UNITED STATES PROVISIONAL PATENT APPLICATION

TITLE: BUMP: A Novel Atropine Pump for patients with Crashing Bradycardia via Continuous BPM Monitoring

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ABSTRACT

[0001] *An embodiment relates to a wearable atropine delivery system, BUMP (Bradycardia Urgent Management Pump), designed for patients with crashing bradycardia. The system comprises a strap-on device that includes: a) a peristaltic pump comprising a reservoir of atropine; b) a heart rate sensor and multiple alerting mechanisms; c) an active delivery mechanism that injects atropine intravenously upon detecting a low BPM via the peristaltic pump; d) a power source supplying energy to the components; e) a microcontroller configured to monitor heart rate data and control the administration of atropine. The device is attached to the patient's body via a velcro strap and a wired heart rate sensor on the index finger. The system remains dormant under normal conditions, but when bradycardia is detected (BPM < 60), it administers an atropine dosage based on a predefined formula, while simultaneously activating visual, auditory, and tactile alerts to ensure prompt medical intervention.*

FIELD OF THE INVENTION

[0002] The present invention relates to the field of medical devices, specifically to wearable emergency medical systems designed for patients diagnosed with crashing bradycardia. This invention addresses the need for a portable and automated solution to administer life-saving medication when a patient's heart rate drops to dangerously low levels.

BACKGROUND OF THE INVENTION

[0003] Crashing bradycardia is a life-threatening condition characterized by an abnormally slow heart rate, which can lead to dizziness, fainting, or even sudden cardiac arrest. Immediate intervention is crucial to stabilize the patient's heart rate and prevent severe complications or death. Traditional methods of treating bradycardia often require medical professionals to administer atropine or other drugs, necessitating the patient's presence in a clinical setting.

[0004] Time is a critical factor in these cases, and patients may not always have access to immediate medical care. This invention, the Bradycardia Urgent Management Pump (BUMP), provides a wearable, autonomous solution for patients at high risk of crashing bradycardia. The device continuously monitors the patient's heart rate and, upon detecting bradycardia (defined as a heart rate below 60 beats per minute), automatically administers a calculated dosage of atropine. This automated system acts as a temporary safeguard, providing a critical window of time for the patient to seek professional medical help.

SUMMARY OF THE INVENTION

[0005] Heart Rate Sensor defines a PulseSensor connected to the Arduino Uno microcontroller that continuously measures the patient's heart rate and sends real-time data to the microcontroller.

[0006] The "Microcontroller (Arduino Uno)" refers to the central processing unit of the device, which is responsible for receiving and processing the heart rate data transmitted by the heart rate sensor. Upon detecting that the patient's heart rate has dropped below a pre-set threshold of 60 beats per minute (BPM), the microcontroller triggers the administration of atropine by activating the peristaltic pump.

[0007] The "Peristaltic Pump" is defined as the mechanical component of the device that is connected to a reservoir of atropine. The pump is responsible for delivering a precise dosage of atropine into the patient’s bloodstream. The dosage is calculated based on the patient's current BPM, using a pre-programmed formula that adjusts the amount of atropine administered according to the severity of the bradycardia.

[0008] The "Alert System" encompasses the visual, auditory, and tactile alert mechanisms of the device. This system includes an LED light, a piezo buzzer, and a vibration motor. When bradycardia is detected (i.e., when the BPM falls below 60), these components are activated simultaneously to alert both the patient and those around them to the medical emergency.

[0009] The "LCD Display" refers to the visual interface of the device that continuously displays the patient's real-time BPM. In the event that bradycardia is detected, the LCD display switches to show an alert message, "BRADYCARDIA DETECTED," providing clear and immediate visual feedback to the patient.

[0010] The "Power Source" is defined as the battery pack that powers the entire device, ensuring that all components, including the microcontroller, peristaltic pump, alert system, and LCD display, remain operational. The battery pack is designed to be portable, allowing the device to function continuously while being worn by the patient during daily activities.

[0011] The term "PulseSensor Heart Rate Monitor" defines the component responsible for continuously measuring the patient’s BPM and sending this data to the Arduino Uno microcontroller. The PulseSensor is a non-invasive sensor attached to the patient’s index finger through a wired connection. It works by detecting changes in blood flow in the finger and converting these changes into BPM readings, which are then processed by the microcontroller to determine if the heart rate has dropped to a dangerous level.

[0012] The term "LED Light" defines the visual indicator that activates when the patient's BPM falls below 60. This LED light provides an immediate visual cue that something is wrong, alerting the patient and potentially those around them that medical attention may be needed.

[0013] The term "Piezo Buzzer" describes the auditory alert mechanism that produces a loud, continuous sound when bradycardia is detected. The buzzer is triggered simultaneously with the LED and vibration motor to ensure that the patient is alerted in multiple ways, enhancing the chances of noticing the emergency situation promptly.

[0014] The term "Vibration Motor" refers to the tactile alert mechanism that activates when the patient's BPM drops below 60. The motor delivers a strong vibration that can be felt by the patient, particularly useful in environments where the auditory alarm might not be heard or for patients who may not notice the visual alerts.

[0015] The device is strapped to the patient's lower bicep, with the heart rate sensor attached to the patient's index finger. It is designed for continuous wear, with a comfortable, unobtrusive design that blends into the patient's daily routine. When the device detects that the patient's heart rate has fallen below 60 BPM, it activates the peristaltic pump to administer atropine intravenously, according to the equation: $f(x) = -0.05x + 3.5$ where $f(x)$ is the atropine dosage in milliliters, and x is the recorded BPM.

SYSTEM INTEGRATION

[0016] The components mentioned above are carefully integrated to work seamlessly together. The Arduino Uno microcontroller serves as the hub of the system, processing data from the PulseSensor and controlling the activation of the peristaltic pump and alert mechanisms based on the heart rate data. The heart rate sensor continuously transmits data to the microcontroller, which monitors the BPM in real-time. If the BPM falls below the threshold of 60, the microcontroller activates the peristaltic pump, delivering the required dose of atropine to the patient.

[0017] Simultaneously, the LED light, piezo buzzer, and vibration motor are triggered to alert the patient. The LCD display updates to show “BRADYCARDIA DETECTED” alongside the current BPM, ensuring that the patient is fully aware of their condition.

[0018] The system is designed to be fail-safe, ensuring that if bradycardia is detected, the appropriate actions are taken immediately. The device operates autonomously once worn by the patient, minimizing the need for user intervention. The system is powered by a battery pack, providing the portability necessary for continuous, everyday use.

OPERATIONAL PROCESS AND USE

[0019] The BUMP device operates autonomously once attached to the patient. The device is worn on the patient's lower bicep using adjustable velcro straps, ensuring it stays securely in place during daily activities. The heart rate sensor is attached to the patient's index finger via a flexible cable, allowing for continuous and non-intrusive monitoring.

[0020] During normal operation, the BUMP device remains in a dormant state, with the LCD screen displaying the patient's current BPM. The system regularly checks the BPM through the PulseSensor, which sends data to the Arduino Uno microcontroller. As long as the BPM is above 60, the device continues to monitor passively, and no actions are taken.

[0021] However, when the patient's BPM drops below 60, the system immediately transitions into emergency mode. The microcontroller executes a series of actions simultaneously.

[0022] The peristaltic pump is activated to deliver atropine into the patient's bloodstream. The dosage is calculated based on the recorded BPM using the pre-defined formula, ensuring that the right amount of atropine is delivered to stabilize the patient's heart rate. The pump continues to operate until the dosage is fully administered, after which it returns to a standby state.

[0023] Alongside the administration of atropine, the LED light flashes, the piezo buzzer sounds an alarm, and the vibration motor activates. These alerts provide the patient with multiple forms of notification, ensuring they are aware of the bradycardia event. The LED provides a visual signal, the buzzer delivers an audible alert, and the vibration motor offers a tactile sensation. This multi-channel alert system is crucial for ensuring the patient notices the emergency, regardless of their environment.

[0024] The LCD screen, which typically shows the patient's BPM, switches to an emergency message: "BRADYCARDIA DETECTED." This message remains on the display until the patient's BPM stabilizes or the system is reset by the patient or a healthcare provider.

DESIGN CONSIDERATIONS

[0025] The BUMP device is designed with user comfort and practicality in mind. The device is lightweight and discreet, with a white exterior to blend in with the patient's attire and minimize any sense of alarm or discomfort. The adjustable velcro straps ensure that the device fits securely on the patient's arm, regardless of arm size. The wired heart rate sensor, attached to the patient's index finger, is flexible and comfortable for long-term wear, allowing the patient to go about their daily activities without interference.

[0026] The device is powered by a rechargeable battery pack, which provides sufficient energy for continuous operation over extended periods. The battery is designed to be easily replaceable or rechargeable, ensuring that the device remains functional without the need for frequent maintenance. The system is also designed to conserve power, with most components remaining in a low-power state during normal operation, only activating fully during an emergency.

[0027] The internal structure of the device is arranged to minimize bulk while ensuring that all components function efficiently. The peristaltic pump is compact yet powerful enough to deliver the required dosage of atropine. The microcontroller and sensors are arranged to allow easy access for any maintenance or updates, should they be required.

USAGE SCENARIOS

[0028] The BUMP device is intended for use by patients who are at risk of crashing bradycardia and need continuous monitoring outside of a hospital setting. It is particularly useful for patients who live in remote areas, have limited access to immediate medical care, or require a safeguard during travel. The device acts as a temporary measure, providing critical intervention until the patient can reach a healthcare facility.

[0029] In addition to its primary function, the BUMP device can also serve as a monitoring tool in non-emergency situations. The LCD display continuously shows the patient's BPM, allowing them to monitor their heart rate throughout the day. The device can be used alongside traditional medical treatments, providing an additional layer of safety for patients with chronic heart conditions.

OBJECTS AND EMBODIMENTS OF THE INVENTION

[0030] The primary objective of the BUMP device is to provide an automated, portable, and reliable means of monitoring and managing crashing bradycardia outside of a hospital setting. This invention offers significant improvements over existing methods and devices by combining real-time monitoring with immediate drug administration in an emergency situation. Current treatments for bradycardia typically involve clinical intervention, where healthcare professionals administer atropine intravenously. These methods depend on the patient's ability to reach medical care quickly, which may not always be feasible, especially in remote areas or during unexpected bradycardia events.

[0031] By integrating heart rate monitoring with an automatic atropine delivery system, the BUMP device addresses this critical gap in care. The device provides patients with continuous protection, automatically administering a calculated dose of atropine when their heart rate drops below a safe threshold. This ensures immediate intervention, potentially preventing severe complications or death due to delayed treatment.

[0032] The device is designed for continuous wear, offering an unobtrusive and user-friendly experience. Its multi-modal alert system (visual, auditory, and tactile) enhances patient safety by ensuring that the patient and those nearby are immediately aware of the emergency situation. Furthermore, the calculated drug delivery is based on a pre-programmed formula, ensuring that the dosage is tailored to the patient's specific heart rate, making it a more precise and personalized treatment option than standard pre-measured injections.

[0033] In addition, the BUMP device incorporates modern microcontroller technology and an efficient power system, making it lightweight and portable without sacrificing functionality. It offers a practical solution for individuals at risk of crashing bradycardia, providing them with peace of mind and a temporary safeguard until professional medical care can be accessed.

DRAFT CLAIMS

[0034] A wearable atropine delivery system for patients with crashing bradycardia, comprising:

[0035] 1. a heart rate sensor configured to continuously monitor the patient's heart rate and transmit BPM data,

[0036] 2. an Arduino Uno microcontroller configured to receive and process the BPM data from the heart rate sensor, compare the BPM to a predetermined threshold, and control subsequent actions,

[0037] 3. a peristaltic pump connected to a reservoir of atropine, wherein the pump is activated by the microcontroller when the BPM falls below 60 beats per minute, and delivers a calculated dosage of atropine according to a pre-programmed formula,

[0038] 4. a multi-modal alert system, comprising an LED light, a piezo buzzer, and a vibration motor, all of which are activated when the BPM falls below 60 beats per minute,

[0039] 5. an LCD display configured to display the patient's current BPM and to flash a message indicating "BRADYCARDIA DETECTED" when the BPM falls below 60 beats per minute,

[0040] 6. a power source configured to provide electrical power to all components of the system,

[0041] 7. wherein the device is configured to be worn on the patient's lower bicep with a heart rate sensor attached to the patient's index finger, and the atropine is delivered intravenously through a connected tube when bradycardia is detected.