Using Kolb's Experiential Learning Cycle as a Guide for Understanding Critical Values in a Clinical Laboratory

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Abstract

Seven medical technologists and medical laboratory technicians employed at a small, rural hospital laboratory located in the Midwest participated in this project. The purpose of this project was to determine if the use of Kolb's experiential learning cycle improved understanding of critical values by laboratory testing personnel in a clinical laboratory setting. When the differences of the posttest and the pretest scores were analyzed, it suggested that the understanding of critical values did not increase with the majority of the laboratory testing personnel who participated in this learning exercise.
This work is dedicated to all medical technologists and medical laboratory technicians who together work twenty-four hours a day and seven days a week to provide healthcare for our neighbors.
Acknowledgements

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# Table of Contents

<table>
<thead>
<tr>
<th>Chapter I: Introduction</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Statement of Problem</td>
<td>2</td>
</tr>
<tr>
<td>Justification</td>
<td>2</td>
</tr>
<tr>
<td>Definition of Terms</td>
<td>3</td>
</tr>
<tr>
<td>Limitations and Appropriate Use of Results</td>
<td>4</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Chapter II: Review of Literature</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Research Question #1: How was Kolb’s experiential learning cycle defined in the literature?</td>
<td>5</td>
</tr>
<tr>
<td>Research Question #2: How was the Kolb’s experiential learning cycle utilized with adult learners?</td>
<td>7</td>
</tr>
<tr>
<td>Research Question #3: What were the benefits of utilizing Kolb’s experiential learning cycle with adult learners?</td>
<td>11</td>
</tr>
<tr>
<td>Conclusion</td>
<td>13</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Chapter III: Methods and Procedures</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Participants</td>
<td>15</td>
</tr>
<tr>
<td>Intervention</td>
<td>16</td>
</tr>
<tr>
<td>Educational materials</td>
<td>18</td>
</tr>
<tr>
<td>Instruments</td>
<td>20</td>
</tr>
<tr>
<td>Procedures</td>
<td>21</td>
</tr>
<tr>
<td>Timeline</td>
<td>22</td>
</tr>
<tr>
<td>Data Analysis</td>
<td>24</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Chapter IV: Results</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>26</td>
</tr>
</tbody>
</table>
List of Figures

Figures

**Figure 1:** Critical Values Pretest and Posttest Scores of the Participants and the Difference between Each Test.  27

**Figure 2:** Critical Values Pretest and Posttest Scores of Each Participant  27

**Figure A1:** Laboratory Tests, Critical Values Threshold, and Potential Life Threatening Events.  39

Threatening Events.
Chapter I: Introduction

In the daily operation of the medical laboratory, diagnostic blood tests were administered to patients in order to investigate medical symptoms they might have had. The goal of the clinical laboratory was not only to accurately report blood test results, but to let a physician immediately know when these results were potentially life threatening. These potentially life-threatening results were known in some hospitals as critical values. Understanding of critical values by laboratory testing personnel was an important part of patient care. The researcher wanted to discover a way to teach not only critical value procedures to laboratory testing personnel, but why these critical values were potentially life threatening to the patient.

The researcher was registered as a Medical Technologist with the American Society for Clinical Pathology and certified as a Clinical Laboratory Scientist by the National Credentialing Agency for Laboratory Personnel. She was employed as a generalist at a small, rural hospital laboratory. As part of her job duties, the researcher was involved with educating coworkers about new policies, procedures, and instrumentation. The researcher was interested in finding educational techniques that were useful in a clinical laboratory setting.

Statement of the Problem

The purpose of this project was to determine if the use of Kolb’s experiential learning cycle improved understanding of critical values by laboratory testing personnel in a clinical laboratory setting.

Research questions:

1. How was Kolb’s experiential learning cycle defined in the literature?
2. How was the Kolb’s experiential learning cycle utilized with adult learners?

3. What were the benefits of utilizing Kolb’s experiential learning cycle with adult learners?

4. Did implementing Kolb’s experiential learning cycle in the clinical laboratory improve understanding of critical values by laboratory testing personnel?

*Justification*

By completing this project, the researcher wanted to find an instructional strategy that taught understanding of critical values by laboratory testing personnel. Complete understanding of critical values required the laboratory testing personnel to know the critical value thresholds of diagnostic tests, the protocol of critical value notification, and why the critical value was life threatening to the patient. Understanding critical values would benefit laboratory testing personnel by enhancing their awareness of the urgency to report critical values to a physician, thus improving patient care. In addition, this research might benefit other trainers of laboratory testing personnel by giving them a method to train colleagues and/or students critical value procedures.

*Definition of Terms*

**Clinical laboratory**- A laboratory that its main purpose was to test patient samples for medical purposes.

**Critical values**- Abnormal high or low values of diagnostic blood tests that could potentially be life threatening. At this hospital, fourteen diagnostic blood tests had critical value thresholds. These diagnostic tests were troponin, BUN, creatinine, potassium, glucose, sodium, calcium, neonatal bilirubin, INR, PTT, absolute neutrophil count, blasts, hemoglobin, and platelet count.
Experiential learning- "...a process whereby concepts are derived from and continuously modified by experience." (Kolb, 1984 p.26) In this project, experiential learning was understanding critical values by knowing the critical values, how to report the critical values, and why the values were critical.

Generalist- A term to describe a category of laboratory testing personnel. These laboratory personnel worked in all areas of the clinical laboratory including but not limited to: hematology, microbiology, coagulation, blood bank, chemistry, and urinalysis.

Kolb's experiential learning cycle- A process in experiential learning that had four stages: concrete experience, reflective observation, abstract conceptualization, and active experimentation. (Kolb, 1984)

Laboratory testing personnel- Medical technologists and medical laboratory technicians.

Medical Laboratory Technician (MLT)- Professionals that were involved in medical laboratory testing, usually under the supervision of a medical technologist. They had an Associate's degree in medical lab technology and certified by an accrediting agency. (American Society for Clinical Pathology, 2004)

Medical Technologist (MT)- Professionals that were involved in medical laboratory testing. Besides testing, they were responsible for the accuracy of test results and reporting the results to physicians. They were required to have a Bachelor's degree in medical technology or life science and certified by an accrediting agency. (American Society for Clinical Pathology, 2004)
Limitations and Appropriate Use of Results

This project was conducted in a small, rural hospital laboratory located in the Midwest. The study was limited by the small number of participants. The participants were laboratory testing personnel, which consisted of medical technologists and medical laboratory technicians. All of the laboratory testing personnel were generalists. There was some limited racial and gender diversity. Because this study was implemented in a small, rural hospital with a small number of participants, the results may not be generalized to other clinical laboratories.
Chapter II: Review of the Literature

The purpose of this project was to determine if the use of Kolb's experiential learning cycle improved understanding of critical values by laboratory personnel in a clinical laboratory setting.

Research questions:

1. How was Kolb's experiential learning cycle defined in the literature?
2. How was the Kolb's experiential learning cycle utilized with adult learners?
3. What were the benefits of utilizing Kolb's experiential learning cycle with adult learners?
4. Did implementing Kolb's experiential learning cycle in the clinical laboratory improve understanding of critical values by laboratory testing personnel?

Research Question # 1: How was Kolb's experiential learning cycle defined in the literature?

In order to answer research question # 1, a review of the literature was conducted. Shannon (2003) noted that educators regarded experiential learning as an important part of adult learning. Many researchers (Lewis & Williams, 1994; Miettinen, 2000; Friedman, Watts, Croston, Durkin, 2002) recognized David Kolb for his work with experiential learning and adult learners. They believed that his theories moved experiential learning from theory to practice.

Kolb (1984) defined experiential learning as "a process whereby concepts are derived from and continuously modified by experience" (p.26). He felt that experience alone did not create knowledge, but rather what one did with the experience created knowledge. Kolb continued by describing experiential learning as a four-stage cycle. His
cycle was a guide for how adults could learn and it had four learning modes: concrete experience, reflective observation, abstract conceptualization, and active experimentation. Kolb believed that in order for knowledge to be created from an experience, a student must pass through all the stages of the cycle.

The first stage of Kolb’s experiential learning cycle was concrete experience. Kolb (1984) described concrete experience as a tangible, felt experience. In other words, the learner needed to participate physically in an outward experience. Other authors (Stanton & Grant, 1999; Sugarman, 1985; Lewis & Williams, 1994; Hickcox, 2002) have described the concrete experience as an immediate, direct experience with events or simply doing. They also thought that concrete experience required the learner to be involved in an experience.

The second stage of Kolb’s experiential learning cycle was reflective observation. Kolb (1984) believed reflective observation was a way of transforming the experience into learning. He further defined reflective observation as an internal reflection on the part of the learner about the experience. Other authors in the literature expanded Kolb’s definition of reflective observation. Sugarman (1985) and Heffler (2001) identified watching and observing as a characteristic of this stage. Pertaining to reflective observation, Kuri (2000) and Lewis and Williams (1994) felt that once a learner has had an experience, he must take a step back and think objectively about the experience from different perspectives.

The third stage of the experiential learning cycle was abstract conceptualization. Kolb (1984) defined abstract conceptualization as the process of taking hold of an experience. He described this stage as the conceptual interpretation and symbolic
representation of the experience by the learner. In agreement, Sugarman (1985) described abstract conceptualization as when a learner understood his/her observations and integrated them into logical and sound theories. Lewis and Williams (1994) described this stage as the generalizations or principles that were created by the learner to move his/her observations into theories.

The final stage in Kolb’s experiential learning cycle was active experimentation. Active experimentation was defined by Kolb (1984) as way of transforming the experience by active external manipulation. Hickcox (2002) as well as Lewis and Williams (1994) believed that this was when the learner tested what he/she learned by applying new knowledge to a new experience. In addition to testing the theories the learner had constructed, Sugarman (1985) said that he/she also used these theories for decision making and problem solving. Kolb (1984) continued by stating that active experimentation led to a new concrete experience that started the whole cycle again.

Through the review of literature, it was determined that Kolb’s experiential learning cycle was a process that described how experiential learning occurred in adult learners. Kolb (1984) described four stages of this cycle: concrete experience, reflective observation, abstract conceptualization, and active experimentation. He believed that a learner must proceed through all four stages of the cycle for new knowledge to occur. Because Kolb believed that experience alone did not create knowledge, he felt that adults could learn by experience when they used his experiential learning cycle as a guide.

**Research question #2: How was the Kolb’s experiential learning cycle utilized with adult learners?**
In order to answer research question #2, a review of the literature was conducted. Because Kolb (1984) believed that learning by experience was a process, he described how learners should utilize his experiential learning cycle by developing their abilities in the four modes of the cycle: concrete experience, reflective observation, abstract conceptualization, and active experimentation.

As a guide for teaching strategies, Kolb (1984) stated that the learner should involve him or herself with each mode of his experiential learning cycle. In concrete experience, he thought that the learner had to involve him or herself fully and openly without bias to a new experience. Secondly, in reflective observation, he believed that the learner needed to stand back and reflect on the experience from many perspectives. In abstract conceptualization, Kolb wanted the learner to create concepts and integrate them into theories. Finally, in active experimentation, he felt that learners needed to use these theories to make decisions and solve problems.

Because Kolb (1984) described his experiential learning cycle as guide to learning from experience, many ways of implementing Kolb's experiential learning cycle with adult learners in and out of the classroom was documented in the research. Kuri (2000) commented that the variety and the combination of teaching strategies used with Kolb's experiential learning cycle were limited only by the instructor's creativity.

Harrelson and Leaver-Dunn (2002) implemented this learning cycle in clinical instruction of athletic trainers. They described that by using planned or impromptu experiences, which were structured or unstructured, the clinical instructor guided the student through Kolb's experiential cycle by asking the student questions. Some of the questions Harrelson and Leaver-Dunn asked the students were: "Tell me how that
experience was for you." (p. 25), "What was your rationale for doing...?" (p. 26), and "What might be the effect if you ...?" (p. 26). Using the students' answers as a springboard for instruction, Harrelson and Leaver-Dunn then brought in research findings and theoretical information to link the classroom with clinical practice.

McGunn (2003) used Kolb’s experiential learning cycle with student teachers. She used this cycle as the basis for the performance analysis of student teachers in their classrooms. McGunn had student teachers answer self-reflective questions after a classroom session that was being observed by a supervisor. The following day, the students discussed their reflections with the supervisor and learned ways to improve their teaching. According to McGunn, the student teachers completed Kolb’s experiential learning cycle when they used what they learned as goals for future lesson plans. The cycle started again when the student teacher and the supervisor assessed the outcome of the goals in the next observed classroom session.

Lyons and Brader (2004) used Kolb’s experiential learning cycle in higher education. They designed an engineering laboratory exercise using the cycle to develop a freshman engineering class' ability to design and conduct experiments. They posed a challenging question and then the students had to explore the question. Following their investigation, the students of Lyons and Brader designed an experiment. Throughout the session, Lyons and Brader used group discussion to see what the groups were thinking, while introducing theory and correcting any misconceptions the students had. To complete this cycle, the students of Lyons and Brader conducted their experiments.

Deeny, Johnson, Boore, Leyden and, McCaughan (2001) investigated using Kolb’s experiential learning cycle to teach nursing students how to deal with dying
patients and their families. They used the drama as the experience, discussion as the reflection, thoughts and insight as the abstract conceptualization, and the application to real life situations as the final step, active experimentation.

Using Kolb's experiential learning cycle as a guide, Hatcher and Bringer (1997) suggested using an experiential research paper with a service-learning project. They had students identify a social issue that they confronted during their service experience. These students had to review the literature concerning the social issue and then they wrote a paper suggesting ways to address it. Hatcher and Bringer felt this was a way for students to work through all the phases of Kolb's experiential learning cycle.

Through the review of literature, it became evident that Kolb's experiential learning cycle was utilized with adult learners. Using his experiential learning cycle as a guide for teaching strategies, Kolb (1984) described how the learner should involve him or herself each of the four modes of his learning cycle: concrete experimentation, reflective observation, abstract conceptualization, and active experimentation.

The literature review also provided different teaching strategies that utilized Kolb's experiential learning cycle. Harrelson and Leaver-Dunn (2002) questioned athletic training students to guide them through the cycle. McGunn (2003) implemented the cycle with her student teachers by using self-reflective questionnaires about their teaching. Lyons and Brader (2004) used Kolb's experiential learning cycle in designing engineering labs. Deeny, et al. (2001) investigated how the cycle could be used in teaching nursing students how to deal with dying patients and their families through drama. Finally, Hatcher and Bringer (1997) suggested using an experiential research
paper with a service learning project in order for the students to work through all of Kolb's experiential learning cycle.

*Research question #3: What were the benefits of utilizing Kolb's experiential learning cycle with adult learners?*

A review of the literature was conducted to answer research question #3. Kreber (2001) suggested that Kolb's experiential learning cycle promoted both logical reasoning and creative thinking in adult learners. Furthermore, Lewis and Williams (1994) believed that there were multiple benefits from learning through experience. They felt that the adult learners not only developed self-understanding and skills, but also used them to problem-solve. Consequently, Lewis and Williams noted that learning through experience appeared "to be more effective in developing skills that employers seek, such as communication skills, the ability to work in teams, and workplace literacy" (p.6).

Harrelson and Leaver-Dunn (2002) discovered some benefits using Kolb's experiential learning cycle with athletic training students. They found that the cycle was easy to use when teaching students and assessing their knowledge and skills over time. They felt it was a good strategy for collaborative learning because learning became a partnership between the teacher and the student. In addition, they stated that this strategy required students to reflect on their experiences and explore what could be learned from them.

McGunn (2003) discovered the benefits of stressing the reflective observation mode of Kolb's experiential learning cycle when working with student teachers. Although reflection on the part of the students did not come easy, McGunn noted that it gave her student teachers a way to analyze their teaching and problem solve ways to
improve. By utilizing the student teacher’s reflections of their own teaching, the supervisors that worked with McGunn felt that their roles went from authoritative to collaborative. They viewed their students as partners in learning and noted that there was more communication between the student and the supervisor, which resulted in less anxiety on the part of the student.

Kuri (2000) reported great satisfaction in engineering students as well as teachers when Kolb’s experiential learning cycle was utilized in the classroom. She observed that when students and teachers used Kolb’s experiential learning cycle as a guide for teaching and learning strategies, both students and teachers maximized their potential by investigating ways to implement the cycle in their teaching and learning. Once the cycle was implemented, Kuri felt that both students and teachers benefited. She believed that the students became more independent, creative, and motivated while the teachers were provided with a practical and accessible teaching model to use in the classroom.

Lyons and Brader (2004) surveyed their students after using Kolb’s experiential learning cycle as model for their engineering laboratory. The students of Lyons and Brader indicated on a survey document that they strongly agreed or agreed that the laboratory exercise reinforced the theory being taught and challenged them to understand the theory better. These students also felt that the laboratory exercise helped them to think with more creativity with 86% of the students said they realized they could learn without an instructor. After analyzing the survey, Lyons and Brader concluded that using Kolb’s experiential learning cycle as a guide for teaching in an engineering laboratory enhanced the students’ understanding of the theory being taught, required more student creativity, and made the students feel more responsible for their own education.
Through the review of literature, the benefits of using Kolb’s experiential learning cycle with adult learners were noted. Kreber (2001), Lewis and Williams (1994), McGunn (2003), and Kuri (2000) reported many benefits of using Kolb’s experiential learning cycle with adults, which included creative thinking, problem-solving abilities, motivation, and independence. Harrelson and Leaver-Dunn (2002) and McGunn (2003) discovered that utilizing Kolb’s learning cycle with adult learners encouraged collaborative learning between the student and the teacher. In addition, Harrelson and Leaver-Dunn (2002) felt that using Kolb’s experiential learning cycle with athletic training students was easy to use when assessing students’ knowledge and skills. Furthermore, Lyons and Brader (2004) showed that utilizing Kolb’s cycle in engineering laboratory exercises enhanced their students’ understanding of theory and made the students feel more responsible for their learning. As a result, the literature review suggested that Kolb’s experiential learning cycle was beneficial to use with adult learners.

Conclusion

A review of the literature was initiated to identify an instructional strategy for improved understanding of critical values by laboratory personnel in a clinical laboratory setting. Kolb’s (1984) experiential learning cycle was found to be a guide pertaining to teaching strategies of adult learners in experiential learning. Kolb described this cycle as having four learning modes: concrete experience, reflective observation, abstract conceptualization, and active experimentation. Kolb believed that learner must proceed through all four stages of the cycle for new knowledge to occur.
The review of literature produced a variety of teaching strategies utilizing Kolb's experiential learning cycle as a guide. These methods included but were not limited to, reflective questioning (Harrelson & Leaver-Dunn, 2002; McGunn, 2003), student inquiry and group discussion (Lyons & Brader, 2004), drama (Deeny, et al., 2001) and an experiential research paper (Hatcher & Bringer, 1997).

In the literature reviewed, the benefits of using Kolb's experiential learning cycle with adult learners were investigated. Kuri (2000), Lewis and Williams (1994), Kreber (2001), and McGunn, (2003) noted the benefits of using Kolb's experiential learning cycle were obtaining new knowledge, creative thinking and problem-solving abilities. Harrelson and Leaver-Dunn (2002) and McGunn (2003) observed that using the cycle also promoted collaborative learning. In addition, Harrelson and Leaver-Dunn (2002) felt that Kolb's experiential learning cycle was easy to use when assessing a student's skills and knowledge. Furthermore, Lyons and Brader (2004) felt that using the cycle in engineering laboratory exercises increased students' understanding of theory and their responsibility for their own learning.

In summary, Kolb's experiential learning cycle was found in the literature to be a guide for instructional strategies of adults (Kolb, 1984). In addition, the literature also documented many teaching strategies that used Kolb's experiential cycle as a guide and described the benefits of using the cycle. Therefore, Kolb's experiential learning cycle could be a guide for improving the laboratory testing personnel's understanding of critical values.
Chapter III: Methods and Procedures

The purpose of this project was to determine if the use of Kolb’s experiential learning cycle improved understanding of critical values by laboratory testing personnel in a clinical laboratory setting.

Research questions:

1. How was Kolb’s experiential learning cycle defined in the literature?
2. How was the Kolb’s experiential learning cycle utilized with adult learners?
3. What were the benefits of utilizing Kolb’s experiential learning cycle with adult learners?
4. Did implementing Kolb’s experiential learning cycle in the clinical laboratory improve understanding of critical values by laboratory testing personnel?

To answer research question #4, a learning exercise was designed to teach laboratory testing personnel about critical values using Kolb’s experiential learning cycle as a guide. The understanding of critical values was assessed by a pretest and a posttest. The scores of these tests were collected and analyzed. The differences of the pretest and posttest scores determined whether or not the understanding of critical values increased with this learning exercise.

When designing this learning exercise, three learning goals regarding critical values were identified:

1. What were the critical values that were adopted by the medical staff?
2. How were the critical values to be reported?
3. What were the life threatening conditions that a patient could encounter by having a critical value laboratory result?
Instruments and procedures were developed to educate and assess the laboratory testing personnel about the three learning goals mentioned above. A critical value procedure, a reflection worksheet, and an educational notebook were designed to aid in the critical values education. A pretest and a posttest were created to assess the laboratory testing personnel's understanding of critical values. Finally, a spreadsheet and bar graph was used to analyze the data from the tests.

Participants

Seven laboratory testing personnel from a small, rural hospital laboratory in the Midwest participated in this study. Three were Medical Laboratory Technicians and four were Medical Technologists. Five worked full time, one worked part-time, and one worked on an as needed basis. The laboratory personnel in this study represented all three shifts. There were six females and one male. The ethnic makeup of the laboratory included four individuals who were Caucasians, two individuals who were Filipinos, and one individual who was Hispanic. English was the second language for the individuals who were of Filipino and Hispanic descent. The participants were chosen for this study because all of the employees of this hospital laboratory needed to be educated on the updated critical values and the new Joint Commission on Accreditation of Healthcare Organizations (JCAHO) National Patient Safety Goals concerning how the critical values were to be reported.

Intervention

A learning exercise for critical values was designed for the laboratory testing personnel using Kolb’s experiential learning cycle as a guide. There were four phases to Kolb’s learning cycle: concrete experience, reflective observation, abstract
conceptualization, and active experimentation. An activity was developed for each phase of Kolb’s learning cycle in order for the laboratory testing personnel to develop an understanding of critical values through experience.

Kolb’s four phases of the experiential learning cycle were evident in this laboratory environment. The first phase of Kolb’s experiential learning cycle was concrete experience. During this phase, the laboratory testing personnel performed their everyday duties within the laboratory environment. The learning cycle was set in motion when the medical technologist or medical laboratory technician encountered a critical value while performing diagnostic blood tests. This particular hospital laboratory had a laboratory information system that assisted in alerting the laboratory testing personnel of critical values. Critical values were bold red in the test results column. Once a critical value was encountered, the laboratory testing personnel needed to follow the critical value procedure in regards to reporting the results to the ordering physician.

The next phase of Kolb’s experiential learning cycle that the laboratory testing personnel experienced was reflective observation. After completing the steps of the critical values procedure, the laboratory testing personnel was asked to reflect or think about the experience. To stimulate their thinking, the medical technologists and medical laboratory technicians were asked to fill out a critical value reflection worksheet. By answering the questions on the worksheet, the laboratory testing personnel could see what steps of the procedure they did not know or understand.

If the medical technologist or medical laboratory technician had questions or lacked knowledge about different steps of the critical value procedure, they were instructed to consult the critical values education notebook. Through researching the
critical values education notebook, the laboratory testing personnel should have been able to find out what they did not know or understand about the critical values procedure.

Finding out what they did not know or understand about critical values lead the participants to the third phase of Kolb’s experiential learning cycle, abstract conceptualization. Once the laboratory testing personnel learned the steps of the critical value procedure and read the background information found in the critical value education notebook, they should have formulated in their own minds an understanding of critical values.

The final phase of Kolb’s experiential cycle was active experimentation. In this learning exercise, the laboratory testing personnel were to take what they have learned about critical values and apply it to their next encounter with a critical value. Thus, the learning cycle began again.

*Educational materials.*

Educational materials were designed to assist the laboratory testing personnel as they progressed through Kolb’s experiential learning cycle. These educational materials included a critical value procedure, a critical value reflection worksheet, and a critical values education notebook.

The critical value procedure was an informational document produced as an official procedure that the laboratory was to follow. This document was entitled, “Critical Values and How to Report Them.” This document listed laboratory tests, their critical value threshold, and the potential life threatening conditions in a table format. Following the table was instructions on how to report critical values for inpatients and outpatients. The procedure concluded by giving guidelines on what to do if the laboratory
personnel was unable to contact the ordering physician within 1-2 hours. (See Appendix A for a copy of the procedure.)

A critical values reflection worksheet was designed to stimulate reflective thinking in the laboratory testing personnel during the reflective observation part of the learning cycle. This document was entitled, “Critical Values Reflection Worksheet.” At the top of the document was a place for the medical technologist’s or medical laboratory technician’s number and the sample identification number of the specimen. The worksheet asked questions following the three learning goals for this exercise. The first question was “What test had a critical value and what was its result? The second question asked was “How was the result reported?” with the follow-up questions, “If given verbally, did the receiving person read the results back to you?” “Was there any problems notifying the doctor of the critical results?” and “If so, what did you do?” The final question asked, “Why is the critical result noted in question #1 potentially life threatening to the patient?” (See Appendix B for a copy of this worksheet.)

An educational notebook was organized to assist the laboratory testing personnel with any questions about the critical values procedure. A three-ringed binder titled, “Critical Values Education Notebook,” contained background information for the critical values procedure. The notebook was divided into sections. The first section gave definitions and descriptions of the life threatening conditions listed in the critical values procedure. The next fourteen sections had information on the clinical significance of each test listed in the critical values procedure. These tests were arranged in alphabetical order. The final section contained information about the 2004 and 2005 JCAHO National Patient Safety Goals that applied to this critical values procedure. These goals contained
requirements for the laboratory concerning how to report critical values. (Joint Commission on Accreditation of Healthcare Organizations, 2005)

The information in the Critical Values Education Notebook for the life threatening conditions and for the clinical significance of each test was found at various on-line medical encyclopedias. Three of these websites for these medical references were University of Maryland Medical Center at [www.umm.edu](http://www.umm.edu), CHC Medical Library and Patient Education at [www.chlibrary.org](http://www.chlibrary.org), and University Pathology Consortium’s Pathology handbook at [www.medicine.uioa.edu/path_handbook/upcrnd](http://www.medicine.uioa.edu/path_handbook/upcrnd)

**Instruments**

To assess how much the laboratory testing personnel learned during the intervention, a pretest and a posttest were developed. The same test was given before and after the intervention. At the top of the test was a place for the participant’s number. The test had four sections. The first section asked the laboratory testing personnel to write in the critical value threshold for each analyte indicated. Fourteen analytes were given with the indication of whether to write the high or low critical value when applicable. For example, the critical value threshold for low glucose was < 50 mg/dl. The next two sections were short answer questions pertaining to how critical values were to be reported. The two questions were “Describe how the physician is notified of a critical value?” and “What can a tech do if the physician cannot be reached concerning the critical result?” The last section of the test asked the laboratory testing personnel to match the life threatening condition with the analyte. Ten analytes were listed along with nine life threatening conditions labeled a-i. In this section, there could be more than one answer per analyte and each answer could be used more than once. For example, a
critical value BUN could cause the life threatening conditions of (b) fatal arrhythmia and (c) coma. Each correct answer on the test was worth one point with a total of 33 possible points. (See Appendix C for a copy of the test with answers.)

Procedures

Each of the laboratory testing personnel was asked if he/she wanted to participate in this project. Once agreed, participants drew a number out of a laboratory specimen bag to be used as their identification number for the project. Then each medical technologist or medical laboratory technician took the critical values pretest as each had time during the first day worked during the week. The laboratory testing personnel were then asked to place the test in the researcher’s mailbox.

After the pretest was taken, the researcher gave an overview of the critical value procedure to the laboratory testing personnel and described how they were to proceed through the learning exercise using the educational materials developed. This was done on a one-to-one basis and when the researcher and the medical technologist or medical laboratory technician had time to meet. For example: The third shift medical technologist was instructed at the end of her shift when the researcher came in for the day.

Once the process of the learning exercise was taught to a participant, he/she was to follow the learning exercise using Kolb’s experiential learning cycle as described in the Intervention section. To demonstrate that laboratory testing personnel were following the learning exercise, all critical value reflection worksheets were to be placed in the researcher’s mailbox. Because the critical results occurred randomly and the laboratory testing personnel worked on various days, they were asked to follow the learning exercise for about four weeks.
After the four weeks were completed, the posttest was given to each participant in this project. The researcher e-mailed each medical technologist and medical laboratory technician that the posttest was in each of his or her mailboxes. The test was to be taken the first day they came to work during week five and placed in the researcher’s mailbox. There was one exception to this procedure. One of the participants took the test one week early because she was going on maternity leave.

**Timeline**

At the end of November, the researcher consulted with her laboratory supervisor concerning any new procedure that the laboratory testing personnel needed to learn that could be used with Kolb’s experiential learning cycle. It was decided that an updated critical values procedure was needed because the medical staff was to revise the current laboratory critical values. There was also new JCAHO National Patient Safety Goals about how to report critical values that needed to be implemented in the laboratory. Because critical values were something that laboratory testing personnel experienced in their daily routine, the researcher thought this was a worthy subject for the project.

Throughout December and January, information for the new critical values procedure was researched. The medical staff of this hospital approved an updated list of laboratory critical values at their December meeting. Then, the researcher investigated the JCAHO safety goals concerning how to report the critical values. Meanwhile, the pathologist overseeing the lab wanted the laboratory testing personnel to also learn the potential life threatening events that could happen if a patient’s test results showed a critical value. Knowledge of the potential life threatening events was to aid the laboratory testing personnel when in the rare instance the laboratory needed to contact the patient.
So then, the researcher found Internet articles pertaining to the life threatening conditions that may occur when a patient had a critical value. In addition, the pathologist was consulted in regards to what life threatening conditions she wanted the laboratory testing personnel to know.

At the end of January, the researcher wrote the new critical laboratory procedure and it was approved by the laboratory pathologist. During this time, the researcher also designed the critical values learning exercise using Kolb’s experiential learning cycle as guide. Instruments for the learning exercise, assessment, and data analysis was also devised.

During the first full week in February, participants were assigned an identification number and asked to take a pretest. The laboratory testing personnel were to take the test as they had time during the first day they worked at the lab that week. After the participants finished the exam, they were instructed by the researcher concerning how they were to proceed through the learning exercise.

For the rest of the first week in February through the beginning of March, the participants were asked to complete the learning exercise whenever they experienced a critical value in their laboratory practice. This totaled about four weeks that the laboratory testing personnel were asked to participate in the learning exercise for critical values.

During the first full week in March, the laboratory testing personnel who participated in this project were asked to take the posttest as they had time on the first day they worked at the laboratory. By the end of that week, the researcher collected all of the posttests and was ready to perform the data analysis.
Data Analysis

The data for this project were the scores of the pretest and posttest and the comparison between the two test scores. A spreadsheet was designed to analyze the data. A bar graph was also developed to visually compare the pretest and posttest scores.

Each pretest and posttest was graded. A correct answer on each of the tests was worth one point for a total of thirty-three possible points. The scores of both tests for each medical technologist and medical laboratory technician were entered in the appropriate column in the spreadsheet. The first column of the spreadsheet was each participant’s identification number. The second column was each medical technologist’s or medical laboratory technician’s score from the pretest. The posttest score of each laboratory testing personnel was listed in the third column. The fourth column showed the difference between the posttest and the pretest scores.

The difference between the two test scores was calculated by the score of the posttest minus the score of the pretest. (Posttest − pretest = difference) A positive number in the difference column of the spreadsheet showed that more questions were answered correctly on the posttest than on the pretest. A negative number in the difference column of the spreadsheet indicated that fewer questions were answered correctly on the posttest than on the pretest.

A bar graph to visually compare the results of the pretest and posttest of each medical technologist or medical laboratory technician was developed. The x-axis was labeled “Participant Number” and the y-axis was labeled “Critical Values Test Scores.” The legend showed the color of each bar pertaining to the pretest score and the posttest score. The first bar, colored blue, showed the pretest score of each participant. The
second bar, colored red, showed the posttest score of each participant. If the blue bar was higher than the red bar, the laboratory testing personnel answered more questions correctly on the posttest than the pretest. If the blue bar was lower than the red bar, the laboratory testing personnel answered fewer questions correctly on the posttest than the pretest.

In order to answer research question #4, instruments and procedures were developed to educate and assess this small hospital laboratory testing personnel’s understanding of critical values. A critical value procedure, a reflection worksheet, and an educational notebook were designed to aid in the education of critical values. A pretest and posttest were created to assess the laboratory testing personnel’s understanding of critical values. Procedures were developed for the intervention using the four phases of Kolb’s experiential learning cycle as a guide. Finally, the data from the pretests and posttests were analyzed by using a spreadsheet and bar graph. This data was analyzed to determine if the laboratory testing personnel increased their understanding of critical values by using Kolb’s experiential learning cycle.
Chapter IV: Results

The purpose of this project was to determine if the use of Kolb's experiential learning cycle improved understanding of critical values by laboratory testing personnel in a clinical laboratory setting.

Research questions:

1. How was Kolb's experiential learning cycle defined in the literature?
2. How was the Kolb's experiential learning cycle utilized with adult learners?
3. What were the benefits of utilizing Kolb's experiential learning cycle with adult learners?
4. Did implementing Kolb's experiential learning cycle in the clinical lab improve understanding of critical values by laboratory testing personnel?

The data for this project came from the test scores of the laboratory testing personnel who took the critical values pretest and posttest. The pretest scores were as follows: Participant #1 had a score of 25 points. Participant #2 had a score of 30 points. Participant #3 had score of 24 points. Participants #4 and #5 each had a score of 19 points. Participant #6 had a score of 24 points. Participant #7 had a score of 14 points.

The posttest scores were as follows: Participant #1 scored 21 points. Participant #2 scored 26 points. Participant #3 scored 22 points. Participant #4 received 19 points. Participant #5 scored 25 points. Participant #6 received 13 points. Participant #7 scored 21 points.

The difference between the posttest and the pretest was calculated. Posttest minus pretest equaled the difference between the two scores. A positive number indicated more questions were answered correctly on the posttest than on the pretest. A negative number
indicated fewer questions were answered correctly on the posttest than on the pretest.

The difference for each participant was as follows: Participants #1 and #2 both had –4
difference. Participant #3 had –2 difference. Participant #4 scored the same on both tests.
Participant #5 had +5 difference. Participant #6 had –14 difference. Participant #7 had a
difference of +7.

Figure 1 shows the data from the Critical Values pretest and posttest scores along
with the difference between each score. Figure 2 shows the pretest and posttest scores
using a bar graph.

<table>
<thead>
<tr>
<th>Participant #</th>
<th>Pretest</th>
<th>Posttest</th>
<th>Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>25</td>
<td>21</td>
<td>–4</td>
</tr>
<tr>
<td>2</td>
<td>30</td>
<td>26</td>
<td>–4</td>
</tr>
<tr>
<td>3</td>
<td>24</td>
<td>22</td>
<td>–2</td>
</tr>
<tr>
<td>4</td>
<td>19</td>
<td>19</td>
<td>0</td>
</tr>
<tr>
<td>5</td>
<td>19</td>
<td>25</td>
<td>+6</td>
</tr>
<tr>
<td>6</td>
<td>27</td>
<td>13</td>
<td>–14</td>
</tr>
<tr>
<td>7</td>
<td>14</td>
<td>21</td>
<td>+7</td>
</tr>
</tbody>
</table>

*Figure 1. Critical Value Pretest and Posttest Scores of the Participants and the
Difference between Each Test.*

*Figure 1. Critical Values Pretest and Posttest Scores of Each Participant*
The data showed that the majority of the laboratory testing personnel scored fewer points on the posttest than on the pretest. Four participants scored lower on the posttest. One participant scored the same amount of points whereas two participants scored more points on the posttest than the pretest.

The data collected from the pretest and posttest scores was analyzed. In addition, the data was presented in narrative and graphic form to communicate and illustrate the results. The data showed that the majority of the laboratory testing personnel scored fewer points on the posttest than on the pretest. Having analyzed the data, the researcher was prepared to discuss her findings in Chapter V.
Chapter V: Discussion

The purpose of this project was to determine if the use of Kolb’s experiential learning cycle improved understanding of critical values by laboratory testing personnel in a clinical laboratory setting.

Research questions:

1. How was Kolb’s experiential learning cycle defined in the literature?
2. How was the Kolb’s experiential learning cycle utilized with adult learners?
3. What were the benefits of utilizing Kolb’s experiential learning cycle with adult learners?
4. Did implementing Kolb’s experiential learning cycle in the clinical laboratory improve understanding of critical values by laboratory testing personnel?

Meaning of Findings

At first glance, the data showed that using this learning exercise did not improve the laboratory testing personnel’s understanding of critical values in this clinical laboratory setting. During the course of the procedures, the researcher made some observations that resulted in recommendations for the replication of this study.

Recommendations were based on perceived problems with some inaccurate pretest scores and the lack of participation using the Critical Values Reflection Worksheet. However, the researcher noticed that when some of the laboratory testing personnel participated fully in the learning exercise, the understanding of critical values improved with those individuals.

The researcher believed that some of the pretest scores did not accurately demonstrate what the laboratory testing personnel already knew. Previously, tests taken
in the laboratory to ensure competency were taken “open book”, which means a medical technologist or medical laboratory technician could look up an answer. The emphasis of the previous competency tests was more on how to retrieve the information than knowing the information. Although the researcher stated that for this project the participants were not to look up any answers for the pretest and it was okay to receive a low score, four laboratory testing personnel scored above 24 points on their pretest. The critical value ranges had been posted in several parts of the lab, which would have provided the answers to part one of the pretest. Unfortunately, these participants (1, 2, 3 and 6) scored less on the posttest after the researcher explicitly stressed that they were not to look up any answers.

There was possible evidence that some test scores were inaccurate. Possible evidence included high pretest scores and confirmation from a medical laboratory technician that some of the laboratory testing personnel did look up the answers. However, the scores could have dropped due to lack of any learning via this learning exercise.

The next perceived problem in this project was the lack of participation in regards to the Critical Values Reflection Worksheet. This worksheet was to be filled out as the laboratory testing personnel had time following a critical value experience to stimulate reflection. Only 26% of the critical values that occurred in the laboratory had a Critical Values Reflection Worksheet filled out. Participants 1, 2, 3, 5, and 7 filled out the worksheet with participants 2 and 5 filling out the majority of the forms. Due to the randomness of critical values occurring, a medical technologist or medical laboratory technician may not have experienced a critical value during this four-week period.
Nevertheless, this leaves 74% of the critical values not being reflected upon. It was noted that many of the critical values with no worksheet occurred during second and third shift hours when there was only one person staffed and it might have become very busy.

The data of the laboratory testing personnel who engaged fully in the learning exercise was examined. The participants engaged fully if they followed all the steps of Kolb’s experiential learning cycle, which included filling out the Critical Values Reflection Worksheet. As indicated previously, participants 2 and 5 filled out the majority of the Critical Values Reflection Worksheets. These two participants received the highest scores on the posttest. Participant 2 scored 26 points and participant 5 scored 25 points. Another active participant, participant 7 had the biggest point increase between the two tests. This participant scored seven points higher on the posttest than on the pretest. The high posttest scores of participants 2 and 5 along with increase in posttest score of participant 7 suggested that this learning exercise might have been effective with the laboratory testing personnel who were actively involved in Kolb’s experiential learning cycle.

Summary

The purpose of this project was to determine if the use of Kolb’s experiential learning cycle improved understanding of critical values by laboratory testing personnel in a clinical laboratory setting. This was achieved by designing a learning exercise that incorporated the four steps from Kolb’s experiential learning cycle. The participants were to increase their understanding of laboratory critical values by knowing the critical values, how to report them to ordering physician, and the life threatening conditions that could result from a patient having a critical value.
Seven laboratory personnel from a small rural hospital participated in this project. After taking a pretest concerning critical values, the participants began the learning exercise. When the medical technologist or medical laboratory technician encountered a critical value during their practice, they were to follow the laboratory’s critical values procedure regarding how to report the result. As they had time following the critical value encounter, the laboratory testing personnel were asked to fill out a Critical Values Reflection Worksheet to stimulate reflection and to identify what they did not know about critical values. The participants could then consult the Critical Values Education Notebook to find information they needed to know about critical values. Using the information they learned, the laboratory testing personnel could apply it to new encounters with critical values in their practice.

After participating in this learning exercise for four weeks, the laboratory testing personnel took a critical values posttest. Using the difference in the posttest and the pretest scores, the data was to show if the posttest scores increased or decreased. An increase in posttest scores would show an increase in the understanding of critical values.

As a whole, the data showed that a majority of the laboratory testing personnel’s posttest scores decreased. This may have indicated that using Kolb’s experiential learning cycle as guide for understanding critical values did not improve the laboratory testing personnel’s understanding of critical values in this clinical laboratory setting.

Recommendations

Through her observations, the researcher compiled recommendations for the replication of this study and for future studies extending Kolb’s experiential learning cycle into other areas of the clinical laboratory. The researcher also suggested
researching other areas in education that may useful in teaching laboratory testing personnel new procedures.

Recommendations for the replication of this study of using Kolb’s experiential learning cycle as a guide for education in a clinical laboratory include using consistent testing protocols, improving the reflection observation step, and increasing the length of time for the intervention. Future studies that monitor the engagement of the participants in the whole learning exercise could provide more evidence that the use of Kolb’s experiential learning cycle was responsible for any increase in understanding the subject. Future investigations could also involve using a laboratory procedure that was more consistent and not a random occurrence in the lab.

The first recommendation for the replication of this study was to enforce a consistent testing protocol. One of the perceived problems of inaccurate pretest scores might have been due to an inconsistent testing protocol. Due to the nature of the laboratory environment, the researcher had the laboratory testing personnel take the pretest and the posttest as they had time on their shift. A better way to promote consistency and accuracy in the test scores might have been to require that the tests needed to be taken at the start of their shift in a room void of any visual aides.

Another recommendation for repeating this project was to find a better way to reflect during the learning exercise. The lack of participation in this project regarding filling out the Critical Values Reflection Worksheet showed that this might not have been a good way to promote reflection. Reflection needed time from the laboratory testing personnel, which apparently they did not have. Teaching laboratory personnel to take the time to reflect on what they experience might be the key to this learning strategy.
The researcher also suggested increasing the length of time for the laboratory testing personnel to participate in this learning exercise. Since critical values occurred randomly, a longer period of time might have been needed for each medical technologist or medical laboratory technician to experience a critical value during their practice. If more time had been allotted for this learning exercise, a critical value might have occurred when the laboratory was operating at a slower pace and the laboratory testing personnel would have been able to take the time to reflect on the experience.

A recommendation for future investigations with Kolb's experiential learning cycle was to develop a procedure to monitor the involvement of the participants. Observations by the researcher lead her to believe that the participants who fully involved themselves in the learning exercise seemed to have increased their understanding of the critical values because their posttest scores were high or their scores increased. If there was a way to monitor the laboratory testing personnel's participation, it might provide more evidence whether Kolb's experiential learning cycle was responsible for an increase in understanding.

Finally, further investigations of using Kolb's experiential learning cycle as an instructional strategy in the clinical laboratory might include using procedures that were preformed on a daily basis. In this small laboratory, critical values were a random occurrence. Future studies using a procedure that the laboratory personnel would experience everyday may show different results. An investigation might examine the use of Kolb's experiential learning cycle when teaching new instrumentation, such as a new chemistry analyzer, to the laboratory testing personnel.
In addition to Kolb's experiential learning cycle, future studies could investigate using other educational techniques to teach critical values to laboratory testing personnel. These other educational techniques might include accommodating individual learning styles of laboratory testing personnel, self-instruction with computers, or cooperative learning groups. The challenge would be to find an effective educational strategy that would be conducive to the busy medical laboratory environment.

Conclusion

The purpose of this project was to determine if the use of Kolb's experiential learning cycle improved understanding of critical values by laboratory testing personnel in a clinical laboratory setting. Procedures and instruments were developed to answer this research question. By determining the difference between posttest and pretest scores, this data were analyzed to determine if the laboratory personnel increased their understanding of critical values. It was determined that the majority of the laboratory testing personnel who participated in this learning exercise did not increase their understanding of critical values. Recommendations were made for the replication of this study and for future studies involving using other educational strategies in the medical laboratory.
References


Joint Commission on Accreditation of Healthcare Organizations (2005). Facts about


Appendix A

Critical Laboratory Values and How to Report Them (A Handbook)

Critical values were approved by this hospital’s medical staff for the following analytes: (The critical values are listed in Figure A1.)

<table>
<thead>
<tr>
<th>Test</th>
<th>Critical values threshold</th>
<th>Potential life threatening events</th>
</tr>
</thead>
<tbody>
<tr>
<td>Absolute Neutrophil Count</td>
<td>&lt; 0.1 x 10^6 cells/mm</td>
<td>Risk of Infection</td>
</tr>
<tr>
<td>APTT</td>
<td>&gt;89 seconds</td>
<td>Internal bleeding</td>
</tr>
<tr>
<td>Blasts</td>
<td>&gt;10%</td>
<td>Leukemia</td>
</tr>
<tr>
<td>BUN</td>
<td>&gt;100 mg/dl</td>
<td>Fatal arrhythmia and coma</td>
</tr>
<tr>
<td>Calcium</td>
<td>&lt; 5 years-&lt;7.0 mg/dl</td>
<td>Low Ca-Laryngeal spasm, convulsion</td>
</tr>
<tr>
<td></td>
<td>&gt;5 years-&lt;6.0 and &gt;13 mg/dl</td>
<td>High Ca-coma</td>
</tr>
<tr>
<td>Creatinine</td>
<td>&gt;4.0 mg/dl</td>
<td>Fatal arrhythmia and coma</td>
</tr>
<tr>
<td>Glucose</td>
<td>&lt;50 mg/dl</td>
<td>Coma, shock</td>
</tr>
<tr>
<td></td>
<td>&gt;500 mg/dl</td>
<td></td>
</tr>
<tr>
<td>Hemoglobin</td>
<td>&lt;8.0 g/dl</td>
<td>Shock</td>
</tr>
<tr>
<td></td>
<td>&lt;9.0 g/dl for obstetric patients</td>
<td></td>
</tr>
<tr>
<td></td>
<td>&lt;10.0 g/dl for neonates</td>
<td></td>
</tr>
<tr>
<td>INR</td>
<td>&gt;5.0</td>
<td>Internal bleeding</td>
</tr>
<tr>
<td>Neonatal bilirubin</td>
<td>&gt;12.0 mg/dl</td>
<td>Brain damage (kernicterus)</td>
</tr>
<tr>
<td>Platelet count</td>
<td>&lt;50 x 10^3 plt/mm</td>
<td>Uncontrollable bleeding</td>
</tr>
<tr>
<td>Potassium</td>
<td>&lt;2.8 mmol/L</td>
<td>Fatal arrhythmia</td>
</tr>
<tr>
<td>Sodium</td>
<td>&lt;125 mmol/L</td>
<td>Low Na-obtundation, coma, seizures, and death if untreated.</td>
</tr>
<tr>
<td></td>
<td>&gt;155 mmol/L</td>
<td>High Na-mental function problem</td>
</tr>
<tr>
<td>Troponin T</td>
<td>&gt;0.1 ng/ml</td>
<td>Early asymptomatic heart attack</td>
</tr>
</tbody>
</table>

*Figure A1: Laboratory Tests, Critical Values Threshold, and Potential Life Threatening Events.*

**Reporting Critical Values**

Once a critical value is encountered, the technologist is to evaluate the result. (See Critical and Abnormal Followup procedure.) When the technologist feels confident
about reporting the critical results, the results should be reported as soon as possible to
the physician ordering the test. **Do not approve the results in the computer until all
documentation of notification is complete.**

*Emergency Room, Medical floor, and Obstetric floor*

Call the nurses that are on duty. If results are given orally, the person receiving
the results needs to read the results back to you. If the results are faxed, the results did
not need to be read back to you. Document who the results were given to in the test
comments with the time and your initials and approve the results. (Computer shortcut /cr
for the comment.)

*Outpatient results*

*Paulding County Hospital physicians.*

Call the physician’s office. If the physician cannot be reached at their office,
have the hospital switchboard page the physician. If results are given orally, the person
receiving the results needs to read the results back to you. If the results are faxed, the
results do not need to be read back to you. Document who the results were given to in the
computer under test comments with the time and your initials and approve the results.
(Computer shortcut /cr for the comment.)

*Other physicians.*

Call the physician’s office. When the physician cannot be reached at their office,
usually a recording will tell how the physician can be reached. If results are given orally,
the person receiving the results needs to read the results back to you. If the results are
faxed, the results did not need to be read back to you. Document who the results were
given to in the test comments with the time and your initials and approve the results.

(Computer shortcut /cr for the comment.)

Unable to Contact the Physician within 1-2 hours.

If the physician or the physician who is covering for them is unable to be reached, the patient should be contacted to alert them of the situation. Consult with the ER nurses/doctor how to handle the critical value. For example, High INR: ER may suggest that the patient might skip their next dose of Coumadin and come in for a repeat Protime the next day.

Call the patient and inform them that the have a critical laboratory test and the laboratory has been unable to contact their doctor. Give instructions per ER when applicable. If the patient needs to be seen by a physician, instruct the patient that it is imperative that they receive medical attention at an emergency room of their choice. Potential life threatening events are listed in the critical result table if needed to stress to the patient the seriousness of the critical result.

Document in the computer under test comments everything done to contact the physician Also document the instructions given to the patient. Approve the result.

The next business day, attempts should be made to contact the ordering physician with the critical result.

References

Paulding County Hospital Medical Staff

Dr. X. Wan, Pathologist

2004 JCAHO National Patient Safety Goals

2005 JCAHO National Patient Safety Goals
Appendix B

Critical Values Reflection Worksheet

Participant #__

Patient Sample #______

1. What test had a critical value and what was its result?

2. How was the result reported?
   a. If given verbally, did the receiving person read the results back to you?
   b. Was there any problems notifying the doctor of the critical results? If so, what did you do?

3. Why is the critical value noted in question #1 potentially life threatening to the patient?
Appendix C

Critical Values Pretest/Posttest with Answers

Participant #_____ 

1. Write the critical results threshold for the analyte indicated. (14 points)

<table>
<thead>
<tr>
<th>Analyte</th>
<th>Threshold</th>
</tr>
</thead>
<tbody>
<tr>
<td>Absolute Neutrophil count</td>
<td>$&lt;0.1 \times 10^3$ cells/mm</td>
</tr>
<tr>
<td>BUN</td>
<td>$&gt;100$ mg/dl</td>
</tr>
<tr>
<td>Low glucose</td>
<td>$&lt;50$ mg/dl</td>
</tr>
<tr>
<td>Hemoglobin for obstetric patients</td>
<td>$&lt;9.0$ g/dl</td>
</tr>
<tr>
<td>INR</td>
<td>$&gt;5$</td>
</tr>
<tr>
<td>Creatinine</td>
<td>$&gt;4.0$ mg/dl</td>
</tr>
<tr>
<td>Blasts</td>
<td>$&gt;10%$</td>
</tr>
<tr>
<td>High Sodium</td>
<td>$&gt;155$ mmol/L</td>
</tr>
<tr>
<td>Low platelet count</td>
<td>$&lt;50 \times 10^3$ cells/mm</td>
</tr>
<tr>
<td>Troponin T</td>
<td>$&gt;0.1$ ng/ml</td>
</tr>
<tr>
<td>Low calcium for &lt;5 years old</td>
<td>$&lt;7.0$ mg/dl</td>
</tr>
<tr>
<td>Low potassium</td>
<td>$&lt;2.8$ mmol/dl</td>
</tr>
<tr>
<td>Neonatal bilirubin</td>
<td>$&gt;12.0$ mg/dl</td>
</tr>
<tr>
<td>APTT</td>
<td>$&gt;89$ seconds</td>
</tr>
</tbody>
</table>

2. Describe how the physician is notified of a critical value. (3 points)

- Call the results to the physicians office if outpatient. If inpatient call results to the medical unit.
- If the results are given verbally, a readback by the person receiving the results is required.
- If the results are faxed, no readback is required.

3. What can a tech do if the physician cannot be reached concerning the critical result. (2 points)

- Consult with ER concerning the critical result
- Notify the patient and give instructions per ER
4. Match the life threatening condition with the analyte. Note: There can be more than one answer/analyte. **Each** answer may be used more than once. (14 points)

<table>
<thead>
<tr>
<th>Analyte</th>
<th>Condition</th>
</tr>
</thead>
<tbody>
<tr>
<td>e Absolute Neutrophil count</td>
<td>a. Internal bleeding</td>
</tr>
<tr>
<td>a APTT</td>
<td>b. Fatal arrhythmia</td>
</tr>
<tr>
<td>b, c BUN</td>
<td>c. Coma</td>
</tr>
<tr>
<td>c High Calcium</td>
<td>d. Shock</td>
</tr>
<tr>
<td>c, d Glucose</td>
<td>e. Risk of infection</td>
</tr>
<tr>
<td>d Hemoglobin</td>
<td>f. Early asymptomatic heart attack</td>
</tr>
<tr>
<td>g Neonatal bilirubin</td>
<td>g. Brain damage</td>
</tr>
<tr>
<td>b High Potassium</td>
<td>h. Obtuntation (decrease consciousness)</td>
</tr>
<tr>
<td>h,c,l Low Sodium</td>
<td>i. Seizures</td>
</tr>
</tbody>
</table>