

In the Laboratory: (Lab Documentation)
An Analytical Laboratory Experiment in Error Analysis: Repeated Determination of Glucose Using Commercial Glucometers

Lab Summary: Attached.

Written Directions: Attached is the descriptive handout given to students prior to the laboratory. We have a short report form (attached) that is turned in after the completion of the first week of lab, however, students are also required to hand in a formal lab report with all of their calculations and an explanation of their individual projects.

Instructor's Notes:

Rationale. At the present time there are few laboratory experiments that permit students to generate meaningful data for statistical analysis. While this experiment is designed for the analysis course, it is applicable to other courses where quantitative assessment of data is performed.

Techniques. Glucose solutions are made up by dissolving pure D-(+)-glucose in deionized water. Make sure the concentration of the glucose solution is approximately that found normally in blood. This is about 100-200 mg/dL. Students can make up their own solutions if the practice is desired. The glucose meters generate data with the units of mg of glucose/deciliter of solution. Statistical F and t tests will be used by students. The importance of calibration of instruments and the use of proper standards should be emphasized.

Concepts Taught. Students not only analyze the data that they generate, but also compare their data with the rest of the class. A compilation of all student results are given to all students for analysis. Beyond statistical analysis, identification of instrumental problems and developing experiments to test a hypothesis can be large part of lab as well.

Chemicals and Instrumentation. In order to perform this experiment glucometers must be purchased. This simple instruments can be purchased at a cost less than \$75 depending on the meter at a local drugstore. The units used in this experiment cost approximately \$50. One meter can easily shared by five to ten students since the analysis time is very short, approximately one minute. Test strips cost between 50 cents and a dollar. Each student is given 6 test strips. One can prepare glucose standard solutions at nominal cost or purchase them from a supplier such as Sigma. Typically, only a few milliliters are need for the entire laboratory.

CAS Registry Numbers: D-(+)-Glucose [50-99-7]

Amplification of Lab Summary: None

Author-Produced Software: None

Other Supplementary Information: None

HANDOUT: THE MEASUREMENT OF GLUCOSE

Introduction

More than 16 million Americans have diabetes, a condition produced by a deficiency in the secretion or action of the pancreatic hormone insulin, which in turn produces profound abnormalities in metabolism. This includes the regulation of blood glucose concentration. Diabetes is the fourth leading cause of death in the United States. The discovery of insulin 75 years ago ended what was once a death sentence to those suffering from diabetes, however, close monitoring of an individual's blood glucose level is essential in determining when insulin should be taken. The exact time when insulin should be taken is critical as life and death. As a result the measurement of glucose in blood is one of the most important and widely performed chemical measurements today.

In this experiment you will assess the reliability of test strip glucometers. Since this is a relatively simple and quick analysis you will perform the experiment many times for statistical analysis. Before coming to lab make sure to do some research to understand the principles behind the glucometer and know what are the normal glucose levels in humans.

General Procedure

Week #1

Each student will be given several glucometer test strips to perform all experiments. You will then determine the accuracy and precision of the glucometer using standard glucose solutions. We will then compare the results you obtain with other students in the lab which will be using separate meters in order to determine if there variations between individual glucometers. Use statistical tests to back up your claims. Next, you will determine the glucose level in a unknown sample. Does the glucose concentration fall within a "normal" range for a human? Enter all of your data into the computer spreadsheet provided. We will use this data in class to analyze the glucometers' performance.

Week #2

From the data obtained in week #1 several questions may arise about the accuracy, precision, dependability, and reproducibility of the glucometers. Your assignment is to address a problem by forming a hypothesis and carrying out experiments to test that hypothesis. Some questions you might consider include:

1. Do outdated test strips give the same results as new strips?
2. Does the time for development of the color matter?
3. Does the size of the sample influence the results?
4. What is the dynamic range of glucometer?
5. Are the meters as reliable throughout the entire dynamic range?
6. Do different meters give the same result on the same sample and why?
7. How are samples prepared? Does the composition of the sample affect results?

Be prepared to present your results to the rest of the class. Finally consider glucose monitoring will become a multi-million or even multi-billion dollar growth industry in the near future as a large population of baby boomers experience the onset of diabetes as they grow older. Can you think of any improvements that could be made in the measurement of blood glucose to make it easier, faster, or less painful?

**WEEK #1 DATA SHEET
THE MEASUREMENT OF GLUCOSE**

Please complete the following:

Standard Glucose Solution Identification Number: _____

Standard Glucose Solution Concentration: _____

Glucometer Model: _____

Glucometer Number: _____

Replicate	Measured Glucose Concentration (mg/dL)
1	
2	
3	
4	
5	
6	

Notes:

- * Can any points be removed by a Q-test?
- * Perform a t-test to determine if your data is the same or different from the nominal concentration of the glucose standard. Are they the same at 90%, 95%, or 99% confidence?
- * **Turn in your data to your instructor.** In class you will be given the complete data set compiled from both lab sections. We will go over this data in class and you will be asked to perform an F-test and a t-test to compare two sets of interesting data. Starting thinking about your independent project. If you will require any additional or special equipment list it below. If you require any additional reagents please list them also with safety guidelines you will use in their handling. Consult MSDS sheets for safety information.

List of Additional Equipment or Reagents: