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Return to Ambulation after Pediatric Liver Transplantation: A First “Step” in Assessing the Impact of Early Mobility

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Over the past few decades, advances in the care of critically ill children have reduced mortality in the pediatric intensive care unit (PICU) significantly (1, 2). While mortality rates in the PICU now range from 2-3%, many more children are left with persistent deficits affecting both their functional abilities and their quality of life (3, 4). Functional decline associated with critical illness is often multi-factorial, related to direct neurologic injury and potentially modifiable factors such as ICU myopathy, deconditioning due to immobility, and pharmacological interventions to provide analgesia, sedation and/or neuromuscular blockade (5, 6). It is often part of a constellation of adverse sequelae referred to as Post-Intensive Care Syndrome (PICS) (7). The prevalence of significant long-term morbidity associated with PICS has appropriately alarmed our community and prompted efforts to prevent and reduce poor outcomes through multiple efforts - including early ICU-based mobility.

Implementation and benefits of early mobility were first described in adult ICUs (8). Critically ill adults participating in early mobility programs had less delirium, shorter lengths of stay, and reduced 1-year mortality compared to usual care or less aggressive ICU-rehabilitation intervention (9, 10). Unfortunately, early mobility in the PICU trailed behind due to unique implementation challenges including poor staffing, variability in the developmental stage of patients, safety concerns and current sedation practices (11, 12).

With significant and coordinated effort, these barriers can be overcome to provide safe and effective early mobility practices in the PICU (13, 14). However, what remains unclear is to what extent, if any, early mobility improves patient outcomes.

Attempting to address this gap in knowledge, Tsuboi *et al.* assessed outcomes of pediatric patients after liver transplantation receiving an early mobility intervention in their PICU (15). Their study published in this issue of *Pediatric Critical Care Medicine* specifically evaluates the impact of an early mobility intervention for pediatric liver transplant recipients on time to independent ambulation following transplant. While the intervention was enacted on all PICU patients, the group chose to limit the heterogeneity of illness in their analysis by focusing only on liver transplant recipients, who frequently have multiple pre-ICU and ICU-based risk factors for developing PICS. They included 35 patients pre-implementation and 40 patients post-implementation who were able to walk prior to their operation. Early mobility was implemented at this center using a 7-step comprehensive approach including increasing resources and multi-disciplinary involvement. With this intervention, Tsuboi *et al.* found that patients who received the early mobility intervention following liver transplant were able to walk five days earlier and had shorter hospitalizations than those receiving transplants prior to implementation of the program.

The authors are to be commended for their dedication towards improving early mobility in their unit. Their early mobility program is comprehensive, multidisciplinary, shows commitment to early rehabilitation and was associated with improved short-term outcomes for liver transplant recipients. Notably, implementation of early mobility in their intensive care required acquisition of new resources, including hiring of two additional physical therapists dedicated to the PICU. At baseline, most PICUs utilize physical and occupational therapists in 29%-46% of patients (16, 17). Successful implementation of early mobility in PICUs, as shown in this study, may require hiring of additional staff or other resources, such as equipment, to support the demand.

As the authors point out, this study was limited by several factors. The comparison of patient outcomes between the pre- and post-implementation groups is limited due to small sample size in a single center, potential differences in severity of illness, and temporal changes in other aspects of care. Patients in the pre-implementation group had more episodes of bacteremia indicating their course may have been more complicated. There is also no mention of neuromorbidity, which occurs in almost one-third of pediatric liver recipients and may result in decline in function independent of immobility (18). Findings from this study may also not be generalizable to all patients in the ICU, especially children previously unable to ambulate due to age or developmental disabilities. However, they do provide a thoughtful blueprint for the development and implementation of a PICU-based early mobility program.

Despite these limitations, data showing improved independent ambulation without adverse effects is exciting and shows promise of improved short-term outcomes with early mobility. However, many questions remain unanswered. First, while early mobility in this specific population was associated with improved short-term functional outcomes, there is no current information regarding long-term outcomes, which are known to be worse than normal in this

population(19). Questions also remain regarding both the short- and long-term benefit of early mobility for the general PICU population, and it continues to be unclear which population stands to benefit the most from early mobility. Furthermore, there is uncertainty regarding optimal timing of initiation, frequency, and duration of early mobility to achieve maximal benefit, as well as if early mobility is more effective when bundled with other practices such as delirium prevention and improved sleep hygiene (20). Finally, given the expense of required equipment and staffing, analyses of the cost-effectiveness of early mobility are necessary. To enhance generalizability, multi-center evaluation of early mobility outcomes is needed to answer these questions.

Overall, this study represents an important step in progressing from assessing safety and feasibility of early mobility to understanding its impact on our patients. With more PICUs adopting early mobility practices, there is an urgent need to understand how this practice will impact our patients' long-term physical function, emotional health, and quality of life. In the future, we hope our care in the PICU leads to children who not only leave the ICU alive, but also are able to return to their homes and families with fewer reminders they were ever sick.

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