

Noninvasive and simple, but accurate? Meta-analysis of evidence-based point-of-care ultrasound for assessing dehydration in children

Jin-Hee Oh, MD, PhD

Department of Pediatrics, St.Vincent's Hospital, College of Medicine, The Catholic University of Korea, Seoul, Korea

Key message

- Point-of-care ultrasound imaging, including measurement of the inferior vena cava/aorta ratio, is powerful for evaluating the hemodynamic status of pediatric patients.
- Owing to the limited feasibility of randomized clinical trials and insufficient data in children, imaging tools require validation.
- Objective validity meta-analyses of imaging studies can affect clinical decision-making and serve as a cornerstone for evidence-based practice in pediatrics.

Dehydration affects young children more seriously than adults and can have devastating consequences, including fatalities. In the clinical setting, it cannot be overstated that a detailed history-taking and physical examination are important for identifying signs of dehydration in infants and children who have limited verbal expressions and find it difficult to undergo blood sampling. However, abnormal capillary refill time, skin turgor, and respiratory patterns have poor sensitivity, necessitating additional diagnostic modalities for identifying dehydration in children.

Although recent remarkable advances in noninvasive imaging have made clinical hemodynamic assessments of patients easy and cost-effective, the accuracy of their results still depends on the learning curves of practitioners. Point-of-care ultrasound (POCUS) has been widely used in pediatric patients for several decades.

The changes in inferior vena cava (IVC) diameter in response to respiration, observed through a standardized subcostal sonographic window, have been used to screen for severe hypovolemia and predict a patient's response to fluid therapy in adults.¹⁾ In this context, point-of-care sonography using IVC versus aorta (Ao) ratio (IVC/Ao) to assess physical dehydration status has garnered attention as a noninvasive ancillary imaging modality in dehydrated children. Factors that influence the interpretation of IVC measurements include ventilator settings, a patient's inspiratory efforts, lung hyperinflation, cardiac conditions impeding venous return, and increased abdominal pressure.²⁾

In pediatric cases, 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.³⁾ Applying the IVC/Ao ratio, which is noninvasive and handy and yields prompt results in practice, requires validation of its accuracy, cost-benefit, and the effects of the aforementioned factors that can lead to biased results since pediatric patients might be afraid during the procedure. Recently, many papers have been published that scrutinize the usefulness of the IVC/Ao ratio in assessing the dehydration status of pediatric patients,⁴⁾ while some suggest that it is insufficiently accurate as a screening tool in dehydrated children <5 years of age.⁵⁾ At this point, more extensive validation studies are needed of pediatric patients using emerging powerful study methods and meta-analyses.

An important study entitled “Inferior vena cava to aorta ratio in dehydrated pediatric patients: a systematic review and meta-analysis,” published in *Clinical and Experimental Pediatrics*, approached this issue with objective validity.⁶⁾ As for the statistical significance actually translated into clinical significance, the meta-analysis should examine the variables that can influence study effect size and heterogeneity. This study thoroughly examines the quality assessments conducted by the authors. The authors revealed a good sensitivity of 86% and a moderate specificity of 73% for the IVC/Ao diameter ratio in the receiver operating characteristic curve. However, the likelihood ratio (LR) can provide a revised probability of disease and appear as preferable indices in clinical decision-making.⁷⁾ Using numerical descriptors of LR, this study provided a slightly increased positive LR of 3.2 and a decreased negative LR of 0.18, with a visualized summary LR on the right lower quadrant on the scattergram along with combined predictive values. The authors concluded that the IVC/Ao ratio was insufficient to exclude or confirm significant dehydration, reiterating that it may be useful in test versus diagnostic research. This systematic study offers an important perspective for clinical decision-making and provides

Corresponding author: Jin-Hee Oh, MD, PhD. Department of Pediatrics, St.Vincent's Hospital, The Catholic University of Korea, 93, Jungbudaero, Paldal-gu, Suwon 16247, Korea

✉ Email: jeany@catholic.ac.kr, <https://orcid.org/0000-0002-2893-0563>

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an in-depth discussion of evidence in pediatric patients.

A scientific statement defines cardiovascular imaging quality.⁸⁾ This type of ultrasound imaging, as a complement to clinical data, is problem-oriented and considers the patient's physiology according to age. A recent report from the American Society of Echocardiography published recommendations for cardiac POCUS in children that consider the anatomical and physiological differences between growing children and adults. It aims to facilitate collaboration among subspecialties, establish indications and recommendations, and assess training for quality assurance.⁹⁾ Proposed indications for cardiac POCUS include the evaluation of hypotension, shock, and circulatory arrest; preload and volume responsiveness; ventricular size and function; and the presence of pericardial effusion.⁹⁾ Typically, the precise result of a sonogram is dependent on patient cooperation and intra- and interobserver variability. Even a simple technique such as the IVC/Ao ratio has pitfalls due to causes that elevate intra-abdominal pressure, especially when infants cry vigorously. However, established multicenter large-cohort pediatric normal values for age are lacking.¹⁰⁾

In this regard, this paper⁶⁾ 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?" with the answer "As long as it is interpreted comprehensively based on more evidence-based studies whose findings complement the clinical findings of growing children."

See the article "Inferior vena cava to aorta ratio in dehydrated pediatric patients: a systematic review and meta-analysis" via <https://doi.org/10.3345/cep.2022.01445>.

Footnotes

Conflicts of interest: No potential conflict of interest relevant to this article was reported.

ORCID: Jin-Hee Oh  <https://orcid.org/0000-0002-2893-0563>

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