Growth Monitoring Through the Continuum of Neonatal Care and its Associated Transitions

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Pediatricians are uniquely aware of the importance of adequate nutrition for short- and long-term health, growth, and development. The risk of acute and sustained nutritional deficits is most commonly and dramatically experienced in ill newborns, who are summarily removed from their fetal transplacental source of nutrition, and then experience a protracted exposure to limited enteral feedings and supplemental parenteral nutrition. This situation results in cumulative deficits of some macro- and micronutrients, which immediately compromise growth, and may ultimately affect somatic growth, neurodevelopment, and overall health.[1] Indeed, the majority of very preterm neonates develop extrauterine growth restriction during their neonatal intensive care unit (NICU) course.[2] Furthermore, inappropriate correction of pre- and postnatal growth deficits may increase the risk of subsequent development of metabolic syndrome.[3]

Deficits in nutrient intakes result from gaps in knowledge of developmental nutrition (including monitoring tools), from inadequacies in sources of nutrition intended for neonates and, importantly, from wide variations in nutritional prescribing practices which account for significant differences in growth rates of preterm infants observed in different NICUs.[1] Such variation might be minimized by close monitoring of growth and timely correction of nutritional inadequacies.

Growth charts display the evolution of anthropometric parameters across stages of neonatal development, thus providing practical, visual tools to monitor adequacy of nutrition across the life stages, thereby allowing immediate adjustments in macronutrient intakes to optimize the growth of individual infants. Defining growth standards is a complex task, particularly for preterm neonates whose postnatal growth is affected by suboptimal early extrauterine nutrition, and additionally confounded by postnatal weight loss due to adaptive extracellular volume contraction; indeed, the acute physiologic water loss which occurs during the fetal to neonatal transition produces an apparent acute pseudo-extrauterine growth restriction condition, which does not directly indicate a nutritional deficit.[4] The American Academy of Pediatrics has recommended "prescriptive" postnatal growth charts for preterm infants, such as the Fenton charts,[5] which are based on idealized fetal growth conditions, with the recognition that such growth standards may not be attainable in practice.[6] However, recent international recommendations favor a new paradigm,[7] using more realistic "descriptive" charts such as those generated by the INTERGROWTH-21st project. Such charts depict actual postnatal growth of preterm neonates with uncomplicated fetal and NICU courses, although they rely on limited data in neonates less than 33 weeks gestation, and they cannot be used in those < 27 weeks gestation.[8] In addition, a tool that generates individualized postnatal growth trajectories has been published,[9] but it is restricted to weight, and it is not applicable to neonates < 24 weeks gestation. Unfortunately, no single set of available growth charts is adequate to assess natal and postnatal anthropometry over the entire range of gestational ages that are represented in modern NICUs.

In this issue of the journal, the Portuguese Neonatal Society publishes updated recommendations for the use of growth curves and reference values applicable to the care of preterm neonates.[10] This important document provides neonatal clinicians with a brief review of relevant evidence, in addition to a well-organized characterization of each growth charts strengths, limitations, and recommended applications. Both technical limitations (*eg*, gestational age restrictions, source data accuracy) and barriers to practical use (*eg*, inability to save a chart or generate a longitudinal printout) are addressed. These recommendations help simplify the complex landscape of growth monitoring in preterm neonates and they should be welcome by neonatal clinicians. However, it will be important to assess the compliance with these guidelines as they are implemented in routine neonatology or neonatal nutrition practice.

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As a neonatologist who has practiced in different eras and NICUs, I first generated growth charts on graph paper without reference lines, later manually plotted points on various charts with reference lines, and more recently utilized a spreadsheet on a desktop computer to generate and print such charts. Currently, our neonatal dietitians use a spreadsheet to generate individual growth charts, which reside on a secure network folder accessible only to them and may be printed weekly. Bedside staff in NICU may use printouts of these charts and manually add points. At the time of discharge or transfer from NICU, dietitians print a final integrated growth chart, based on Fenton,[5] along with updated anthropometric measurements, nutritional assessment, and a customized prescription for continued nutritional monitoring and intakes, which is sent to the pediatrician (and also used in family education pre-discharge). Meanwhile, our electronic medical record displays growth graphs with limited utility, since they lack reference lines (a module that contains reference lines is prohibitively expensive). Throughout the various phases of my neonatology career, the chief problem with postnatal growth charts was that they were often not created at all or, if maintained, they were not readily available to decision-makers at the bedside and across the transitions of care. Although the technical correctness of the reference curves was always suboptimal, the poor practical usability of our growth monitoring systems has been the major barrier to their usefulness in improving nutritional outcomes. It is crucial to evaluate whether the need to use multiple charts in the same NICU inhibits implementation and compliance with the universal use of a growth monitoring system.

From my perspective, the ideal system for anthropometric evaluation of preterm newborns should evaluate and classify body size measurements including body mass index at birth. It should then automatically integrate these measurements into a single customized chart (electronic or paper) that would permit growth monitoring throughout NICU care. This system should apply to all preterm babies in NICU including those of peri-viable gestational ages. The visual tool for longitudinal growth assessment should be readily available at the bedside, enabling rapid use and easy communication among multidisciplinary teams and families. At discharge, the growth charts should be provided to the pediatricians, along with information needed to start populating post-discharge growth charts. Over time, electronic data on subgroups of particular interest could be compared across centers and populations, thus helping to refine ideal postnatal growth benchmarks for both healthier preterm neonates and those born with specific growth disturbances.

In sum, three major gaps remain in neonatal growth monitoring:

1. Missing reference growth data from critical subgroups of neonates receiving care in modern NICUs;
2. Integration of such data and charts into electronic medical record, paper or other practical, usable tools that facilitate and guide nutritional monitoring of individual neonates;
3. Communication and coordination of nutritional assessments and plans across disciplines and transitions of care for each infant.

The first gap may be filled through the judicious use of selective “big data” sets. The second is a relatively simple technical task, if financial and legal barriers (*eg*, copyright) are avoided. The third gap can be bridged by streamlining workflows of neonatal nurses, neonatologists, neonatal dietitians and pediatricians, enabling growth information to be readily transmitted through electronic health records or paper summaries, and involving the infants’ families as necessary. Hopefully, these gaps will be filled when the next version of the Portuguese Neonatal Society recommendations is published.

Keywords: Growth Charts; Infant, Premature/growth & development; Body Weights and Measures/methods; Reference Standards

Conflicts of Interest

The authors declare that there were no conflicts of interest in conducting this work.

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