAT specimen. The laboratory's benchmark for the TAT of routine specimens is approximately 4 hours which was met.

Table 3. Mean Difference in Average Technical Staff Cost

Group Comparisons	Mean Differences in Staff Cost ($)	t-value	p-value
STAT hem vs. Routine hem	1.68	-0.54	0.5907
STAT hem vs. STAT nonhem	1.31	-0.49	0.6329
STAT hem vs. Routine nonhem	5.53	-3.81	0.0001
Routine hem vs. STAT nonhem	0.32	0.09	0.9326
Routine hem vs. Routine nonhem	3.90	-1.80	0.0743
STAT nonhem vs. Routine nonhem	4.22	-2.38	0.0188*

This table shows the mean differences for technical staff costs; the t- and p-values for all comparisons are presented. Degrees of freedom = 1.
*When performing multiple comparisons, the accumulation of errors is enhanced. After using a correction method (Bonferroni), STAT nonhem vs. Routine nonhem showed no statistical difference.

It is interesting to note that in general, the hemolyzed specimens were processed faster and at a lower cost than non-hemolyzed specimens, although the difference was not statistically significant. This lack of a significant difference means that the technologists in the core laboratory are calling and receiving replacement specimens for hemolyzed specimens very quickly. In other words, the chemistry technologist can call, ask for a redraw, get a new specimen (not hemolyzed), process the new specimen, and report the results all within the TAT and within the same time as the non-hemolyzed specimen that does not require all the extra work. In fact, they can process and report two specimens when the first is hemolyzed, faster than they can do one nonhemolyzed specimen.

These results are unexpected and seem to contradict traditional thinking about hemolyzed specimens. Laboratorians know that these specimens require more attention and time; however, it appears that the efficiency of this laboratory corrects for any additional time needed to process and report results from these specimens. Though not what we would expect, the results confirm the efforts of GRHS to successfully

manage this ongoing problem. Our results also likely confirm Carraro's et al (2000) observation that true costs of processing these specimens are masked by the laboratory personnel's efficiency as well as the efficiency of the phlebotomy and/or nursing departments that respond to the request for a redraw in a timely manner yet are not considered here.[4]

CONCLUSION

This study concludes that the core laboratory's new approach for processing and recollecting suboptimal specimens is working well. Hemolyzed specimens processed according to the new protocol are not significantly different with regards to processing time and technical cost when compared to non-hemolyzed specimens. In fact, this study shows that the new approach for processing all hemolyzed specimens is faster and costs less than processing routine specimens. As well, the results indicate that laboratory personnel are able to meet goal TAT, even in the case of hemolyzed specimens. The study also implies that the laboratory has the cooperation of other healthcare professionals outside the laboratory who are responding quickly to the issue of hemolysis. This study shows how one laboratory met quality issues with suboptimal specimens and achieved results much better than expected.

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