EFFECTS OF FORMAL TRAINING ON ACCURACY OF VARIOUS METHODS IN BLOOD GLUCOSE MONITORING INVOLVING MULTIPLE OPERATORS

A THESIS

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BY

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July 2, 1986
Date

To the Provost of the Graduate School:

I am submitting herewith a thesis written by Effie P. Nix entitled "Effects of Formal Training on Accuracy of Various Methods in Blood Glucose Monitoring Involving Multiple Operators." I have examined the final copy of this thesis for form and content and recommend that it be accepted in partial fulfillment of the requirements for the degree of Master of Science, with a major in Nursing.

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ABSTRACT

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This explanatory study compared the variances of blood glucose test results obtained by multiple operators. A convenience sample of 12 registered and licensed vocational nurses were instructed in use of Visidex II Reagent Strips, Dextrostix, and Glucometer after each nurse had performed blood glucose analysis using the different methods. Blood glucose laboratory values were used as the comparative control for obtained values. Pearson product-moment correlation coefficients and *t*-tests were used to analyze the group-related differences between obtained blood glucose measurement values on the three tests. All post-instruction correlations were numerically higher than before correlations; however, the only statistically significant change was between the Glucometer and Visidex II ($p=.03$). The Glucometer/Dextrostix values were more highly correlated with laboratory values before and after instructions. It was concluded the Visidex II Reagent Strip is not a reliable method for monitoring blood glucose with multiple users.

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CHAPTER 1

INTRODUCTION

Diabetes, a chronic systemic disorder of metabolism, is the third leading cause of death in the United States. It has been estimated that more than 600,000 new cases of diabetes are diagnosed annually. In addition, it is predicted that the number of diabetic individuals will reach 20 million by 1990 (Skillman & Tzagournis, 1983).

The medical, social, and economic burdens caused by the disease process and associated complications are well documented (Bonheim, 1985; Brownlee, 1981; Tattersal, 1981). According to Bonheim, the direct and indirect cost of diabetes is approximately $14 billion annually. Chronic complications such as cardiovascular, neuropathy, renal failure, and diabetic retinopathy contributes greatly to the indirect cost.

The management of diabetes involves the prevention and/or reduction of acute and chronic complications. Major research in the pathophysiology of the disease as well as improvement in management methods is ongoing. A significant discovery within the last 10 years is the relatively inexpensive test for blood glucose monitoring. Self-monitoring of blood glucose (SMBG) was designed to allow the

patient to monitor glucose levels unsupervised in the home (Baskin, 1985). However, SMBG is fast becoming an accepted method of monitoring glucose levels in the physician's office as well as on the clinical units of many hospitals (Peterson, 1985).

Due to the brittle and unstable status of the diabetic patient admitted to the endocrine unit of a large medical center hospital, frequent monitoring of blood glucose values is essential. The number of patients involved averages 8 to 10 daily, and the frequency of blood glucose values is at least four times a day for each patient. Considering the number of patients involved and the frequency with which glucose values are needed, glucose values determined from serum and processed in the laboratory would place an increased demand on laboratory manpower. In addition, the potential for delay in patient care is increased due to the time element involved in processing plasma glucose values (drawing specimen, transporting specimen to laboratory, and waiting for laboratory personnel to report results). In an effort to improve patient care, conserve time and simplify the procedure for obtaining glucose values, the finger stick method utilizing capillary blood has been instituted.

The finger stick method of glucose monitoring can be performed utilizing a variety of reagent strips such as

Visidex II and Dextrostix (Ames, 1980, 1982, 1983). The Destrostix is designed for use with the Ames Dextrometer or Glucometer reflectance photometer. Visidex II reagent strips are designed for visual interpretation utilizing a color chart. Both products are in current use on the hospital endocrine unit.

The accuracy of Dextrostix and Visidex II glucose values is dependent upon users' techniques (Ames, 1982). Consequently, proper training of personnel and a method of verifying accuracy of results are necessary. Random comparison of finger stick capillary blood glucose values with simultaneous laboratory plasma values revealed a wide range of percentage of error. The highest percentage of error suggested by the manufacturer of Dextrostix and Visidex II is 15% (Ames, 1983).

Previous studies (Ames, 1982, 1983; Aziz & Hsiang, 1983; Clements, Keane, Kirk, & Boshell, 1981; Reeves, Forham, Skyler, & Peterson, 1981; Shapiro et al., 1981; Worth, Harrison, Anderson, Johnson, & Alberti, 1981) involving single operators to determine the differences between capillary blood glucose values and plasma glucose values performed by a standard laboratory method have yielded percentage of error varying from ±4% to ±20%. These results do not reflect percentage of error involved with

multiple operators of the photometer or variation in operator technique. In addition, no method of quality control has been established. Consequently, data supporting an acceptable percentage of error due to multiple users of the photometer and for variation in users' techniques are not available. Therefore, there is a need to evaluate the percentage of error involved and to determine if data support the development of a plan for quality control.

Problem Statement

The finger stick method of blood glucose monitoring is currently being utilized in the endocrine unit of a large medical center hospital. According to the manufacturer of the Visidex II and Dextrostix reagent strips (Ames, 1980, 1983), the accuracy of the blood glucose level may vary depending upon users' techniques. Proper training of personnel and a method of verifying results are essential in establishing reliability. Therefore, the purpose of this study was to determine if a formal training program would improve the percentage of error of glucose values performed by the finger stick method.

Justification

The finger stick method of blood glucose monitoring is being performed on hospital wards, intensive care units,

operating rooms and emergency rooms (Baskin, 1985). Due to the tremendous reduction in time (under 5 minutes) and the simplicity of the procedure, the improvement of patient care is evident. The method is currently supplementing the standard laboratory method and has shortened the hospital stay for the patient with diabetes (Baskin, 1985). In addition, the method is cutting down on the use of laboratory manpower and reducing cost to the hospital and the patient. The finger stick method allows for 25 glucose determinations to be performed at the approximate cost of $14.00, compared to a single standard laboratory determination at the approximate cost of $17.00 (Methodist Hospital, 1985). The relatively inexpensive test is so simple that it allows the patient to monitor his or her glucose level at home unsupervised. However, in the hospital setting, many different individuals may be involved in the monitoring of a patient glucose level at various times and it is essential that proper training of these individuals is performed and standardized. Due to insufficient data to support proper training of operators, quality control, and timely and proper maintenance of equipment, resistance to the finger stick method is strong in many institutions. A new burden is being placed upon the medical and nursing staff to maintain testing standards consistent with laboratory practices

(Peterson, 1985). To date there are no specific policies or standards addressing the practice of in-hospital use of the finger stick method of blood glucose monitoring. Consequently, data collected from this study were utilized to provide an effective method of standardizing training and development of quality control policies and procedures.

The Ames Company (1983) reported the following results in a Visidex II Reagent Strip versus an independent investigator's use of whole blood comparative assay.

Glucose Concentration Range	Number of Specimens	Average Percent Different from Comparative Assay
0-125 mg/dl	302	+2%
126-250 mg/dl	207	-4%
251-800 mg/dl (n.p.)	109	-4%

Aziz and Hsiang (1983) studied the correlation between the auto analyzer glucose and Visidex II glucose values with the following results: $N = 160$, $r = .955$, $y = 25.30 + 0.93 x$. In addition, the correlation between the auto analyzer glucose and Glucometer was $N = 157$, $r = .974$, $y = 24.72 + 0.91 x$.

Results of the Shapiro et al. (1981) study of the relationship of venous serum glucose and capillary blood glucose concentrations are summarized in Table 1. Additionally, Reeves, Forham, Skyler, and Peterson (1981) compared the self-monitoring Glucometer method of blood

monitoring with the Beckman standard reference method of blood glucose monitoring. Their findings are also shown in Table 1.

Table 1

Summary of Blood Glucose Concentrations Using Dextrometer vs. Standard Laboratory Analysis (Shapiro et al., 1981) and Using Both Glucometer Wet and Dry vs. Beckman Standard Glucose Analyzer (Reeves et al., 1981)

Study/ Method	No. in Sample	Intercept	Slope	Correlation Coefficient	Deviation Mean n	Deviation Mean %
Shapiro et al. (1981)						
Dextrometer	132[a]	32.3	0.94	0.91	N/A	N/A
	93[b]	45.6	0.78	0.90	N/A	N/A
Reeves et al. (1981)						
Glucometer (wet) vs. Beckman	68	-16.44	1.12	0.98	14.8	10.0
Glucometer (dry) vs. Beckman	68	-17.18	1.14	0.98	16.8	11.4

[a]Range 48-464 mg/dl.

[b]Range 48-250 mg/dl.

Conceptual Framework

The conceptual framework for this study was taken from Malcolm Knowles' (1978, 1980) andragogical model of learning. According to Knowles, andragogy is the art and science of helping adults learn. The adult is self-directed and, unlike the child, does not need to be taught, but does require assistance as he or she matures from dependency to varying capacities of self-direction. In an attempt to differentiate andragogy from pedagogy, the art and science of teaching children, Knowles has identified four main assumptions of andragogy. Knowles (1980) proposed that:

1. The adult learner experiences a change in self-concept from total dependency to increasing self-directiveness.
2. The adult learner places increased value on personal and other experiences and utilizes these experiences as resources for learning.
3. Social roles and role expectations become predominant in determining the adult's readiness to learn; the adult is problem- or task-oriented.
4. The adult learner will be motivated to learn to the extent in which he or she feels the need to met personal goals and expectations.

To facilitate learning, Knowles (1978, 1980) suggested that the adult learner share in the assessment of the need

to gain knowledge. The climate for learning should be informal, collaborative, and supportive. He further stated that the adult learner experiments in learning technique and basically engages in independent study. Evaluation of learning is learner-oriented and supported by learner-acquired evidence.

Knowles' (1978) andragogical model of learning is applicable to the proposed study in that the participants of the study are adults. Assuming that the adult learner is self-directed, task oriented, and motivated by internal incentive, the participants were provided with the necessary materials to engage in independent study. The investigator was available to assist in the learning process if necessary. The investigator set the climate by informing participants of the current trend toward certification of hospital staff to perform finger stick blood glucose monitoring (Baskin, 1985). The formulating of objectives as identified by Knowles (1978) was the collection of data to support the need for a hospital policy addressing quality assurance and/or quality control. The results of the before instructions, simultaneous plasma glucose values performed in the laboratory were shared with each participant to be utilized in conducting an individual needs assessment. Investigator-identified errors in technique were shared with each participant.

Assumptions

This study, based on Knowles' (1978, 1980) andragogical model of learning, is designed under the following assumptions:

1. The adult learner is self-directed, task oriented, and motivated by internal incentives (Knowles, 1978, 1980).
2. Because of the individuality of task-oriented learning, there may be variations in operators' techniques in performing the finger stick method of blood glucose monitoring (Knowles, 1978).
3. Knowledge gain is measurable (Knowles, 1978, 1980).

Hypothesis

For the purpose of this study, the following directional hypothesis was formulated:

> Nurses participating in a formal training program will incur a lower percentage of errors in glucose values performed by the finger stick method than they display using the same method prior to formal training.

Definition of Terms

For the purpose of this study, the following terms are defined:

1. Visidex II Reagent Strip: a plastic strip with two pads containing the enzyme glucose oxidase which is specific

for determining the concentration of glucose in whole blood.

2. Dextrometer: an electronic instrument with a digital display which reads Dextrostix quantitatively.
3. Dextrostix: disposable reagent strips impregnated with glucose oxidase, peroxidase, and a chromogen indicator system. The chromogen indicators cause a color change that is quantitatively measured by the Dextrometer.
4. Finger stick method of blood glucose monitoring: the use of capillary blood obtained from a finger stick and transferred onto a reagent strip. After sufficient time (as dictated by the manufacturer), the blood is either wiped or washed off, the pad is examined, and glucose concentration is determined.
5. Percentage of error: the comparative difference between the finger stick capillary blood glucose value and the plasma glucose value expressed in mean percentage. Generally, plasma glucose values are higher than capillary blood glucose values (Ames, 1983). In this study, the percentage of error should not exceed ±15%.
6. Formal training program: a period of individual instruction which involves independent study and investigator-assisted step-by-step review of the Visidex II and Dextrostix dextrometer methods of blood glucose monitoring.

7. Independent study packet: a collection of written materials to assist the participant in becoming proficient in the finger stick method of blood glucose monitoring.
8. Nurses: either registered or licensed vocational nurses assigned to perform finger stick blood glucose monitoring.

Limitations

Possible limitations of this study include the following:

1. A possible narrow range of blood glucose values in the patients tested may be a limitation in this study. Additionally, patients with extremely high or low glucose values may be too sick to participate and/or may not give consent to participate.
2. The results cannot be generalized to the total population because of convenience sampling technique.

Summary

The management of diabetes involves the prevention of and/or reduction of acute and chronic complications. A significant discovery within the last 10 years is the relatively inexpensive test for blood glucose monitoring,

self-monitoring of blood glucose (SMBG). Although this test was designed to allow patients to monitor their own blood glucose levels unsupervised, it is fast becoming an accepted method of monitoring in the physician's office as well as at patients' bedsides in many hospitals. The manufacturer (Ames, 1982) of the reagent strips used in SMBG suggested that accuracy is dependent upon user technique and recommended proper training of personnel and a method of verifying accuracy of results. Therefore, a study of in-hospital blood glucose monitoring by nurses was undertaken. This study was based on Knowles' (1978, 1980) andragogical model of learning.

CHAPTER 2

REVIEW OF LITERATURE

The current management of diabetes may include self-monitoring of blood glucose levels. This method of monitoring is becoming increasingly popular. Initially designed for the use of the patient in the home, its usage has become routine in the physician's office and at the bedside of the hospitalized patient (Peterson, 1985). However, questions concerning the accuracy of values as well as problems with and complications of the method are beginning to surface. This literature review describes data concerned with the importance, advantages, and disadvantages of self-monitoring. In addition, the current status of Quality control guidelines is reviewed.

Self-monitoring introduces a new learning experience for the diabetic of any age group; however, the experience will be viewed differently by the child and the adult (Knowles, 1978, 1981). To illustrate how adult learning differs from that of a child, a review of adult learning concepts is included.

Blood Glucose Monitoring

The achievement of the primary objective of diabetes management, maintenance of a normal glucose range, requires the joint participation of the person with diabetes, the family, and the health care professional. It is, however, essential that the diabetic accept responsibility for the management of his or her disease. An important step to assist the diabetic in becoming self-confident is education about the disease and how to benefit from new treatments. The single most important advancement in the treatment of diabetes in the last 10 years is self blood glucose monitoring (Kilo & Dudley, 1984). Self-monitoring allows the patient to gain control of the situation and to assist in maintaining the glucose at an acceptable level. According to the authors, normalization of blood glucose will result in the delay and/or prevention of vascular complications, diabetic retinopathy, neuropathy, and nephropathy.

Self blood glucose monitoring, also referred to as home glucose monitoring, was introduced by the Ames Company in 1970 (Jonvononic & Peterson, 1980). The procedure, labeled the first solid phase system for measuring blood glucose with a reagent strip and reflectance meter, has become a widely used and accepted method for determining glucose

control. Currently replacing urine testing in many situations, blood glucose monitoring has eliminated many of the major pitfalls of urine testing. Factors such as variations in individual renal thresholds, exercise, pregnancy, fever and infection may render urine glucose testing unreliable (Jonvononic & Peterson, 1980).

Davidson (1981) discussed the importance of blood glucose monitoring in the office management of the diabetic patient. Although plasma glucose concentration is the best available indicator for assessing diabetic control, an isolated value may not represent the patient's usual metabolic state. Recently measurements of glycosylated Hgb (15) or Hgb A_{1C} have been utilized in conjunction with plasma glucoses to evaluate diabetic control, however, the gylcosylated Hgb (15) is an index of long term control. Consequently, home glucose monitoring, a procedure performed by the patient, is an extremely valuable discovery in the office management of the diabetic patient. The simplicity of the procedure and the speed in which results are obtained makes it easier to maintain glucose levels in an acceptable range (Davidson, 1981).

Davidson (1981) also compared capillary blood to venous blood. Capillary blood contains a mixture of arterial and venous blood. Samples obtained from the earlobe or fingers

will demonstrate little difference between capillary and venous samples if taken during the fasting state; however, after a glucose challenge there are appreciable differences between capillary and venous values. According to Davidson, glucose concentrations measured in plasma or serum are approximately 15% higher than the samples utilizing whole blood. This is due in part to the fact that in whole blood glucose is excluded from the portion of the sample which comprises the red blood cells (Davidson, 1981).

Stevens (1981) illustrated the usefulness of home blood glucose monitoring by identifying the benefits of monitoring for the diabetic mother. The rate of complications of infants born to diabetic mothers may decrease significantly if glucose levels are maintained within a normal range from before conception and throughout the first trimester, according to Stevens. In addition, insulin infusion pump users have the advantage of constant control of glucose levels below the normal renal threshold level. Blood monitoring is also advantageous for the patient with renal disease who may not produce adequate amounts of urine for testing (Stevens, 1981).

Brecher and Birrer (1984) compared the advantages of home glucose monitoring to the more traditional method of urine testing. Problems associated with urine testing

included the following: some products will not indicate a positive result until the glucose exceeds 250 mg/dl; many drugs have been known to interfere with the accuracy of the urine test; and a urine test does not warn the patient of impending hypoglycemia. The authors, however, listed the following advantages of blood glucose monitoring: serves as a motivator for patients to take an active role in their diabetes control; improves patient-physician relationships; reduces the number of readmissions to the hospital; and allows the patient to modify treatment regimens.

Sönksen, Judd, and Lowry (1978) reviewed the records of 53 patients after an extended period of self-monitoring of blood glucose. The records indicated a significant improvement of blood glucose control including a decrease in the frequency of hypoglycemic episodes and an overall lower average blood glucose level during the period of self-monitoring. In addition to improvement of glucose control, Sönksen et al. reported that patients expressed greater satisfaction with blood monitoring than with the traditional urine test for glucose.

Walford, Gale, Allison, and Tattersal (1978) studied the effects of self-monitoring of capillary blood glucose in 69 patients. In addition to monitoring blood, simultaneous urine tests were conducted and venous blood samples were

measured by an Autoanlayzer. The correlation between the capillary and venous blood was $\underline{r}$ = .96. Urine tests carried out at the same time of the blood glucose testing provided a simple method of estimating the renal threshold. The study results also reflected a good correlation between blood and urine glucose results in patients with a normal renal threshold. The authors concluded that self-monitoring of blood glucose can yield good results if obtained by well trained individuals. In addition, Walford et al. reported that the results are more reliable and informative in controlling glucose levels than the Hemoglobin A_{1C} or urine test.

Barr, Leichter, and Taylor (1984) evaluated the accuracy and reliability of capillary versus venipuncture glucose monitoring of 20 hospitalized patients. The Pearson correlation between patients was $\underline{r}$ = .87, the mean deviation was 17.6 ± 2.9 mg/dl or 8.9% which was considered within the 20% range that is accepted as sufficiently accurate. The authors suggested that close supervision of patients and routine simultaneous laboratory glucose checks be performed to maintain and confirm accuracy of capillary testing of the hospitalized patient.

Saucier (1984) assessed long-term control of children performing blood glucose monitoring using the hemoglobin A_{1C}

as the indicator. The mean hemoglobin A_{1C} before the beginning of self-monitoring was 12.1 ± 2.1% and 11.35 ± 2.25% after long-term monitoring. The data supported the usefulness of self-monitoring as a method of glucose regulation.

Most, Gross, Davidson, and Richardson (1986) conducted a study to demonstrate the accuracy of use of home monitors by patients in their natural environment. Subjects were asked to collect and mail in preserved capillary blood samples along with their meter readings of blood glucose values. The patient's capillary readings were compared to a standard laboratory method of glucose analysis. The collected data revealed that 53% of the glucose readings taken by the individuals were not within the ±20% range of clinical acceptability. In addition, the data revealed no relationship between accuracy and age, sex, training format, knowledge, duration of diabetes, educational level, or frequency of meter use. The authors attributed individual carelessness as a possible explanation for the unacceptable readings.

Mazze et al. (1984) reported on the reliability of blood glucose monitoring performed by patients. The authors replaced standard glucose meters with internally modified meters with memory chips capable of storing glucose reading

by date and time. Patients were unaware of the modifications and recorded generated data in a logbook. Reported differences in memory readings and logbook ranged from 0 to 109 mg/dl. Reported under readings of results were 75% and over readings were 10%. Phantom values averaged 40% and recordings of actual times that tests were performed varied on 26% of the logbook records. The authors concluded that based upon the information provided as a result of this study, the reliability of patient generated data as a method of clinical judgment in diabetes management is questionable.

Ryan, Miller, and Skyler (1983) reported on the possible serious complications of repeated finger sticks for the purpose of blood glucose monitoring. Citing two case studies, the authors concluded that healthy skin will tolerate repeated punctures without lasting effects. However, in many diabetic patients due to impaired blood supply, neuropathy, and collagen abnormalities, there is an increased risk of infection and/or tissue necrosis if intensive monitoring is continued over an extended period of time. According to the authors, finger stick monitoring is very beneficial for glucose control, but the possibility of serious complications cannot be overlooked.

Fox et al. (1984) conducted interviews of 33 patients performing blood glucose monitoring to identify whether

self-monitoring influenced perception about diabetes and to examine patterns of usage and problems encountered. The frequency in usage decreased after 3 months in 14 subjects. Problems encountered included sore or calloused fingers, infected fingers, difficulty reading strips, difficulty sticking fingers, and inconvenience. Twenty-three subjects reported that self-monitoring changed their perception of their disease, either confirming the disease or assisting in better control.

Paduano and Smith (1985) offered suggestions to minimize errors and/or complications of blood glucose monitoring. Proper hygiene such as good hand washing and not reusing lancets decreases the risk of infections, while getting a large drop of blood and close attention to timing reduces the chances of erroneous glucose values.

Blood Glucose Monitoring Quality Control

According to Waltington (1985), while blood glucose monitoring has the potential of reducing response time and hospital cost, it places a new burden on the medical and nursing staff. It is imperative that bedside monitoring maintain testing standards that are consistent with laboratory practices. The need for policies and/or standards regarding bedside monitoring has been recognized. Currently there are specific policies and standards that

address bedside monitoring by any of the national regulatory bodies. However, the Joint Commission on the Accreditation of Hospitals has issued some unofficial guidelines.

The Joint Commission on Accreditation of Hospitals, according to Affeldt (1985), suggested the following guidelines for bedside glucose monitoring: (a) written identification of the persons responsible for performing the test; (b) persons performing the test must have adequate and specific training; (c) policies and procedures addressing specimen collection and preservation, instrument callibration, quality control, and test performance must be current and readily available; and (d) daily quality control check, along with maintenance of appropriate records. Affeldt emphasized that the suggested guidelines should not be regarded as standards or interpretations of standards.

Peterson (1985) identified three variables that are essential for quality control systems; these variables are accuracy, precision, and correlation with a standard reference. The author offered the following guidelines for implementing a workable program of quality control in the hospital or clinic areas. To maximize accuracy, equipment should be checked frequently for reliability, the method of testing should be checked utilizing standard control solutions. In addition, the method should be checked

against a standard laboratory method for correlation. Duplicate tests should be performed to check precision; values should agree within 10% of one another.

The Concept of Adult Learning--Andragogy

Tough (1979) conducted the adult learning projects which investigated patterns of adults' participation in learning. According to Tough, most adults engage in at least one major learning effort each year. The author described several factors which may influence how and why adults enter into the learning projects. Past life experiences; psychological characteristics such as mental ability, energy level, and degree of initiative; other people; as well as societal and community conditions were listed as decision making factors. Additionally, Tough stated that the most common motivation for learning is anticipated immediate application of the learning materials.

Later studies conducted by Tough (1985) were focused on various aspects of adults' initial effort to learn and intentional change. The results of the study suggested that adults are highly active in initiating learning when faced with a crisis or problem. Tough's studies indicated that 90% of the participants in 55 studies of adult learning made deliberate efforts to gain knowledge and/or skills in at least one area during a 12-month period prior to

participating in the study. In regard to intentional change for the adult, Tough offered the following summary: (a) Men and women are remarkably successful at achieving large and significant changes that are of personal benefit to themselves as well as others. (b) The individual decides the size and importance of intentional change and is therefore an active agent in managing and guiding the change process. (c) Friends, groups, teachers, and helpers act as resources and aid in fostering and facilitating change.

Knowles (1978, 1980), utilizing the works of Tough, identified four key assumptions of andragogy, and he has continued to develop his adult education model from previous and current studies conducted by Tough.

Hilgard and Bower (1975) identified and summarized a list of empirical relationships or principles of learning. Among these empirically accepted generalizations are the following: (a) the learner should be an active participant in the learning situation; (b) drive or motivational conditions are important for learning to take place; (c) the meaningfulness of the learning experience affects retention; (d) goal setting is an essential focus of learning; (e) learning is culturally related; and (f) motives for learning may be internal or external. Taken from many theories of learning currently being utilized in educational

institutions, the identified principles are consistent with Knowles' assumptions of how adults learn.

Cass (1971), in her discussion of the psychology of adult learning, identified several characteristics of adult life experiences which correlate with the concepts of andragogy. According to Cass, the major difference between child and adult learning is in the how of the adult learning process. Learning experiences for adults must be goal directed and action centered. These experiences must be meaningful for the individual, and the learner exercises control over content and method. The teacher serves as a facilitator of learning due to self-motivation of the learner. Cass further pointed out that the adult learner learns for personal satisfaction and to cope with societal and environmental changes in addition to identifying an immediate benefit from the learning experience.

Darkenwald (1982) conducted studies which supported the concept of andragogy. Through the process of open-ended interviews and principal component factor analysis, the author studied the teaching behaviors of 173 professional teachers who taught both adults and pre adults. An analysis of the data revealed that teachers tend to emphasize learner centered behaviors, utilized group discussions, based class materials to the learners' life experiences, and solicited

student feedback when dealing with adults. However, when teaching pre adults, teacher-centered behaviors were demonstrated.

Bigge (1982) identified factors which affect efficient education. Among these were the traditional ways in which subjects are organized and presented in schools, information that has little or no meaning for the student, and the passive role of the student. As an alternative to the traditional approach, Bigge introduced the reflective teaching method of education. This method was described as a problem-centered approach, in which the teacher serves as a facilitator of learning and guides the student in resolving an identified problem. According to Bigge, in order for learning to take place, a problem must be identified by the learner, and a personal spontaneous goal must be set. Knowles' (1978, 1980) andragogical model supports the concept of goal-directed learner-centered instruction.

Knowles and associates (1984), in an attempt to gather support for the andragogical model of learning has published a compilation of research studies which describes the effectiveness of the key assumptions in this model. Included are the works of Loacker and Doherty (1984) and James (1984).

Loacker and Doherty (1984) illustrated the effectiveness of andragogy in action when the andragogical model's assumptions were utilized as the basis for the development of an undergraduate education program. The primary goal of the program was increasing delegation of responsibility to the learner. The author identified three phases for accomplishing self-direction. The identified phases are internalizing learning, transferring learning, and directing learning. As the learner progresses through each phase, evidence of the process elements of the andragogical model were utilized. Identified processes included goal setting, individual assessment, problem solving techniques, and assuming more initiative for planning and evaluating personal development.

James (1984) supported the use of the andragogical model in his evaluation of the appropriateness of environmental education for adults. James emphasized the importance of self-directed learning in the need to identify local problems that were of interest to the learner and to use experimental techniques based on life experiences in seeking resolutions. In addition, the author suggested that a readiness to learn is present in the adult involved in environmental learning due to the immediate application of the gained information.

Holmes (1980) reported the results of a study which compared interpersonal behaviors as their relationship to the andragogical and pedagogical orientation of adult educators. Holmes concluded that adult educators who tend to feel comfortable in beginning and maintaining relationships place a great deal of faith in the students' abilities to guide and control their own learning experiences, a concept which is basic to an andragogical orientation to learning. In addition, these adult educators were more subject to encourage situations which elicited cooperative interaction among learners and increased self-direction. According to Holmes, self-direction is the goal of an andragogical approach to education.

Summary

The importance, advantages, and disadvantages of blood glucose self-monitoring were described. Data supporting the usage of blood glucose monitoring, as well as information for improving accuracy and preventing complications, were emphasized. Because of the increasing use of the self-monitoring method in physicians' offices and hospitals, a review of the current status of quality control guidelines was included. Self-monitoring of blood glucose introduces a new learning experience for the adult diabetic. Therefore, a review of adult learning concepts was also conducted.

CHAPTER 3

PROCEDURE FOR COLLECTION AND TREATMENT OF DATA

This study was classified as an explanatory study. The explanatory approach tries to explain a relationship between two or more variables to compare the differences between two groups (Polit & Hungler, 1978). The design for this study was quasi-experimental. In the quasi-experimental design, the randomization and/or control group components may be missing. However, the quasi-experimental design does involve manipulation of an independent variable (Polit & Hungler, 1978). The independent variable was the proficiency of the nurse. The dependent variable, type of training, was manipulated by introducing an independent study packet as the treatment. The participants were selected from the staff regularly employed on the Endocrine Unit of the selected hospital, therefore, a convenience sampling technique was used. There was no control group.

Setting

This study was conducted over a one-month period on the Endocrine Unit of a large medical center hospital located in a metropolitan area of southwest Texas. The Endocrine Unit was selected because at the time of this study it was the

only area in the hospital that utilizes both the Dextrostix/ Glucometer and Visidex II methods of finger stick capillary blood glucose monitoring.

Population and Sample

The population for this study included all registered nurses and licensed vocational nurses employed at the hospital who were involved in finger stick blood glucose monitoring. All registered nurses and licensed vocational nurses regularly assigned to the Endocrine Unit were invited to participate in the study. The sample was limited to nurses regularly assigned to the Endocrine Unit because at the time of the study the Endocrine Unit was the only area in the hospital utilizing the Visidex II and Dextrostix/ Glucometer methods of finger stick blood glucose monitoring. The sample consisted of all those nurses assigned to the Endocrine Unit who volunteered to participate.

Protection of Human Subjects

Agency approval was obtained from the selected hospital (Appendix A). Additionally, Texas Woman's University Human Subjects Committee guidelines were followed. To protect the rights of the subjects, a letter of invitation to participate in the study was issued. An explanation of the purpose of the study and the procedure to be used was included. A

description of risks, benefits, and compensation was given. Confidentiality and anonymity were assured. Subjects were advised of their rights to refuse to participate or to withdraw from the study at any time. Alternatives to the study were explained.

Instruments

The instruments used in this study included the following: (1) Visidex II Reagent Strip; (2) Glucometer; (3) Dextrostix; (4) laboratory blood specimens; and (5) the Independent Study Packet. This study packet was used to administer the treatment (nurses' self-instruction in technique).

Visidex II Reagent Strip

The Visidex II Reagent Strip is a plastic strip with two pads containing the enzyme glucose oxidase which is specific for determining the concentration of glucose in whole blood. The lower range pad responds to glucose levels from 20-110 mg/dl; the higher range pad responds to glucose levels of 140-800 mg/dl. Visidex II is for visual interpretation only. The procedure for the use of Visidex II involves one large drop of whole blood sufficient to cover both pads, accurate timing for 30 seconds, careful wiping or blotting, additional timing for 90 seconds, and proper

visual interpretation. The accuracy and limitation of Visidex II as suggested by the manufacturer (Ames, 1983) are as follows: A 72% to 89% of reading within 1/2 color block of the average was obtained by 22 Ames Laboratory personnel participating in a precision study using Visidex II Reagent Strips and glucose control solutions. In another study (Ames, 1983), three independent investigators performed glucose assays on clinical specimens of a 6 to 10 day period using Visidex II reagent Strips and comparative laboratory glucose assays which yielded an average percent difference of +2% to -4%. Limitations of Visidex II Reagent Strips include the following: Visidex II Reagent Strips are not recommended for use with neonatal blood specimens and are not designed for use with plasma or serum. When compared with serum or plasma glucose levels, the Visidex II results will generally be 10% to 15% lower (Ames, 1983).

Glucometer

The Glucometer is an electronic instrument with a digital display which reads Dextrostix quantitatively. A single drop of capillary blood will yield glucose levels from 0-399 mg/dl in less than two minutes. The manufacturer of the Glucometer suggests that prior to performing blood glucose testing with the Glucometer/Dextrostix System, the calibration and control procedure should first be performed.

The investigator was responsible for performing this procedure during the data collection period of this study.

Dextrostix

Dextrostix are disposable plastic reagent strips impregnated with glucose oxidase, peroxidase, and a chromogen indicator system. The chromogen indicators cause a color change that is quantitatively measured by the Glucometer. The procedure for the use of Dextrostix includes one drop of capillary blood sufficient to cover the reactive area of the strip, exact timing for 60 seconds, proper washing with a short stream of water from a wash bottle for 2 seconds, blotting with a lint-free paper towel and inserting the reagent strip into the Test Chamber of the Glucometer.

The manufacturer (Ames, 1980) of Dextrostix states the Glucometer/Dextrostix system is specific for blood glucose. Studies revealed multiple assays of whole blood pools spiked with glucose gave a within-run coefficient of variation less than 5% and an overall coefficient of variation of 7%. Correlation coefficients of 0.97, 0.96, and 0.99 were obtained from three outside investigators testing clinical specimens (Ames, 1980).

Laboratory Specimens

Blood specimens for laboratory processing were all drawn from in-hospital patients by the primary investigator. The serum glucose levels were determined using the Astra 6 automated analyzer. Quality control was assured by the following laboratory procedure:

1. All quantitative tests were reported only if the controls run with the test fell within plus-minus two standard deviations.
2. If the controls are out of range, all tests are to be repeated along with the control.
3. If controls still do not fall in the range, the pathologist-in-charge is to be contacted.

Independent Study Packet

The Independent Study Packet (Appendix B) is a collection of policies and procedures to be utilized by the nurse participant to develop proficiency in performing the Visidex II and Dextrostix/Glucometer methods of finger stick blood glucose monitoring. These policies and procedures were developed by the Diabetes Nurse Educator and the hospital's Policy Committee and Therapeutic Methods Committee, following the suggested manufacturer's procedural guidelines. The policies and procedures have been approved by the hospital's Executive Nursing Committee.

Data Collection

Prior to the formal training program, each nurse participant was requested to perform three finger stick capillary blood glucose values utilizing the Visidex II and Dextrostix/Glucometer procedures. At the same time, a plasma specimen was sent to the laboratory for determining the plasma glucose value. The plasma glucose specimen was drawn by the investigator. The finger stick capillary glucose values and the plasma glucose values were utilized to establish the before-training percentage of error. Following the before-instruction evaluation, each nurse participant received an independent study packet. Each nurse participant was requested to conduct an individual needs assessment. After one week of independent study, each nurse received a step-by-step review of the Visidex II and Dextrostix/Glucometer procedures. After the review, the nurse participant was requested to perform each procedure three times. A simultaneous plasma specimen was sent to the laboratory to determine the plasma glucose value. The investigator utilized the Performance Requirement Checklist included in the Independent Study Packet to evaluate accuracy in nurse participants' techniques.

Treatment of Data

A comparative analysis of before-training and after-training percentage of error was conducted. The statistical analysis consisted of the *t*-test and the Pearson *r*. The *t*-test was utilized to analyze the mean difference between the plasma glucose values and the Visidex II and Dextrostix/Glucometer glucose value. According to Polit and Hungler (1978), the parametric procedure for testing differences in group means is the *t*-test. The Pearson *r* is the most commonly used correlation index, according to Polit and Hungler. Also referred to as the product-moment correlation coefficient, the correlation coefficient attempts to answer the question to what extent the two variables are related to each other. The Pearson *r* is a descriptive and inferential statistic (Polit & Hungler, 1978). The data were displayed in tables.

CHAPTER 4

ANALYSIS OF DATA

Since the accuracy of blood glucose level may vary depending upon users' techniques, the purpose of this study was to determine if a formal training program would improve the percentage of error of glucose values performed by the finger stick method. A description of the sample of participating nurses is offered in this chapter. Additionally, analyses of the findings are presented. The chapter concludes with a summary of the findings.

Description of the Sample

Twelve nurses were conveniently selected to participate in this study. Each nurse was assigned to the Endocrine Unit of the participating hospital and had frequent daily experience with the Visidex II, Dextrostix/Glucometer, and laboratory blood glucose procedures. Ten of the nurses were professional and 2 were licensed vocational nurses. All 12 nurses had worked on the Endocrine Unit for at least 1 year and had equal exposure to the blood glucose procedures.

Findings

Procedure

Prior to formal instructions, each nurse was requested to perform three Visidex II and three Dextrostix/Glucometer finger stick capillary blood glucose procedures. At the same time the investigator performed a venipuncture, collected a specimen, and a plasma glucose was done by a standard laboratory method utilizing the Astra 6 Automated Analyzer. Following the before instructions Visidex II and Dextrostix/Glucometer procedures, each nurse received the independent study packet for review for at least one week. Each nurse received individual written and verbal instructions of the Visidex II and the Dextrostix/Glucometer procedures. After instructions, each nurse was requested to perform both procedures on three patients. The nurse was informed that she may ask questions at any time during the procedures.

Laboratory Specimens

Blood specimens for laboratory processing were drawn by the primary investigator. The specimens were sent to the laboratory for immediate processing. The glucose levels were determined by use of the Astra 6 Automated Analyzer, a standard method of glucose analysis with established quality control guidelines.

Findings

The following directional hypothesis was formulated: Nurses participating in a formal training program will incur a lower percentage of errors in glucose values performed by the finger stick method than they display using the same method prior to formal training.

For this study, findings were considered statistically significant at $p \leq .05$.

Twelve nurses, 10 professional nurses and 2 licensed vocational nurses, participated in the comparative analyses of blood glucose levels utilizing the Visidex II and Dextrostix/Glucometer methods. A total of 36 Visidex II and 36 Dextrostix/Glucometer tests were completed by the participants prior to instructions. Simultaneous venous samples were sent to the laboratory for glucose analysis. An instructional program was carried out and 46 Visidex II and Dextrostix/Glucometer tests were performed. Four additional Dextrostix/Glucometer tests could not be used because of the limited range of the Glucometer digital reading. These glucose levels exceeded the 399 mg/dl readings of the meter. The Pearson r and the t-test were used to test the hypothesis.

Pearson r correlations and a t-test were used to analyze the group-related difference between the three procedures. All of the after correlations were numerically higher than the before correlations (Table 2). However, the only statistically significant change was between the Glucometer and Visidex II methods ($p=0.3$). The Glucometer method was found to be more highly correlated to the lab on both the before and after correlations involving multiple operators.

Table 2

Comparison of Group Related Difference Between Blood Glucose Levels According to Test Before and After Instructions

	Before		After		t	p
	n	r	n	r		
Glucometer/Lab	36	.902	45	.920	0.45	.65
Visidex II/Lab	36	.633	45	.780	1.28	.20
Glucometer/ Visidex II	36	.620	45	.844	2.19	.03*

*$p \leq .05$

One nurse consistently obtained somewhat higher values on the Glucometer for the before readings relative to the laboratory values. One nurse consistently obtained somewhat

low values on the Glucometer values relative to the laboratory values. The before and after correlations for the Glucometer vs. laboratory method of testing illustrated good agreement between the methods (r=.902 and .920, respectively). The Glucometer values were neither consistently higher or lower than the laboratory values. The before correlation (r=.633) for Visidex II vs. laboratory was significantly lower than the Glucometer vs. laboratory method. In general the Visidex II values were significantly lower than those of the laboratory ($p \leq .005$). The agreement of the Visidex II/laboratory values correlation (r=.780) was not significantly different (p=.20). Four Visidex II values were much higher than the laboratory values. The before correlation (r=.620) between the Visidex II and Dextrostix/Glucometer method was poor. However, the Visidex II values were neither consistently higher nor lower than the Dextrostix/Glucometer values. The after correlation (r=.844) for the Visidex II and Dextrostix/Glucometer was significantly better than the before data (p=.03). In general, the Visidex II values were significantly higher than the Dextrostix/Glucometer values (p=.01).

Summary of Findings

All of the after correlation coefficients were numerically higher than the before correlations. However, the only significant change was between the Dextrostix/ Glucometer and Visidex II values ($p=.03$). The Dextrostix/ Glucometer values were more highly correlated to the laboratory on both the before and after correlation. The Dextrostix/Glucometer values were neither consistently higher nor lower than the laboratory values. The before and after correlations for the Visidex II/laboratory method were significantly lower than the Dextrostix/Glucometer and laboratory method. The correlation for the after Visidex II and Dextrostix/Glucometer methods was significantly better than the before data.

CHAPTER 5

SUMMARY OF THE STUDY

The management of diabetes involves the prevention and/or reduction of acute and chronic complications. A significant discovery within the last 10 years is the relatively inexpensive test for blood glucose monitoring, self-monitoring of blood (SMGB). Although this test was designed to allow the patient to monitor glucose levels unsupervised, it is fast becoming an accepted method of monitoring glucose levels in physicians' offices as well as at patients' bedsides in the hospitals. The manufacturer (Ames, 1982) of the reagent strips used in the SMBG suggested that accuracy is dependent upon users' techniques and proper training of personnel as well as a method of verifying accuracy of results were recommended. Therefore, a study of in-hospital blood glucose monitoring by nurses was conducted. This study was based on Knowles' (1978, 1980) andragogical model of learning.

Summary

This explanatory study compared the variances of blood glucose test results which were obtained by multiple operators. Twelve registered and licensed vocational nurses

were instructed in the use of Visidex II and Dextrostix/ Glucometer methods of glucose monitoring, after each participant had performed blood glucose analysis using the different methods. Blood glucose laboratory values were used as the comparative control for the obtained values. Pearson *r* correlation coefficients and a *t*- test were used to analyze the group related differences between obtained blood glucose values of the three methods.

Discussion of Findings

Previous studies have examined various methods of self-monitoring of blood glucose by making comparisons in the laboratory. Such comparisons do not provide information about the statistical significance of formal training programs on the accuracy of the various methods or if multiple operators were involved in the testing.

In this study, the performance of the Dextrostix/ Glucometer method of testing was consistent with the results reported by authors of previous studies (Ames, 1982; Aziz & Hsiang, 1983; Clements, Keane, Kirk, & Boshell, 1981) who found a close correlation with the laboratory method. However, variations of consistently higher values by one nurse and lower values by another nurse with the use of the Dextrostix/Glucometer may be contributed to individual technique during the washing phase of the procedure. A

similar suggestions was made by Silverstein et al. (1983) in an evaluation of a reagent strip which requires a washing procedure; standardization of the washing procedure is difficult.

The before and after correlations of the Visidex II were considerably lower than the Dextrostix/Glucometer correlations in this study. The lower correlation could be attributed to the increment scale of the Visidex II which allows the operator to estimate intermediate values. In addition, the accuracy of Visidex II is dependent upon adequate color vision interpretation. A possible explanation for the significantly better correlation in this study for the after Visidex II and Dextrostix/Glucometer methods may have been the repeated exposure and consistent visual interpretation during the period of the study. Although all the nurses were familiar with the Visidex II procedure, daily visual interpretation of the strips was not a routine procedure in the study hospital before the research study was initiated. The use of Visidex II was generally limited to providing instruction for patient upon discharge home. However, the Dextrostix/Glucometer procedure was used daily in determining capillary blood glucose values.

A vigilant effort was made by the investigator to eliminate any blood tests that were observed to be in gross

error or unacceptable. The individual performance check list was utilized to assist in identifying errors in technique. Four blood tests were eliminated in this study prior to analysis of data due to the limited range of the glucometer.

Conclusions and Implications

In this study all correlations of post-instructions blood tests results were numerically higher than correlations of pre-instructions blood tests results. The Dextrostix/Glucometer values were more highly correlated than the Visidex II values. The Dextrostix/Glucometer method is a reliable method for monitoring blood glucose values when there are multiple operators. It may be concluded that Visidex II method of blood glucose monitoring is not a reliable method for monitoring blood glucose values when there are multiple operators. The statistically significant change between the Dextrostix/Glucometer and Visidex II methods ($p=.03$) implies that repeated use of the Visidex II method, and the use of a standard reference method to verify accuracy, may improve the reliability of Visidex II when multiple users are involved.

Because of the differences in operators' techniques when performing blood glucose monitoring by either methods, the possibility of error exists, especially during the

washing phase of the Dextrostix/Glucometer method and the visual interpretation of the Visidex II method. Consequently, the need to develop a quality control system utilizing a standard laboratory reference to verify test results has been justified by the findings of this study.

Recommendations for Further Study

Recommendations for further study include the following:

1. This study should be replicated in another setting.
2. This study should be replicated and other visually read blood glucose reagent strips should be included.
3. An additional step should be added to this study design in that the reliability of the patients' glucose test results should be compared against the nurses' test results both before and after formal training.

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APPENDIX A

AGENCY APPROVAL AND INFORMED CONSENTS

TEXAS WOMAN'S UNIVERSITY
COLLEGE OF NURSING
DENTON, TEXAS 76204

DALLAS CENTER
1810 INWOOD ROAD
DALLAS, TEXAS 75235

HOUSTON CENTER
1130 M. D. ANDERSON BLVD.
HOUSTON, TEXAS 77030

AGENCY PERMISSION FOR CONDUCTING STUDY*

THE Houston Veterans Administration Medical Center

GRANTS TO Effie P. Nix
a student enrolled in a program of nursing leading to a Master's Degree at Texas Woman's University, the privilege of its facilities in order to study the following problem:

Effects of Formal Training on Accuracy of Various Methods in Blood Glucose Monitoring Involving Multiple Operators

The conditions mutually agreed upon are as follows:

1. The agency (may) (may not) be identified in the final report.
2. The names of consultative or administrative personnel in the agency (may) (may not) be identified in the final report.
3. The agency (wants) (does not want) a conference with the student when the report is completed.
4. The agency is (willing) (unwilling) to allow the completed report to be circulated through interlibrary loan.
5. Other _____

Date: 4/29/86

Arnold Bernard Storm, M.D.
Signature of Agency Personnel

Effie P. Nix
Signature of Student

Betty R. Rudnick
Signature of Faculty Advisor

* Fill out and sign three copies to be distributed as follows: Original-Student; First copy - agency; Second copy - TWU College of Nursing.

Dear Nurse,

You are being asked to participate in a research project in which two methods of blood glucose monitoring will be compared. By participating you will assist in identifying problems related to a selected method of monitoring, you will also assist in providing data to improve health care delivery. Participation is voluntary and you may refuse to participate or withdraw at any time without affecting your employment.

Participating in the study involves performing the finger stock method of blood glucose monitoring on six patients and allowing the investigator to observe your technique. In addition, you will be asked to review an independent study packet provided by the investigator. Performing the finger sticks will take about 15 minutes of your time. Reviewing the independent study packet will take approximately 1 hour of your time. The independent study packet contains materials that are beneficial to your work and therefore will be useful for you even if you decide not to participate in this study. Please remember that you can withdraw at any time. At no time during or after the research will any individual identifying information be released. Only group coded data will be used. No information will be placed in your records. Information comparing your glucose value with the laboratory value will only be released to you. Every effort will be made to minimize any discomfort or personal embarrassment that you may experience Please remember you may withdraw from this study at any time. The investigator will be glad to provide you with a copy of the results of this study if you request it.

In case of injury as a result of research, no medical services or compensation will be provided by the investigator; however, services are available to research subjects the same as to the general public.

If you have any questions, please ask me. Also, you may telephone me at 635-3233 if you want further information.

Sincerely,

Effie P. Nix BS

EFFIE P. NIX, R.N., B.S.

PARTICIPANT'S STATEMENT OF INFORMED CONSENT

I have read the information above. The purposes, procedures, potential discomforts and benefits of participation in the study of the effects of formal training on accuracy of various methods for blood glucose monitoring involving multiple operators have been explained to me. I have been given the opportunity to ask questions, which have been answered to my satisfaction.

I understand that my responses will be confidential and that data collected will be made available without individual identification. No information will be placed in my records and my name will not be used at any time. Only group data will be used. I understand that information comparing my glucose values and laboratory glucose values will be released only to me. Every effort to minimize personal embarrassment will be made. I understand that my participation is voluntary and I may withdraw at any time without jeopardizing my employment at VA Hospital. Furthermore, I understand that in case of injury as a result of research, no medical services or compensation will be provided by VA Hospital or Texas Women's University, but that services are available to research subjects just as to the general public. I understand that I will not receive any direct or immediate benefit from the procedures. The results of procedures and investigation will assist in the collection of data to be utilized in the development of policies for Quality Control and Quality Assurance for blood glucose monitoring performed by nurses.

My signature below indicates that I have been informed and have decided to participate voluntarily. A copy of this form will be provided for me.

_____ _____

Signature of Nurse Date

_____ _____

Signature of Investigator Date

_____ _____

Signature of Witness Date

APPENDIX B

INDEPENDENT STUDY PACKET

SELF-ASSESSMENT CHECKLIST

Before Instructions	Correct	Incorrect	Comments
Glucometer Dextrostix 1. Assemble equipment. 2. Calibrate Glucometer 3. Obtain large drop of blood. 4. Wait exactly 60 seconds. 5. Washing technique. 6. Blotting technique. Visidex II 1. Assemble equipment. 2. Obtain large drop of blood. 3. After 30 seconds off blood. 4. After an additional 90 seconds compare with color chart.			
After Instructions			
Glucometer Dextrostix 1. Assemble equipment 2. Calibrate Glucometer. 3. Obtain large drop of blood. 4. Wait exactly 60 seconds. 5. Washing technique. 6. Blotting technique. Visidex II 1. Assemble equipment. 2. Obtain large drop of blood. 3. After 30 seconds off blood. 4. After an additional 90 seconds compare with color chart.			

Blood Glucose Monitoring

I. PURPOSE: To state policies and procedures for blood glucose monitoring.

II. POLICIES AND DEFINITIONS:

A. Blood glucose monitoring is a method of testing a drop of capillary blood obtained from a finger prick; using special reagent strips with either a color comparison chart or a reflectance meter.

B. Blood glucose monitoring provides information about the pattern of blood glucose fluctuations enabling the physician to change treatments.

C. Methods available are Dextrostix reagent strips which should be used with a reflextance meter (Dextrometer or Glucometer) and Visidex II, a visual method. Visidex II are restricted to Endocrine Staff, Ward 308, ER, HBHC and Critical Care. Dextrostix are restricted to those areas with a refractance meter. Visidex II requires the signature of a staff member of the Endocrine Service.

D. To decrease incidence of complications, mainly infections, aseptic technique of finger puncturing will be taught to RNs, LVNs, and patients performing blood glucose monitoring.

E. Nursing interventions are designed to promote independence of the patient in caring for his/her own health. Thus, nurses will not perform routine blood glucose monitoring for patients being discharged on home glucose monitoring. For patients whose methods are questionable, a period of supervision and teaching may be necessary.

III. PROCEDURES:

A. Blood glucose monitoring will be performed by the RNs and LVNs who have been instructed by the diabetes nurse educator. The frequency of monitoring will be ordered by the physician.

B. Patients being discharged on home blood glucose monitoring will be instructed by the diabetes nurse educator or Registered Nurse. The patient will be supervised by the diabetes nurse educator or Registered Nurse until the patient is proficient in the procedure.

C. Nurses will document the teaching on the Diabetes Teaching Plan or progress notes.

D. Results of glucose monitoring should be recorded on the Diabetes Record Form 10-2561.

CERTIFICATION FOR CAPILLARY BLOOD GLUCOSE MONITORING

1. PROGRAM GOAL: To provide the performance requirements for certification to monitor blood glucose levels, utilizing the finger stick capillary blood/reagent strip methods:

   - Dextrostix/Dextrometer Method
   - Dextrostix/Glucometer Method

2. PURPOSE: To provide the Registered Nurse and Licensed Vocational Nurse with an opportunity to develop knowledge and skills necessary to perform capillary blood glucose monitoring, utilizing the Dextrostix/Reflectance Meter Method.

3. PROGRAM DESCRIPTION:

   a. One day in length.

   b. Classroom experience--directed independent review of Nursing Service Policy and Procedures for Blood Glucose Monitoring will assist in the development of cognitive skill. A slide presentation, in addition to a demonstration, will assist in the development of psychomotor skills.

   c. According to the Performance Standards, demonstrate with 100% accuracy, the procedure for Dextrostix/Reflectance Meter Blood Glucose Monitoring.

4. PROGRAM OBJECTIVES:

   Upon completion of the program, the nurse should be able to:

   a. State the purpose of Capillary Blood Glucose Monitoring.

   b. State the rationale for the essential steps of the selected method of monitoring.

   c. According to performance standards, demonstrate with 100% accuracy, the procedure for Capillary Blood Glucose Monitoring.

5. METHOD OF TEACHING:

   a. Independent study.

   b. One to one demonstration/return demonstration.

   c. Group instructions/demonstration/return demonstration.

6. EDUCATIONAL PERIOD:

   a. Successful completion of the certification program is based upon the following criteria:

      (1) Each individual will review the following:

          -Nursing Service Policy #83-13 Blood Glucose Monitoring.

          -Blood glucose monitoring procedure for the selected method(s) of testing.

          -Procedure for calibration of the reflectance meter.

      (2) With the guidance of the Diabetes Nurse Educator and/or instructor in the clinical area, observe and demonstrate the selected method(s) of Capillary Blood Glucose Monitoring. Each individual will:

          -Demonstrate, with 100% accuracy, the selected method(s) of Capillary Blood Glucose Monitoring times three.
          -Verbalize the rationale for essential step of selected procedure.

NOTE:

1. An individual failing to attain 100% accuracy in the return demonstration will be requested to repeat steps (1) and (2) as stated above.

2. Successful completion of the above requirement qualifies the individual to perform Capillary Blood Glucose Monitoring.

GLUCOSE MONITORING USING DESTROSTIX

I. PURPOSE: To test for the amount of glucose in the blood.

II. EQUIPMENT:

1. Lancet.
2. Alcohol prep.
3. Paper towels.
4. Dextrostix reagent strips.
5. Glucometer.
6. Ames wash bottle.

III. PROCEDURE:

Essential Steps	Key Points
1. Vigorously wipe the finger to be punctured with an alcohol prep. Allow area to dry.	This cleanses the area and increases circulation.
2. Using a sterile lancet, make a puncture on the side of the side of the fingertip, midway between the edge of the midpoint of the fingertip. Press the time button.	The nerves, which allow pain to be felt, are more concentrated in inner part of the finger.
3. At the sound of the first buzzer, apply a large drop of blood sufficient to cover entire reagent area on printed side of strip.	Keep Dextrostix in a horizontal position to keep blood from running off the reagent strip.
4. Wait exactly 60 seconds. (Sound of second buzzer).	Exposure of blood less (greater) than 1 minute will yield a lower (higher) reading.
5. At the end of 60 seconds, quickly wash off the blood from the reagent area with a sharp stream of water from the Ames wash bottle.	

Essential Steps	Key Points
6. Quickly blot the reagent area of the strip on a lint free paper towel.	
7. Quickly open the test Chamber Lid and insert the reacted strip into the strip channel (reagent area down) and gently close the lid.	
8. Press the READ button. The blood glucose value will appear on the digital display.	The reflectance meter will record values between 0-399 mg dl. If greater than 399 mg dl, the symbol, ---, will appear.

GLUCOMETER CALIBRATION

Perform Steps a-e with "LOW" Calibrator solution; repeat with "HIGH" calibration solution.

a. Turn instrument on. Be sure the words "LOW CAL" are in the display. If not press "CAL" button. Now press "TIME" button.

b. At sound of first buzzer, quickly apply one large drop of Low Calibrator solution to a Dextrostix. Cover entire pad.

c. At sound of second buzzer (60 seconds) wash Dextrostix.

d. Quickly and gently blot reagent area of Dextrostix.

e. Insert Dextrostix into Glucometer (reagent area side down), close lid, press read button.

CONTROL PROCEDURE

a. Press Time button.

b. At sound of first buzzer, quickly apply one large drop of Dextro-Chek Control solution to a Dextrostix. Cover entire pad.

c. At sound of second buzzer (60 seconds) wash Dextrostix.

d. Quickly and gently blot reagent area of Dextrostix.

e. Insert Dextrostix (reagent area side down) into Glucometer, close lid, press READ button. Check control insert for range.

GLUCOSE MONITORING USING VISIDEX II REAGENT STRIPS

I. PURPOSE: To test for the amount of glucose in the blood.

II. GENERAL INFORMATION:

Visidex is restricted to Endocrinology Staff and Critical Care areas.

III. EQUIPMENT:

1. Lancet.
2. Alcohol prep.
3. Watch with second hand.
4. Dry cotton ball or absorbent tissue.
5. Visidex II reagent strips.

III. PROCEDURE:

Essential Steps	Key Points
1. Wash your hands.	
2. Vigorously wipe the finger to be punctured with an alcohol prep. Allow area to dry.	This cleanses the area and increases circulation.
3. Using a sterile lancet, make a puncture on the side area of the fingertip. Avoid the inner part of the finger.	The nerves, which allow pain to be felt, are more concentrated in inner part of the finger.
4. Obtain and apply a large drop of blood sufficient to cover both reagent pads.	Keep reagent strip in a horizontal position to keep blood evenly distributed on pads.
5. Wait <u>exactly</u> 30 seconds.	Exposure of blood less/ greater than 1 minute will yield a lower/higher reading.

Essential Steps	Key Points
6. At the end of 30 seconds, quickly blot or gently wipe off the blood from the reagent area with a lint free paper towel.	
7. After blood has been removed, wait an additional 90 seconds (total time 2 minutes).	Exposure of blood less than 2 minutes will yield a lower reading. The reagent stabilizes after 2 minutes.
8. After the total 2 minutes have elapsed, immediately compare the reacted green pad to the nearest green block.	The green pad will yield reading from 20-110 mg/d. If the color of the lower range pad is 110 or less, ignore any slight orange color which may appear on the higher range pad.
9. Compare the higher range (orange) pad to the matching orange color block.	This will only be necessary if the green pad is darker than 110 mg/d. The higher range pad (orange) yields results from 140-800 mg/d.
10. Document glucose results on Diabetic Record VA Form 10-2561.	When color falls between blocks estimate the results.

PERFORMANCE REQUIREMENTS FOR CAPILLARY BLOOD GLUCOSE MONITORING

1. Verify physician's order and identify patient.
2. Wash hands and assemble equipment:
   a. Dextrostix, Reagent Strips, Ames Wash bottle, paper towel, *Reflectance Meter (Dextrometer or Glucometer) or Visidex II Reagent Strips.
   b. Alcohol swabs.
   c. Lancet.
   d. Tissue.
3. Select site for puncture.
4. Cleanse site with alcohol swab--allow to dry.
5. Puncture site with Lancet.
6. Squeeze a large drop of blood onto reagent strip.
7. Glucometer/Reflectance Meter:
   a. After exactly 60 seconds, wash blood off with water from Ames wash bottle.
   b. Blot with paper towel.
   c. Insert test strip (reagent area down) into the machine.

   Visidex II:
   a. After exactly 30 seconds, wipe blood off strip with tissue.
   b. Wait an additional 90 seconds and compare strips with color chart.
8. Read results and record on Diabetes Record Sheet.

*Reflectance meter must be calibrated according to manufacturer's instructions.