



Physiologic Effects of Electrically Grounding Preterm Infants in the NICU

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Introduction

Preterm infants cared for in a modern NICU are exposed to electromagnetic fields (EMFs) from incubators and other electrical equipment. These fields create a measurable charge on newborn's skin when referenced to ground (floating skin voltage). In adults, electrical grounding (EG) reduces this charge and improves parasympathetic tone, suggesting a reduction in stress. To our knowledge, no studies have examined the effects of EG on preterm infants cared for in the high-tech environment of the NICU.

Objectives

- 1) To determine if EG lowers floating skin voltage
- 2) To measure the effect of EG on vagal tone.

We hypothesized that EG would improve parasympathetic tone as measured by high frequency power in spectral analysis of heart rate variability (HF-HRV).

Methods

To measure floating skin voltage, a voltmeter was connected to the infant's skin using a wire and standard snap electrode and to the dedicated ground pin in the bedside console. To provide electrical grounding (EG) an additional electrode was placed on the infant and the connecting wire, which extended outside the incubator, was inserted into the ground outlet. To measure the effect of EG on HRV, the analog EKG signal from infant's bedside monitor was digitally captured for a duration of 20-40 minutes while standardizing for time of day, environmental stimuli and post-feeding behavioral state. HRV was calculated by averaging the results of 3-4 repeated 2 min recordings during epochs which represented the time before, during and after EG. Grounding was discontinued by removal of the wire from the ground outlet without handling the infant. For each epoch of sampling, HRV spectral analysis was used to determine HF-HRV at the 0.3-1.3 Hz bandwidth.

Results

Fig 1 Floating Skin Voltage of Preterm Neonates in the NICU

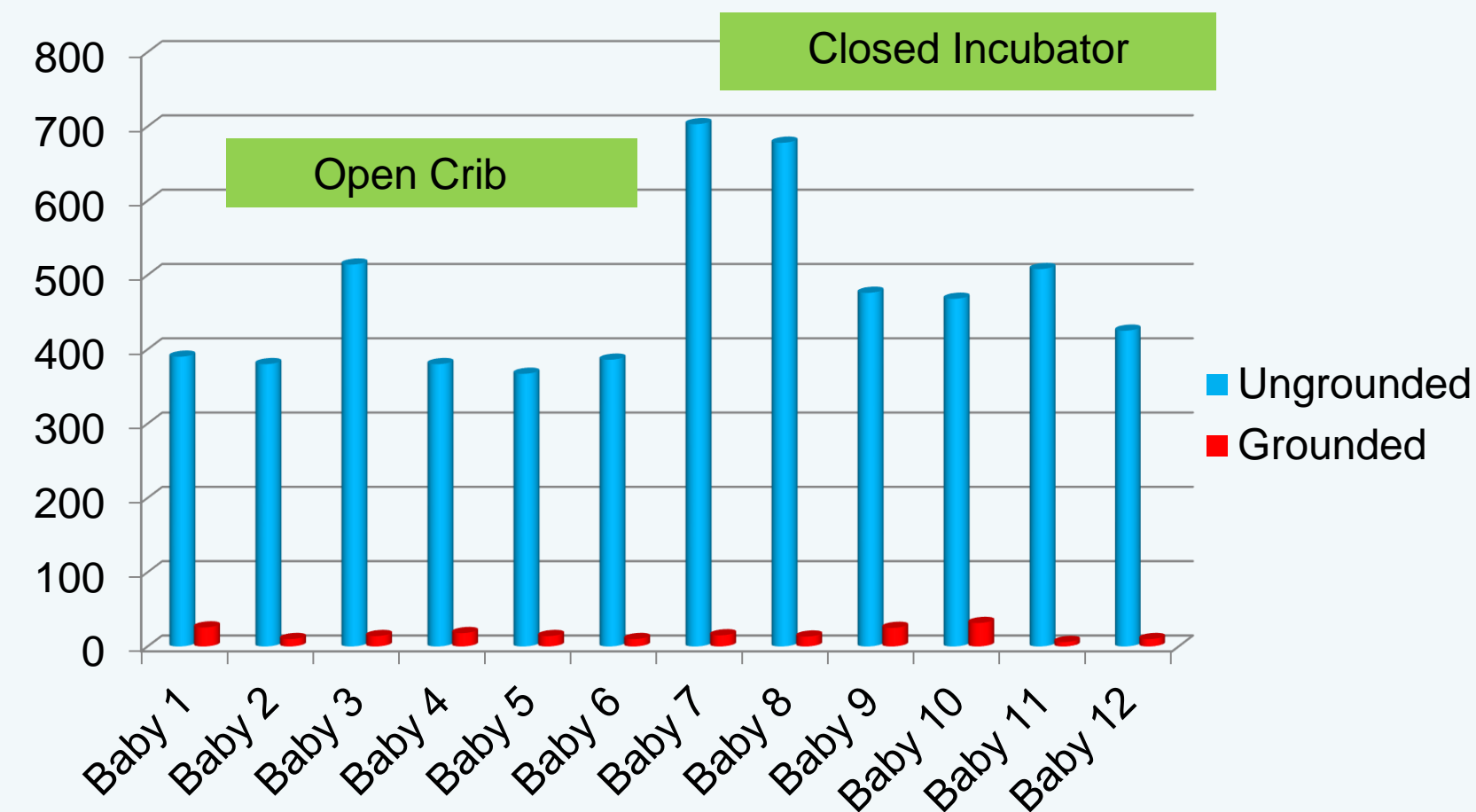
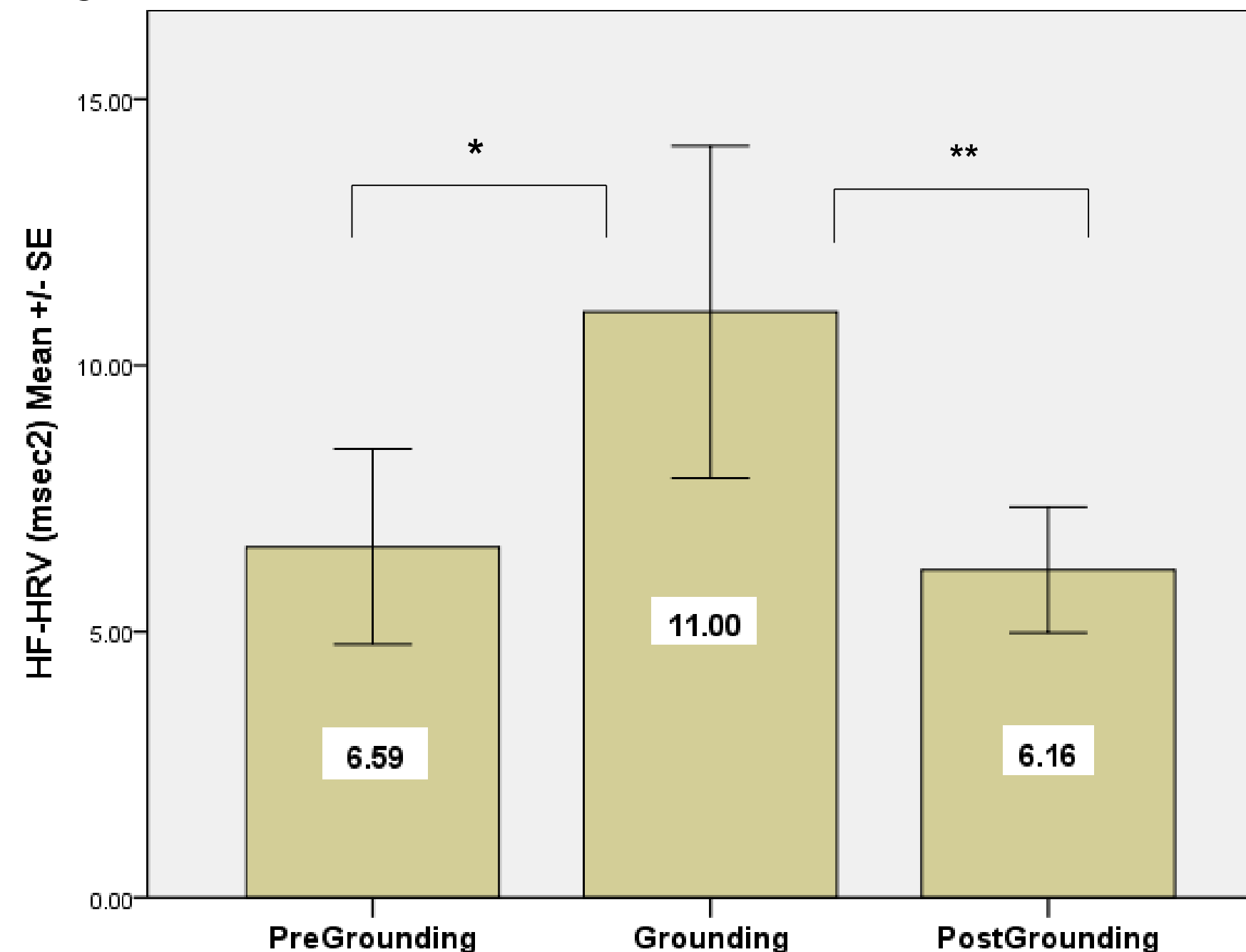


Fig 2 Effect of Electrical Grounding on Parasympathetic Tone (N=20)



RM-ANOVA *PreGrounding to Grounding (P=0.001) and **Grounding to PostGrounding (P=0.006)

Results

Prior to Electrical Grounding (EG), the skin voltage ranged between 39 -1,660 mvolts and upon EG, there was an immediate reduction in skin voltage by 93% (See Fig1 for representative cases). Vagal tone measured by HF-HRV increased during EG by 66.9%, RM-ANOVA (p =0.001) and decreased by 44% when grounding was discontinued,(p=0.006) (See Fig 2 for details).

Discussion

In this study, floating skin voltage varied among infants. Electrical Grounding was associated with a lowering of skin voltage. In addition, grounding led to an increase in HF-HRV of nearly 67%, indicating an improvement in vagal tone. The effect of EG was lost when grounding was discontinued. Tonic activity of the parasympathetic system (vagal tone) is critically important in the regulation of inflammatory and stress systems. EG may provide a means to enhance vagal tone and thereby improve stress regulatory mechanisms in preterm infants.

References

1. American Heart Association (AHA) Task Force of the European Society of Cardiology the North American Society of Pacing Electrophysiology (1996). *Heart rate variability: Standards of measurement, physiological interpretation, and clinical use.* **Circulation** 93: 1043-1065.
2. Bellieni, C. V., M. Acampa, et al. (2008). *Electromagnetic fields produced by incubators influence heart rate variability in newborns.* **Archives of Disease in Childhood. Fetal and Neonatal Edition** 93(4): F298-301.
3. Chevalier, G., K. Mori, et al. (2006). *The effect of earthing (grounding) on human physiology.* **European Biological Medicine** 2(1): 600-621.
4. Chevalier, G. and S. T. Sinatra (2011). *Emotional stress, heart rate variability, grounding and improved autonomic tone: Clinical applications.* **Integrative Medicine** 10(3): 16-21.
5. Doheny, K. K., C. Palmer, K. N. Browning, P. Jairath, D. Liao, F. He and R. A. Travagli (2014). *Diminished vagal tone is a predictive biomarker of necrotizing enterocolitis-risk in preterm infants.* **Neurogastroenterology and Motility**: doi: 10.1111/nmo.12337.
6. Gordin, Y., Doheny, K.K. and C. Palmer (2012). *Extremely low frequency magnetic fields (ELF-MFs) measured within and surrounding standard neonatal intensive care incubators.* **Pediatric Academic Societies Meeting, E-PAS**, 4524.284.
7. Sokal, K. and P. Sokal (2011). *Earthing the human body influences physiologic processes.* **Journal of Alternative and Complementary Medicine** 17(4): 301-308.