Austin Journal of Biosensors & Bioelectronics

Open Access

Austin Publishing Group

Research Article

Understanding Blood Glucose for Healthcare Monitoring

*Corresponding author: **Mukesh Thapa**
Department of Biomedical Engineering, School of Medicine, Keimyung University, 1095 Dalgubeol-daero, Dalseo-gu, Daegu 42601, Korea

Received: November 16, 2022; **Accepted:** January 11, 2023**; Published:** January 16, 2023

Abstract

Glucose is the major glycolytic biomarker in blood. Measurement of blood glucose can assist in monitoring of various disease (like diabetes and, blood pressure) and understanding of individual health status (like obesity). Concentration of glucose in blood is easily affected by food intake and physical activities. So, measurement of only glucose can provide misinterpretation of health status. Phenomenon of protein glycation caused by glucose in blood-can be a basis for understanding glucose condition in blood within longer period. Also, alternative biomarker of glycolysis like lactate can assist the results of blood glucose concentration. Understanding the concentration of glucose together with lactate and glycated proteins can provide complete glycolysis status in bloodso recently doctors are requesting measurement these biomarkers along with glucose for high-risk disease management. This short communication dwells upon the importance of glucose in blood for health care management.

Keywords: Glucose; Glycolysis; Lactate; Healthcare; Obesity

Introduction

The main source of energy in blood is glucose. When glucose break downs inside cells, it produces ATP as source of energy. Generally, the glycolytic activity in any cells is governed by the availability of glucose. Universally, glucose is the main biomarker related to glycolytic activity. But secondary biomarker like lactate can also contribute to understand the glycolytic status in blood samples. Glucose and Lactate are previously known, significant biometabolites [1-3]. Both are important metabolic symbols which play a significant role in glycolytic and anaerobic metabolic cycles. The measurement of blood lactate, on the other hand, has also long been used as a marker of exercise intensity and training status but current research has revealed involvement on glycolytic contribution [3-5]. Glucose is the key metabolic substrate for tissue energy production so its quantification can help for monitoring of diabetic imbalance through a given period [10]. The concentration of glucose in our body is determined by metabolic activities and food intake. The glucose limit of a body also depends upon the age, size, and lifestyle of a person. Supply of glucose is either external (food intake) or reserved as in the perinatal period mother supplies glucose to the fetus. Certain limits were determined for medical purpose to sustain and understand the influence of high blood glucose towards various diseases [6]. The normal limit of glucose concentration is 3.5–5.5 mmol/L for a normal child or adult. Factors which control glucose production and glucose utilization maintains the blood glucose level. Fluctuation over key hormones insulin, glucagon, epinephrine, norepinephrine, cortisol and growth hormone which is caused by some pathological factor can increase or decrease the blood glucose level from normal range but in a normal person glucose limit is always dependent on lifestyle and health condition [7].

Lactate is secondary metabolite produces by cells to get energy from food. Most lactate in blood helps to maintain the PH of blood. Lactate is produced mainly during critical cases when primary mode of energy production is disrupted. Lactate concentration for a normal condition is 0.5 to 1 mmol/L but various conditions: lactic acidosis, pyruvate metabolism defects, suspected sepsis, hypoxia, fetal scalp, fetal hypoxia, meningitis can increase lactate level [5,8]. Determination of glucose and lactate in clinical samples like serum blood and urine can help to monitor over all glycolytic and healthcare status of an individual [5,9-12].

The glucose level in blood is very unstable, even over one single day, and fluctuates depending upon diets and physical activities [13], so measuring glucose can have confusing results. The measurement of glycated blood proteins like glycated he-

Citation: Thapa M. Understanding Blood Glucose for Healthcare Monitoring. Austin J Biosens & Bioelectron. 2023; 8(1): 1043.

moglobin (HbA1c) and glycated albumin can provide more accurate state of blood glucose because of half-life of 21 days [14]. Measurement of HbA1c is important for confirm long-term glycemic conditions in [15,16].

Gone are the days when measuring blood glucose concentration could conclude the health care status. Currently, overall glycolytic status of blood is measured with the help of blood glucose, glycated proteins and lactate concentration and conclusion are drawn regarding disease prognosis. This brief communication dwells upon overall glycolytic understanding for health case management.

Healthcare and Obesity

According to The World Health Organization (WHO) obesity is defines as: "A condition of abnormal or excessive fat accumulation in adipose tissue, to the extent that health may be impaired" [17]. Obesity, one of the relevant global pandemics is on the rise around all the countries worldwide but especially prevalent for population of high-income countries of world. Obesity is generally identified with the increase in body weight, but the index of obesity is measured in relation to one's Body Mass Index (BMI). Higher the BMI, higher the rate of obesity. Traditionally, the Body Mass Index (BMI) is calculated as weight in kilograms divided by height squared in meters. The most current guidelines for obesity presented by WHO, only on basis of body mass index, BMI ≥30 kg/m^2. If the BMI continuously rises for long period of time, A healthy individual would ultimately become obese [18].

Obesity causes various complication in body, including various diseases. Although obesity causes various complications various obesity factors also affect the disease conditions. Normal individual first changes into pre-obese followed by obese and extremely obese cases [19]. If an individual remains obese for long period of time, then the complication is associate with long term obesity in addition to causing various diseases, obesity also have a risk for patients if associated to various diseases like type 2 diabetes, coronary heart diseases and cancer which ultimately decreases the life expectancy. For these reasons, obesity is considered as one of the major health issues and pose great danger to an individual health care system. Although various biomarkers are related to these diseases, changes in obesity also develop changes in certain biomarkers in body that ultimately can be related to these diseases [20].

Biomarkers for Monitoring Healthcare and Diseases

The understanding of the various biomarkers of disease via given sample to understand its structure, functions, and their contribution towards disease metastasis process, had been a long-term diagnosis process. Significant increase or decreases of bio compounds formed during various stage of metabolism can provide information about pathogenicity and liability of various critical diseases. Controlled regulation of metabolites in food that regulates disease helps to either keep us healthy or manage risk of disease. Critical diseases always show sigh and symptoms but evidence of these biometabolites can confirm stage of disease. Along with diabetes various diseases like blood pressure, cardiovascular illness is codependent upon our lifestyle and food habit. There are various stages of this type of diseases and changes in our lifestyle and food habit can influence the aggravation of them into something serious. Circulating hormones, adipokines, transcriptomes are some complex biomarkers of obesity [21] but simple monosaccharides and proteinslike glucose, lactate, glycated hemoglobin, glycated albumin, can help to monitor the basic initiation and development of disease by confirming the glycolytic status of sample [22].

Glucose as Glycolytic Biomarker

The main source of energy in blood is glucose. When glucose breakdowns inside cells, it produces ATP as source of energy. Generally, the glycolytic activity in any cells is governed by the availability of glucose. Universally, glucose is the main biomarker related to glycolytic activity. But secondary biomarker like lactate can also contribute to understand the glycolytic status in blood samples. Glucose and Lactate are previously known, significant biometabolites [1-3]. Both are important metabolic symbols which play a significant role in glycolytic and anaerobic metabolic cycles. The measurement of blood lactate, on the other hand, has also long been used as a marker of exercise intensity and training status but current research has revealed involvement on glycolytic contribution [3-5]. Glucose is the key metabolic substrate for tissue energy production so its quantification can help for monitoring of diabetic imbalance through a given period [10]. The concentration of glucose in our body is determined by metabolic activities and food intake. The glucose limit of a body also depends upon the age, size, and lifestyle of a person. Supply of glucose is either external (food intake) or reserved as in the perinatal period mother supplies glucose to the fetus. Certain limits were determined for medical purpose to sustain and understand the influence of high blood glucose towards various diseases [6]. The normal limit of glucose concentration is 3.5–5.5 mmol/L for a normal child or adult. Factors which control glucose production and glucose utilization maintains the blood glucose level. Fluctuation over key hormones insulin, glucagon, epinephrine, norepinephrine, cortisol and growth hormone which is caused by some pathological factor can increase or decrease the blood glucose level from normal range but in a normal person glucose limit is always dependent on lifestyle and health condition [7].

Lactate is secondary metabolite produces by cells to get energy from food. Most lactate in blood helps to maintain the PH of blood. Lactate is produced mainly during critical cases when primary mode of energy production is disrupted. Lactate concentration for a normal condition is 0.5 to 1 mmol/L but various conditions: lactic acidosis, pyruvate metabolism defects, suspected sepsis, hypoxia, fetal scalp, fetal hypoxia, meningitis can increase lactate level [5,8]. Determination of glucose and lactate in clinical samples like serum blood and urine can help to monitor over all glycolytic and healthcare status of an individual [5,9-12]. Thapa. M *et al*., 2021 emphasize importance of lactate along with glucose for obesity related disease management. Mainly during prolonged disease conditions results for lactate are needed to support results from glucose monitoring [23].

The glucose level in blood is very unstable, even over one single day, and fluctuates depending upon diets and physical activities [13], so measuring glucose can have confusing results. The measurement of glycated blood proteins like glycated hemoglobin HbA1c can provide more accurate state of blood glucose because of half-life of 21 days [14]. Measurement of HbA1c is important for confirm long-term glycemic conditions in [15,16]. Thapa. M also emphasized importance of glycated protein like HbA1c for understanding glycolytic status of blood. This work suggested that measurement of glucose might draw false conclusion in some cases, so HbA1c is also measured to conclude the results obtained from glucose measurement [24].

Concluding Remarks

Measuring only glucose concentration in blood for health care management is not enough for understanding glycolytic status. So, modern healthcare management suggests that glucose, glycated proteins, and lactate measurement would be required to conclude and understand the glycolytic status. Devices that can measure these biomarkers together using single strip and single sample drop would give overall glycolytic results in blood for monitoring health conditions.

References

1. Schneider SM, Sridhar V, Bettis AK, Heath-Barnett H, Balog-Alvarez CJ, et al. Glucose Metabolism as a Pre-clinical Biomarker for the Golden Retriever Model of Duchenne Muscular Dystrophy. Mol Imaging Biol. 2018; 20: 780-8.
2. van Holten TC, Waanders LF, de Groot PG, Vissers J, Hoefer IE, et al. Circulating Biomarkers for Predicting Cardiovascular Disease Risk; a Systematic Review and Comprehensive Overview of Meta-Analyses. PLOS ONE. 2013; 8: e62080.
3. Brooks GA. The Science and Translation of Lactate Shuttle Theory. Cell Metab. 2018; 27: 757-85.
4. Gass GC, Rogers S, Mitchell R. Blood lactate concentration following maximum exercise in trained subjects. Br J Sports Med. 1981; 15: 172-6.
5. Rathee K, Dhull V, Dhull R, Singh S. Biosensors based on electrochemical lactate detection: A comprehensive review. Biochem Biophys Rep. 2016; 5: 35-54.
6. Aziz S, Hsiang YH. Comparative study of home blood glucose monitoring devices: Visidex, Chemstrip bG, Glucometer, and Accu-Chek bG. Diabetes Care. 1983; 6: 529-32.
7. Guemes M, Rahman SA, Hussain K. What is a normal blood glucose? Arch Dis Child. 2016; 101: 569-74.
8. Moioli A, Maresca B, Manzione A, Napoletano AM, Coclite D, et al. Metformin associated lactic acidosis (MALA): clinical profiling and management. J Nephrol. 2016; 29: 783-9.
9. Hui S, Ghergurovich JM, Morscher RJ, Jang C, Teng X, et al. Glucose feeds the TCA cycle via circulating lactate. Nature. 2017; 551: 115-8.
10. Zanini VP, López de Mishima B, Solís V. An amperometric biosensor based on lactate oxidase immobilized in laponite–chitosan hydrogel on a glassy carbon electrode. Application to the analysis of l-lactate in food samples. Sensors and Actuators B: Chemical. 2011; 155: 75-80.
11. Al-Mhanna NM, Huebner H, Buchholz R. Analysis of the Sugar Content in Food Products by Using Gas Chromatography Mass Spectrometry and Enzymatic Methods. Foods. 2018; 7: 185.
12. Gooding JJ, Yang W, Situmorang M. Bioanalytical Experiments for the Undergraduate Laboratory: Monitoring Glucose in Sports Drinks. Journal of Chemical Education. 2001; 78: 788.
13. Teixeira AM, Tsukamoto R, Lopes CT, Silva R. Risk factors for unstable blood glucose level: integrative review of the risk factors related to the nursing diagnosis. Rev Lat Am Enfermagem. 2017; 25: e2893.
14. Soboleva A, Mavropulo-Stolyarenko G, Karonova T, Thieme D, Hoehenwarter W, Ihling C, et al. Multiple Glycation Sites in Blood Plasma Proteins as an Integrated Biomarker of Type 2 Diabetes Mellitus. Int J Mol Sci. 2019; 20: 2329.
15. John WG. Haemoglobin A1c reference method. Scand J Clin Lab Invest. 2006; 66: 1-4.
16. Zendjabil M. Glycated albumin. Clin Chim Acta. 2020; 502: 240-4.
17. Choo V. WHO reassesses appropriate body-mass index for Asian populations. The Lancet. 2002; 360: 235.
18. Ryan AM, Duong M, Healy L, Ryan SA, Parekh N, Reynolds JV, et al. Obesity, metabolic syndrome and esophageal adenocarcinoma: Epidemiology, etiology and new targets. Cancer Epidemiology. 2011; 35: 309-19.
19. Haslam DW, James WPT. Obesity. The Lancet. 2005; 366: 1197-209.
20. Kalupahana NS, Moustaid-Moussa N, Claycombe KJ. Immunity as a link between obesity and insulin resistance. Molecular Aspects of Medicine. 2012; 33: 26-34.
21. Aleksandrova K, Egea Rodrigues C, Floegel A, Ahrens W. Omics Biomarkers in Obesity: Novel Etiological Insights and Targets for Precision Prevention. Current Obesity Reports. 2020; 9: 219-30.
22. Nimptsch K, Konigorski S, Pischon T. Diagnosis of obesity and use of obesity biomarkers in science and clinical medicine. Metabolism. 2019; 92: 61-70.
23. Thapa M, Sung R, Heo YS. A Dual Electrode Biosensor for Glucose and Lactate Measurement in Normal and Prolonged Obese Mice Using Single Drop of Whole Blood. Biosensors (Basel). 2021; 11: 507.
24. Thapa M, Heo YS. Label-free electrochemical detection of glucose and glycated hemoglobin (HbA1c). Biosensors and Bioelectronics. 2023; 221: 114907.