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(54) **Title**: METHOD AND APPARATUS FOR CHRONIC DISEASE CONTROL

(57) **Abstract**: The invention provides an apparatus and method for measuring the blood glucose level and physical activity of an individual, and providing an individualized prediction of the blood glucose level of the individual over time based upon the measurements. The individualized prediction is updated in a recursive manner as additional measurements are received. Incentives are determined and provided for maintaining a blood glucose level within a threshold of the individualized predicted blood glucose value and for achieving benchmark levels of physical activity and exertion.

METHOD AND APPARATUS FOR CHRONIC DISEASE CONTROL

CROSS-REFERENCE TO RELATED APPLICATIONS

This application claims priority under 35 U.S.C. §119(e) to U.S. Provisional Patent Application. No. 61/091,313, filed on August 22, 2008, which is incorporated herein by reference in its entirety.

FIELD OF THE INVENTION

The present invention generally relates to management of chronic diseases, and in particular to a method and apparatus for predicting the blood glucose level of a diabetic patient based upon periodic measurements of blood glucose levels after meals, quantifying physical exertions, physical activity, incentivizing the proper maintenance of blood glucose levels and physical activity within the predicted levels, and providing patient-specific disease management advice to the patient.

BACKGROUND OF THE INVENTION

Obesity is pandemic. Over 1 billion people worldwide are obese with this number rising rapidly. This trend is clearly established in youth, with the number of overweight children tripling within the last 30 years. It is now estimated that 1 in 3 U.S. children are overweight or obese. Unfortunately, at least two-thirds of obese children 10 years and older will become obese adults.

Following a similar trend is the rise of Type 2 diabetes in children under 18 years old. Once thought to be primarily a disease of adults, studies now show that as many as 45% of

children newly diagnosed with diabetes actually have Type 2 diabetes. Type 2 diabetes is now one of the most rapidly growing forms of diabetes in the United States and perhaps worldwide. Type 2 diabetes occurs when the body does not produce enough insulin or loses its ability to efficiently use insulin. High or low blood glucose can harm blood vessels, cause heart attacks or strokes, and causes other health problems. There is no doubt that the driving force behind this obesity/diabetes trend is sedentary lifestyle, more unhealthy foods and larger portion sizes.

The bad news continues when the co-morbidities associated with obesity and Type 2 diabetes are considered. These include hypertension, dyslipidemia, sleep apnea, gall bladder disease, and polycystic ovarian syndrome. These all contribute to the earlier development of cardiovascular disease. A higher disease burden on our youth means they will be living longer with these diseases, adding significantly to the overburdened healthcare system and health care expenditures.

The rapid emergence of the Type 2 diabetes epidemic in children has resulted in a paucity of studies teaching how to best manage this type of diabetes in our youth. Central to any treatment plan of Type 2 diabetes is rigorous exercise and calorie restriction. One recent large study has demonstrated the superiority and cost-effectiveness of lifestyle changes in preventing Type 2 diabetes: lifestyle changes alone decreased the incidence of Type 2 diabetes by 20% in high-risk individuals and delayed the onset of diabetes by 11 years. Those treated with medication and no lifestyle alteration showed a drop in diabetes incidence by only 9% and onset of diabetes was delayed by only 3 years. Cost estimates of lifestyle changes were about $1,100 per year, whereas medication was estimated at $31,300 per year. In spite of compelling evidence promoting healthy lifestyle changes, long term adherence to modifications is poor, especially among teenagers.

In addition to a diet and exercise plan, home glucose monitoring is essential for the day-to-day care and safety of children with diabetes. Consequences of poorly monitored and supervised therapies are several. Hypoglycemia is the most feared given its immediate potential for harm, including altered consciousness or loss of consciousness, and seizures. Hyperglycemia poses long-term risk of kidney, eye, nerve, and cardiovascular disease. Consequences can also be immediate including severe dehydration and coma.

Current approaches to self-management of diabetes stress rules and procedures instead of mental models and strategies. Expertise is acquired in many cognitive activities by establishing goals, engaging in practice, and modifying strategies based on feedback. Thus, the ability to manage one's diabetes requires an understanding of the key factors that affect glucose levels and how those factors interact with one another over time. This is a challenging task for many adults, let alone teenagers.

Children with diabetes must be monitored regularly by their endocrinologist, preferably 3-4 times per year. Productive visits depend on the patient providing their home blood sugar readings, usually obtained by downloading their glucose meters via computer link. This is time consuming, often wasting half of the person's visit attempting to get the data. Complicating factors include incorrect time/date settings in the glucose meter, which are very common, low meter battery, technical problems with the glucose meter/computer link, late arrivals, and often forgotten meters.

In order to improve the outcomes for children with diabetes, frequent glucose monitoring is needed. In addition, better adherence to a healthier lifestyle, and close supervision by parents and healthcare providers is required. Past practices for long-term monitoring of glucose control in patients relied on calendar information, which requires manually recording the blood glucose

level of the individual through each day (and over many days) after meals and exercise. Usually when exercising, the body uses more of the glucose in the blood, which results in a blood glucose concentration decrease and a risk that hypoglycemia may be encountered. Therefore, it is important for diabetics to plan their physical activity carefully to avoid serious complications. Also, it may not be recommended to exercise when the blood glucose is too low, which can serve as an indicator that there is too much insulin in the body. The effect of exercise varies from one person to another, and depends on several factors, such as: duration of exercise, intensity of exercise, glucose level at the beginning of the exercise, level of hydration or dehydration and some other factors.

Counterproductive to this is the older child/teenager with diabetes eagerly seeking independence which is often associated with risk-taking behavior, including missed medication, lack or absence of glucose monitoring, diet indiscretion and the resultant increase in the occurrence of hypoglycemic or hyperglycemic episodes requiring rescue therapy. Even in the very compliant child willing to increase exercise and eat healthier, hypoglycemia is often unavoidable at times, making an adult presence necessary for the child's safety.

SUMMARY OF THE INVENTION

It is one feature and advantage of the present invention to enable teenagers to control their blood glucose level and keep it in the range advised by a doctor. The present invention helps teenagers make healthy food choices, eat the right amounts of food, be active, stay at a healthy weight, and take glucose readings as planned with their doctors.

Preferred embodiments of the present invention provide an apparatus and method for receiving periodic measurements of the blood glucose level of an individual, as well as periodic

measurements of the type, duration and intensity of the physical activity of the individual. Using this information, the apparatus and method of the present invention forms a predicted blood glucose level of the individual, which may be recursively refined as additional measurements are received. Upon further receiving measurements of the blood glucose level of the individual, the apparatus and method of the present invention determines whether the received measurement conforms to the predicted blood glucose value and provides feedback to the individual. According to preferred embodiments of the present invention, feedback may include an indication that the measured blood glucose level is too high or too low as well as provide encouragement for maintaining a blood glucose level within an predicted healthy range.

Further, the apparatus and method of the present invention may provide, based upon the determination whether the received measurement conforms to the predicted blood glucose value, indications how to conform the individual's blood glucose level to the prediction, such as eating more at the next meal, eating less at the next meal, indicating to the individual to take insulin or indicating to the user to modify exercise.

Preferred embodiments of the apparatus and method of the present invention determine and provide rewards for maintenance a blood glucose level within a predetermined threshold of a predicted blood glucose level and for achieving certain levels of physical activity. Rewards may be determined based upon the amount of time the individual has conformed their blood glucose level to the predicted blood glucose values. Rewards may also be provided for performing physical activity and for compliance with providing timely measurements of blood glucose.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Reference now will be made in detail to the presently preferred embodiments of the invention. Such embodiments are provided by way of explanation of the invention, which is not intended to be limited thereto. In fact, those of ordinary skill in the art may appreciate upon reading the present specification and viewing the present drawings that various modifications and variations can be made.

For example, features illustrated or described as part of one embodiment can be used on other embodiments to yield a still further embodiment. Additionally, certain features may be interchanged with similar devices or features not mentioned yet which perform the same or similar functions. It is therefore intended that such modifications and variations are included within the totality of the present invention.

Numerous embodiments are described in this patent application, and are presented for illustrative purposes only. The described embodiments are not intended to be limiting in any sense. The invention is widely applicable to numerous embodiments, as is readily apparent from the disclosure herein. Those skilled in the art will recognize that the present invention may be practiced with various modifications and alterations. Although particular features of the present invention may be described with reference to one or more particular embodiments or figures, it should be understood that such features are not limited to usage in the one or more particular embodiments or figures with reference to which they are described.

The terms "an embodiment", "embodiment", "embodiments", "the embodiment", "the embodiments", "an embodiment", "some embodiments", and "one embodiment" mean "one or more (but not all) embodiments of the present invention(s)" unless expressly specified otherwise.

The terms "including," "having," "comprising." and variations thereof mean "including but not limited to," unless expressly specified otherwise.

The term "consisting of" and variations thereof mean "including and limited to," unless expressly specified otherwise.

The enumerated listing of items does not imply that any or all of the items are mutually exclusive. The enumerated listing of items does not imply that any or all of the items are collectively exhaustive of anything, unless expressly specified otherwise. The enumerated listing of items does not imply that the items are ordered in any manner according to the order in which they are enumerated.

The terms "a," "an" and "the" mean "one or more," unless expressly specified otherwise. Headings of sections provided in this patent application and the title of this patent application are for convenience only, and are not to be taken as limiting the disclosure in any way.

The present invention allows for the control and management of the blood glucose concentration of an individual and the prevention of many diabetic complications. This is achieved by calculating a model or predicted value of the blood glucose level of an individual through the day (or longer); the model based on one or both of periodic measurements of the blood glucose level of the individual at prescribed times during the day and the measurements of the physical activity level of the individual. Using this model, the individual can determine whether his or her current blood glucose level is within an acceptable range or tolerance, and

using this information, determine whether to eat or drink , what to eat or drink, whether to exercise, how to exercise, and how long to exercise.

According to various embodiments of the present invention, the model may be updated in a recursive manner; using the period measurements of blood glucose level and physical activity to refine the model or predicted blood glucose level over time. As the blood glucose level of each individual responds differently to food and exercise, continuous refinement of the model or predicted blood glucose level allows the present invention to be tailored to each individual. By updating the glucose level prediction parameters each time with the different readings of the patient, the present invention is able to track and predict the glucose level at different times of the day and suggest certain recommendations if the level is not in the safe range or there is not any improvement noticed. In addition to the recommendations, the application would be able to generate alarms or reminders when the glucose concentration exceeds the normal range threshold or when readings were not provided or missed. It is significant that the application helps the patient prevent reaching certain unsafe glucose levels, such as, hypoglycemia and hyperglycemia.

Hypoglycemia occurs when levels of glucose in the blood are too low. It happens when the diabetic takes too much insulin, does not eat enough food, exercises vigorously without eating a snack, or waits too long between meals. Hyperglycemia develops when there is too much sugar in the blood; it can be caused by eating too much food or the wrong food, increased stress, or decreased activity and exercise.

An apparatus according to one embodiment the present invention will now be described in detail. While separate components are described, one of ordinary skill will understand that the apparatus of the present invention may be a unified device containing all of the components in

one housing or may be provided as separate components coupled in a wired or wireless manner, for example, USB, infrared, Bluetooth, etc.

A glucometer is provided for measuring the blood glucose level of an individual. Blood glucose may be measured according to the understanding of one of ordinary skill, including but not limited to piercing the skin to directly sample the blood, continuous blood glucose monitoring using an implantable sensor, near IR detection, ultrasound and dielectric spectroscopy. The glucometer may be integrated into a single device with other components of the present invention or it may be a separate device coupled to other components in a wired or wireless manner.

According to one embodiment of the present invention, an accelerometer is provided for measuring the physical activity of the individual. According to one embodiment of the present invention the accelerometer is a three-axis accelerometer capable of measuring both acceleration and gravity by sensing the amount of inertial force in a given direction. The accelerometer may be integrated with other components of the present invention or it may be a separate device coupled to other components of the present invention in a wired or wireless manner.

According to an additional embodiment of the present invention the apparatus is provided with a clock. According to other embodiments, the current time is provided to the apparatus of the present invention through an external source, for example, a cellular network, a Bluetooth connection, etc. The clock may be periodically updated by connection to computer or docking station or over a wireless network, such as a Wi-Fi network, cellular network, etc.

According to one embodiment, the apparatus of the present invention is provided with a screen for displaying information visually to a user. The screen may be color or black and white and may a liquid crystal display, light emitting diode display, CRT display, etc. In further

embodiments, the apparatus is provided with speakers and/or an audio output jack to allow a user to connect headphones.

According to one embodiment of the present invention one or more processors are provided. Each processor is provided with associated memory for storing received data and calculations performed by the processor. The processor may be an application specific processor or a general purpose processor running software enabling the processor to perform the functions of the present inventive method. The processor is configured to receive periodic measurements of the blood glucose level from the glucometer and periodic measurements of the physical activity level of the individual from the accelerometer. Calculations or determinations made by the processor may be performed by one or more processors in an individual or shared manner.

Measurements from one or both of the glucometer and the accelerometer may be received by the processor in a wired or wireless manner. For example, the glucometer, the accelerometer and the processor may be directly connected and communicate in a wired manner or over a network. The glucometer and accelerometer may also be operated as separate components and provide measurements when the components are physically connected or are joined on a network. According to certain embodiments, measurements from the glucometer and/or the accelerometer are provided to the processor at the time the measurement is taken, while in other embodiments, measurements are stored and provided at a later time.

According to another embodiment of the present invention, the processor of the present invention is provided with stored measurements taken with an accelerometer during known exercises, such as cycling, running, walking, elliptical trainer, etc. Collected data movements for different types of exercises are used to characterize movements of different exercises. The processor is configured to calculate the type, duration and intensity of the physical activity of the

individual using measurements received from the accelerometer by comparison to these stored measurements. For example, being able to characterize the change of the Cartesian coordinates of a movement will allow the apparatus of the present invention to determine the type of exercise the individual is performing as well as the intensity. In certain embodiments, the duration of the physical activity is provided to the processor with the measurements from the accelerometer. In other embodiments, the duration of the physical activity may be determined by the processor using the provided clock or an external time source.

The processor is configured to form a prediction of the blood glucose level of the individual. The prediction can be based on one or more of baseline blood glucose values of the individual, periodic measurements of the blood glucose level of the individual received by the processor, periodic measurements of the physical activity of the individual as well as previous predictions of the individual's blood glucose level. For example, measurements of the blood glucose level can be received by the processor after the individual has eaten. The time of the meal can be determined by the processor using the time provided by an internal clock or an external source.

Additionally, the processor may be provided with periodic measurements of the physical activity level of the individual. Again, the time of the physical activity can be determined by the processor using the time provided by an internal clock or an external source. Since the amount of calories burned depends on the type and intensity of exercise, the processor determines the type, duration and intensity of the physical activity of the individual using the periodic measurements received from the accelerometer. By knowing the information concerning a certain physical activity (time duration, intensity of exercise, and calories or carbohydrates burned), the prediction of the exercise effect on glucose level will be more accurate. The change

in blood glucose after exercise is going to be unique for each patient. For example, using a high order polynomial least squares fitting technique which included the exercise effect for an individual that works out three times a week at 10 a.m; the result of the work out is assumed to have 15% drop in the glucose level for the rest of the day of the workout. As will be understood by one of ordinary skill, this is a parameter that would be updated for each individual over time. A more accurate exercise effect will be generated after a few days or weeks, depending upon the regularity of the individual in exercising.

For example, the prediction may be refined over time by using previous predictions as an input for future predictions. Previous predictions of blood glucose level may be stored in memory associated with the processor. Additional embodiments envision storing predictions of blood glucose level of the individual external to the apparatus of the present invention, for example, using removable memory, a home computer or a server.

The processor is further configured to compare the predicted blood glucose level with one or more of the received blood glucose levels. The comparison can include one or more of a subtraction of the received blood glucose level from the predicted blood glucose level to determine a difference value, division or multiplication to determine a percentage difference, etc.

The difference (or percentage difference) value may be used by the processor for various determinations. For example, if the processor determines, based upon the difference value, that received blood glucose measurement is lower or higher than a predetermined threshold, the processor may generate an alarm or reminder either visually or aurally to the user to respond accordingly. For example, if the processor determines that the received blood glucose level is below a certain threshold or lower than the predicted blood glucose level for that time of day, the user may be reminded to eat or drink to raise their blood glucose level to safe levels. The

reminder may be provided in an audio fashion through a recording, visually or both. The user may also be reminded to eat more at their next meal. As a contrary example, should the processor determine that the user's blood glucose level is higher than a certain threshold or higher than the predicted blood glucose level for that time of day, the user may be instructed to eat less at their next meal, or warned not too eat as much of the type of food consumed at their previous meal. Different recommendations or suggestions may given to the patient by the apparatus according to the actual glucose level and the difference between predicted glucose level and the actual glucose level; for instance, if the glucose level goes below 60mg/dL, the apparatus will remind the patient about the "rule of 15," which is making sure to have 15 grams of sugar. Also, comments or compliments will be provided depending on the improvement and control of the glucose level. In addition, alarms and alerts will be provided if any serious dangerous stage is encountered or for any irregular glucose behavior.

According to additional embodiments of the present invention, the apparatus is provided with a global positioning system device to locate the position of the individual. In certain embodiments, the global positioning device may be used in conjunction with the accelerometer to determine the type, duration and intensity of the physical activity of the individual. In other embodiments, a transmitter is provided, such that if the processor determines that the blood glucose level is higher or lower than a predetermined threshold, the position of the user may be transmitted to the individual's physician or local emergency services for medical attention.

In other embodiments, the transmitter may be used to transmit information for storage or analysis at another location. For example, the model or predicted blood glucose level may be transmitted to the physician of the user for tracking over time. As well, the last blood glucose measurement may be transmitted to the user's physician for analysis, in response to which the

physician could send a message providing instructions to eat, rest, take insulin, etc. received by a provided antenna. Glucometer information may be transmitted to a caretaker and can be entered into a data base to track patients' trends. It will be recognized that this also allows particular data indicating danger to be acted on emergently.

The present invention incentivizes proper maintenance of blood glucose level and can be used as a tool to help train individuals what and when to eat at as well how to exercise, for how long and at a particular intensity. As stated above, according to certain embodiments, the processor is configured to determine whether the blood glucose level of the individual is within a certain threshold of a predicted value at a certain time. In certain embodiments, the processor is configured to further determine an appropriate reward to be provided to the user based upon whether the blood glucose level is within the threshold. For example, the processor may provide predetermined encouraging remarks, stored music, games, provide access to websites, dispense points or credits, etc.

Furthermore, according to various embodiments, the processor stores previous recordings and glucose level readings of the patient. Based on the improvement of the glucose level, exercise, and many other factors that help and improve controlling the blood glucose level, the processor will determine a reward for the patient such as points, which can be used to download music, games, videos, and encourage him/her for the desired behavior and control of the glucose concentration. The processor may determine the type or quantity of reward based upon the amount of time the user has maintained their blood glucose level within a threshold of the predicted value. For example, the processor, upon determining the user has maintained his or her blood glucose level within the specified threshold for 1-week will provide a first reward, and upon determining the user has maintained his or her blood glucose level within the specified

threshold for 1-month will award a second reward. The second reward may be different than the first reward and may be a reward of greater value for achieving a longer result.

As will be understood, the threshold may be reduced over time to increase the difficulty of maintaining a blood glucose level over time and further train the individual to keep his or her blood glucose level within a smaller range. As well, as described above, the predicted blood glucose level itself may change over time as additional measurements are provided to the processor, which will also change the range or threshold the blood glucose of the individual must stay within.

Is it envisioned that the apparatus of the present invention is a portable device that may be carried in a pocket or on a clip attached to the individual. Each of the glucometer, accelerometer and the processor may be contained in a single housing or may be utilized separately. For example, certain embodiments include a detachable accelerometer carried by the individual during exercise or throughout the day that provides measurements of the physical activity of the individual when coupled to the processor at a later time.

Various methods can be used for predicting the blood glucose level, such as, Bayesian estimation technique, and neural networks. Glucose level variation during the day can be represented by a theoretical functions, for example, Weibull, Lognormal, Gamma, etc.

Weibull function:

$$f(x;\lambda,k) = \begin{cases} \frac{k}{\lambda}\left(\frac{x}{\lambda}\right)^{k-1} e^{-(x/\lambda)^k} & x \geq 0 \\ 0 & x < 0 \end{cases}$$

Lognormal function:

$$f_X(x;\mu,\sigma) = \frac{1}{x\sigma\sqrt{2\pi}} e^{-\frac{(\ln x-\mu)^2}{2\sigma^2}}, \quad x > 0$$

As will be understood, both functions have the same types of parameters: shape, location, and scale. Using these distributions, the prediction of glucose level with the exercise effect and food intake can be as accurately utilized as the high order polynomial method curve fitting method. According to one embodiment, a theoretical function is applied separately to the intervals between meals such as between breakfast and lunch, between lunch and dinner, and between dinner and breakfast. Accordingly, there will be different parameter values for each interval to best approximate the individual.

Blood glucose may be predicted according to the following methods. After any meal during the day, the glucose level increases immediately for the following few minutes, between 30 min to 45 min, and decreases again afterwards. Therefore, it is not recommended to measure blood glucose levels immediately following a meal.

Some background information for each user of the application is required for an accurate monitoring of the glucose level; data such as age, gender, and weight. These may be significant factors in determining a safe and normal blood glucose range that can help establish better starting values for our monitor. The patient inputs glucose readings, about two to four times a day which will help the application predict the glucose level variation throughout the day and update the overall glucose prediction for the following days, as it will be discussed in detail later. The prediction and the update of the glucose level also takes into consideration the food intake during the day --breakfast, lunch, and dinner-- and any type of workout; these factors significantly affect the glucose concentration.

According to one embodiment of the present invention, the day is divided into several periods, with predicted meal times for breakfast, lunch, and dinner. The predicted meal times provide an accurate prediction because the blood glucose distribution of the individual will be

based on that and the time of the glucose reading. The predicted meal times are updated each time a blood glucose measurement is received; where again individualization to a particular patient/user is provided. As will be understood by one of ordinary skill, the accuracy of the predicted blood glucose level improves over time as the number of blood glucose measurements are received and the predicted meal times are more accurately predicted.

For instance, if the glucose reading was recorded after a meal, but it was lower than a predicted value for the assumed meal time, the predicted meal time will be subtracted by an appropriate amount (such as 10% of assumed time difference). According to another example, if the blood glucose measurement was before meal and provided a blood glucose measurement greater than the assumed meal time, an appropriate amount of time would be added to the assumed meal time.

As will be understood, after several glucose readings the system will adapted to the individual and will tend over time to have a better prediction. According to one embodiment, in the case where a patient forgets to record the glucose reading, the prediction is still made based on the previous data collected.

While examples of the present invention have been provided in the context of type II diabetes, one of ordinary skill in the art will understand that the present invention may be adapted for use with other chronic diseases, such as type I diabetes, weight control/obesity, and asthma.

Other embodiments, extensions, and modifications of the ideas presented above are comprehended and within the reach of one skilled in the art upon reviewing the present disclosure. Accordingly, the scope of the present invention in its various aspects should not be limited by the examples and embodiments presented above. The individual aspects of the

present invention, and the entirety of the invention should be regarded so as to allow for modifications and future developments within the scope of the present disclosure. The present invention is limited only by the claims that follow.

What is claimed is:

1. A system for monitoring the blood glucose level of an individual, comprising:

a glucometer for measuring the blood glucose level of the individual;

an accelerometer for measuring physical activity of the individual; and

at least one processor, coupled to the glucometer and the accelerometer, forming a predicted blood glucose level of the individual using periodic measurements of the blood glucose level received from the glucometer and measurements of the physical activity received from the accelerometer,

the at least one processor determining the type and duration of the physical activity of the individual using the measurements from the accelerometer,

the at least one processor comparing the predicted blood glucose value to at least one of the periodic measurements of the blood glucose level of the individual to determine a first value, and

the at least one processor transmitting the first value.

2. The system of claim 1, wherein the processor, compares the first value to a predetermined value, and determining the first value is greater than or less than the predetermined value, generates at least one of an alarm or reminder.

3. The system of claim 2, further comprising:

a global positioning system device for determining the location of the individual.

4. The system of claim 3, wherein the processor, upon determining first value is greater than or less than the predetermined value, transmits the location of the individual and the blood glucose level of the individual.

5. The system of claim 1, wherein at least one of the glucometer, accelerometer and the at least one processor are coupled wirelessly.

6. The system of claim 1, further comprising:

a transmitter for transmitting at least one of the predicted blood glucose level, the blood glucose level of the individual, and the physical activity level of the individual; and

an antenna for receiving messages for display to the individual.

7. A computer implemented method for monitoring the blood glucose level of an individual, comprising the steps of:

receiving, at a processor, periodic measurements of the blood glucose level of the individual;

receiving, at the processor, periodic measurements of the physical activity of the individual;

determining, by the processor, the type, duration, and intensity of the physical activity of the individual using the measurements from the accelerometer;

determining, by the processor, a predicted blood glucose level of the individual, using the received periodic measurements of the blood glucose level and measurements of the physical activity received,

comparing, by the processor, whether the periodic measurements of the blood glucose level of the individual conforms to the predicted blood glucose level; and

displaying data to the individual representative of the comparison.

8. The method of claim 7, wherein the data displayed to the individual includes at least one of, comments to compliment the individual, reminders, instructions for future meal intake, and instructions for future physical activity.

9. The method of claim 7, further comprising the step of:

receiving, by the processor, at least one of the age, gender, weight and medication intake of the individual,

wherein the processor determines the model using at least one of the age, gender, weight and medication intake of the individual.

10. The method of claim 7, further comprising the steps of:

calculating, by the processor, the period of time during which the blood glucose level of the individual conforms to the predicted blood glucose level; and

determining, by the processor, a reward based on the calculated period of time.

11. The method of claim 7, further comprising the steps of:

saving the predicted blood glucose level of the individual in a memory; and

determining, by the processor, a predicted blood glucose level of the blood glucose level of the individual, using the received periodic measurements of the blood glucose

level, received measurements of the physical activity and at least one predicted blood glucose level of the individual.

12. A computer implemented method for monitoring the blood glucose level of an individual, comprising the steps of:

receiving, at a processor, periodic measurements of the blood glucose level of the individual;

receiving, at the processor, periodic measurements of the physical activity of the individual;

determining, by the processor, the type, duration, and intensity of the physical activity of the individual using the measurements of physical activity;

determining, by the processor, a predicted blood glucose level of the individual using the received periodic measurements of the blood glucose level and received measurements of the physical activity,

comparing, by the processor, at least one of the received periodic measurements of the blood glucose level of the individual conforms to the predicted blood glucose level; and

determining, by the processor, a response to be provided to the individual,

the response determined on the comparison between the predicted blood glucose level and the at least one received period measurement of the blood glucose of the individual, and

the response including at least one of comments to compliment the individual, reminders, instructions for future meal intake, instructions for future physical activity, and warnings.

13. The method of claim 12, further comprising the steps of:

calculating, by the processor, the period of time during which the blood glucose level of the individual conforms to the predicted blood glucose level; and

determining, by the processor, a reward based on the calculated period of time.

14. The method of claim 12, further comprising the steps of:

saving the predicted blood glucose level of the individual in a memory; and

determining, by the processor, a predicted blood glucose level of the individual using the received periodic measurements of the blood glucose level, received measurements of the physical activity and at least one saved predicted blood glucose level of the individual.

15. The method of claim 12, further comprising the step of:

transmitting at least one of the received periodic blood glucose levels of the individual, the received periodic measurements of the physical activity level of the individual, the predicted blood glucose level of the individual, and the response to be provided to the individual.

16. The method of claim 15, wherein the transmitting step is performed asynchronously with at least one of receiving, at a processor, periodic measurements of the blood glucose level

of the individual, receiving, at the processor, periodic measurements of the physical activity of the individual, determining, by the processor, a predicted blood glucose level of the individual using the received periodic measurements of the blood glucose level and received measurements of the physical activity and determining, by the processor, a response to be provided to the individual.

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US 09/54747

A. CLASSIFICATION OF SUBJECT MATTER
IPC(8) - A61B 5/00 (2009.01)
USPC - 600/301
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC8 : A61B 5/00 (2009.01)
USPC : 600/301

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
IPC8 : A61B 5/103, A61B 5/11, A61B 5/145 (2009.01)
USPC : 600/300, 600/316, 600/319, 600/347, 600/365, 600/587, 600/595

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
PubWEST (PGPB,USPT,EPAB,JPAB), Google Scholar reward, incentiv$, prize, transmit, receiv$, bluetooth, wireless, internet, gps, position, location, alert, alarm, remind, instruct, compliment, encourag$, predict, forecast, accelerometer, pedometer, meter, monitor, measure, physical, activity, movement, exercis$,glucometer, blood glucose

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X --- Y	US 2003/0208113 A1 (MAULT et al) 06 November 2003 (06.11.2003) see especially para [0068], [0069], [0073]-[0075], [0077], [0092], [0099], [0100], [0103], [0106], [0111], [0118], [0124]-[0128], [0134]-[0137], [0142], [0143], [0198]	1-9, 11-12, 14-16 ---------- 10, 13
Y	US 2007/0288266 A1 (SYSKO et al) 13 December 2007 (13.12.2007) see especially para [0113]	10, 13
A	US 2007/0060803 A1 (LILJERYD et al) 15 March 2007 (15.03.2007) see whole document	1-16

☐ Further documents are listed in the continuation of Box C. ☐

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
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"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
28 September 2009 (28.09.2009)	15 OCT 2009
Name and mailing address of the ISA/US Mail Stop PCT, Attn: ISA/US, Commissioner for Patents P.O. Box 1450, Alexandria, Virginia 22313-1450 Facsimile No. 571-273-3201	Authorized officer: Lee W. Young PCT Helpdesk: 571-272-4300 PCT OSP: 571-272-7774