Toward Incorporating the Infant Weight Into Incubator’s Automatic Temperature Control

A premature infant needs a stable thermal environment. This paper studies if the infant weight can be employed in the standard heat regulation system in incubators. This was done in two stages. First, a weight sensor was designed by means of using strain gauge in order to provide weight measurement. Later, a heat regulation circuit was designed and implemented by means of using a microcontroller. The humidity, environmental and skin temperature, and infant’s weight are measured and used as inputs. The experiments showed that infant’s weight can be successfully added to the control circuit in the incubator instrument. The results showed that infant’s weight can productively contribute in temperature control with good confidence. The average standard error was equal to 0.48 °C. The results reveal that the infant’s weight can contribute to increase quality assurance of incubators. [DOI: 10.1115/1.4032633]

Keywords: premature infant, infant’s weight, temperature regulation, skin temperature, control system

1 Introduction

Incubator is designed to maintain newborn infant, premature low birth weight, or sick infant in stable environment of temperature, air flow, and humidity until the infant is able to cope with the environmental variations without external help, so the risk of hypothermia is vanished [1]. Therefore, temperature is the major factor that needs to be maintained with minimum variations. The value of the temperature is usually set by physician and should be maintained constant. The preset temperature value is set using the well-known clinically experimental tables based on the thermal distribution of infant body according to the infant ages [1–3].

There are mainly two common methods to control temperature within incubators. The first one utilizes the skin temperature ($T_s$), whereas the second one employs the air temperature ($T_a$) of the incubator air space. It was reported that the use of $T_s$ (i.e., skin temperature control) often leads to large fluctuations in air temperature [4,5]. In contrast, the use of $T_a$ (i.e., air temperature control) leads to skin temperature fluctuations. Moreover, in the air control, it is often difficult to maintain the core temperature of the infant in the desired range [4,5]. In the modern incubator designs, the physician has to select either the air control or the skin control. These incubators do not permit simultaneous air and skin control.

In literature, various research activities are reported. Knobel et al. concluded that the occurrence of hypothermia can be reduced by placing the infants in polyurethane bags in the delivery room [6]. This result was repeated later by Godfrey et al. emphasizing its positive impact on clinical practice [7]. Knobel et al. also found, in another study, that there is no significant difference between abdominal and foot temperature measurement for extremely low birth weight (less than 1 kg) [8]. On the other hand, the impact of the type of bath after birth for preterm infant was conducted by Loring et al. [9]. The results showed that the preterm infants bathed by immersion would exhibit less temperature variations during their first 10 min after birth than those were sponge bathed. Lei et al. monitored the variation in temperature for preterm infants, who are 1800–2200 g in weight, after turning off the incubator (i.e., weaning). They concluded that infants’ temperature decreases after weaning once their weight reaches 1800 g [10].

The computer technology has been also attempted in incubators [11–15]. In 2001, Lyon and Oxley tested the use of a computer program to set the incubator humidity and air temperature instead of the preset values by the nurse [11]. No significant difference was concluded. This study was done for infants born at less than 29 gestational weeks and only for the first 4 days after birth. Helder et al. repeated similar research but they covered a 2-week...