ABSTRACT

Tragically more babies fall victim to sudden infant death syndrome than the combined numbers of respiratory ailment, heart disease and cancer deaths. The cases take place for those babies who were under one year of age and especially often for those babies who were in the age around two to four month old. Despite extensive research, the exact cause of sudden infant death syndrome is still not known. Shockingly, it can even happen to apparently healthy babies left alone for just a little while. The conventional infant apnea monitor adopts disposable electrodes as sensors for apnea detection and thus inducing the problems of skin irritated or other hazards. To tackle these shortcomings, we develop a non-attached type apnea monitor. The device monitors the temperature of the breathing airflow by means of thermo sensors. These airflow frequencies linking with respiratory rates are indicated on the monitor. There is absolutely no contact with the babies’ skin, avoiding the possibilities of any skin irritations. The system detects temperature changes induced by breathing and analyzes the breathing frequency changes displayed with both LED array and computer monitor. The data are collected and analyzed simultaneously by a personal computer, which can link to the central nursery room. The device provides a convenient way for pediatricians or nurses to detect abnormal respiratory frequency in real time so they can handle any emergency and gives the necessary treatment immediately. Ten clinic cases have been analyzed and presented. Function validation of the device, on the other hand, is performed as well.

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1. INTRODUCTION

The mechanism of the sudden infant death syndrome (SIDS) remains controversial. Impaired cardio-respiratory controls, hyperthermia, lethal re-breathing of carbon dioxide trapped in sleeping, and arousal deficiencies are among the postulated mechanisms that are currently the focus of much interest and debate. [1-3] This statement focuses on the epidemiologic aspects of SIDS, the lack of a proven association between episodic apnea and SIDS, strategies for prevention of SIDS, and appropriate use of home cardio-respiratory monitoring.

Apnea monitors were first introduced in the
mid-1960s for the management of apnea of premature babies in hospital settings. [4] Subsequently, cardio-respiratory monitoring has become widely used in the care of infants with a variety of acute and chronic disorders.

The hypothesis that apnea is the pathopsychologic precursor to SIDS was first proposed in 1972. [5] The apnea theory never has been proven despite extensive independent research in the several decades. [6] Nevertheless, the home cardio-respiratory monitoring industry, fueled by increasing demand from parents concerned about the risk of SIDS, rapidly developed products aimed at preventing SIDS. [7] Despite the absence of a scientific foundation or evidence of efficacy [8-9], home cardio-respiratory monitoring continues to be a common practice. [10]

Home monitoring is commonly indicated for infants who have prolonged episodes of apnea (halted breathing) and/or bradycardia (slow or absent heart rate) resulting from premature babies, and infants who have an apparent life-threatening event (ALTE). [11-12] In addition to these conditions, being a direct sibling of a SIDS victim is a factor that may also suggest home monitoring. [13]

Nowadays, the infant apnea monitors have been well equipped in the hospital even private residences. Majority of the infant apnea monitors adopt attached electrodes as sensors for apnea detection and possibly induce the problems of skin irritated or other hazards. The purpose of the study is therefore to develop a non-attached type apnea monitor. By the non-attached thermo-sensors, the device can monitor the temperature changes of the breathing airflow and linking with the associated RR value and indicates on the monitor. There is absolutely no contact with the babies’ skin, avoiding any possibility of skin irritations. Fig 1 shows the system’s block diagram. Temperature changes induced by breathing are detected by the thermo-sensors and magnified by a pre-amplifier. By the use of gain amplifier, sensitivity is adjusted and the signal is sent to the micro-control unit (MCU) through the analog/digital converter. The MCU adopts high-speed pulse processor as central control unit. Mission of the MCU is to link, control and communicate among the subsystems. The detected signal and physiological data are then transported to the personal computer in site and that in the central nursery room. Fig 2 demonstrates the complete hardware system. The device provides a convenient way for pediatricians or nurses to detect abnormal respiratory frequency in real time so they can handle any emergency and gives the necessary treatment immediately. Audio alarms, on the other hand, are provided for apnea and internal computer failure.

2. METHOD

2.1 Non-Attached Apnea Monitor

The non-attached apnea monitor is designed to detect and display infant’s respiratory rate (RR) by utilizing a thermo-sensors array. There is no need to use with electrodes applied transthoracically as that of the conventional monitor (for example, Corometrics infant monitor). The device monitors the temperature changes of the breathing airflow and linking with the...
The thermo sensors are sensitive to detect airflow temperature while they should appropriately located to catch breathing flow. It is quite possible to miss the signal when the infant turns his/her head. To avoid missing the detection, an ellipsoid-shaped mask is produced and the thermo sensors are placed on the mask (Fig. 3) so that breathing can be detected when the baby’s head turns.

2.2 Clinic Setting

The study was planned with two stages and conducted at Chi-Mei Medical Center (Tainan, Taiwan). The first stage concentrates on validating the function of the developed non-attached apnea monitor. Two healthy adults are tested. Their breathings are detected both by the attached apnea monitor and the non-attached device. One adult breathes with a continuous mode of controlled respiratory rate. Another adult breathes with an intermittent breathing-and-stop mode to check if any noise signal disturbs the device when the breathing stops and if the device responds the respiratory rate in real time. Data obtained both from the device and the attached apnea monitor is compared to validate the function of the device.

The second stage focused on clinic monitoring for babies born prematurely at the hospital and those had other medical conditions required apnea monitoring. Ten referrals were chosen that met the following criteria:

1. There was no serious respiratory disease of the referrals but with other medical conditions required apnea monitoring.
2. The referrals were confirmed by pediatricians or nurses with the conditions for taking the clinic study.

The test was then proceeding with the following steps:

(a) The health conditions were evaluated and recorded by the nursery staff.
(b) The thermo-sensors were sterilized.
(c) The staff began to adjust the sensitivity of the device and locate the sensors in order to measure RR.
(d) The attached apnea monitor's electrodes were attached and the monitor was powered.
(e) The staff recorded the measured RR for the values from the attached apnea monitor and the device.

3. RESULTS

3.1 Function Validation

To validate the function of the device, we collected referrals' RR data simultaneously both from the attached apnea monitor (Neo-Trak 502, COROMETRICS) and from the developed device and established the co-relation between the data. Schematic diagram for the validation work is demonstrated in Fig. 4. Two healthy adults were chosen for the test. One adult was detected with a controlled RR rate of 12 cycles per minutes. A comparison of the detected RR values by the attached apnea monitor and non-attached apnea monitor is shown in Table 1. The recorded RR values of the non-attached apnea monitor are depicted as Fig. 5. It has been shown that that the referral breathes in a continuous mode the RR values measured from both the devices are rather coincident and both with well accuracies.

Another referral was tested with an intermittent breathing mode. It was controlled by a mode of breathing 20 seconds and then stopping with a period of 10 seconds. The detected RR values of the non-attached apnea monitor are depicted in Fig. 6. The intermittent characteristics are performed. A comparison of the data of the ones from the attached apnea monitor and those from the developed device is shown in Table 2. It should be noted that the newly
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REFERENCES
