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(54) **DYNAMICALLY CALIBRATED BLOOD PRESSURE REFERENCE VALUE ELECTRONIC SPHYGMOMANOMETER**

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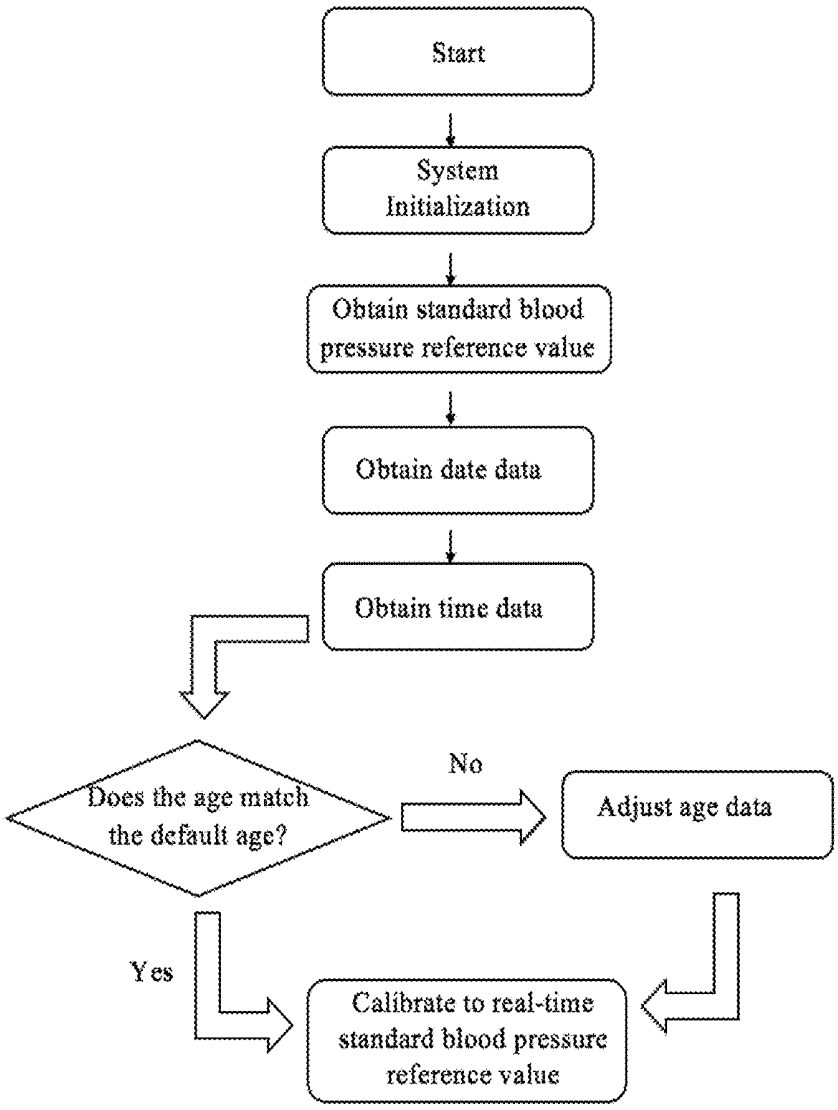
(52) **U.S. Cl.**

CPC ***A61B 5/7221*** (2013.01); ***A61B 5/022*** (2013.01); *A61B 2560/0223* (2013.01); ***A61B 5/7246*** (2013.01); ***A61B 5/746*** (2013.01)

(57) **ABSTRACT**

The invention is an electronic sphygmomanometer that dynamically calibrates for a real-time standard blood pressure reference value, which is determined based on the objective condition of human blood pressure fluctuation influenced by various factors such as age, date and time of measurement, and establishes age/blood pressure reference value, date/blood pressure reference value and time/blood pressure reference. The value database, or through mathematical operations, obtains the real-time standard blood pressure reference value under the specific conditions of the subject's age, test date, and test time, and calibrates it as a benchmark for judging the abnormality state of the real-time blood pressure measurement value. This improves the ability of the sphygmomanometer in producing an accurate judgement of the subject's blood pressure, and reduces the margin of error for false positive tests or false negative tests.



Blood pressure / Age	Systolic pressure (mmHg)	Diastolic pressure (mmHg)
16-20	115	73
21-25	115	73
26-30	115	75
31-35	117	76
36-40	120	80
41-45	124	81
46-50	128	82
51-55	134	84
56-60	137	84
61-65	148	86

Fig 1

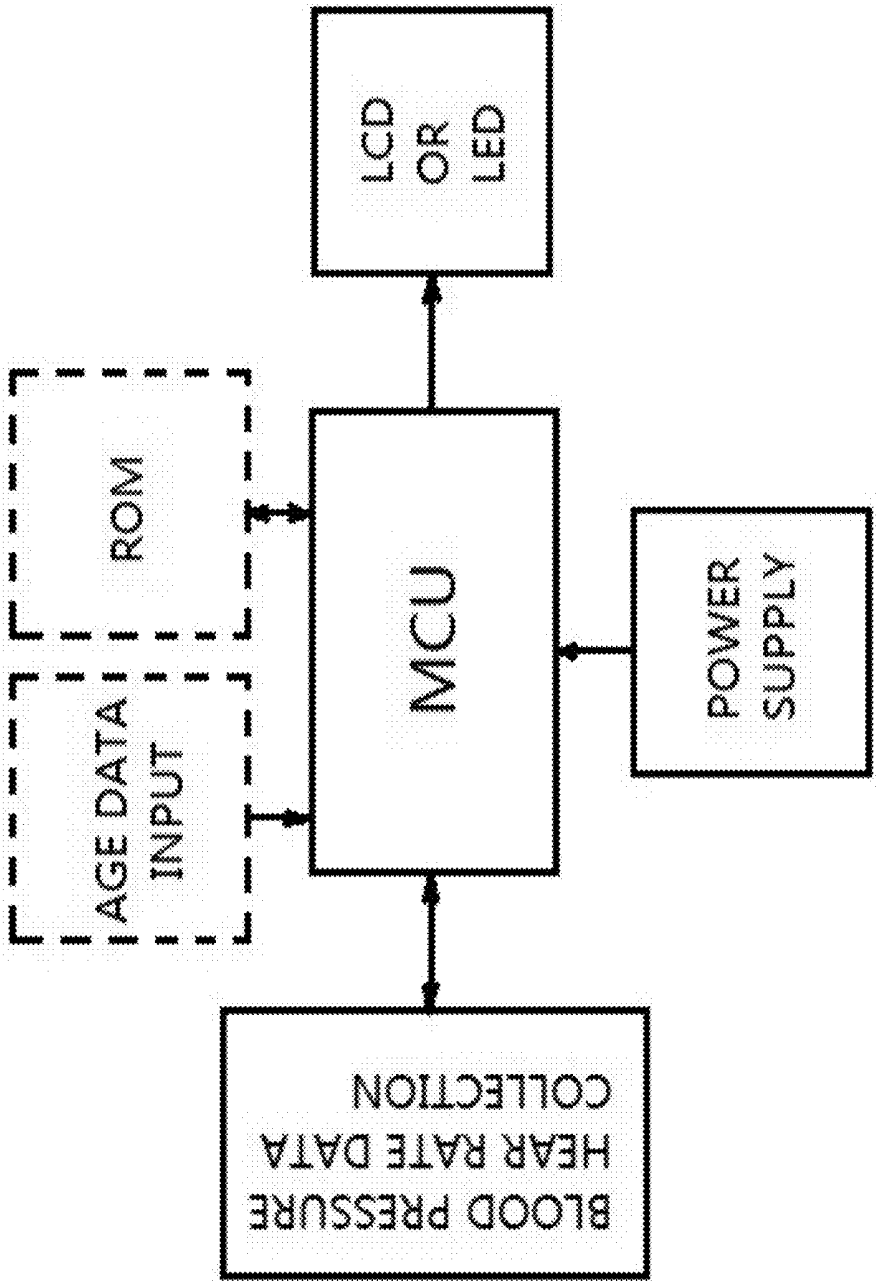

LCD OR LED
ROM
AGE DATA INPUT
MCU
POWER SUPPLY
BLOOD PRESSURE HEAR RATE DATA COLLECTION

Fig 2

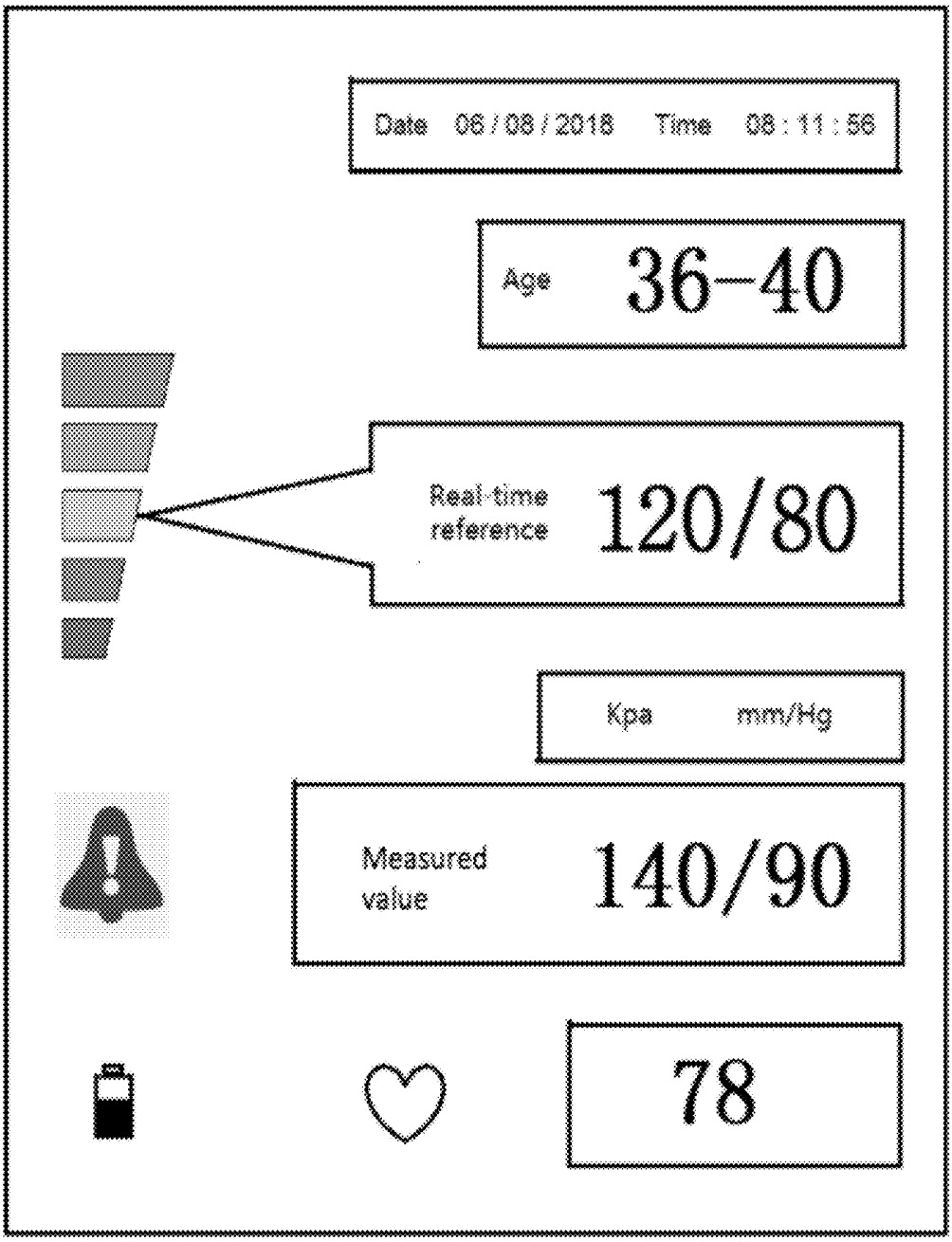

Date 06 / 08 / 2018 Time 08 : 11 : 56
Age 36–40
Real-time reference 120/80
Kpa mm/Hg
Measured value 140/90
78

Fig 3

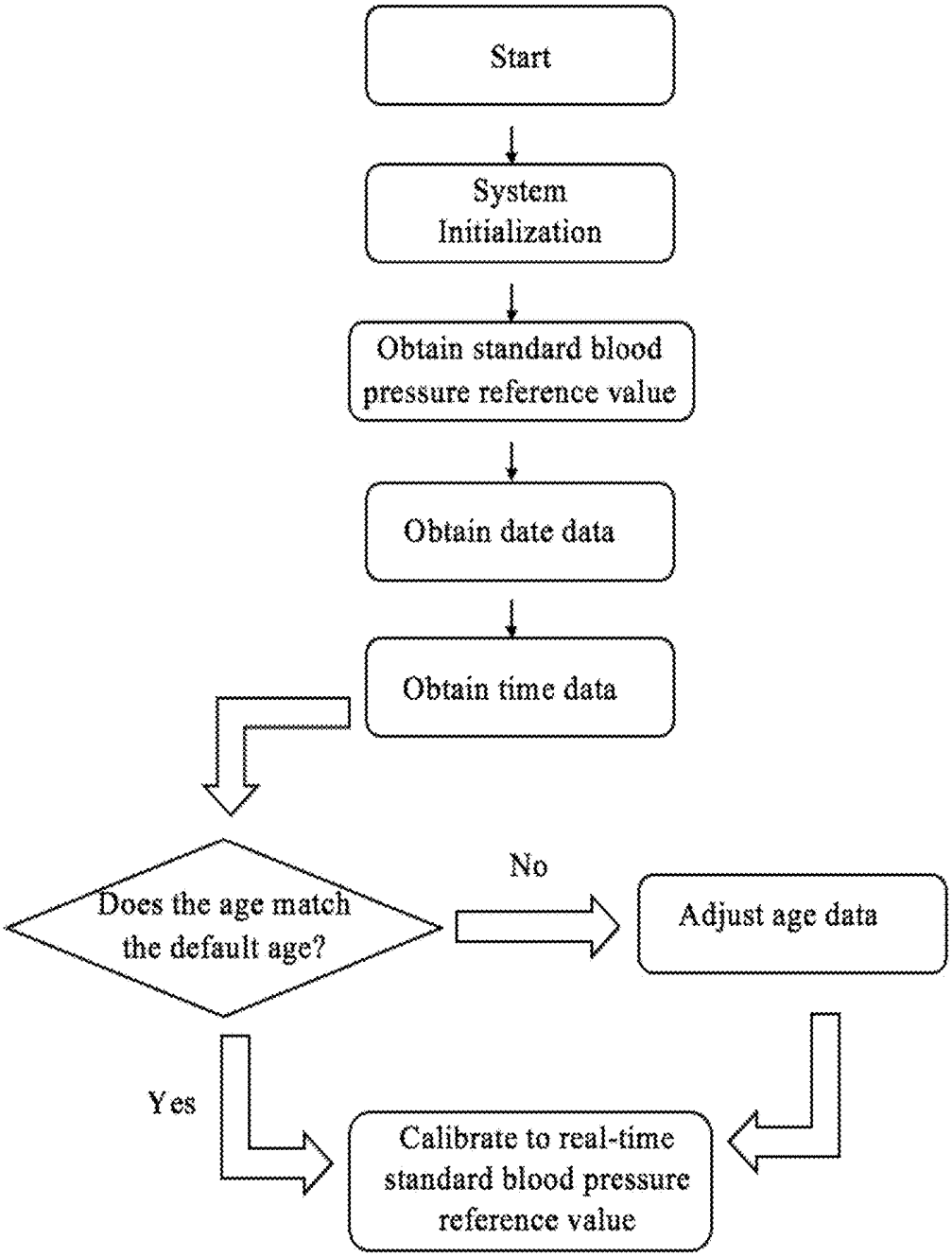

Start
System Initialization
Obtain standard blood pressure reference value
Obtain date data
Obtain time data
Does the age match the default age?
No
Adjust age data
Yes
Calibrate to real-time standard blood pressure reference value

Fig 4

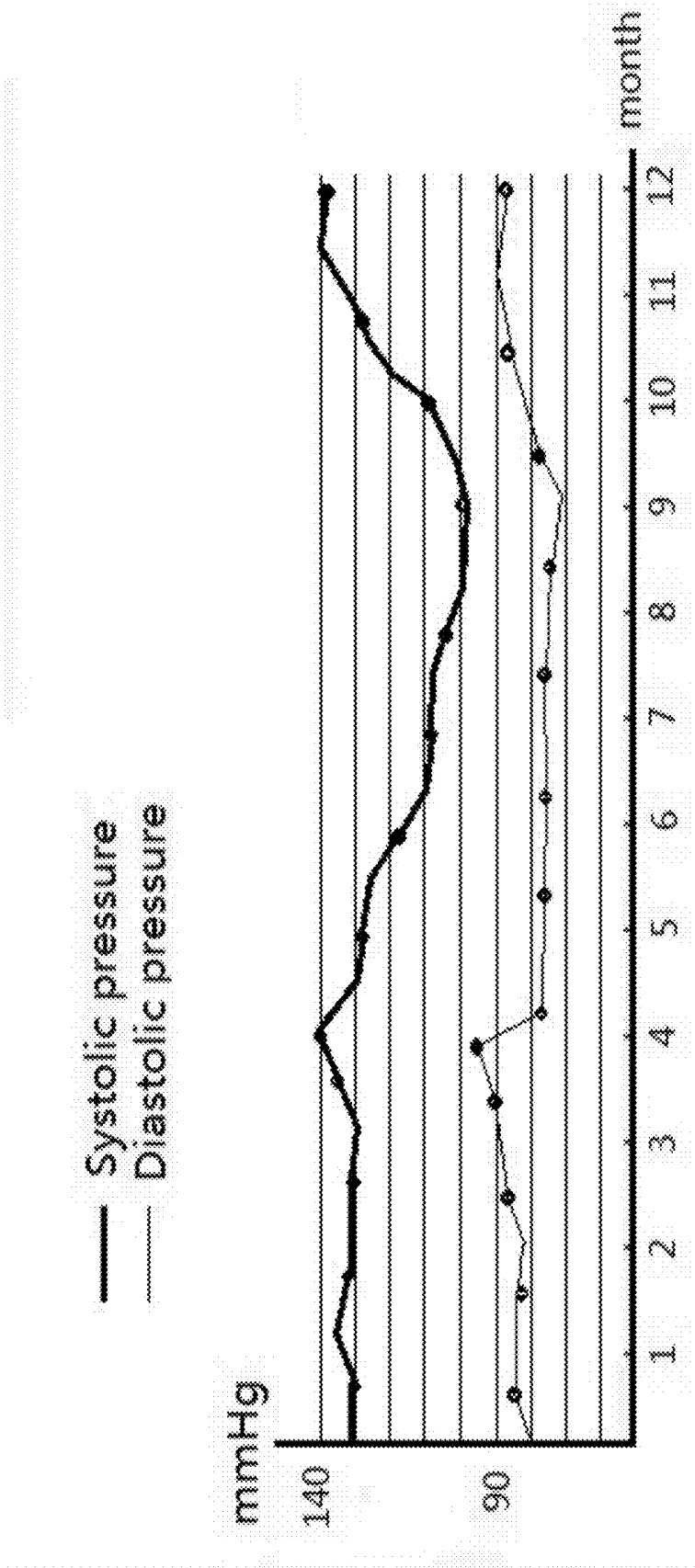

Systolic pressure
Diastolic pressure
mmHg
140
90
month
1
2
3
4
5
6
7
8
9
10
11
12

Fig 5


diastolic blood pressure
systolic blood pressure
mmHg
140
120
100
80
10
15
20
1
6
Time (hour of day)

Fig 6

DYNAMICALLY CALIBRATED BLOOD PRESSURE REFERENCE VALUE ELECTRONIC SPHYGMOMANOMETER

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] (Not Applicable)

STATEMENT REGARDING FEDERALLY SPONSORED RESEARCH OR DEVELOPMENT

[0002] (Not Applicable)

REFERENCE TO SEQUENCE LISTING, A TABLE, OR A COMPUTER PROGRAM LISTING COMPACT DISC

[0003] (Not Applicable)

BACKGROUND OF THE INVENTION

[0004] Cardiovascular disease is one of the three most common diseases among humans, alongside diabetes and cancer. Abnormal blood pressure is the most dangerous factor of cardiovascular diseases. The characteristics of chronic diseases with abnormal blood pressure are obvious, and many patients suffer from these diseases. Daily blood pressure monitoring is an important method to prevent stroke and heart disease. There is a huge demand for non-medical (self-testing by patients and family members outside the doctor) blood pressure monitoring, placing new requirements on the convenience and the accuracy of abnormal blood pressure assessments.

[0005] The electronic sphygmomanometer technology is developed and widely used. The mainstream products are available in both arm and wrist styles. They have real-time blood pressure data (systolic/diastolic pressure) measurement display, abnormal blood pressure warning information, heart rate display, and other major functions (such as date, time, battery display, and other ancillary information display functions). The reference value of the abnormal blood pressure data of the existing electronic sphygmomanometers is a fixed value (such as 120/80). The real-time measured blood pressure value is compared with the fixed blood pressure reference value to determine whether the real-time measured blood pressure value is abnormal and to provide warning messages about blood pressure status (sound, light, icons, and etc.).

[0006] Since the human blood pressure is affected by age, measurement date and time of day, the above-mentioned single factors and multiple factors can all lead to blood pressure fluctuations. However, many false judgements of blood pressure status can occur when these factors are neglected and the real-time measured numerical value is compared to a fixed standard value. Thus, the existing electronic sphygmomanometers have obvious deficiencies or defects.

[0007] The available information (FIG. **4**) shows that the standard reference value of systolic blood pressure for males between the ages of 61 and 65 is about 129% of the standard systolic blood pressure reference value for males aged 16 to 20 years, with a fluctuation of 33 mmHg and a standard diastolic blood pressure fluctuation of 13 mmHg between these age groups.

[0008] The date (month) has a more prominent effect on blood pressure fluctuations. The reference values for standard systolic blood pressure are about 140 mmHg in April and December, the reference value for standard systolic blood pressure in September is about 100 mmHg which shows a fluctuation amplitude of about 40 mmHg. Likewise, the standard diastolic blood pressure fluctuation between these months is about 30 mmHg (as shown in FIG. **5**).

[0009] At the same time, the values of blood pressure fluctuation at different times of the day (24 hours) are also obvious. The standard systolic blood pressure peak at 8:00 am and 4:00 am is 140 mmHg while the peak of the standard diastolic blood pressure at these times is 100 mmHg. In comparison, the peak standard systolic pressure is about 95 mmHg at 2 am, and the peak standard diastolic pressure is about 60 mmHg at the same time (as shown in FIG. **6**). The fluctuation amplitudes are 45 mmHg and 35 mmHg, respectively.

[0010] The above data show that in current sphygmomanometers, only a fixed value of the blood pressure reference value (such as 120/80 mmHg) is used as a benchmark for the real-time measured blood pressure value, making it difficult to correctly judge whether the real-time blood pressure is abnormal or not, leading to errors in the abnormal blood pressure warning information of the existing electronic sphygmomanometer. Because one fixed blood pressure reference value neglects age, date and time, the possibility of a false judgment by patients and their family members is very high. Only doctors can correctly judge the status of the real-time measured blood pressure data of the measured subjects according to their respective information. This deficiency or defect in the sphygmomanometers may cause it to be a harmful instrument to patients and other users by committing false positive or false negative errors.

BRIEF SUMMARY OF THE INVENTION

[0011] Proposed is a type of electronic sphygmomanometer that dynamically calibrates in reference to real-time blood pressure standards. The dynamically calibrated blood pressure reference value electronic sphygmomanometer according to the invention can dynamically calibrate the real-time blood pressure reference value of the measured subject according to the age of the measured object, date and time of measurement. Furthermore it analyzes the deviation between the real-time measured blood pressure and the real-time blood pressure reference value to accurately assess blood pressure status of the measured subject. The comparison to dynamically calibrated reference values makes it possible to significantly increase the accuracy of the blood pressure abnormality information of the electronic sphygmomanometer and, to a certain extent, make it easier for the user or family to analyze or monitor blood pressure.

BRIEF DESCRIPTION OF THE SEVERAL VIEWS OF THE DRAWING

[0012] FIG. **1** is a schematic block diagram of a dynamically calibrated electronic sphygmomanometer with a blood pressure reference value according to the present invention.

[0013] FIG. **2** is a schematic diagram of a display interface of a blood pressure reference value dynamic calibration electronic blood pressure monitor according to the present invention.

[0014] FIG. **3** is a flow chart of the dynamic calibration procedure of the blood pressure reference value of the blood pressure reference value dynamically calibrated electronic sphygmomanometer.

[0015] FIG. **4** is a graph of age/blood pressure (systolic/diastolic) fluctuations.

[0016] FIG. **5** is a graph of date/blood pressure (systolic/diastolic pressure) fluctuations.

[0017] FIG. **6** is a graph of time/blood pressure (systolic/diastolic pressure) fluctuations.

DETAILED DESCRIPTION OF THE INVENTION

[0018] Proposed is a type of electronic sphygmomanometer that dynamically calibrates in reference to real-time blood pressure standards, including blood pressure data acquisition, an MCU and a display. The reference standard blood pressure determined by age, date (month) and measurement time. The MCU is configured to dynamically calibrate based on real-time blood pressure and the real-time standard blood pressure reference to analyze the blood pressure reference value deviation in order to describe the abnormality of the real-time blood pressure status; The real-time blood pressure reference value is determined by the MCU through the "age/blood pressure reference value database," the "date/blood pressure reference value database" and the "measurement time/blood pressure reference database" association calibration, or according to the "age/blood pressure reference value function curve," "Date/blood pressure reference value function curve" and "time/blood pressure reference value function curve" and other mathematical relationship calculation and determination; the display shows the standard real-time blood pressure reference value, measured blood pressure value and an analysis of the blood pressure status, or a warning of abnormalities.

[0019] The dynamically calibrated electronic sphygmomanometer is characterized in that:

[0020] a. the age/blood pressure reference value is determined by the age of the measured object (or age group) and the set of corresponding standard blood pressure reference values according to age (or age group).

[0021] b. The date/blood pressure reference value is determined by the date of measurement (month) and the set of corresponding standard blood pressure reference values according to the date (or month).

[0022] c. The time/blood pressure reference value is determined by the time of measurement and the set of corresponding standard blood pressure reference values according to the time.

[0023] d. A mathematical relation or function can be composed from the set of age/blood pressure reference data pairs of coordinates (points), creating the age/blood pressure reference value function curve.

[0024] e. A mathematical relation or function can be composed from the set of date/blood pressure reference data pairs of coordinates (points), creating the date/blood pressure reference value function curve.

[0025] f. A mathematical relation or function can be composed from the set of time/blood pressure reference data pairs of coordinates (points), creating the time/blood pressure reference value function curve.

[0026] g. Database and mathematical relations/functions are stored in ROM (but not limited to ROM).

[0027] The dynamically calibrated electronic sphygmomanometer is also characterized in that: the input of age data of the measured object is carried out by human-computer interaction (HCI), including a touch screen, key input and voice input, etc. The date (month) and measurement time data is provided by an MCU clock unit or an independent clock unit, or provided by an electronic timing system such as a WIFI signal timing.

[0028] The dynamically calibrated electronic sphygmomanometer contains an analysis of the real-time blood pressure status, wherein the real-time measured blood pressure value is displayed in a specially designed single-side arrow-shaped graphic frame, and the arrow points to the middle position of the blood pressure warning bar.

[0029] The main display contents of the dynamic calibrated blood pressure reference value electronic sphygmomanometer display interface include: (see FIG. **2**.)

[0030] 1. Age data display of the measured object,

[0031] 2. Date, time display,

[0032] 3. Real-time blood pressure reference value (systolic/diastolic pressure) data display,

[0033] 4. Real-time measured blood pressure (systolic/diastolic) data display,

[0034] 5. Abnormal blood pressure information sound and light tips, battery power display.

[0035] The specific embodiments of the invention will be described in detail below with reference to the accompanying drawings. As shown in FIG. **1**, the present invention is composed of six parts, specifically including a blood pressure (heart rate) data acquisition unit, a measured subject information data input unit, a database (age/blood pressure reference value, date/blood pressure reference value, time/blood pressure reference value), an MCU, a display and a power supply. The solid line represents the frame part of existing electronic sphygmomanometers. The information data input unit and database of the measured object are shown by the dashed line frame and are contents of the invention new to existing sphygmomanometers.

[0036] FIG. **2** is a schematic diagram of a display unit according to the invention. The dashed line frame portion is a content of the invention new to existing sphygmomanometers, specifically the "real-time standard blood pressure reference value data display" and "age data display." Age data can be input through a touch screen or a key input method (conventional technology design, not shown on FIG. **2**) to adjust the age data to match the age of the measured subject. Then the MCU can use the currently displayed data as the age data of the measured subject.

[0037] The real-time standard blood pressure reference data is displayed in a specially designed single-sided arrow-shaped graphic frame. The arrow points to the middle position of the blood pressure warning bar, and the image indicates the meaning of the standard blood pressure reference value to show the blood pressure status in terms of (ab)normality.

[0038] The clock display (circuit) is a standard configuration of an existing electronic sphygmomanometer, providing date (day, month, year) and time data, including a MCU-driven clock unit, an independent clock unit independent of the MCU, and a wireless (e.g. WIFI) timing clock unit. The date and measurement time data of the invention can be obtained through the above three methods. When the blood pressure monitor starts the blood pressure data acquisition process, the MCU obtains the real-time clock data to dynamically calibrate the blood pressure reference value with the date and measurement time data.

[0039] FIG. **3** is a flowchart of the dynamic calibration procedure of the standard blood pressure reference value

according to the invention. The program flow is as follows: after the power of the sphygmomanometer is turned on, the system (MCU) is initialized, and the default age data is the median age (36-40 years old). The default standard blood pressure reference value is 120/80.→The MCU collects the date and time data displayed on the system clock.→According to the date and time displayed, the standard blood pressure reference value would be adjusted by data obtained from a date/blood pressure reference value database composed of a mathematical function or curve (see FIG. **5**) and a time/blood pressure reference value database composed of a mathematical function or curve (see FIG. **6**). Age data modification. If yes, the age data is used to modify the standard blood pressure reference value displayed, which would be obtained from an age/blood pressure reference value database composed of a mathematical function or curve (see FIG. **4**). If not, maintain the age data as the default value, and maintain the standard blood pressure reference value as corrected by date and time data. That is, when the condition data of the measured subject's age, measurement date, and measurement time are obtained, the system (MCU) dynamically calibrates the real-time standard blood pressure reference value data of the measured subject through database search or mathematical operations, driving the display to display the real-time standard blood pressure reference value data.

[0040] In addition to the real-time standard blood pressure reference data through three conditions of age, date and time dynamic calibration procedure, the real-time blood pressure measurement procedure of the electronic sphygmomanometer of the present invention is the same as the existing electronic sphygmomanometers. After the real-time blood pressure measurement data is generated, the MCU compares and calculates the real-time blood pressure data with the real-time standard blood pressure reference value data to determine the (ab)normality state of the measured subject, and drives the display to display the real-time blood pressure data and blood pressure abnormality information of the measured subject.

1. Proposed is a type of dynamically calibrated blood pressure reference value electronic sphygmomanometer that dynamically calibrates in reference to real-time blood pressure standards, including blood pressure data acquisition, an MCU and a display; the reference standard blood pressure determined by age, date (month) and measurement time; the MCU is configured to dynamically calibrate based on real-time blood pressure and the real-time standard blood pressure reference to analyze the blood pressure reference value deviation in order to describe the abnormality of the real-time blood pressure status; the real-time blood pressure reference value is determined by the MCU through the "age/blood pressure reference value database," the "date/blood pressure reference value database" and the "measurement time/blood pressure reference database" association calibration, or according to the "age/blood pressure reference value function curve," "Date/blood pressure reference value function curve" and "time/blood pressure reference value function curve" and other mathematical relationship calculation and determination; the display shows the standard real-time blood pressure reference value, real-time measured blood pressure value and an analysis of the blood pressure status, or a warning of abnormalities.

2. The dynamically calibrated electronic sphygmomanometer as described in claim **1** is characterized in that:

- the age/blood pressure reference value is determined by the age of the measured object (or age group) and the set of corresponding standard blood pressure reference values according to age (or age group);
- the date/blood pressure reference value is determined by the date of measurement (month) and the set of corresponding standard blood pressure reference values according to the date (or month);
- the time/blood pressure reference value is determined by the time of measurement and the set of corresponding standard blood pressure reference values according to the time;
- a mathematical relation or function can be composed from the set of age/blood pressure reference data pairs of coordinates (points), creating the age/blood pressure reference value function curve;
- a mathematical relation or function can be composed from the set of date/blood pressure reference data pairs of coordinates (points), creating the date/blood pressure reference value function curve;
- a mathematical relation or function can be composed from the set of time/blood pressure reference data pairs of coordinates (points), creating the time/blood pressure reference value function curve;
- the database and mathematical relations/functions are stored in ROM (but not limited to ROM).

3. The dynamically calibrated electronic sphygmomanometer as described in claim **1** is also characterized in that: the input of age data of the measured object is carried out by human-computer interaction (HCI), including a touch screen, key input and voice input, etc.; the date (month) and measurement time data is provided by an MCU clock unit or an independent clock unit, or provided by an electronic timing system such as a WIFI signal timing.

4. The dynamically calibrated electronic sphygmomanometer as described in claim **1** contains an analysis of the real-time blood pressure status, wherein the real-time standard blood pressure reference value is displayed in a specially designed single-side arrow-shaped graphic frame, and the arrow points to the middle position of the blood pressure warning bar.

* * * * *

专利名称(译)	动态校准血压参考值电子血压计		
公开(公告)号	US20190000395A1	公开(公告)日	2019-01-03
申请号	US16/032047	申请日	2018-07-10
[标]发明人	FU KAYDEN BEIBEI		
发明人	FU, KAYDEN BEIBEI		
IPC分类号	A61B5/00 A61B5/022		
CPC分类号	A61B5/7221 A61B5/022 A61B5/746 A61B5/7246 A61B2560/0223 A61B5/02141 A61B5/02208 A61B5/742 A61B5/7475 A61B2560/0238		
外部链接	Espacenet USPTO		

摘要(译)

本发明是一种电子血压计，其动态校准实时标准血压参考值，该参考值是根据受年龄，测量日期和时间等各种因素影响的人体血压波动的客观条件确定的，并确定年龄/血压参考值，日期/血压参考值和时间/血压参考。值数据库，或通过数学运算，在受试者年龄，测试日期和测试时间的特定条件下获得实时标准血压参考值，并将其校准为判断实际状态的异常状态的基准。时间血压测量值。这提高了血压计对受试者血压的准确判断的能力，并降低了假阳性测试或假阴性测试的误差范围。