Changes in lean body mass in early pediatric critical illness

Karolina Brook, MD[1]; Sadeq A. Quraishi, MD, MHA, MMSc[1,2]

[1]Department of Anesthesia, Critical Care and Pain Medicine, Massachusetts General Hospital, Boston, MA, USA; [2]Harvard Medical School, Boston, MA, USA

BACKGROUND

Patients who are admitted to intensive care units (ICUs) have nutritional deficits, both due to acute and underlying chronic disease states. The delivery of nutrition is recognized as being an integral part of the recovery process for the critically ill patient. However, the poor concordance between nutritional support and improved clinical outcomes reflects our limited understanding of the underlying mechanisms in these critically ill patients [1,2]. A major barrier, especially in critically ill pediatric patients, is that the estimation of nutritional requirements, which currently rely on predictive equations, is challenging and often inaccurate. Consequently, *nutrition therapy failure occurs in an estimated 40-70% of critically ill children*, with consequent under- or overfeeding [3].

Muscle wasting, also referred to as muscle atrophy or sarcopenia, is a problem that often pre-exists in the critically ill adult population, occurs rapidly during critical illness, and further plagues survivors should they recover from their period of critical illness [4]. There is only preliminary information on muscle atrophy in critically ill pediatric patients [5-7].

Muscle ultrasonography is a noninvasive, low-cost, reliable, easy-to-learn point-of-care tool, and has been used as a modality to assess longitudinal changes in muscle mass in critically ill adults [8]. In critically ill adults, rapid muscle atrophy is visible by ultrasound within 3-5 days of ICU admission [4]. Limited longitudinal studies exist evaluating muscle ultrasonography in critically ill pediatric patients.

Thus, the aim of this study was to examine quadriceps muscle thickness in critically ill pediatric patients over a period of seven days to better define ultrasonographic skeletal muscle changes in early pediatric critical illness and to determine the feasibility of this method in the critically ill pediatric population.

METHODS

We longitudinally assessed quadriceps thickness in 50 patients who were admitted to the pediatric ICU at the Massachusetts General Hospital, Boston, Massachusetts. All patients were intubated, sedated, and on bed rest for the duration of the study. Measurements were performed on days 1, 3, 5 and 7 (day 0 being day of admission) using a Sonosite M-Turbo (Fujifilm, Bothell, Washington). We standardized our measurements (performed separately by two different evaluators) by using the midpoint of a line drawn between the anterior superior iliac spine and the mid-patella. An average of three measurements was recorded for every patient on each day.

RESULTS

Mean age of patients enrolled was 8 (SD 2), 44% were females, average Pediatric Risk of Mortality (PRISM III) score was 9 (SD 3), and mean body mass index for age was 61st percentile (SD 29). Demographic data is shown in *Table 1.*

Table 1*:* Demographic factors and baseline information for pediatric intensive care unit patients with assessed quadriceps thickness (n=50).

Age (years)	8 (SD 2)
Sex (%)	
Female	44
Male	56
Race (%)	
Non-white	40
White	60
SES (%)	
Low	42
Medium	46
High	12
BMI for age (Percentile)	61 (SD 29)
PRISM III	9 (SD 3)

Data are reported as mean (standard deviation [SD]). SES = socioeconomic status; BMI = body mass index; PRISM = Pediatric Risk of Mortality.

Visualization of the quadriceps by ultrasound is shown in *Figure 1.*

The average daily decrement in quadriceps thickness was 3% (SD 1), with the greatest loss occurring between days 3 and 5. Intrarater reliability was substantial to excellent (Cohen's kappa was 0.62-0.87) with an observed percentage agreement of 77-96%. Interrater reliability was also substantial to excellent (Cohen's kappa was 0.79 - 0.86) with high agreement, ranging from 89-100%.

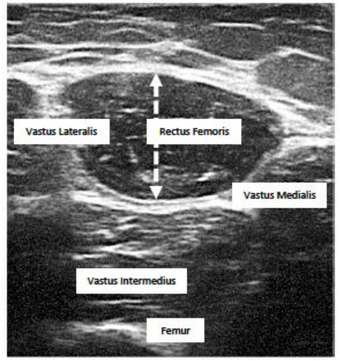

Figure 1*:* Example of quadriceps muscle as assessed in a pediatric intensive care unit patient. This image was captured using a Sonosite M-Turbo. The thickness of the rectus femoris as measured at the mid-point of the muscle is indicated.

DISCUSSION

Muscle weakness (also known as ICU-acquired paresis or critical illness polyneuropathy and myopathy) is a phenomenon that has been characterized in critically ill adults and children, but has traditionally been difficult to characterize [9,10]. For example, handgrip strength requires an awake patient to cooperate; electromyogram cannot be done at the bedside, is expensive and requires expert interpretation. Therefore, **focus has shifted recently to the related concept of muscle atrophy, which we show here occurs rapidly and early in critically ill pediatric patients.**

Ultrasonography is a noninvasive point-of-care modality with high intra- and inter-rater reliability and shows promise as a tool to assess changes in lean body mass. There is a need for standardized protocols for the use of muscle ultrasonography in pediatric patients, including an agreement on choice of muscle, and a greater understanding of which muscle structural elements may be the most informative of a patient's overall muscle health.

CONCLUSIONS

Our data suggests that a significant decrement in lean body mass occurs during early critical illness in critically ill pediatric patients. Ultrasonography may be a readily available and objective tool to assess changes in lean body mass. Future studies are needed to assess whether lean body mass measurements using ultrasonography can be used to predict patients at risk for adverse perioperative or critical care outcomes, and whether nutritional interventions can impact these outcomes. Additional studies are needed to determine normative curves of quadriceps thickness based on patient age and gender.

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