Publication Brief

Novel Ultrasound Dilution Technology To Routinely Measure Blood Volumes in Pediatrics and Neonates (In Vitro Validation)

Transonic Systems Inc., Ithaca, NY

BACKGROUND
- Vascular volume status is crucial in the care of the critically ill patients.
- No existing method can be routinely used with neonates and pediatrics due to inherent limitations including small vessel sizes of the patients and invasiveness of the method.

OBJECTIVE
To present the theory and in-vitro validation of a new ultrasound dilution (UD) method using isotonic saline as an indicator for measurement of CBV (volume in heart and lungs); TEDV (sum of end-diastolic volumes of the atria and ventricles) and ACV (blood volume in which the indicator mixes in one minute).

STUDY
ULTRASOUND FLOW/DILUTION MEASUREMENTS: An extracorporeal AV loop was connected between the clinical catheters in an in-vitro patient model. Reusable UD sensors were used with HCP101 system (Transonic Systems Inc, USA) to measure the volumes, upon injection of 0.3–10 ml body temperature saline into the AV loop. Two variations of the model were used to mimic neonatal and pediatric conditions.

RESULTS
CO, CBV, TEDV and ACV were determined both by dilution and volumetrically. Accuracy is estimated by the absolute percentage difference (\( \text{delta} = \text{Mean} \pm \text{SD} \)) between the two methods. Saline concentration in blood stabilizes in 40-60 secs from the time of injection and this is used to calculate ACV.

<table>
<thead>
<tr>
<th>PARAMETER</th>
<th>N</th>
<th>NEONATE</th>
<th>PEDIATRIC</th>
<th>NEONATE (( \text{delta} ))</th>
<th>PEDIATRIC (( \text{delta} ))</th>
</tr>
</thead>
<tbody>
<tr>
<td>CO (ml/min)</td>
<td>245</td>
<td>106 - 370</td>
<td>212 - 1200</td>
<td>4.4 ± 4.1</td>
<td>4.0 ± 3.0</td>
</tr>
<tr>
<td>CBV (ml)</td>
<td>245</td>
<td>50 - 62</td>
<td>59 - 315</td>
<td>4.4 ± 4.1</td>
<td>4.6 ± 3.1</td>
</tr>
<tr>
<td>TEDV (ml)</td>
<td>225</td>
<td>N/A</td>
<td>24 - 211</td>
<td>N/A</td>
<td>4.1 ± 3.1</td>
</tr>
<tr>
<td>ACV (ml)</td>
<td>44</td>
<td>104 - 247</td>
<td>247 - 645</td>
<td>5.4 ± 4.4</td>
<td>3.3 ± 3.1</td>
</tr>
</tbody>
</table>

STUDY’S CONCLUSIONS
- Cstatus® UD technology can accurately measure flows and volumes in neonates and pediatrics.

COSTATUS® OBSERVATIONS
- Ultrasound dilution technology works with existing arterial and venous catheters in ICU patients. Therefore, it can be routinely used to assess fluid status in the critically ill.
- The minimally invasive technology uses an extracorporeal AV loop and can be used with any age or size patients.

REFERENCES
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