Original Investigation

# Impact of an Infant Transport Mattress on CT Dose and Image Quality

William F. Sensakovic, PhD, Ali Agha, BS, Matthew Hough, MS, Baiywo Rop, MD, Joseph Howley, MS, Angela Donohoe, MS, Laura Varich, MD

**Abbreviations and Acronyms**

**ITM**
infant transport mattress

**CT**
computed tomography

**AP**
anteroposterior

**$CTDI_{vol}$**
computed tomography dose index

**ROI**
region of interest

**TCM**
tube-current modulation

**SSDE**
size-specific dose estimate

**HU**
Hounsfield units

**Rationale and Objectives:** Neonates are at increased risk for cold stress and hypothermia in cool environments. An infant transport mattress (ITM) is commonly used to increase neonate temperature during transport and has been used during CT scanning. This study determined the impact of an ITM on radiation dose and image artifacts during CT scanning.

**Materials and Methods:** CT images from a single clinical patient scanned with an ITM were reviewed, and observations of image artifacts were recorded. A phantom was scanned with and without the ITM while varying tube-current modulation, reconstruction method, slice thickness, metal reduction algorithm, tube voltage, and tube current. The effects of the ITM on computed tomography dose index ($CTDI_{vol}$), mean Hounsfield unit (HU), and HU standard deviation were recorded.

**Results:** The clinical patient scan demonstrated significantly decreased mean HU and increased HU standard deviation. In the phantom, the ITM increased $CTDI_{vol}$ 27% and induced an artifact that decreased the mean HU by 3.5 HU and increased HU standard deviation by 4.6 HU. Angular tube-current modulation, strong iterative reconstruction, thick slices, metal artifact reduction, and high mA reduced the artifact.

**Conclusions:** Using ITM during CT scanning is not recommended given the relatively brief scanning time, increased dose, and induced image artifacts. Based on our results, several acquisition parameters may be altered to mitigate the image artifact if an ITM is required during scanning.

**Key Words:** Neonate; Image artifact; Radiation dose; Computed tomography; Transport mattress.



## INTRODUCTION

Thermal maintenance of the patient is an essential aspect of neonatal care, especially in pre-term (1) and low birth weight infants (2). Cold stress and possible hypothermia due to loss of thermal maintenance can contribute to increased morbidity and mortality (3,4). Previous studies have demonstrated that covering the patient with a polyethylene wrap immediately after birth reduces cold stress and rates of hypothermia among neonates in the delivery room (5). Similarly, a specially designed warming infant transport mattress (ITM) placed under the neonate during transport has been shown to increase admission temperature and decrease the incidence of hypothermia (2,6). The use of a polyethylene or a warming mattress has also been endorsed by the American Heart Association (7) and American Academy of Pediatric (8). In a survey of English neonatal units, 25.2% of units employed a warming mattress either alone or in conjunction with a polyethylene wrap for premature infants (9).

Little information currently exists related to neonatal cold stress and hypothermia during imaging. One brief study from 1980 (10) suggests using a warming mattress during computed tomography (CT) scanning to decrease cold stress and the chance of hypothermia; however, studies using modern CT technology do not exist. Modern CT scanners implement several automatic exposure control technologies to reduce patient radiation dose and improve image quality. Although these technologies typically lead to reduced patient radiation dose, it is possible that the presence of a foreign object could confuse the automatic exposure control algorithms leading to increased patient radiation dose. Further, a foreign object could alter beam characteristics and cause image artifacts (11,12).

This study reviews a patient's CT scan that was acquired with an ITM and performs phantom studies quantitatively

**Acad Radiol 2015; ■:■■–■■**

From the Imaging Administration, Florida Hospital, 601 E. Rollins Street, Orlando, FL 32803 (W.F.S., A.A., L.V.); Florida Hospital, Altamonte Springs, Florida (M.H., J.H., A.D.); Radiology Residency, Florida Hospital, Orlando, Florida (B.R.). Received September 9, 2015; revised September 9, 2015; accepted October 10, 2015. **Address correspondence to:** W.F.S. e-mail: wfsensak@gmail.com


http://dx.doi.org/10.1016/j.acra.2015.10.011

measuring radiation dose and image artifact characteristics while varying acquisition parameters. We hypothesize that an ITM will cause image artifacts and will increase radiation output to the patient. We also determine how varying acquisition parameters impact radiation output and image artifacts caused by the ITM.

## MATERIALS AND METHODS

The project received institutional acknowledgment from the Florida Hospital Office of Research Administration. The ITM used for all scans in this study was a TransWarmer Infant Transport Mattress (Cooper Surgical, Trumbull, CT). The ITM consists of a laminated nylon bag ($0.26 \pm 0.02$ mm thick when empty) filled with sodium acetate, water, and thickeners, which crystallize in an exothermic reaction when a stainless-steel disk ($0.51 \pm 0.02$ mm thick and $19.55 \pm 0.04$ mm diameter) contained within the bag is flexed. Sodium acetate has an effective atomic number of 8.6 and linear attenuation coefficient at typical CT effective energies (70 keV) of 0.283 (1/cm). All CT images were acquired after crystallization of the mattress to simulate clinical use of the ITM. Both patient and phantom CT scans were performed on the same Philips Ingenuity 128-slice CT scanner (Philips, Andover, MA). Images of the phantom and mattress are shown in Figure 1.

### Clinical Patient Scan

Images from a patient (3 wks, male, 3 kg) with a congenital melanoma were retrospectively collected. The patient had undergone post-resection abdomen/pelvis contrast-enhanced CT scanning with 6 ml of Optiray 300 to screen for metastasis

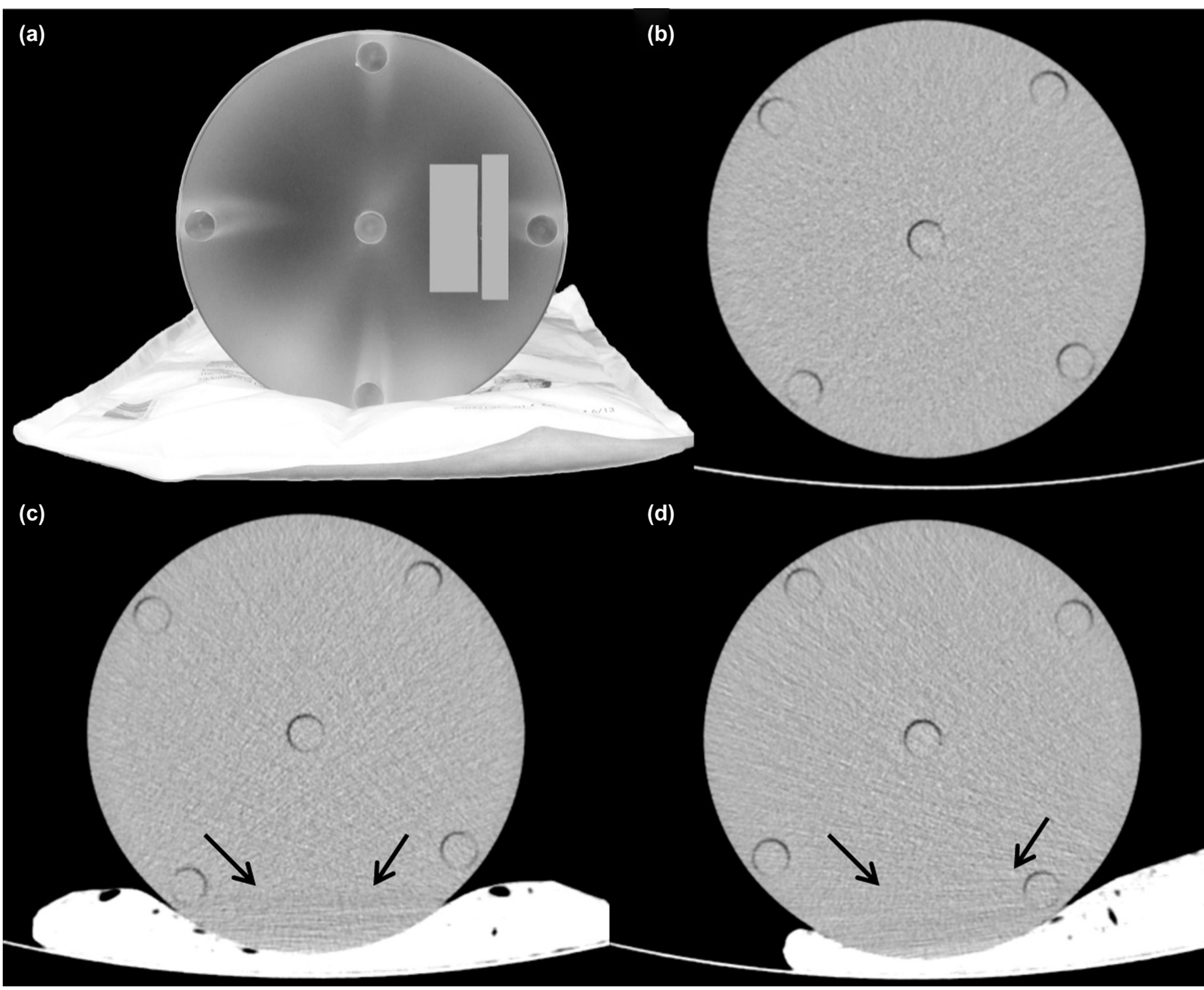


**Figure 1.** Phantom and ITM. (**a**) Photograph of the CTDI phantom and ITM. (**b** and **c**) CT image of phantom using the baseline acquisition parameters without ITM (**b**) and with ITM (**c**). Note the artifact induced by ITM (*arrows*). (**d**) CT image of phantom and ITM in the shifted ITM acquisition. Note that the noise and gray-level artifacts induced by the ITM appear less severe in the shifted ITM acquisition (*arrows*). Window: 360; Level: 40. CT, computed tomography; CTDI, computed tomography dose index; ITM, infant transport mattress.