Correlation of $_{Tc}CO_2$ Values with $_{Pa}CO_2$ Values in a Limited Set of Critically Ill Neonates

John W. Schmidt, M.D., Jessica P. Holland, M.D., and William F. Walsh, M.D.
Pediatrics, Monroe Carell Jr. Children's Hospital at Vanderbilt, Nashville, TN.

Study Background

Currently, the gold standard to determine the arterial carbon dioxide tension ($_{Pa}CO_2$) in critically ill neonates requires periodic arterial blood sampling. A new device, the SenTec Digital Monitor (Therwill, Switzerland), has the ability to obtain continuous, non-invasive transcutaneous carbon dioxide tension ($_{Tc}CO_2$). If the $_{Tc}CO_2$ and $_{Pa}CO_2$ values correlate in a clinically meaningful fashion, the non-invasive and continuous technique of monitoring ventilation would be very useful, especially if it could be safely used on a wide range of neonates.

Objectives

-To assess the correlation of $_{Tc}CO_2$ measurements obtained from the SenTec Digital Monitor with the standard of care $_{Pa}CO_2$ values obtained from arterial blood gas samples in a limited set of critically ill neonates.

-To determine if there were any negative effects on the skin caused by the device.

Methods

-Inclusion criteria:
Current weight > =1000gms, need for mechanical ventilation, arterial access and signed informed consent by parents/legal guardians.
-The SenTec Digital Monitor sensor was placed on the abdominal wall of the patient per directions of the manufacturer. When a routine ABG sample was obtained, the reading on the device was recorded.
-A photograph of the abdomen was taken before placement and after removal of the monitor to evaluate for injury to the skin. Following completion of the study, the photographs were randomized and a blinded reviewer rated them as normal, mild erythema or burn/blistering.
-Study was approved by the IRB.

Table 1- Patient Characteristics (n = 15)

Study #	Gestational age	BW (gm)	Diagnosis	Ventilation	Pressors	Time-on monitor (hours)
1	33.5	2380	Prenatal atrial flutter	Conventional	No	51
2	37		Pulm. htn	Conventional	Yes	40
3	34	2060	Right dysplastic kidney	Conventional	No	31
4	38	2002	Pulm. htn	HFOV	Yes	51
5	40	2940	TOF	Conventional	No	21
6	31	1720	Left CDH	Conventional	No	37
7	39	2550	Left CDH	Conventional	No	41
8	40	3420	d-TGA	Conventional	No	21
9	40	2807	d-TGA	Conventional	No	8.5
10	35.6	2950	Cloaca	HFJV	Yes	19
11	41	3062	Left CDH	HFJV	Yes	20.5
12	40	2800	Urea cycle	Conventional	No	10
13	30.1	2590	Hydrops	HFOV	Yes	41.5
14	37	3160	Left CDH	HFOV	Yes	16
15	27	1000	Prematurity	Conventional	No	18

Figure 1 – Photographs

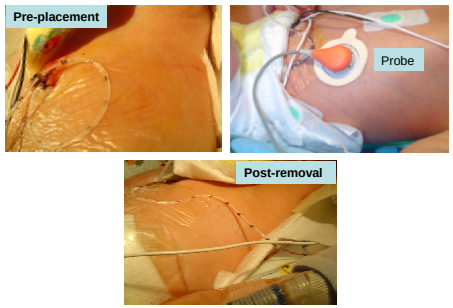


Figure 2

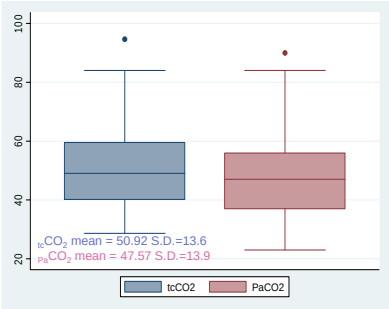


Figure 3

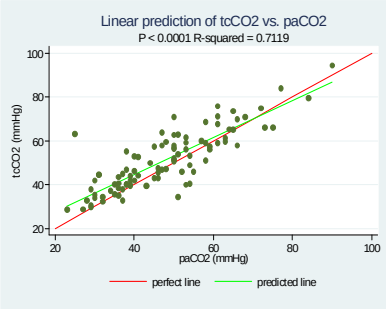


Figure 4

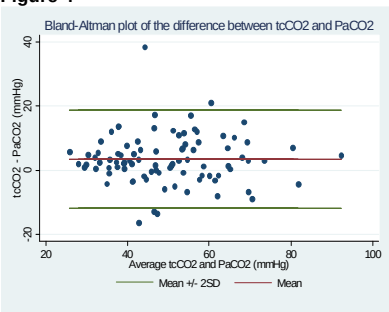
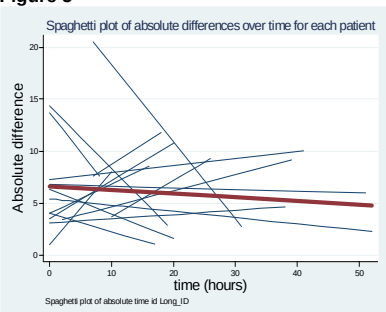


Figure 5



Results

-A total of 15 patients were enrolled in the study with gestational ages ranging from 27week to term.
-Fig. 1 - Blinded review of photographs confirmed investigators exams revealing no adverse skin changes.
-Fig. 2 –The mean $_{Tc}CO_2$ was slightly higher than the mean $_{Pa}CO_2$.
-Fig. 3 –The correlation of $_{Tc}CO_2$ and $_{Pa}CO_2$ values is significant ($P<0.0001$, $r^2=0.7119$).
-Fig. 4 –The $_{Tc}CO_2$ overestimated the $_{Pa}CO_2$ level with a mean difference and a S.D. of the differences of 3.45 +/-7.66.
-Fig. 5 – Over time, the absolute difference between the $_{Tc}CO_2$ and $_{Pa}CO_2$ values tended to improve.

Conclusions

-$_{Tc}CO_2$ measurements obtained from the SenTec Digital Monitor sensor correlated with $_{Pa}CO_2$ values obtained from arterial blood gas samples in a clinically relevant manner.

-The device was safe, not causing any adverse skin changes in this limited set of critically ill neonates.

Limitations and future directions

-The maintenance of proper probe placement by bedside staff was variable, but improved with familiarity with the device.

-Evaluation of ease of use and cost effectiveness should be considered.

-Efficacy in infants <1000gms should also be evaluated.