

Year in Review 2006: The Critically Ill Patient in the Pediatric ICU

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The care of the critically ill patient in the pediatric intensive care unit (PICU) has remained an important topic for those health care providers dealing with children. The purpose of this article is to introduce to the reader a summary of selected papers which we consider relevant to the care of the pediatric critically ill patient and that were published

in the year 2006. These articles were selected on the basis of application to the PICU, overall importance and are not to be solely considered authoritative in their field. There are many other useful articles. We have attempted to choose those articles with scientific merit and rigorous methodology that we believe present interesting data in the field.

Key words: Pediatric intensive care unit, child, pediatrics, outcome prediction, cardiopulmonary resuscitation.

Long-Term Outcome After Cardiopulmonary Resuscitation (CPR)

Rodriguez-Nunez A, Lopez-Herce J, Garcia C, Carrillo A, Dominguez P, Calvo C, Delgado MA; Spanish Study Group for Cardiopulmonary Arrest in Children. Effectiveness and long-term outcome of cardiopulmonary resuscitation in paediatric intensive care units in Spain. *Resuscitation* 2006;71:301-309.

This study included 116 children who had a respiratory or cardiopulmonary arrest, with the rationale to ascertain the outcome of patients hospitalized in the PICU, and following their functional and neurological long-term outcome using the Utstein style. As a result they found-out that patients who underwent respiratory

arrest had better outcomes and reduced mortality on the first year of follow-up as compared to those that had a primary cardiac arrest. Approximately one third of PICU patients who faced cardiopulmonary arrest survived, and fortunately the vast majority without long-term functional or neurological deficits.

Independent factors that decreased survival rates were sepsis, use of vasoactive drugs and bicarbonate, mechanical ventilation, duration of CPR, or volume load. Other factors that had no impact on mortality included age, gender and weight of patients. The factor noted to be the best prognostic indicator was the time elapsed from the arrest.

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Prognosis Six Months After Admission to the PICU

Jones S, Rantell K, Stevens K, Colwell B, Ratcliffe JR, Holland P, Rowan K, Parry GJ; United Kingdom Pediatric Intensive Care Outcome Study Group. Outcome at 6 months after admission for pediatric intensive care: a report of a national study of pediatric intensive care units in the United Kingdom (UK). *Pediatrics* 2006;118:2101-2108.

This study done over a one year period in the UK, and it reported outcome after 6 months of admission to the PICU. It included data from 7214 admissions in 22 PICU. The Health Utilities Index (HUI) 2 was used as a tool to measure health status, and it included 6 parameters: pain, mobility, emotion, cognition, self-care and sensation.

The mortality rate before discharge from the PICU was 5.9%, and additional 1.9% of patients died after six months of discharge. Almost one third (27.3%) of children ≥ 6 months old, that completed HUI 2 questionnaire, were completely healthy six months after the PICU admission, and only 4.4% of respondents did have some kind of impairment. The two most common impairments seen were sensation and cognition. One limitation of this study is the exclusion of 29% of admissions to the PICU, because patients were < 6 months of age, decreasing the sample size. Another limitation was that the HUI 2 questionnaire was answered by the parents/health care providers, and limited to their knowledge of normal child development.

Endotracheal Intubation

Lau N, Playfor SD, Rashid A, Dhanarass M. New formulae for predicting tracheal tube length. *Paediatr Anaesth* 2006;16:1238-1243.

Confirmation of the position of endotracheal tube (ETT) after insertion is mandatory in any patient, especially in the PICU. The most commonly used techniques include auscultation, end-tidal carbon dioxide measurement as well as bilateral chest expansion movements and air entry respectively. Another confirmatory test for proper ETT positioning is the chest radiograph. In addition, there are a wide variety of formulas and reference charts to determine the proper depth markers for calculating the ETT length.

This was a retrospective study that included a total of 226 children between 1 day to 15 years of age and a weight from 1.5-112 kg who required endotracheal intubation. The investigators assessed

age, weight, route of intubation, final tracheal tube length and the internal diameter of the tracheal tube. For children over the age of one, the data obtained was compared to the length calculated by the Advanced Paediatric Life Support (APLS) formula. For patients under age of one, the tube length was compared to the reference chart in the 'Drug Doses' handbook by Shann. The results obtained from this search showed significant differences when comparing to the weight formulas or to APLS formula with actual tube length. Based on these findings new and more accurate formulas predicting the length of the trachea were identified and are the following:

Children > 1 year of age:

- a) Insertion depth (cm) of orotracheal intubation = $\text{age}/2 + 13$,
- b) Insertion depth (cm) of nasotracheal intubation = $\text{age}/2 + 15$.

Children < 1 year of age:

- a) Insertion depth of orotracheal tube (cm) = $\text{weight}/2 + 8$,
- b) Insertion depth of nasotracheal tube (cm) = $\text{weight}/2 + 9$.

This is useful because as previously reported, almost one third of pediatric patients are re-intubated when transferred from non specialty facility to a pediatric hospital. This easy to remember formulas are handier for health professionals that rarely participate in pediatric intubations than those on reference tables.

Burns

Mlcak RP, Jeschke MG, Barrow RE, Herndon DN. The influence of age and gender on resting energy expenditure in severely burned children. *Ann Surg* 2006;244:121-130.

The hypermetabolic state in the pediatric burn injured patient was thought to last only for a short period of time. This recent study enrolled a total of one hundred severely burned (>40% of total body surface area) pediatric patients that had the same treatment. It consisted of prompt excision of the wound, antimicrobial therapy, and enteral feeding.

There was confirmatory evidence that this hypermetabolic state persisted no less than for 12 months after the injury. Some comparisons were made between age and gender, and proved that male children had a larger resting energy expenditure (REE), lower anabolic hormones and a longer PICU stay than females. Age was also an important issue in this study, since younger children had a REE/BMI (Body Mass Index) lower than older children. Another important finding was that infants and toddlers were found not to have an increased REE, and that gender made no difference in this population.

The significance of this data is to be capable of recognizing male children or teenagers of either sex in the burn population, so that early drug intervention is considered and hypermetabolism is diminished to its maximum. By doing this we could approach with anabolic hormones to a more specific population, and eluding the use of unnecessary treatment to patients that would barely benefit.

Acute Transfusion Reactions

Gauvin F, Lacroix J, Robillard P, Lapointe H, Hume H. Acute transfusion reactions in the pediatric intensive care unit. *Transfusion* 2006;46:1899-1908.

Because of the instability and great variety of derangements of the PICU patient, they frequently require the benefits from blood product transfusions. Unfortunately this could be a predisposing factor for developing an acute transfusion reaction (ATR). These reactions are a serious threat, and tend to occur immediately after, but can also appear several days and weeks later.

It is sometimes quite difficult to discern a critically ill child from a child with an ATR, because

of the similar and compatible signs and symptoms for these two different scenarios. Indeed, it is possible that ATR's are underdiagnosed.

This prospective observational study recorded all transfusions in a PICU for two consecutive years; trying to establish the incidence, type and severity of ATR's. A total of 2509 transfusions were analyzed, including red blood cells (35%), platelets (31%), and fresh frozen plasma (32%). Manifestations of new sign(s) and symptom(s) were informed in 51 transfusions, from which 55% presented with more than one sign or symptom. The most common signs and symptoms reported by the nurse, in order of frequency were the following: fever, chills, hypotension, rash and/or pruritus, dyspnea and/or hypoxemia, hypertension, hemoglobinuria, and anxiety and/or agitation.

Among their results, the investigators showed that mortality was higher in children with a higher number of transfusions. The overall incidence of ATR's was 1.6 per 100 transfusions of labile blood products, and no significant difference in mortality could be made between transfused PICU patients with ATR's and those without ATR's.

Cardiac Arrest and Therapeutic Hypothermia (TH)

Haque IU, Latour MC, Zaritsky AL. Pediatric critical care community survey of knowledge and attitudes toward therapeutic hypothermia in comatose children after cardiac arrest. *Pediatr Crit Care Med* 2006;7:7-14.

Based on the results of two randomized trials, therapeutic hypothermia (TH) has gained popularity in recent years. Some preliminary reports regarding the use of TH in neonates with anoxic brain injury have been encouraging, showing positive results. More evidence is needed regarding the use of TH in children, since we cannot extrapolate adult data to the pediatric population. As part of the planning for a randomized trial using TH in children, a survey designed for the pediatric critical care community was created trying to assess knowledge and attitude towards TH in comatose

children after cardiac arrest. A total of 159 web-based surveys were completed, the vast majority fellowship-trained pediatric critical care physicians.

Interestingly, this study revealed that the pediatric critical care community is familiar with the concept, and aware of its benefits in the adult population they still are not using this modality of treatment on daily basis. Some of the reasons described included a lack of evidence in children, nonexistence of validated management protocols and a difficult technique. Most of the physicians agreed that a randomized study is needed and should be performed to evaluate more thoroughly the effectiveness of this therapeutic method for its use in the pediatric's clinical field.

Approaching the Family

Shudy M, de Almeida ML, Ly S, Landon C, Groft S, Jenkins TL, Nicholson CE. Impact of pediatric critical illness and injury on families: a systematic literature review. *Pediatrics* 2006;118:S203-S218.

There are a wide variety of responses from the parents or children to the environment in the PICU, even though some could be considered understandable. A child admitted to the PICU regardless of the situation, produces a series of stressors in his/her whole family. This study was arranged to encompass stressors encountered by families, their needs, and the global family impact of the critically ill or injured child. It reported, in a systematic literature review from 115 articles, that critically ill children cause a variety of psychosocial derangements in their families while they are being cared in the PICU.

Recent unemployment could be expected in such parents, greatly impacting the family in a financial manner. Divorce or separation in couples after living under such pressure and anxiety because of these disastrous events are said to be quite common, even though no studies proving this thoughts were found.

It is a must that medical practitioners need to supply the families in each one and every one of their needs; including rest, nutrition, hydration,

communication, and feeling of alliance with health care practitioners. The incorporation of these capabilities at all medical levels confidently will benefit families attending these difficult times.

Ethics and the End of Life

Robinson MR, Thiel MM, Backus MM, Meyer EC. Matters of spirituality at the end of life in the pediatric intensive care unit. *Pediatrics* 2006;118:e719-e729.

This was a qualitative study based on parental feedback to open-ended questions. Fifty-six parents whose children had passed away in the PICU after removal of life-sustaining therapies were surveyed. Seventy-three percent of parents answered that they had spiritual/religious beliefs when they were asked what had been more helpful to them and what advice they would give to other parents in the same situation.

Parents pointed out four major important spiritual/religious aspects during end of life: prayer, faith, access to and support of clergy, and belief in the transcendent quality of the parent-child relationship that endures beyond death. They often shared spiritual beliefs and their own experience, and encouraged other parents to depend on their personal and spiritual values.

Because many parents survived by holding on to their spirituality through the difficult end-of-life decision making, it is fundamental that all the staff work together during this time at the PICU to convey the best possible spiritual care. This can be summarized with the following phrase: "Clinicians can aim to be spiritual generalists and medical specialists, whereas chaplains can aim to be spiritual specialists and medical generalists." Meaning that in a higher or lower level, we all can help in a spiritual manner.

PICU Educational Advances

Eppich WJ, Adler MD, McGaghie WC. Emergency and critical care pediatrics: use of medical simulation for training in acute pediatric emergencies.

Curr Opin Pediatr. 2006;18:266-271.

When referring to pediatric emergencies, we inherently notice that new daily challenges are encountered by pediatricians. In contrast to adults, children have anatomical, physiological and behavioral differences that make it a more troublesome situation when referring to critical emergencies. This article reviews in detail newer diagnostic and educational techniques and points out the importance of required training to manage children in an acute critical episode.

The use of simulated based training (SBT) has been progressing. There are multiple scenarios that are useful for medical simulation, such as emergency airway management, advance pediatric life support, and improved non-technical skills. SBT has promising benefits for critical care of children, as well as for improving medical preparation and gaining of skills. We definitely require exhaustive future research and new studies to be done on this subject, for new technologies and improvements to pop up.