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# Effect of high sun intensity on neonatal incubator functionality in a tropical climate

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**Abstract** The effect of meteorologically-induced high room temperature on neonates and incubators in a tropical climate was studied. Two rooms were designated for the study. The main nursery hall served as the 'control-room' where environmental conditions remained unaltered. A sun-shading and wall-lagging method was applied to the 'test-room' to reduce the warming effect of high sunlight intensity. A weather monitoring station was installed to separately record meteorological changes outside the nursery and both study rooms. Incubator set-points and process temperatures were recorded hourly using digital thermometer from 8:00 h to 21:00 h daily. All set ups were allowed to continue through the harmattan and dry season months. On the cumulative average, 80% of Incubators malfunctioned in the control-room, and 9% in the test-room. Minimisation of meteorological heat transmission into nursery wards is an essential factor to consider for designing and setting up a neonatal centre in a tropical climate.


## Introduction

Thermal distress accounts for a high rate of neonatal mortality and morbidity in a host of developing countries (da Mota Silveira et al., 2003; Kago et al., 1991; Kambarami and Chidede, 2003; Kaushik et al., 1999; Manji et al., 1998; Mathur et al., 2005; Ogunlesi et al., 2008; Simiyu, 2004; Zayeri et al., 2005). Incubators are widely used across the world to maintain body temperatures of newborns especially the pre-term babies as their organs are not yet fully developed to support them. Incubators are unable to do much unless they are knowledgeably and interactively regulated based on the physiological changes of the neonate throughout the period of incubation

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nursing (Bell, 1983; Cinar and Filiz, 2006; Ellis, 2005; Johanson et al., 1993; Macnab et al., 1995; Mok et al., 1991; Risbourg et al., 1991; Sherman et al., 2006). Incubators are designed to provide a separate microenvironment for the neonate's comfort different from the general nursery conditions. These are equipped to stabilise and maintain a neutral body temperature for the neonates, provide adequate humidification and seclude the neonate for infection control among other functions (Ellis, 2005; Tourneux et al., 2009). Many studies have shown that several external factors can affect the ability of the incubator to provide these services adequately (Amadi et al., 2007; Bell, 1983; Cinar and Filiz, 2006; Ellis, 2005; Johanson et al., 1993; Macnab et al., 1995; Mok et al., 1991; Risbourg et al., 1991; Sherman et al., 2006; Tourneux et al., 2009). Amadi et al. (2007, 2010) studied the factors militating against adequate provision of functional incubators and the impact of recycled incubators in Nigeria, proposing the application of appropriate incubator technology that could guaranty the affordability of the systems. These identified certain cases of applications leading to overheat of incubators directly associated with mortality and morbidity in neonates (Amadi et al., 2007). Incubator overheat might be as a result of malfunction or the presence of external heat generating sources through radiant heat transfer (Cinar and Filiz, 2006; WHO, 1997).

Previous studies have identified various sources of nursery heat radiation that cause incubator overheat and of course neonatal hyperthermia (Cinar and Filiz, 2006; Laptook and Watkinson, 2008). Observably, external heat sources in the tropical climate includes, but not limited to these factors as the high sun intensity may well be doing more harm than any of the aforementioned factors. Unknowledgeable use of certain heat conductive materials in the construction of nursery building and the siting of such buildings in the direction of sun rays and reflections may also be contributing to high cases of nursery and incubator overheat. In as much as this may not be a sensible factor in the relatively colder regions of the world, it is evident that air temperatures in some sub-Savannah African climates can get as high as 39 °C, with maximum high of up to 47 °C (Shawesh, 1993). This is significantly high and could constitute a great build-up of heat within the nursery rooms and able to overheat any neonate within the incubator's baby-compartment. It has been observed that in contrast to hypothermia, the knowledge base regarding elevated temperatures at birth is more limited (Bowman and Roy, 1997; Laptook and Watkinson, 2008). During such high heat periods, some Nigerian hospital Centres have resorted to the practice of opening up all portholes and access doors of incubators in the attempt to cool the incubator and the occupant neonate. This has often not yielded the desired result but has rather compromised the microenvironment and undermined the reasons for creating such separate environment for the neonate (Lyon, 2007). Ambient temperatures in some Nigerian cities can rapidly rise above 37 °C before noon on certain days and remain even higher than this for most of the day. Stabilisation of neonates' body temperatures for effective treatment has hence remained a huge challenge as what might be required then is the extraction of excess heat rather than heat supply by the incubation system. This has often led to longer periods of admission as treatment of the thermally unstable neonates becomes less effective.

We hypothesise that some measures of environmental heat minimisation within the nursery building can reduce the observable incubator overheat and hence improve thermal stability in the neonate.

## Materials and methods

The incidence and consistency of weather-dependent incubator over-warming were preliminarily monitored in 16 referral centres across four tropical climatic zones in Nigeria. Site and building parameters that might be aiding the adverse effect of high sun intensity on the incubators in these centres were identified and noted. These include (1) the positioning of the nursery building within the hospital complex in relation to the direction of sun-rise and sunset (2) building design and materials used for the interior (3) the roof design and materials (4) presence of trees or other buildings shading nursery from direct heat of the sun etc.

One referral centre was chosen for in-depth study to identify how changes in weather conditions varied with the ability of the incubators to maintain set-point. This was at the Neonatal Intensive Care Unit (NICU) of the University of Ilorin Teaching Hospital (UITH) Nigeria. A weather monitoring device (Touch Screen weather station W-8681, Germany) and its accessories were installed outside the neonatal nursery building without any meteorological obstructions. This measured and reported the weather changes on the outside environment of the nursery. The weather station's display and remote monitoring modules were mounted on a stand inside the nursery, amongst the incubators. This monitored the environmental changes within the nursery, displaying all recordings and also transferring the