High-Frequency Jet Ventilation Is Making Slow Inroads to the Pediatric ICU

High-frequency jet ventilation (HFJV) and high-frequency oscillatory ventilation (HFOV) have been used as both elective and rescue therapy for respiratory distress syndrome and other causes of respiratory failure in neonates. Both modalities are thought to enhance ventilation by bulk convection, turbulence, asymmetric air flow velocities, pendelluft, cardiogenic mixing, laminar flow with Taylor dispersion, collateral ventilation, and molecular diffusion.^{1,2} HFJV differs from HFOV in several ways. First, HFJV is used in combination with conventional mechanical ventilation, with invasive ventilation providing PEEP and tidal breaths termed “sighs.”^{3,4} The jet flow is created by a valve that releases jets of gas into the inspiratory limb through a small cannula centered in the endotracheal tube adapter, with expiration occurring passively.^{3,4} In HFOV, oscillatory pressure is generated through movement of a piston or diaphragm, and both inspiration and expiration are active.^{3,4} Use of HFJV has been traditionally restricted to neonates because their lower lung compliance allows for greater passive exhalation. No studies have compared HFJV and HFOV in subjects with respiratory distress syndrome.⁵ Furthermore, little evidence exists comparing HFJV to conventional mechanical ventilation,⁶ and published literature on HFJV has generally been limited to small case series.⁷⁻⁹

In this issue of *RESPIRATORY CARE*, Miller et al¹⁰ report on the use of HFJV in a young pediatric population using a single-center retrospective case series. The subjects are slightly older and more clinically diverse than previously published studies on HFJV. The authors describe how their pediatric ICU uses HFJV as an intermediate mode between invasive ventilation and HFOV and report the effects of HFJV on measures of pulmonary mechanics and gas exchange. In subjects who remained on this ventilator modality, HFJV improved ventilation as measured with both pH and P_{aCO_2} , but it had minimal effect on oxygenation. Of 35 subjects, 51% (18) were successfully transitioned from HFJV to invasive ventilation; 15 (43%) required transition to extracorporeal membrane oxygenation or other high-frequency modalities, and 9 (26%) did not survive. As the authors note in their discussion, only subjects who tolerated HFJV were analyzed at later end

points, with nonresponders transitioning to other support modalities resulting in survivor bias at these later time points. While there is no reason to believe that adverse events such as pneumo-

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thorax would be more likely during HFJV than during conventional mechanical ventilation, the absence of such events is not reported. Lastly, with a median age of 2.9 months, the findings are only applicable to a fraction of the pediatric ICU population.

These comments notwithstanding, this report is an important addition to the literature on HFJV and demonstrates it as an acceptable alternative to HFOV for hypercarbic respiratory failure unresponsive to conventional mechanical ventilation in young infants. As one might expect with a therapy with the same mean airway pressure as invasive ventilation, HFJV does not substantially improve oxygenation, but it does not appear to be detrimental either. Although the authors did not comment on the benefits of HFJV over HFOV, one might imagine that infants treated with HFJV would have reduced sedative and neuromuscular blockade requirements. Future studies on HFJV in the pediatric ICU should compare the change in oxygenation index on HFJV with similar infants receiving conventional mechanical ventilation and possibly HFOV. Additionally, future studies should attempt to determine whether there is an age at which increasing lung compliance makes HFJV ineffective. While a randomized controlled trial of HFJV is unlikely, such data could be collected in a prospective observational manner with propensity matching of subjects at the same or other institutions. The role for HFJV in the pediatric ICU is not yet clearly defined, but thanks to Miller and colleagues,¹⁰ we now have a starting place.

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The authors have disclosed no conflicts of interest.

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DOI: 10.4187/respcare.08797

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