Title: Non-invasive, Simple, but, Accurate Enough? : Meta-analysis for the Evidence-Based Point of Care Ultrasound in Assessing Dehydrated Children

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Key message

- Point-of-care ultrasound imaging, including the inferior vena cava/aorta ratio, has been assumed as a powerful tool for evaluating the hemodynamic status of pediatric patients.

- Due to the limited feasibility of randomized clinical trials and insufficient data in children, validation of imaging tools is necessary.

- Objective validity studies using meta-analysis of imaging studies can affect clinical decision-making and serve as a cornerstone for evidence-based practice in pediatric patients.
Dehydration affects young children more seriously than adults and can have devastating consequences, including fatality. In a clinical setting, it cannot be overstated that the importance of detailed history-taking and physical examination in searching for signs of dehydration in infants and children who have limited verbal expressions and difficulty in getting blood samples. However, abnormal capillary refill time, skin turgor, and respiratory patterns are known to have poor sensitivity, necessitating additional diagnostic modalities for small dehydrated children.

Recent remarkable advances in non-invasive imaging have made clinical hemodynamic assessment of patients ready, and cost-effective, although the accurate results still depend on the learning curves of practitioners. Point-of-care ultrasound has been widely applied in pediatric patients for several decades.

The changes in inferior vena cava (IVC) diameters in response to respiration, observed through a standardized subcostal sonographic window, have been used to screen for severe hypovolemia and predict response to fluid therapy in adults. In this context, point-of-care sonography using IVC versus aorta (Ao) ratio (IVC/AO) to assess the physical dehydration status has garnered attention as a non-invasive ancillary imaging modality in dehydrated children. Factors that influence the interpretation of IVC measurements include ventilator settings, patient’s inspiratory efforts, lung hyperinflation, cardiac conditions impeding venous returns, and increased abdominal pressure. Special considerations in pediatric cases are that the IVC can be manually compressed by excessive probe pressure on the abdominal wall, and patients may not be developmentally mature enough to comply with a “sniff test”. IVC measurements vary with growth and must be interpreted in the context of body surface area. Applying the IVC/Ao ratio, which is non-invasive, handy, and yields prompt results in practices, requires validation of its accuracy, cost-benefit analysis, and the effects of the aforementioned
factors that can lead to biased results in the peculiarity of pediatric patients who might be scared during the procedure. Recently, many papers have been published scrutinizing the usefulness of the IVC/Ao ratio in assessing dehydration status in pediatric patients, while some suggest it is not accurate enough as a screening tool in dehydrated children under five years. At this point, we need more extensive validation studies in pediatric patients with recent emerging powerful study methods using meta-analysis.

An important study titled “Inferior Vena Cava to Aorta Ratio in Dehydrated Pediatric Patients: A systemic Review and Meta-Analysis” published in Clinical and Experimental Pediatrics approached this issue with objective validity. As for the statistical significance actually translated into clinical significance, the meta-analysis should examine the variables that can influence the effect size and heterogeneity of studies. This study noticeably examined the quality assessment thoroughly by the authors. The authors revealed a good sensitivity of 86% and a moderate specificity of 73% of IVC/Ao diameter ratio, in the receiver operating curve. However, the likelihood ratio (LR) can provide revised probability of disease and appear as preferable indices in clinical decision-making. Using numerical descriptors of LR, this study provided with a slight increased positive LR of 3.2, and decreased negative LR of 0.18, with visualized summary LR on the right lower quadrant on scattergram, along with combined predictive values. The authors concluded that the IVC/Ao ratio is insufficient to exclude or confirm significant dehydration, reiterating as the IVC/Ao ratio may only be good in test research and not diagnostic research. This systematic study offers an important perspective in clinical decision-making, providing with an in-depth discussion searching for evidence in pediatric patients.

There has been a scientific statement defining quality in cardiovascular imaging. This type of ultrasound imaging, as a complement to clinical data, is recommended to be problem-oriented
and consider the patient’s physiology according to their age. A recent report from the American Society of Echocardiography published recommendations for cardiac point-of-care ultrasound (POCUS) in children, taking into account anatomic and physiologic differences between growing children and adults. This aims to facilitate collaboration among subspecialties, establish indications, recommendations, and assess training for quality assurance. Proposed indications for cardiac POCUS are the evaluation of hypotension, shock, and circulatory arrest, preload and volume responsiveness, size and function of ventricles, and the presence of pericardial effusion. Typically, the precise result of a sonogram depends on the patient’s cooperation and intra- and inter-observer variability. Even a simple technique like the IVC/Ao ratio has pitfalls due to causes that elevate intra-abdominal pressure, especially when infants cry vigorously. We lack established multicenter, large-cohort pediatric normal values for age, as the IVC diameter changes with the age of growing children.

In this regard, this paper presents the cornerstone for the future of evidence-based treatment by addressing the question, ‘Is this non-invasive, simple clinical point-of-care ultrasound absolutely reliable in dehydrated children?’ answering ‘As long as it is interpreted in a comprehensive manner based on more evidence-based studies complement to the clinical findings of children undergoing their somatic growth’.

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