Critical Care Nephrology and Renal Replacement Therapy in Children

Akash Deep
Stuart L. Goldstein
Editors

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Foreword 1

Perhaps no other area of pediatric intensive care medicine (PICM) has changed in the last decade as much as renal failure and its management: New definitions for acute kidney injury, biomarkers to define and guide treatment, and the normalization of safe and effective renal replacement therapy as a standard PICM therapy, rather than a rescue option. Children of all ages with severe sepsis, metabolic diseases, and intrinsic kidney disease together with those undergoing cardiac surgery or admitted with complications from stem cell transplant all benefit from this focus, and now with the prospect of long-term outcomes for affected children our knowledge base and concepts are expanded rapidly.

Textbooks from even a few years ago are now obsolete, and so this new textbook is necessary, relevant, and actually a very good read!

This book will serve as the current definitive textbook for intensivists and nephrologists dealing with acute kidney injury and diseases, including providing safe renal replacement therapies for critically ill children of all ages.

True world experts have provided chapters on the core areas of knowledge, meaning this work forms the ideal resource for those taking professional exams, such as the ESPNIC (European Society of Pediatric and Neonatal Intensive Care) diploma, and for the multidisciplinary teams caring for critically ill and injured children affected by renal failure and diseases, or needing renal replacement therapies in the intensive care environment.

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Foreword 2

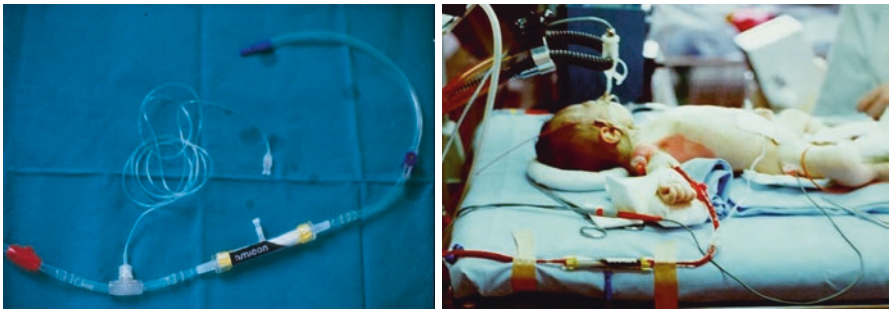
For the last 40 years, I have been trying to combine the fields of adult nephrology and intensive care studying the common ground of the critically ill patient with kidney problems. Indeed, such patients are too complex for a single specialist to deal with, and a common collaborative effort via a multidisciplinary task force is probably the solution for the multiple problems that we are facing in this setting. I also tried to take advantage of the bionic convergence and applied technology to create a new discipline called Critical Care Nephrology. It was in the early 1990s when Rinaldo Bellomo and I gave birth to Critical Care Nephrology as a new specialty combining the knowledge of dedicated intensivists and nephrologists focusing on the complex field of kidney disorders in critically ill patients. Our idea was that critical illness is a complex entity that may require more than one physician and more than one specialist at the bedside of the patient. A single musician can play a melody but it takes an orchestra to play a symphony. We can play different instruments but we must all be in the same key. Since then, the field Critical Care Nephrology has grown continuously as a result of studies and clinical trials, consensus conferences, and therapeutic innovation. In particular, new devices, biomaterials, and kidney support therapies have been developed and some of them have become a routine in clinical practice. The consequence of this process has been a progressive decrease in mortality of our patients in spite of a more complex and a sicker/older population. Since the early 1980s, I have had the chance to become interested in the pediatric application of adult techniques, and I discovered early on that there was a remarkable gap in translation of technology from adults to children and, in particular, neonates. New technologies are often tested in adults while technological knowledge in pediatric nephrology and intensive care is often insufficient due to limited number of procedures and cases. These factors, together with a limited engagement of industry in the pediatric field due to small size of the business and longer times for validation of dedicated technologies, explain the slow transfer of technological advances from adults to children. Nevertheless, there is a tremendous unmet need which can only be solved by dedicated physicians and passionate groups of investigators like the authors of many chapters of the present book. When I treated the first newborn with continuous arteriovenous hemofiltration in Vicenza in 1981, I discovered immediately that supplies were lacking and a dedicated technology was simply not available. Since then, I have spent a significant amount of my time to be an ambassador for the needs of children and neonates in the field of

Critical Care Nephrology. This led to a profound engagement in promoting the transition of adult technology into the pediatric field and even in designing from scratch new devices such as minifilters for CRRT or new equipment such as the CARPEDIEM device (Cardio Renal Pediatric Dialysis Emergency Machine). This endeavor begun several years ago and today we have outstanding physicians and investigators continuing the mission for an improved care of children and newborns. For this reason, I am particularly honored to open with my foreword the book on *Critical Care Nephrology and Renal Replacement Therapy in Children* edited by two outstanding authors and long lasting friends: Stuart Goldstein and Akash Deep. The book is a real compendium of information and current knowledge in the field, organized in two specific sections: Acute Kidney Injury and Renal Replacement Therapy. The first part describes the evolution of epidemiology, the understanding of pathophysiology, and the practice of monitoring of acute kidney disease in the last two decades, leading to the most recent advances in diagnosis and management of AKI in different settings using advanced tools such as the newest biomarkers. All chapters in this section pay particular attention to the collaborative effort between pediatric nephrology and pediatric intensive care for a better care of our small patients. The second part describes the most important aspects of renal replacement therapy in children and neonates with particular attention to the basic concepts, the optimal timing of application of extracorporeal techniques, the rationale for different modalities, and other practical issues such as prescription, monitoring, anticoagulation, and drug adjustments. Finally the book includes chapters on the use of CRRT and other techniques in special settings such as cardiac surgery, sepsis, liver failure, and exogenous intoxication.

I could not imagine a better organization of the table of contents that are so complete and exhaustive. I am gratified to see that the concept of critical care nephrology has crossed the line and barrier between adult and pediatric medicine. The authors of this book should be congratulated for the difficult but successful work they have done for the benefit of the scientific community and the patients and families we serve. Critical Care Nephrology in Children, the time has come!

The First Patient treated with CAVH

(Vicenza-Italy, 1980)

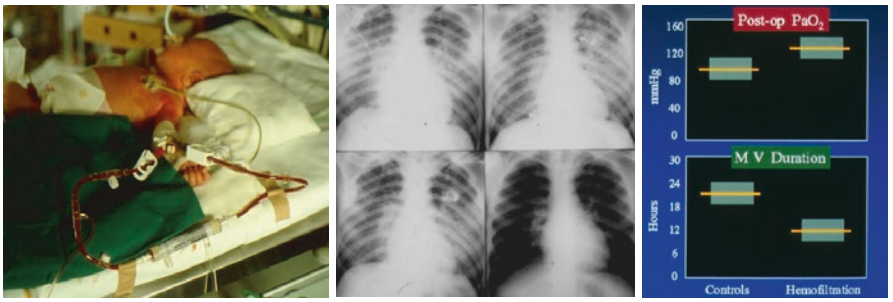


Renal function recovery after 96 hours of CAVH treatment

*Ronco C, Brendolan A, Bragantini L, et Al. :*Treatment of acute renal failure in newborns by Continuous Arterio-Venous Hemofiltration.

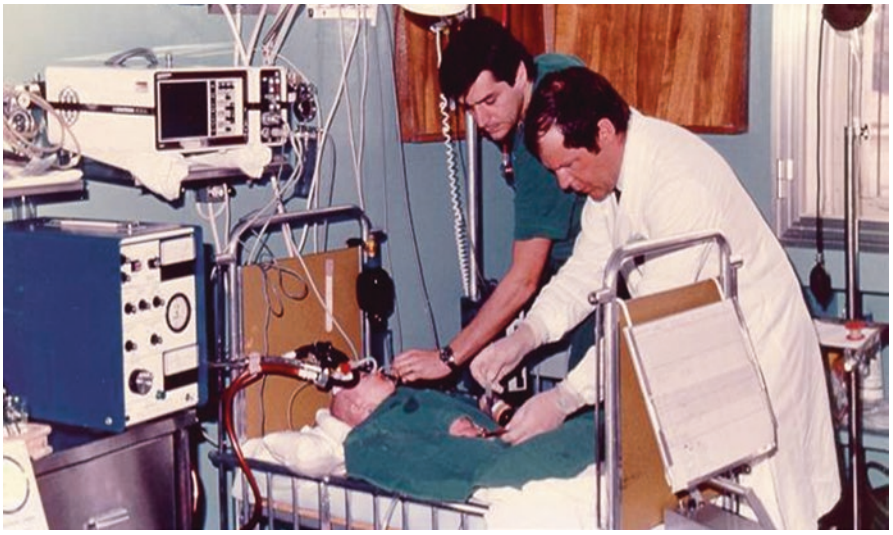
Kidney International, 1984. Courtesy of C. Ronco

CAVH improves pulmonary exchanges and reduces the duration of mechanical ventilation



Ronco C, Brendolan A, Bragantini L, et Al: Treatment of acute renal failure in the newborn by continuous arteriovenous hemofiltration. Trans ASAIO 1985;31:634-8. Courtesy of C. Ronco

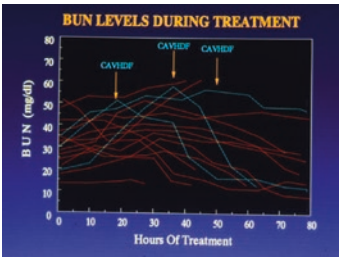
CAVH efficiency and the hypercatabolic patient



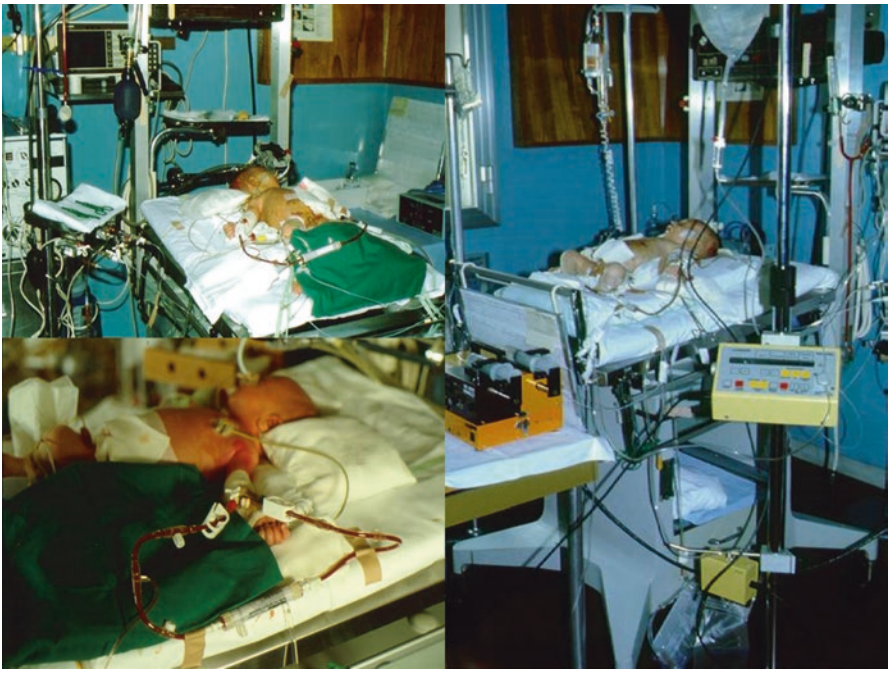
Courtesy of C. Ronco

The birth of CVVHDF

Ronco et Al, Int. J. Artif Organs, 1985



Courtesy of C. Ronco



Courtesy of C. Ronco

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Foreword 3

The care of the critically ill child and infant has evolved over the last 20 years, to a level where renal replacement therapy and care of the kidney has now become an integral part of the holistic care of the patient. While this may be seen as the "bread and butter" of intensive therapy, management of the kidney is often still relatively neglected, as management of "ABCD" may seem to take precedence. However, it has become increasingly clear that unless the kidneys are managed carefully and effectively, the patient will ultimately suffer—either by prolonged intensive care stay, increased morbidity, or even mortality.

I am honored to be asked to provide a foreword to the important work *Critical Care Nephrology and Renal Replacement Therapy in Children* edited by Akash Deep and Stuart Goldstein.

The editors are to be congratulated in assembling a complete and comprehensive anthology of important texts reviewing current state-of-the-art management and knowledge on a broad range of issues affecting the pediatric intensivist and nephrologist, when dealing with a neonate or child with critical illness.

I am particularly pleased to see that the editors have included chapters on nursing care, management of nephrotoxic medications, plasma exchange, metabolic and toxicological subjects, thus demonstrating the true multidisciplinary and multiprofessional nature of pediatric critical care medicine. It is also very helpful to have specific chapters on renal management in specific conditions such as the child on extracorporeal life support or with liver failure.

This book brings together current thinking from world experts on state-of-the-art management of all aspects of renal medicine in the critically ill child and is an important addition to our armory.

Simon Nadel

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Geneva, Switzerland

Preface

The fields of pediatric acute kidney injury and renal replacement therapy provision for the critically ill child have undergone a clinical and research revolution over the past two decades, with advancements accelerating exponentially over the past 5 years. Small single-center studies have been supplanted by robust, multicenter and multinational epidemiological reports that clearly demonstrate that acute kidney injury is independently associated with child morbidity and mortality. Outcome assessment for the child with AKI has now been published repeatedly across the entire spectrum of pediatric critical illness, from neonates to young adults, and in every conceivable nonrenal system illness such as stem cell and solid organ transplantation, sepsis, heart and liver disease.

Provision of renal replacement therapy is no longer considered to be experimental or heroic—broad and detailed experiences have been published with respect to acute peritoneal dialysis, continuous renal replacement therapies, and integration of renal support with other advanced extracorporeal support. These publications and experiences form the foundation for a standard of care that can be provided by any intensive care unit focused on caring for the critically ill child.

In addition, many advancements in clinical and translational science have emanated from the pediatric experience. These include development of novel AKI risk stratification systems, discovery, validation, and clinical decision support integration of novel biomarkers to predict AKI development and severity and focus on fluid balance as an indication for renal replacement therapy initiation.

Previous compilations of the pediatric critical care nephrology literature have resided either as small components of larger pediatric nephrology, pediatric critical care, or critical care nephrology textbooks. Given the pediatric-specific advancements noted above, we felt strongly that a single volume dedicated to pediatric critical care nephrology and renal replacement therapy was needed to provide the appropriate space for detailed discussion about the field that is our professional passion. We are indebted to all the authors of the chapters contained herein, who are all international experts in their respective fields, and acknowledged as such in their own professional communities and in the critical care nephrology community as a whole. Their shared passion for our field is evident from the outstanding quality contained in each chapter. We are grateful to the European Society of Pediatric and Neonatal Intensive Care (ESPNIC) for all the support and endorsement of this book.

We are also greatly appreciative of our families Bonilla and Trisha Arora (Deep), and Elizabeth and Beau Goldstein, who suffer our long clinical hours and extensive professional commitments to serve as two of the pied pipers of our tightknit pediatric critical care nephrology community. Our time spent editing this unique textbook is just one of the many of our endeavors they have had to endure to support our careers. Neither of us would be able to achieve our goals without their support and patience.

Finally, in the words of one of the great leaders of pediatric nephrology, the late Dr. William Harmon, we are reminded that "it is a privilege that families allow us to care for their most precious children with kidney disease." This is especially true for families of children with critical illness who develop AKI. Most of these families meet us for the first time during one of the most stressful times of their lives, placing their faith and trust in us to provide expert care in the most complex of settings, and in many cases, agreeing to enroll their child in a research study which may not benefit their own but improve the outcomes for children in the future. We are a truly privileged group to work in this field.

London, UK — Akash Deep
Cincinnati, OH — Stuart L. Goldstein

Contents