

## What's to Be Learned From 10 Patients in One Pediatric ICU?

Treatment strategies for patients with acute lung injury (ALI) and ARDS have improved markedly in the past 2 decades.<sup>1,2</sup> Despite these improvements, mortality and morbidity remain high in affected patients, and the optimal ventilation strategy for these patients remains controversial.<sup>3</sup> There is general consensus, based primarily on adult studies, that low-tidal-volume strategies are associated with improved survival<sup>4</sup>; however, such strategies are not successful in all patients, and may also be associated with progressive lung collapse. Moreover, derecruitment itself may perpetuate lung injury, further exacerbating the initial insult.<sup>5</sup>

Various recruitment maneuvers have been proposed as adjuncts to low-tidal-volume ventilation, to improve pulmonary function in patients with ALI and ARDS; however, few data exist to either support or refute their effectiveness.<sup>6,7</sup> Multiple studies have demonstrated short-term recruitment maneuver benefits in lung inflation, oxygenation, ventilation, and lung compliance, but data for longer-term benefit are lacking.<sup>8-10</sup> Indeed, there is no evidence that recruitment maneuvers improve survival.

There are several real and potential benefits associated with successful application of recruitment maneuvers. First, repetitive collapse of vulnerable lung units is a source of lung injury, and successful permanent recruitment of such units would serve to improve pulmonary function and reduce ongoing injury. Several studies in pediatric patients have shown improvements in oxygenation for 6–12 hours following recruitment maneuvers.<sup>9,11</sup> Second, given that the mortality for ALI/ARDS remains stubbornly high despite current practices, recruitment maneuvers followed by optimization of PEEP could represent a means of improving outcomes in targeted populations.

Recruitment maneuvers also raise concerns. First, shear injury may not be a ubiquitous cause of ALI/ARDS, and therefore strategies designed to minimize such injury would be ineffective except in specific cases. Second, even if recruitment maneuvers are helpful, it is not clear which recruitment method is most effective, nor what the optimal protocol for application should be.<sup>12</sup> Third, recruitment maneuvers are potentially a source of direct injury, including pneumothorax, subcutaneous emphysema, and hemodynamic instability.<sup>13</sup> Finally, it is not clear that the changes brought about by successfully applied recruit-

ment maneuvers are important drivers of improved outcomes.

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Kheir et al address some of these questions in their paper.<sup>14</sup> This well designed study of the application of 2 specific recruitment maneuvers in 10 children with ALI adds important data to the small but growing body of literature on this subject. Specifically, the authors demonstrate that in a carefully selected population of stable children with ALI, sequential application of recruitment maneuvers is associated with short-term improvements in  $P_{aO_2}$  (well illustrated in their Fig. 3) and functional residual capacity, and, importantly, is well tolerated from a cardio-respiratory perspective. It is also reassuring that most of the patients completed the entire protocol with complete lung opening. Nevertheless, real concerns remain; the patients in this study had significant increases in dead-space ventilation and  $P_{aCO_2}$ , and significant reductions in  $CO_2$  elimination and pulmonary compliance. Perhaps most importantly, lung recruitment and functional residual capacity rapidly returned to pre-recruitment levels, suggesting that this protocol does not adequately address PEEP optimization.

We believe that recruitment maneuvers in pediatric ICUs are not routinely used to maximize oxygenation in children with ALI. Further, we suggest that this derives from a dearth of pediatric data available to the PICU practitioner about the safety and efficacy of such maneuvers. Reports describing small cohorts of 6 or 10 patients, as noted previously, are unlikely to change PICU clinical practice. Yet, despite such concerns, the information provided by Kheir et al supports the notion that a carefully designed ventilation protocol consisting of a specific recruitment strategy, an effective PEEP optimization protocol, and low-tidal-volume ventilation could form the basis of improved care in selected children with ALI. Before this can become routine practice, such a protocol requires further testing in a randomized trial(s), to determine both safety and, more importantly, benefit beyond a short-term increase in oxygenation. Thus, we end by stating that 10 patients can be the harbinger of the larger study that an-

swers the question still often posed: "What is the role of recruitment maneuvers in children and adults with severe ALI/ARDS?"

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The authors have disclosed no conflicts of interest.

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