Three Alternative Structural Configurations for Phlebotomy: A Comparison of Effectiveness

HEIDI MANNION, TERESA NADDER

OBJECTIVE: This study was designed to compare the effectiveness of three alternative structural configurations for inpatient phlebotomy. It was hypothesized that decentralized was less effective when compared to centralized inpatient phlebotomy.

DESIGN: A non-experimental prospective survey design was conducted at the institution level. Laboratory managers completed an organizational survey and collected data on inpatient blood specimens during a 30-day data collection period.

SETTING/PARTICIPANTS: A random sample (n =31) of hospitals with onsite laboratories in the United States was selected from a database purchased from the Joint Commission on Accreditations of Healthcare Organizations (JCAHO).

MAIN OUTCOME MEASURE: Effectiveness of the blood collection process was measured by the percentage of specimens rejected during the data collection period.

RESULTS: Analysis of variance showed a statistically significant difference in the percentage of specimens rejected for centralized, hybrid, and decentralized phlebotomy configurations [F (2, 28) = 4.27, p = .02] with an effect size of .23. Post-hoc comparison using Tukey's HSD indicated that mean percentage of specimens rejected for centralized phlebotomy (M = .045, SD = 0.36) was significantly different from the decentralized configuration (M = 1.42, SD = 0.92, p = .03).

CONCLUSION: Phlebotomy configuration has a significant effect on the percentage of specimens rejected. Based on this outcome, the centralized phlebotomy configuration was found to be more effective when compared to the decentralized configuration.

ABBREVIATIONS: ANOVA = analysis of variance; JCAHO = Joint Commission on Accreditation of Healthcare Organizations; Tukey's HSD = Tukey's honestly significant different; LSD = least significant difference; M = mean; SD = standard deviation

INDEX TERMS: decentralized; effectiveness; patient-focused; phlebotomy.

Clin Lab Sci 2007;(20)4:210

Heidi Mannion PhD MT (ASCP) *is* ***associate professor*** *and* ***program director****, Department of Medical Technology, University of Alaska Anchorage.*

Teresa Nadder PhD CLS (NCA) *is* ***associate professor*** *and* ***chair****, Department of Clinical Laboratory Science, Virginia Commonwealth University.*

Address for correspondence: *Heidi Mannion PhD MT (ASCP), associate professor and program director, Department of Medical Technology, University of Alaska Anchorage, AHS 172, 3211 Providence Drive, Anchorage AK 99508. (907) 786-6924, (907) 786-6938 (fax). afham@uaa.alaska.edu*

This study was funded by a Professional Development Grant from the University of Alaska Anchorage and the Allegiance Healthcare Graduate Research Award from the American Society of Clinical Laboratory Science. Results from this study were included in a dissertation submitted by Heidi Mannion in partial fulfillment of the requirements for the degree of Doctor of Philosophy in Health Related Sciences at Virginia Commonwealth University.

In recent years hospitals have utilized many methods to improve the efficiency and quality of their services. In an effort to improve patient satisfaction by reducing delays and the number of health professionals encountered during a hospital stay, some hospitals have implemented a patient-focused care model which includes decentralizing inpatient

The peer-reviewed Research and Reports Section seeks to publish reports of original research related to the clinical laboratory or one or more subspecialties, as well as information on important clinical laboratory-related topics such as technological, clinical, and experimental advances and innovations. Literature reviews are also included. Direct all inquiries to David G Fowler PhD CLS(NCA), Clin Lab Sci Research and Reports Editor, Dept of Clinical Laboratory Sciences, University of Mississippi Medical Center, 2500 North State St, Jackson MS 39216. (601) 984-6309, (601) 815-1717 (fax). dfowler@shrp.umsmed.edu

phlebotomy services. With this model, nurses and nurse extenders such as patient care technicians and patient care assistants collect the inpatient blood specimens for laboratory testing. Prior to the introduction of patient-focused care models, hospitals utilized a centralized approach, in which the laboratory controlled the management and delivery of phlebotomy services.

Advantages and disadvantages are associated with each type of system for phlebotomy services. Centralized phlebotomy affords reductions in cost from eliminating duplication of effort and resources. A comparison of the systems may indicate that a centralized system carrying out all specimen collection requests for the hospital may be slower than a decentralized arrangement where each individual nursing unit is responsible for its own specimen collections. Decentralized phlebotomy locates the blood collector near the patient allowing flexibility in the blood collection schedule, which may reduce delays in the blood collection process.[1] At the same time, the blood collector's skill level is difficult to maintain when phlebotomy is performed on an irregular basis and the logistics of phlebotomy training and competency testing becomes more complex with the increased number of personnel performing phlebotomy procedures.[1-2]

The purpose of this study was to compare alternative structural configurations of inpatient blood collection, centralized, hybrid and decentralized, to determine if equally effective outcomes result from all three systems. In this study, the percentage of specimens deemed unacceptable for analysis by the laboratory (rejected) was used to compare the effectiveness of the three structural configurations. Based on previous studies[2-4] it was hypothesized that decentralized inpatient phlebotomy would have a significantly higher percentage of blood specimens rejected than centralized inpatient phlebotomy and be, therefore, less effective.

MATERIALS AND METHODS

This study was conducted at the institution level using a non-experimental prospective survey design. A random sample of 750 hospitals with onsite laboratories in the United States was selected from a database (N = 3454) purchased from the Joint Commission on Accreditation of Healthcare Organizations (JCAHO). Laboratory managers from these institutions were solicited to participate in the study. Facilities that chose to participate signed a consent form, completed an organizational survey, and collected data on inpatient blood specimens that were rejected over a 30-day period. The study was approved by the Institution Review Boards at both Virginia Commonwealth University and the University of Alaska Anchorage.

Due to the low response rate from the first mailing, a second random sample was selected using sampling with replacement. A total of 1,387 letters were sent to solicit participation in the study; 268 (19.3%) facilities responded to the invitation. Prior to selecting a third random sample, the sample size was calculated using the data submitted from three centralized and three decentralized facilities from the first random sample. Minitab software[5] was used to perform a power calculation based on an unequal variance t-test. Using a power of .90 with an alpha level of .05, the unequal variance t-test gave a required sample size of six institutions per group. Although 63 facilities agreed to participate, only 31 submitted acceptable data before the close of the study.

Laboratory managers from the random sample that agreed to participate in the study were asked to provide the following organizational information on their facility: 1) average daily census for the hospital during the past six months; 2) average daily census for critical care and pediatric units during the past six months; 3) utilization of students from training programs for inpatient blood collection during the past six months (yes/no); 4) utilization of students from training programs for inpatient blood collection during the data collection period (yes/no); 5) structural configuration of inpatient phlebotomy service (centralized or decentralized); 6) total billable inpatient and outpatient blood collections for the last fiscal year; 7) total cost of phlebotomy consumables for the last fiscal year; 8) information contained on specimen labels printed by the laboratory information system; 9) use of hand-held computer technology at the bedside for patient and specimen identification (yes/no); 10) on the job training for inpatient phlebotomy (yes/no), if yes length of training in weeks; 11) educational background of the laboratory manager; 12) method of billing for inpatient blood collections; and 13) use of standard operating procedures for specimen acceptability (yes/no), identify standards if used. In addition to the organizational information, specimen processors were asked to collect data on inpatient specimen rejections over a 30-day period. Reasons for rejecting specimens included: compromised integrity (e.g., hemolyzed, clotted, or contaminated), improper collection, inadequate identification, lab accident (specimen damaged after being received in the lab), lost/damaged during transit, quantity not sufficient for test ordered, and other. Fewer than seven percent of the specimens rejected were due to lab accidents and lost/damage during transit. Compromised integrity

was the major reason for specimen rejection for all three phlebotomy configurations.

Six percent of the respondents indicated that they were unable to classify their phlebotomy configuration based on the description provided in the organizational survey. They estimated that the responsibility for collecting inpatient blood specimens was equally divided among the laboratory (centralized) and nursing services (decentralized). A third category for phlebotomy configuration (hybrid), therefore, was added prior to analyzing the data. Subsequently, the phlebotomy configurations were recoded based on the percentage of laboratory and nonlaboratory personnel collecting the inpatient blood specimens. The percentages were calculated using the data collected from the specimen rejection study. The three configurations were defined as: centralized, >80% collected by laboratory personnel; decentralized, >80% collected by nonlaboratory personnel; and hybrid, all other facilities.

RESULTS

The sample size requirement was met with 11 centralized (4,219 specimens), 10 hybrid (25,180 specimens) and 10 decentralized (33,449 specimens) facilities included in the analysis. Though a significant difference ($p < .01$) was found in the average daily census among the three phlebotomy configurations, a significant correlation was not found between the average daily census during the study and the percentage of specimens rejected ($r = .10$, $n = 31$, $p = .60$); therefore, it was not controlled for in the data analysis.

Effectiveness of the blood collection process was measured by the percentage of specimens rejected during the data collection period. Results from the analysis of variance (ANOVA) showed a statistically significant difference in the percentage of specimens rejected for the three phlebotomy configurations, centralized, hybrid, and decentralized [$F(2, 28) = 4.27$, $p = .02$] with an effect size of .23. Post-hoc comparison using the least significant difference (LSD) test indicated that the mean for percentage of specimens rejected for centralized phlebotomy ($M = 0.45$, $SD = 0.36$) was significantly different from the hybrid ($M = 1.22$, $SD = 1.0$, $p = .04$) and decentralized ($M = 1.42$, $SD = 0.92$, $p = .01$) phlebotomy configurations. The hybrid and decentralized configurations did not differ significantly ($p = .59$). Moreover, the results from the Tukey's HSD, a more conservative method, mirrored those of the LSD. A significant difference ($p = .03$) for the mean percentage of specimens rejected for centralized phlebotomy ($M = 0.45$, $SD = 0.36$) was also found when compared to decentralized phlebotomy ($M = 1.42$, $SD = 0.92$). The hybrid versus decentralized ($p = .85$) and hybrid versus centralized

Figure 1. Means plot of percentage of specimens rejected for the three phlebotomy configurations

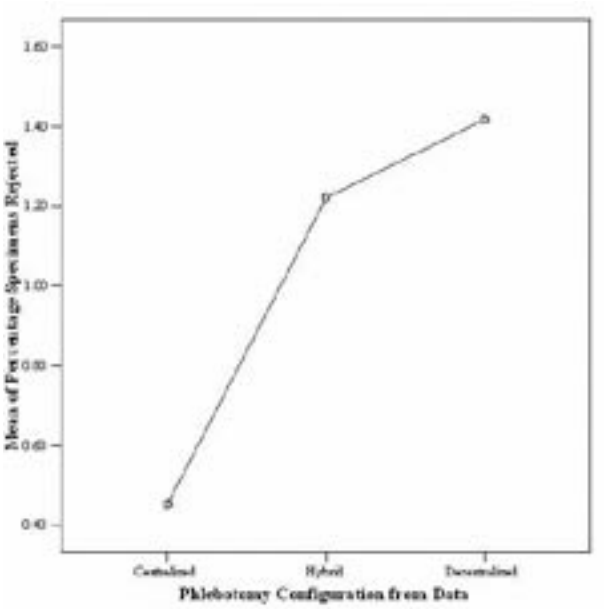
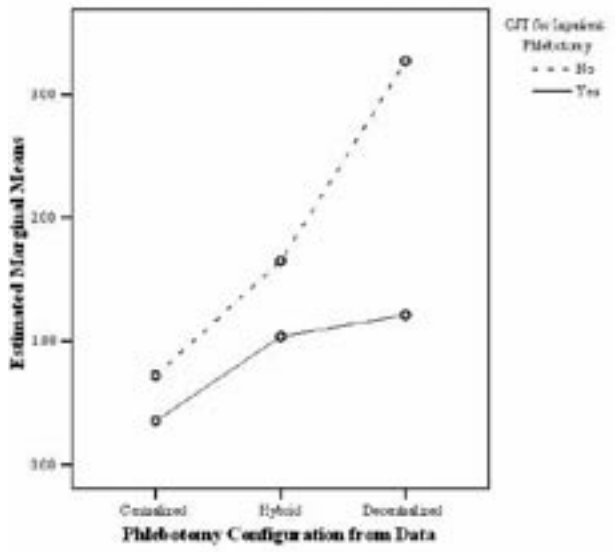


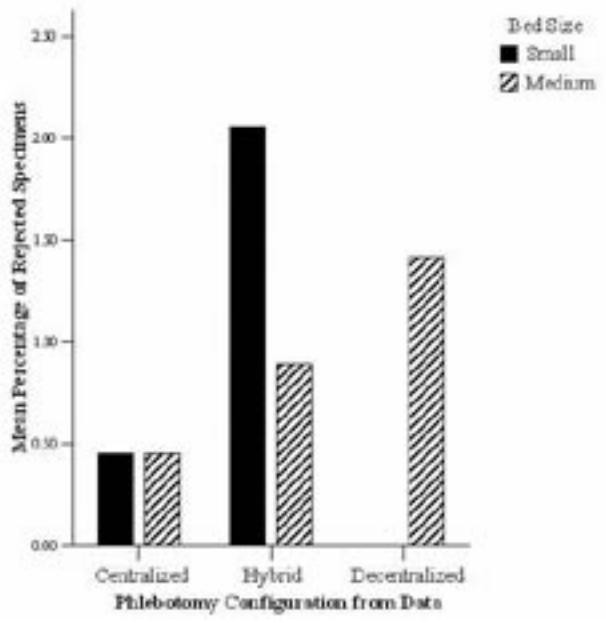
Figure 2. Comparison of estimated marginal means for the mean percentage of specimens rejected based on provision of on the job training (OJT) and phlebotomy configuration



(p =.09) comparisons were not significant. Nonetheless, the results from the latter comparison approached statistical significance. The means plot in Figure 1 demonstrates the differences in percentage of specimens rejected among the three phlebotomy configurations. The data supports the hypothesis that there is a significant difference in the percentage of rejected inpatient blood specimens between centralized and decentralized inpatient phlebotomy services.

A factorial ANOVA was utilized to explore the interactions and effects of the organizational properties measured in the study (phlebotomy configuration, on the job training, and information on labels). With this model there were no significant interactions, and the only significant main effect (p<.01) observed was with phlebotomy configuration. The variable information on labels was not significant and had the lowest effect size; therefore, it was excluded from the analysis and a two-way between groups ANOVA was run. Subsequent ANOVA analysis produced no significant interaction between on the job training and phlebotomy configuration; however, statistically significant main effects were observed for both phlebotomy configuration [F (2, 25) = 7.474, p <.01] and on the job training [F (1, 25) = 8.563, <.01]. Furthermore, a large effect size was observed with both variables (partial eta squared = .37 and .26 respectively). For small samples, SPSS provides an adjusted coefficient of determination (r^2), a more conservative estimate of how much variance in the dependent variable is explained by the model. In this model, the adjusted r^2 = .33; therefore, 33% of the variance in the percentage of specimens rejected can be explained by the model.

Figure 3. Comparison of percentage of specimens rejected grouped by configuration and bed size



Note: There were no small hospitals that utilized a decentralized configuration

As can be seen in Figure 2, facilities that provided on the job training have a lower percentage of inpatient blood specimens rejected than facilities that do not provide on the job training. Therefore, on the job training is also associated with a higher level of effectiveness for inpatient phlebotomy services.

DISCUSSION

This study found differences in effectiveness when comparing hospitals that utilized centralized, hybrid, and decentralized systems for inpatient phlebotomy services. Centralized phlebotomy services were more effective at providing quality specimens for the laboratory to analyze as reflected in the lower percentage of specimens rejected. Part of this difference may be attributable to the use of phlebotomist and other laboratory personnel who have received training in specimen collection and who understand the impact of the pre-analytical variables on the quality of the tests results produced by the laboratory. In addition to the training, a dedicated phlebotomy team performs inpatient phlebotomy on a regular basis allowing skill level to be maintained. The importance of training is demonstrated in Figure 2; facilities in which the laboratory provided on the job training for their specimen collectors had a lower percentage of specimens rejected across all three phlebotomy configurations.

In this study laboratory personnel collected 92.8% of the inpatient specimens in centralized facilities and nonlaboratory personnel collected 96.5 % of the specimens in decentralized facilities. Centralized facilities had a significantly lower (p =.03) percentage of specimens rejected than decentralized facilities. This study supports the findings of several CAP Q-Probes studies[6-8] which found that nonlaboratory personnel had a significantly higher percentage of specimens rejected than laboratory personnel when comparing aggregate data.

Figure 3 shows no difference in the percentage of specimens rejected for small (< 100 beds) and medium (100-500 beds) sized facilities when a centralized inpatient phlebotomy configuration is used. This was not case for hospitals that

used a hybrid configuration; smaller hospitals had a higher percentage of specimens rejected than medium-sized hospitals. This may be due to the difficulty in maintaining the specimen collector's competency when the number of blood collections requested is small. Further, there is an increased number of personnel performing the procedures due to the laboratory and nursing units sharing the responsibility for blood collection. Future research comparing the effectiveness of the three phlebotomy configurations should include the number of phlebotomies performed each day for all personnel responsible for inpatient blood collection.

Results from the study can be generalized only to a population similar to those who responded to the surveys. None of the small hospitals in the study used a decentralized configuration which may have biased the results if this is not reflective of the target population. JCAHO, the owner of the dataset used in the study, was contacted to determine if information on the phlebotomy configurations for the target population was available. They were unable to determine the phlebotomy configurations used by the facilities in their dataset.

Limitations of this study also included the accuracy of the self-reported information on the organizational survey and the interrater reliability of the specimen processors. In addition, the conclusions were based on the analysis of a single measure of effectiveness, percentage of rejected specimens. Therefore, the inclusion of other measures of effectiveness including patient satisfaction and complications from the blood collection process (bruising, nerve damage) are recommended for further studies.

ACKNOWLEDGEMENTS

This study was funded by a Professional Development Grant from the University of Alaska Anchorage and the Allegiance Healthcare Graduate Research Award from the American Society of Clinical Laboratory Science.

Clin Lab Sci encourages readers to respond with thoughts, questions, or comments regarding this article. Email responses to ic.ink@mchsi.com. In the subject line, please type "CLIN LAB SCI 20(4) RR MANNION". Selected responses will appear in the Dialogue and Discussion section in a future issue. Responses may be edited for length and clarity. We look forward to hearing from you.

REFERENCES

1. Lark S. Patient-focused care is it working? Is it here to stay? Lab Med 1997;28(10): 644-51.
2. Gable JT, Pyevac ZP. Paradigm shift: Phlebotomy belongs to nursing. Clinical Laboratory Management Review. 1995; 9(4): 286-97.
3. Marchwinski J. Transferring inpatient specimen collection to nursing: the multidisciplinary path to success. Clinical Laboratory Management Review. 1997; 11(6): 368-73.
4. Bologna LJ, Lind C, Riggs RC. Reducing major identification errors within a deployed phlebotomy process. Clinical Leadership & Management Review. 2002; 16(1): 22-6.
5. Minitab [computer program]. Version 12. Reading: Addison-Wesley Longman Inc; 1999.
6. Dale JC, Novis DA. Outpatient phlebotomy success and reasons for specimen rejection. Arch Pathol Lab Med 2002; 126(4): 416-9.
7. Jones BA, Calam RR, Howanitz PJ. Chemistry specimen acceptability: A College of American Pathologist Q-Probes study of 453 laboratories. Arch Pathol Lab Med 1997; 121(1): 19-26.
8. Jones BA, Meier F, Howanitz PJ. Complete blood count specimen acceptability. a College of American Pathologist Q-Probes study of 703 laboratories. Arch Pathol Lab Med 1995; 119(3): 203-8.