SYLLABUS

THE 28TH INTERNATIONAL CONFERENCE ON
ADVANCES IN CRITICAL CARE NEPHROLOGY

Updates in ICU Medicine: Controversies, Challenges and Solutions

AKI & CRRT 2023

MARCH 29 - APRIL 1, 2023

MARRIOTT MARQUIS SAN DIEGO
SAN DIEGO, CALIFORNIA

Jointly Provided by

UC San Diego SCHOOL OF MEDICINE *and* CRRT, INC.

CRRTONLINE.COM

AKI&CRRT 2023

28TH INTERNATIONAL CONFERENCE ON ADVANCES IN CRITICAL CARE NEPHROLOGY

MARCH 29 - APRIL 1, 2023 SAN DIEGO, CALIFORNIA

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Schedule Pages

(guides to presentation outlines if available)

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CONFERENCE DESCRIPTION AND LEARNER OBJECTIVES

The CRRT conference provides a comprehensive review of advances in clinical care, research and technology in critical care medicine with a focus on the kidney and renal support techniques. The conference is designed to facilitate interdisciplinary interactions among caregivers involved in the management of patients in intensive care units. Physicians, nurses, pharmacists, nutritionists and other allied personnel from industry have opportunities to learn from each other. The conference utilizes a combination of invited lectures; case based small group workshops, debates, hands on interactive and simulation based workshops. Attendees have an opportunity to interact with the faculty through focused panel discussions and symposia.

At the end of this conference attendees should be able to:

1. Describe the recent advances in the pathophysiology and management of critically ill patients with a focus on sepsis, multi-organ failure, infections, lung and kidney injury in different settings.
2. Discuss the best ways to identify, treat and follow up patients with acute kidney injury (AKI) resulting from different causes utilizing biomarkers, imaging and lab studies and applying educational tools to raise awareness of AKI.
3. Describe the principles and practice of renal replacement techniques including CRRT, IHD and plasma exchange and demonstrate how to setup and use these techniques for managing critically ill patients.

ACCREDITATION STATEMENT

This activity has been planned and implemented in accordance with the Essential Areas and policies of the Accreditation Council for Continuing Medical Education (ACCME) through the joint providership of the University of California San Diego School of Medicine and CRRT, Inc. The University of California San Diego School of Medicine is accredited by the ACCME to provide continuing medical education for physicians.

AMA: The University of California San Diego School of Medicine designates this live activity for a maximum of **32.75** *AMA PRA Category 1 Credits™* . Physicians should claim only the credit commensurate with the extent of their participation in the activity.

AAPA: AAPA accepts certificates of participation for educational activities certified for *AMA PRA Category 1 Credit™* from organizations accredited by ACCME or a recognized state medical society.

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Pharmacists: The California Board of Pharmacy accepts as continuing education for pharmacists coursework which meets the standard of relevance to pharmacy practice and is accepted as continuing education by the Medical Board of California.

NEEDS ASSESSMENT

Several sources of information were utilized to identify the practice gaps prompting this educational conference. These include literature review of multiple publications in Pubmed, publications from the American Society of Nephrology, International Society of Nephrology, published KDIGO and European Best Practice and NICE guidelines and feedback from participants and faculty at prior CRRT conferences and discussions with the organizing committee.

TARGET AUDIENCE

The CRRT target audience includes: MD/DOs, NP/PA/Nurses, Dieticians, Industry, Pharmacists, Residents and Fellows. Specialties include: Anesthesiology, Cellular & Molecular Medicine, Critical Care, Emergency Medicine, Family & Preventive Medicine, Geriatrics, and Internal Medicine.

CULTURAL AND LINGUISTIC COMPETENCY

This activity is in compliance with California Assembly Bill 1195 which requires continuing medical education activities with patient care components to include curriculum in the subjects of cultural and linguistic competency. Cultural competency is defined as a set of integrated attitudes, knowledge, and skills that enables health care professionals or organizations to care effectively for patients from diverse cultures, groups, and communities. Linguistic competency is defined as the ability of a physician or surgeon to provide patients who do not speak English or who have limited ability to speak English, direct communication in the patient's primary language. Cultural and linguistic competency was incorporated into the planning of this activity. Additional resources can be found on the UC San Diego CME website (cme.ucsd.edu).

CME ACTIVITIES

The following Pre-Conference Events, Plenary Sessions, Workshops, Topical Symposia and Meet the Expert Sessions qualify for CME Credit:

Tuesday and Wednesday Elective Workshop
Practice Based Learning in CRRT: The Science and the Art

Wednesday Elective Workshop
Changing Paradigms in Acute Kidney Injury:
From Mechanisms to Management

Thursday
MEET THE EXPERT SESSIONS 1 & 2
MORNING SYMPOSIA - A & B
OPENING SESSION I: PATIENT CHARACTERISTICS
GROUP 1 - SIMULTANEOUS STANDARD WORKSHOPS
GROUP 2 - SIMULTANEOUS STANDARD WORKSHOPS

Friday
MEET THE EXPERT SESSIONS 3 & 4
MORNING SYMPOSIA - C
GROUP 3 - SIMULTANEOUS STANDARD WORKSHOPS
SESSION II: CONTROVERSIES IN CRITICAL CARE NEPHROLOGY
SESSION III: EMERGING CONCEPTS IN AKI AND RRT

Saturday
MEET THE EXPERT SESSIONS 5 & 6
MORNING SYMPOSIA - E & F
SESSION IV: IMPROVING OUTCOMES IN AKI
SESSION V: FUTURE TRENDS IN CRRT AND CRITICAL CARE

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Disclosure Summary
28th International Conference on Advances in Critical Care Nephrology – AKI & CRRT
March 29 – April 1, 2023

Disclosure Summary Statement *(for Activity Disclosure to Learners)*
It is the policy of University of California San Diego Continuing Medical Education to ensure that the content of accredited continuing education and related materials is accurate, balanced, objective, and scientifically justified. Education must be free of the influence or control of ineligible companies, and protect learners from promotion, marketing, and commercial bias. All persons in a position to control the content of accredited continuing education must disclose all financial relationships held with ineligible companies, prior to assuming a role in the activity. Those relationships deemed relevant to the education are mitigated prior to the activity through one of the following strategies: 1) divesting the financial relationship, 2) altering the individual's control over content, and/or 3) validating the content through independent peer review. Persons who refuse or fail to disclose are disqualified from participating in the activity. Activities are evaluated by participants and peer reviewers to determine if the content was free of bias and met acceptable scientific standards. This information is considered in future activity planning.

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SUNDAY & MONDAY, MARCH 28 & 29

PRE-CONFERENCE WORKSHOP

Practice Based Learning in CRRT: The Science and the Art

(Page numbers are present if presentation outline was submitted)

•Describe the underlying concepts and review the process of decision making for prescribing and delivering CRRT
•Learn machine set-up for different modalities, alarm conditions, troubleshooting, monitoring and charting
•Utilize the tools provided to manage complex cases

Co-Chairs: Ashita Tolwani, MD and Jorge Cerda, MD

TUESDAY, March 28 - SESSION 1 *(all workshop attendees)*

1:45-2:00pm **Opening Remarks** - Ashita Tolwani, Jorge Cerda 33
1:45-6:00pm **CRRT PRINCIPLES**
2:00-2:30 **Pre-Test** - Ashita Tolwani, Jorge Cerda 35
2:30-3:00 **Access, Membrane, Circuit** - Manish Kaushik
3:00-3:30 **CRRT Machine and Modality Selection** - Jorge Cerda 36
3:30-4:00 **CRRT Rx and Delivery of Dose** - Javier Neyra
4:00-4:15 Coffee Break
4:15-4:45 **Solutions and Fluid Balance** - Javier Neyra 27
4:45-5:15 **Anticoagulation** - Ashita Tolwani 37
5:15-6:00 **Interactive Case Discussion** - Ashita Tolwani, David Askenazi and CRRT Faculty 38
6:00 pm **Adjourn**

WEDNESDAY MORNING, March 29 - SESSION 2

8:00am-12:00pm **CRRT APPLICATIONS**
8:00-8:20 **Patient Selection** - Jorge Cerda 40
8:20-8:40 **Initiation and Discontinuation** - Manish Kaushik
8:40-9:00 **Management of Dysnatremias** - Lenar Yessayan 41
9:00-9:20 **Drug Dosing and Adjustments** - Linda Awdishu
9:20-9:40 **Adjusting Nutrition** - Michael Connor
9:40-10:00 **Q and A** - All Faculty
10:00-10:20 Coffee Break
10:20-10:40 **Management of Acid-Base Disorders** - Lenar Yessayan 41
10:40-11:00 **CRRT in the Operating Room** - Shina Menon
11:00-11:20 **Achieving Survival and Recovery** - Michael Connor
11:20-11:40 **Patient Mobilization and Rehabilitation** - Keith Wille
11:40-12:00 **Q and A** - All Faculty

12:00-1:00pm *Lunch Hosted by Conference for Workshop Participants*

Workshop schedule continues on following page

WEDNESDAY AFTERNOON, MARCH 29 - SESSION 3

PRE-CONFERENCE WORKSHOP

Practice Based Learning in CRRT: The Science and the Art

1:00-3:00pm **IMPLEMENTING CRRT**

1:00-1:20 **Prescription / Order Sets / Decision Making** - Jorge Cerda

1:20-1:40 **Machine Priming, Circuit Set up, Anticoagulation Programing to Match Orders**
Katrina Eggleston

2:00-2:20 **Therapy Charting, Monitoring and Troubleshooting**
Katie Plomaritas, Ashita Tolwani

1:40-2:00 **Implementing Therapy Delivery, Dose Adjustments, Fluid Balance** - Javier Neyra 42

2:20-2:40 **Connectology with Hybrid Systems: ECMO, Apheresis, ECCOR**
Keith Wille, Shina Menon

2:40-3:00 **Integrating Multidisciplinary Support Team for CRRT Delivery**
Katie Plomaritas, Linda Awdishu

3:00-3:20 **Developing Quality Measures for CRRT Delivery** - David Askenazi

3:20-3:40 **Q and A** - All Faculty

3:40-4:00 *Coffee Break*

WEDNESDAY AFTERNOON, March 29 - SESSION 4

4:00-5:30pm **INTERACTIVE TRACKS**

These sessions will have adult and pediatric tracks to familiarize attendees with the available CRRT machines. Participants will be guided on user inter-faces, learn how to set up for different modalities and adjust and monitor for therapy delivery based on the prescription. Machines connections for combination therapies with ECMO, apheresis and adsorption techniques will be shown.

4:00-4:45 **CRRT Equipment Demonstrations Simultaneous** *(select one)*
Overview of the Hardware, Disposables and basic functionality of the CRRT device, including Modality Selection, CircuitModifications, Therapy Dosing, Fluid management Monitoring, Troubleshooting Alarms and Adjustments for Targeted Interventions.

1. Baxter Prismaflex/PRISMAX - Ashita Tolwani, Javier Neyra, Katie Johnson 43

2. Fresenius NxStage/Multifiltrate - Lenar Yessayan, Katrina Eggleston

3. Pediatric Systems - David Askenazi, Katie Plomaritas, David Selewski

4:45-5:15 **Interactive Clinical Case (DecisionMaking)** - (Ashita Tolwani and CRRT Faculty).....43

5:15-5:30 **Post-test and Wrap-up**.....45

5:30 **Adjourn**

5:30-7:30pm **Wednesday Evening Reception & Poster Review** - *For All Conference Attendees*

1: CLINICAL RESEARCH IN AKI - I
Alex Zarbock & Michael Joannidis *(Moderators)*

2: TRANSLATIONAL RESEARCH - I
Vincenzo Cantaluppi & Danielle Soranno *(Moderators)*

3: EPI AND OUTCOMES - I
Patrick Murray & Etienne Macedo *(Moderators)*

WEDNESDAY, MARCH 29

PRE-CONFERENCE AKI SYMPOSIUM

(Page numbers are present if presentation outline was submitted)

7:55am-5:30pm **Changing Paradigms in Acute Kidney Injury: From Mechanisms to Management**
Presented by UAB/UCSD O'Brien Center for AKI Research

7:55 am **Opening Remarks** - Ravindra Mehta, MD

PLENARY 1 **Molecules, Mechanisms and Targets**
Co-Chairs: Mark Okusa and Volker Vallon

8:00-8:20 **Neural Control of Inflammation in AKI/CKD** - Mark Okusa 47
8:20-8:40 **KLF Transcription Factors in AKI** - Sian Piret
8:40-9:00 **Mitochondrial DNA in Systemic Inflammation and Lung Injury due to AKI**
Mark Hepokoski 48
9:00-9:20 **Epithelial Plasticity in Renal Repair after AKI** - Sanjeev Kumar
9:20-9:40 **Cilia and PCP in AKI and Kidney Repair** - Zheng Dong
9:40-10:00 **Discussion**
10:00-10:15 *Coffee Break*

PLENARY 2 **Of Mice and Men: Harmonizing Human and Animal AKI**
Co-Chairs: Zheng Dong and Prabhleen Singh

10:15-10:35 **Mechanisms of Phagocytosis and Cell Clearance: Implications in Inflammation**
Sanja Arandjelovic
10:35-10:55 **Metabolism and Nutrition in Sepsis** - Sarah Huen 49
10:55-11:15 **Mitochondrial Therapy in AKI** - Amandeep Bajwa
11:15-11:35 **Angiopoietins as Biomarkers in AKI** - Sherry Mansour 50
11:35-11:55 **Kidney Microphysiological Models for Nephrotoxicity Assessment** - Sejoong Kim.....51
11:55-12:15 **Discussion**
12:15-1:15 pm *Lunch Hosted by Conference*

PLENARY 3 **Bench to Bedside: Translating Discoveries to Clinical Care**
Co-Chairs: Kathleen Liu and Matthieu LeGrand

1:15-1:35 **Bone Dysregulation in AKI and Critical Illness** - Orson Moe 52
1:35-1:55 **Harnessing Tubular Transport for Reducing Drug Nephrotoxicity** - Pranav Garimella
1:55-2:15 **Novel Therapeutics in AKI: Can Hydrogels Work in Humans?** - Danielle Soranno
2:15-2:35 **RCA to Limit Inflammation and Mitochondrial Tubular Cell Dysfunction in SA-AKI**
Vincenzo Cantaluppi
2:35-2:55 **Sympathetic Nerve Activation in AKI** - Kent Doi 54
2:55-3:15 **Discussion**
3:15-3:30 *Coffee Break*

PLENARY 4 **Controversies in AKI**
Co-Chairs: Marlies Ostermann and Eddie Siew

3:30-3:50 **Subphenotypes of AKI in Children** - Shina Menon
3:50-4:10 **Tubular Dysfunction Predicts MAKE** - Alex Bullen 54
4:10-4:30 **Nephrotoxin Stewardship** - Sandra Kane Gill 55
4:30-4:50 **IPC: Does it Work?** - Alex Zarbock
4:50-5:10 **The Economics of AKI: What Makes it so Costly?** - Glenn Chertow
5:10-5:30 **Discussion**
5:30 **Adjourn**

5:30-7:30pm **Monday Evening Reception & Poster Review -** *For All Conference Attendees*

THURSDAY MORNING, MARCH 30

SESSION I: PATIENT CHARACTERISTICS

8:20-10:30am **Plenary 1 - MINI-SYMPOSIA**

Organ Dysfunction in the Critically Ill Patient: Emerging Concepts

Co-Chairs: Kathleen Liu and Michael Joannidis

8:20-8:30 **Opening Remarks**
Ravindra L Mehta

8:30-8:45 **Hepato Renal Syndrome or Hepato CardioRenal Syndrome** 63
Amir Kazory

8:45-9:00 **Metabolic Measurement in Sepsis** 64
Kent Doi

9:00-9:15 **Acute on Chronic Liver Failure**
Francois Durand

9:15-9:30 **Muscle Wasting During Critical Illness**
John Prowle

9:30-9:45 **Vasodilators in Septic Shock**
Matthieu LeGrand

9:45-10:00 **Artificial Intelligence and Big Data for Sepsis Phenotyping**
Azra Bihorac

10:00-10:30 **SPECIAL LECTURE**
ADQI 28 REPORT:
Sepsis Associated AKI 65
Lui Forni and Claudio Ronco

10:30-11:00 **Industry Demonstration Showcase**
Coffee Break / Faculty Picture

THURSDAY AFTERNOON, MARCH 30

Continuation of:

SESSION I: PATIENT CHARACTERISTICS

4:00-6:00pm **Plenary 2 - MINI-SYMPOSIA**

Acute Kidney Injury (AKI): Pathophysiology

Co-Chairs: Anitha Vijayan and Emmanuel Burdmann

4::00-4:15 **Emerging Findings from the Kidney Precision Medicine Project** 76
Raghavan Murugan

4:15-4:30 **The Use of Vasopressors to Prevent Post-operative AKI**
Matthieu LeGrand

4:30-4:45 **Angiotensin II in AKI: Perpetrator or Savior**
Alex Zarbock

4:45-5:00 **Choice of Crystalloid: Does it Matter?**
Edward Siew

5:00-5:15 **Dynamic Tests for Kidney Function: The Role of Renal Functional Reserve**
Vincenzo Cantaluppi

5:15-5:30 **Magnesium: A Role in Cisplatin-AKI?** 76
Shruti Gupta

5:30-6:00 **Men are From Mars and Women are fromVenus:**
Does it Matter for AKI?
Yes it Does: Danielle Soranno
Maybe: Neesh Pannu
No it Doesn't: Lui Forni 77
Moderator: Claudio Ronco

6:00pm **Adjourn**

6:00-8:00pm **EXHIBIT RECEPTION AND POSTER SESSION**

1: CLINICAL RESEARCH IN AKI II
Nick Selby and Vincent Wu (Moderators)

2: CLINICAL RESEARCH IN AKI (Session 3)
Michael Connor and Harin Rhee (Moderators)

3. EPI AND OUTCOMES (Session 2)
Samira Bell and Emmanuel Burdmann (Moderators)

FRIDAY MORNING, MARCH 31

SESSION II: CONTROVERSIES IN CRITICAL CARE NEPHROLOGY

10:15am-12:30pm **Plenary 3 - MINI-SYMPOSIA**

Challenges in ICU Management

Co-Chairs: Thomas Rimmelle and Samira Bell

10:15-10:30 **Volume Management in the Critically Ill: To Fill or Not to Fill?** 84
Amir Kazory

10:30-10:45 **Timing of RRT in Patients with AKI and Cirrhosis**
Mitra Nadim

10:45-11:00 **De-resuscitation of Fluid Therapy**
Marlies Ostermann

11:00-11:15 **Micronutrient Deficiency: Cause for Concern?**
Nuttha Lumertgul

11:15-11:30 **Bicarbonate: The Good, the Bad and the Ugly** 85
Lui Forni

11:30-11:45 **Integrated Hemodynamic Assessment and Management in the ICU**
Andrew Shaw

11:45-12:15 **SPECIAL LECTURE**
San Diego AKI & CRRT Award
Translating Discoveries to Enhance Management in AKI
How Precise Can We Ever Be with AKI?
Sean Bagshaw

12:15-12:30 **Top Abstract Awards**

12:30-2:00pm *Lunch*

FRIDAY AFTERNOON, MARCH 31

SESSION III: EMERGING CONCEPTS IN AKI AND RRT

2:00-3:45pm **Plenary 4 - MINI-SYMPOSIA**
Novel Strategies in AKI Management

Co-Chairs: Mitra Nadim and Patrick Murray

2:00-2:15 **Update on Renal Imaging and Applications in AKI**
Nick Selby

2:15-2:30 **Managing AKI in Patients with Advanced CKD**
Ron Wald

2:30-2:45 **Risk of AKI After Cardiac Surgery: A Personalized Approach**
Andrew Shaw

2:45-3:00 **AKI Prevention: Role of Sick Day Guidance**
Neesh Pannu

3:00-3:15 **Clinical Decision Support for AKI: What to do When**
Perry Wilson

3:15-3:30 **SGLT 2 Inhibitors: Is AKI the Next Frontier?**
Glenn Chertow

3:30-3:45 **Value Based Care for AKI: The Time has Come**
Ravindra Mehta

3:45-4:15 *Coffee Break*

FRIDAY AFTERNOON, MARCH 31

Continuation of:

SESSION III: EMERGING CONCEPTS IN AKI AND RRT

4:15-6:00pm **Plenary 5 - MINI-SYMPOSIA**
Challenges and Controversies in Renal Support and CRRT

Co-Chairs: Ashita Tolwani and Danielle Soranno

4:15-4:30 **Harmonzing Nomenclature for ECOS Consensus Recommendations**
Claudio Ronco

4:30-4:45 **Personalizing Dialysis Application: The Way Forward**
Ravindra L Mehta

4:45-5:00 **PIRRT vs CRRT: Competition or Collaboration**
Anitha Vijayan

5:00-5:15 **Interpreting Timing of Dialysis Trials:**
What Criteria Should We Use? 85
Sean Bagshaw

5:15-5:30 **AKI and RRT in Patients Receiving ECMO**
Keith Wille

5:30-6:00 **SPECIAL LECTURE ADQI 27 REPORT:**
Digital Health in AKI
Kianoush Kashani and Azra Bihorac

6:00 **Adjourn** - *Free Evening*

SATURDAY MORNING, APRIL 1

SESSION IV: IMPROVING OUTCOMES IN AKI

8:00-10:30am **Plenary 6 - MINI SYMPOSIA**
Global Burden of AKI
Co-Chairs: Etienne Macedo and David Selewski

8:00-8:15 **Pediatric AKI and CRRT**
Rajit Basu

8:15-8:30 **Education in AKI: What's Needed?**
Jorge Cerda

8:30-8:45 **Kidney Long Term Sequelae of SARS-CoV-2 Infection**
Emmanuel Burdmann

8:45-9:00 **Health System Perspectives in AKI: Commitment to Kidney Health** 88
Sandra Kane Gill

9:00-9:15 Obstetric AKI
Rajasekara Chakravarthi

9:15-9:30 **The COVID-19 Global Snapshot Study: Lessons Learned**
Harin Rhee

9:30-9:45 **AKI Outcomes in Resource Limited Settings: In-SEA Study**
Nattachai Srisawat

9:45-10:00 **Epidemiology of AKI: The UK Experience** 88
Samira Bell

10:00-10:15 **CRRT Modality Practice in the World: Results of the ESICM Survey**
Thomas Rimmele

10:15-10:30 **AKI and CRRT Trends in South Korea** 89
Sejoong Kim

10:30-11:00 *Coffee Break*

SATURDAY MORNING, APRIL 1

SESSION V: FUTURE TRENDS IN CRRT AND CRITICAL CARE

11:00am-1:00pm **Plenary 7 - MINI SYMPOSIA**
Emerging Strategies in AKI and Extracorporeal Support
Co-Chairs: Vincent Wu and Jorge Cerda

11:00-11:15 **Monitoring the Health of the Kidney During RRT**
Alex Zarbock

11:15-11:30 **AKD Care and Clinical Outcomes - Time to Ditch the Dogma**
Vincent Wu, MD

11:30-12:35 **Update from Ongoing and Late Breaking Trials**
8-10 minutes each

1. The RELIEVE-AKI Trial 90
Raghavan Murugan

2. The REVIVAL Trial
Peter Pickkers

3. The VIBAKI Trial
Rolando Claure-Del Granado

4. TAKE CARE Trial
Peter Pickkers

5. The predARRT Trial 91
Christian Nusshag

6. Caring for Outpatients after Acute Kidney Injury (COPE-AKI) Trial
Eddie Siew

7. RCA for ECCO2R 92
Thiago Reis

12:30-12:55 **Critical Care Nephrology: Literature Review**
Kianoush Kashani

12:55-1:00 **Closing Remarks**
Ravindra L. Mehta
Chairman

1:00pm **Conference Adjourns**

THURSDAY MORNING, MARCH 30

11:00am-12:30pm **SIMULTANEOUS STANDARD WORKSHOPS GROUP 1**

A01 Biomarker Enhanced Management of AKI and RRT (C,N,AP) 66

Several biomarkers are now available to assess kidney function and damage. Which patients should get these assessments and how should these be applied will be discussed in this case based workshop *(Murray, Basu, Koyner)*

B02 Citrate Anticoagulation for CRRT: How to Use it? (C,N,AP) 67

Regional citrate anticoagulation (RCA) is increasingly utilized for CRRT. Advances in technology have enabled automated citrate anticoagulation. However, concerns remain about its ease of use and application in patients with liver failure and reduced tissue perfusion. This workshop will discuss the best approaches for utilizing RCA for CRRT. *(Tolwani, Joannidis, Askenazi)*

C03 Focus on POCUS: Assessment of Fluid Responsiveness, Hemodynamic Monitoring and Targets (C,N) 69

Determining which patient needs fluids, what type, when and how much will be addressed in this workshop which will cover the principles and strategies for volume assessment with point of care ultrasound and hemodynamic monitoring in critically ill patients. *(Fuhrman, Wald, Kashani)*

D04 Managing Patients with Combined Kidney and Liver Failure (C,N,AP) 70

Patients with combined liver and kidney failure are difficult to manage. This workshop will discuss the pathophysiology and illustrate best approaches for differential diagnosis and management of these patients. *(Nadim, Durand, Deep)*

THURSDAY AFTERNOON, MARCH 30

2:00-3:30pm **SIMULTANEOUS STANDARD WORKSHOPS GROUP 2**

A05 Pediatric AKI and RRT: Beyond the Basics (I,N,AP)

This workshop will highlight the epidemiology and best practices for AKI management and CRRT, peritoneal dialysis and tandem therapies application in neonates and children. *(Menon, Plomaritas, Askenazi)*

B06 Precision Solute Control and Dynamic Dosing with CRRT? (I,N,AP)

CRRT techniques have evolved with availability of new technology to customize dialysis delivery. This interactive case based workshop will discuss how to apply the technology for dose adjustments, monitoring for adequacy, modality selection and transitions in CRRT. *(Kaushik, Prowle)*

C07 Starting, Transitioning and Stopping RRT for AKI: Science and Art (A) 72

One of the most vexing issues for clinicians is determining when to initiate RRT in critically ill patients, when and how to transition modalities and when it can be stopped. This workshop will use case studies to explore various approaches and establish the principles for clinical decisions for renal support. *(Mehta, Bagshaw, Lumlertgul)*

D08 Managing Patients with Sepsis: Modifying the Course with (ECOS) (C,N,AP) 74

Septic patients often require ECOS to allow time for recovery. This workshop covers the rationale and strategies for the practical application of extracorporeal support techniques for sepsis. Case studies will be utilized to delineate different options. *(Pickkers, Rimmele, Basu)*

FRIDAY MORNING, MARCH 31

8:15-9:45am **SIMULTANEOUS STANDARD WORKSHOPS GROUP 3**

MEET THE EXPERT BREAKFAST (Electives, CME Available)

THURSDAY, MARCH 30

ME1 - How do I Manage the Patient with Septic AKI - 7:00-8:00am
Claudio Ronco and Peter Pickkers

ME2 - How do I Dose Volume during CRRT? - 7:00-8:00am 57
Marlies Ostermann and Raghavan Murugan

FRIDAY, MARCH 31

ME3 - When Do I say No to Offer RRT - 7:00-8:00am
John Prowle and Ashita Tolwani

ME4 - How do I Manage the Oliguric Patient? - 7:00-8:00am
Patrick Murray and Glenn Chertow

SATURDAY, APRIL 1

ME5 - Deciding who Needs to Start and Stop RRT - 7:00-8:00am
Ron Wald and Marlies Ostermann

ME6 - How do I Assess the Volume Status of My Patient? - 7:00-8:00am
Kianoush Kashani and Andrew Shaw

BREAKFAST SYMPOSIA (CME Available for A, B, C, E & F)

THURSDAY, MARCH 30 - 7:00-8:00am

A - Plasma Exchange in Critically Ill Patients: Who, When and How 58
Dana Fuhrman (Moderator)
Esiei Noiri and Akash Deep *(Discussants)*

B - Personalized Management of Shock: How to use Biomarkers, Vasopresssors and Fluids? 59,60
Sean Bagshaw (Moderator)
Kianoush Kashani and Michael Joannidis *(Discussants)*

FRIDAY, MARCH 31 - 7:00-8:00am

C - Optimization of the CRRT Program to Improve Outcomes 78
Ashita Tolwani and Stuart Goldstein (Moderators)
Manish Kaushik, David Selewski and Javier Neyra *(Discussants)*

SATURDAY, APRIL 1 - 7:00-8:00am

E - Innovations in Caring for Patients with Dysnatremias 87
Thomas Rimmelle (Moderator)
Lenar Yessayan and Nuttha Lumertgul *(Discussants)*

F - Optimizing Fluid Management in the ICU: Fit for Purpose? 87
Michael Connor *(Moderator)*
Lui Forni and Kathleen Liu *(Discussants)*

EPIDEMIOLOGY AND OUTCOMES FROM AKI

Poster Number

EPIDEMIOLOGY AND OUTCOMES FROM AKI

RESEARCH IN AKI

RRT TECHNIQUE CHARACTERISTICS

RRT APPLICATIONS AND TARGETED INTERVENTION

NEW TECHNOLOGY

RRT RESEARCH

NURSING ISSUES

AKI & CRRT 2023

Practice Based Learning in CRRT: The Science and the Art

Opening Remarks

Ashita Tolwani MD
1:45-2:00
Tuesday, March 28

Educational Objectives:
1.Describe the underlying concepts and review the process of decision making for prescribing and delivering CRRT
2.Learn machine set-up for different modalities, alarm conditions, troubleshooting, monitoring and charting
3.Utilize the tools provided to manage complex cases

Content Description:
This workshop is designed to provide participants with the knowledge and understanding for the effective utilization of CRRT to manage critically ill patients.

Session 1 focuses on a didactic review of the fundamentals of CRRT including the components and operational characteristics, CRRT machine and modality selection, solutions and fluid management, and anticoagulation. The session will end with an interactive session with cases emphasizing the concepts learned during the didactic sessions.

Session 2 focuses on advanced CRRT topics, including drug dosing, nutrition, management of dysnatremias and acid/base disorders, patient mobilization, and intraoperative CRRT.

In Session 3 delegates will be guided on user inter-faces, learn how to set up for different modalities and adjust and monitor for therapy delivery based on the prescription. Machines connections for combination therapies with ECMO, apheresis and adsorption techniques will be shown.

At the end of this workshop delegates will have an improved understanding of how to utilize CRRT for optimizing renal support. A quiz will be administered pre-and post- course for assessment.

Suggested Reading:
Baldwin, Ian, and Theresa Mottes. “Acute Kidney Injury and Continuous Renal Replacement Therapy: A Nursing Perspective for My Shift Today in the Intensive Care Unit.” Seminars in Dialysis, vol. 34, no. 6, Wiley Subscription Services, Inc, 2021, pp. 518–29, https://doi.org/10.1111/sdi.12992.

Claure-Del Granado, Rolando, and William R. Clark. “Continuous Renal Replacement Therapy Principles.” Seminars in Dialysis, vol. 34, no. 6, Wiley Subscription Services, Inc, 2021, pp. 398–405, https://doi.org/10.1111/sdi.12967.

Connor, Michael J., et al. “Organizational and Financial Aspects of a Continuous Renal Replacement Therapy Program.” Seminars in Dialysis, vol. 34, no. 6, Wiley Subscription Services, Inc, 2021, pp. 510–17, https://doi.org/10.1111/sdi.13013.

Davenport, Andrew, and Patrick M. Honore. “Continuous Renal Replacement Therapy Under Special Conditions Like Sepsis, Burn, Cardiac Failure, Neurotrauma, and Liver Failure.” Seminars in Dialysis, vol. 34, no. 6, Wiley Subscription Services, Inc, 2021, pp. 457–71, https://doi.org/10.1111/sdi.13002.

Jang, Soo Min, and Linda Awdishu. “Drug Dosing Considerations in Continuous Renal Replacement Therapy.” Seminars in Dialysis, vol. 34, no. 6, Wiley Subscription Services, Inc, 2021, pp. 480–88, https://doi.org/10.1111/sdi.12972.

Juncos, Luis A., et al. "Vascular Access, Membranes and Circuit for CRRT."
Seminars in Dialysis, vol. 34, no. 6, Wiley Subscription Services, Inc, 2021, pp. 406–15, https://doi.org/10.1111/sdi.12977

Kovvuru, Karthik, and Juan C. Q. Velez. "Complications Associated with Continuous Renal Replacement Therapy." Seminars in Dialysis, vol. 34, no. 6, Wiley Subscription Services, Inc, 2021, pp. 489–94, https://doi.org/10.1111/sdi.12970.

Legrand, Matthieu, and Ashita Tolwani. "Anticoagulation Strategies in Continuous Renal Replacement Therapy." Seminars in Dialysis, vol. 34, no. 6, Wiley Subscription Services, Inc, 2021, pp. 416–22, https://doi.org/10.1111/sdi.12959.

Macedo, Etienne, and Jorge Cerdá. "Choosing a CRRT Machine and Modality." Seminars in Dialysis, vol. 34, no. 6, Wiley Subscription Services, Inc, 2021, pp. 423–31, https://doi.org/10.1111/sdi.13029.

Neyra, Javier A., and Ashita Tolwani. "CRRT Prescription and Delivery of Dose." Seminars in Dialysis, vol. 34, no. 6, Wiley Subscription Services, Inc, 2021, pp. 432–39, https://doi.org/10.1111/sdi.12974.

Neyra JA, Yessayan L, Thompson Bastin ML, Wille K, Tolwani AJ. How to prescribe and troubleshoot continuous renal replacement therapy: A case-based review. Kidney360 December 2020, 10.34067/KID.0004912020; DOI: https://doi.org/10.34067/KID.0004912020

Neyra, Javier A., and Kianoush Kashani. "Improving the Quality of Care for Patients Requiring Continuous Renal Replacement Therapy." Seminars in Dialysis, vol. 34, no. 6, Wiley Subscription Services, Inc, 2021, pp. 501–09, https://doi.org/10.1111/sdi.12968.

Ostermann, Marlies, et al. "Nutritional Assessment and Support During Continuous Renal Replacement Therapy." Seminars in Dialysis, vol. 34, no. 6, Wiley Subscription Services, Inc, 2021, pp. 449–56, https://doi.org/10.1111/sdi.12973

Prowle, John, and Ravindra Mehta. "Fluid Balance Management During Continuous Renal Replacement Therapy." Seminars in Dialysis, vol. 34, no. 6, Wiley Subscription Services, Inc, 2021, pp. 440–48, https://doi.org/10.1111/sdi.12964.

Ronco, Claudio, and Thiago Reis. "Continuous Renal Replacement Therapy and Extended Indications." Seminars in Dialysis, vol. 34, no. 6, Wiley Subscription Services, Inc, 2021, pp. 550–60, https://doi.org/10.1111/sdi.12963.

Teixeira JP, Neyra JA, Tolwani A. Continuous KRT: A Contemporary Review. Clin J Am Soc Nephrol. 2023 Feb 1;18(2):256-269.

Selewski DT, Wille KM. Continuous renal replacement therapy in patients treated with extracorporeal membrane oxygenation. Semin Dial. 2021;34(6):537-549. doi:10.1111/sdi.12965

Wald, Ron, and Edward D. Siew. "Survival and Kidney Recovery Among Recipients of Continuous Renal Replacement Therapy." Seminars in Dialysis, vol. 34, no. 6, Wiley Subscription Services, Inc, 2021, pp. 495–500, https://doi.org/10.1111/sdi.13016.

Yessayan, Lenar T., et al. "Management of Dysnatremias with Continuous Renal Replacement Therapy." Seminars in Dialysis, vol. 34, no. 6, Wiley Subscription Services, Inc, 2021, pp. 472–79, https://doi.org/10.1111/sdi.12983.

Pre-Test

Ashita Tolwani MD
2:00-2:30
Tuesday, March 28

Educational Objectives:
The objectives of the pre and post test are:
•To measure a starting point or the amount of pre-existing knowledge on CRRT
•To measure the learning as a result of the CRRT course experience
•To discuss the answers and provide explanations

Content Description:
At the beginning of the workshop, the participants will be given a 5 question pre-test as part of a power point presentation and audience response system. Participants will also be given a hard copy of the test to work on throughout the day. The same test will be administered again at the end of the workshop to assess improvement in the participant's knowledge base. The answers will be discussed and explanations provided.

Suggested Reading:

Claure-Del Granado, Rolando, and William R. Clark. "Continuous Renal Replacement Therapy Principles." Seminars in Dialysis, vol. 34, no. 6, Wiley Subscription Services, Inc, 2021, pp. 398–405, https://doi.org/10.1111/sdi.12967.

Connor MJ Jr, Karakala N. Continuous Renal Replacement Therapy: Reviewing Current Best Practice to Provide High-Quality Extracorporeal Therapy to Critically Ill Patients. Adv Chronic Kidney Dis. 2017 Jul;24(4):213-218. doi: 10.1053/j.ackd.2017.05.003. PMID: 28778360.

Jang, Soo Min, and Linda Awdishu. "Drug Dosing Considerations in Continuous Renal Replacement Therapy." Seminars in Dialysis, vol. 34, no. 6, Wiley Subscription Services, Inc, 2021, pp. 480–88, https://doi.org/10.1111/sdi.12972.

Juncos, Luis A., et al. "Vascular Access, Membranes and Circuit for CRRT." Seminars in Dialysis, vol. 34, no. 6, Wiley Subscription Services, Inc, 2021, pp. 406–15, https://doi.org/10.1111/sdi.12977

Kovvuru, Karthik, and Juan C. Q. Velez. "Complications Associated with Continuous Renal Replacement Therapy." Seminars in Dialysis, vol. 34, no. 6, Wiley Subscription Services, Inc, 2021, pp. 489–94, https://doi.org/10.1111/sdi.12970.

Legrand, Matthieu, and Ashita Tolwani. "Anticoagulation Strategies in Continuous Renal Replacement Therapy." Seminars in Dialysis, vol. 34, no. 6, Wiley Subscription Services, Inc, 2021, pp. 416–22, https://doi.org/10.1111/sdi.12959.

Macedo, Etienne, and Jorge Cerdá. "Choosing a CRRT Machine and Modality." Seminars in Dialysis, vol. 34, no. 6, Wiley Subscription Services, Inc, 2021, pp. 423–31, https://doi.org/10.1111/sdi.13029.

Neyra, Javier A., and Ashita Tolwani. "CRRT Prescription and Delivery of Dose." Seminars in Dialysis, vol. 34, no. 6, Wiley Subscription Services, Inc, 2021, pp. 432–39, https://doi.org/10.1111/sdi.12974.

Neyra JA, Yessayan L, Thompson Bastin ML, Wille K, Tolwani AJ. How to prescribe and troubleshoot continuous renal replacement therapy: A case-based review. Kidney360 December 2020, 10.34067/KID.0004912020; DOI: https://doi.org/10.34067/KID.0004912020

Teixeira JP, Neyra JA, Tolwani A. Continuous KRT: A Contemporary Review. Clin J Am Soc Nephrol. 2023 Feb 1;18(2):256-269.

Yessayan, Lenar T., et al. "Management of Dysnatremias with Continuous Renal Replacement Therapy." Seminars in Dialysis, vol. 34, no. 6, Wiley Subscription Services, Inc, 2021, pp. 472–79, https://doi.org/10.1111/sdi.12983.

CRRT Machine and Modality Selection

Jorge Cerda MD, MS, FACP, FASN,
3:00-3:30
Tuesday, March 28

Educational Objectives:
1. At the end of the presentation, attendees will be able to describe the different modalities of CRRT, and the factors which determine the magnitude of clearance and ultrafiltration across membranes
2. Attendees will be able to calculate the prescribed and delivered dose of CRRT when different CRRT modalities are utilized
3. Attendees will be able to recognize and troubleshoot treatment complications determined by different RRT modalities and treatment characteristics

Content Description:
SUMMARY
This presentation will describe: 1. The basic characteristics of different modalities of RRT and, within CRRT modalities, describe the pros and cons of each variety; 2. The underlying kinetic considerations that permit a quantitative description of the magnitude of filtration; the impact of solute molecular weight; the characteristics of different membranes; 3. The characteristics of different circuit setups and their advantages and disadvantages in every circumstance; 4. The consequences of each treatment setup on prescribed and delivered CRRT dose; 5. The procedures to troubleshoot complications including decreased delivered dose due to predilution and excessively high filtration fraction

Suggested Reading:
1. Bagshaw SM, Darmon M, Ostermann M, et al. Current state of the art for renal replacement therapy in critically ill patients with acute kidney injury. Intensive Care Med 2017.

2. Tolwani A. Continuous renal-replacement therapy for acute kidney injury. N Engl J Med 2012; 367: 2505-2514.

3. Wang Y, Gallagher M, Li Q, et al. Renal replacement therapy intensity for acute kidney injury and recovery to dialysis independence: a systematic review and individual patient data meta-analysis. Nephrol Dial Transplant 2017.

4. Cerda J, Baldwin I, Honore PM, et al. Role of Technology for the Management of AKI in Critically Ill Patients: From Adoptive Technology to Precision Continuous Renal Replacement Therapy. Blood Purif 2016; 42: 248-265.

Solutions and Fluid Balance

Javier Neyra MD, MS
4:15-4:45
Tuesday, March 28

Educational Objectives:
-Review key concepts of selection of CRRT solutions
-Review key elements to determine fluid balance goals for the patient on CRRT
-Review key elements of how to monitor fluid management during CRRT

Content Description:
This talk will review key concepts on the selection of CRRT solutions to manage and/or prevent common electrolyte/acid-base abnormalities. This talk will also review key elements about how to determine fluid balance goals and how to monitor fluid management for patients on CRRT.

Suggested Reading:
Beaubien-Souligny W, Trott T, Neyra JA. How to Determine Fluid Management Goals during Continuous Kidney Replacement Therapy in Patients with AKI: Focus on POCUS. Kidney360. 2022 Jul 19;3(10):1795-1806. doi: 10.34067/KID.0002822022. PMID: 36514727; PMCID: PMC9717662.

Thompson Bastin ML, Adams PM, Nerusu S, Morris PE, Mayer KP, Neyra JA. Association of Phosphate Containing Solutions with Incident Hypophosphatemia in Critically Ill Patients Requiring Continuous Renal Replacement Therapy. Blood Purif. 2022;51(2):122-129. doi: 10.1159/000514418. Epub 2021 Apr 29. PMID: 33915554.

Neyra JA, Yessayan L, Thompson Bastin ML, Wille KM, Tolwani AJ. How To Prescribe And Troubleshoot Continuous Renal Replacement Therapy: A Case-Based Review. Kidney360. 2020 Dec 14;2(2):371-384. doi: 10.34067/KID.0004912020. PMID: 35373031; PMCID: PMC8741005.

Anticoagulation

Ashita Tolwani MD
4:45-5:15
Tuesday, March 28

Educational Objectives:
1.Recognize the factors that contribute to clotting of the CRRT circuit
2.Review various anticoagulation strategies for CRRT with a focus on regional citrate anticoagulation (RCA)
3.Discuss the metabolic complications of RCA

Content Description:
This lecture will review factors contributing to clotting of the CRRT circuit and various anticoagulation strategies for CRRT.

Clotting of the CRRT filter is a common problem, leading to reduced circuit life, reduced clearance, increased blood loss, and increased work load and cost of therapy. Filter clotting can be promoted by the technical aspects of therapy. For instance, post-filter replacement fluid with low blood flow rates can increase the filtration fraction and enhance filter clotting. This can be mitigated by changing the replacement fluid to pre-filter, using a dialysate-

based therapy, or increasing the blood flow rate. Vascular access is of paramount importance to maintaining CRRT circuit function since CRRT will not work adequately with a suboptimal access. Even with optimized circuit factors and adequate vascular access, most patients on CRRT require anticoagulation. Regional citrate anticoagulation (RCA) and unfractionated heparin are most commonly used as anticoagulants for CRRT with RCA rapidly becoming the therapy of choice.

Suggested Reading:

1.Li R, Gao X, Zhou T, Li Y, Wang J, Zhang P. Regional citrate versus heparin anticoagulation for continuous renal replacement therapy in critically ill patients: A meta-analysis of randomized controlled trials. Ther Apher Dial. 2022 Dec;26(6):1086-1097.
2.Legrand, Matthieu, and Ashita Tolwani. "Anticoagulation Strategies in Continuous Renal Replacement Therapy." Seminars in Dialysis, vol. 34, no. 6, Wiley Subscription Services, Inc, 2021, pp. 416–22, https://doi.org/10.1111/sdi.12959
3.Morabito S, Pistolesi V, Tritapepe L, Fiaccadori E, et al. Regional citrate anticoagulation for RRTs in critically ill patients with AKI. Clin J Am Soc Nephrol 2014; 9(12):2173.
4.Oudemans-van Straaten HM, Ostermann M. Bench-to-bedside review: Citrate for continuous renal replacement therapy, from science to practice. Crit Care. 2012 Dec 7;16(6):249.
5.Schneider AJ, Journois D, Rimmelé T. Complications of regional citrate anticoagulation: accumulation or overload? Critical Care (2017) 21:281
6.Szamosfalvi, Balazs, et al. "Regional citrate anticoagulation protocol for patients with presumed absent citrate metabolism." Kidney360 (2020).
7.Tolwani AJ, Wille KM. Anticoagulation for continuous renal replacement therapy. Seminars in Dialysis 2009; 22(2):141.
8.Wei T, Tang X, Zhang L, Lin L, Li P, Wang F, Fu P. Calcium-containing versus calcium-free replacement solution in regional citrate anticoagulation for continuous renal replacement therapy: a randomized controlled trial. Chin Med J (Engl). 2022 Oct 20;135(20):2478-2487
9.Yessayan L, Sohaney R, Puri V, Wagner B, Riddle A, Dickinson S, Napolitano L, Heung M, Humes D, Szamosfalvi B. Regional citrate anticoagulation "non-shock" protocol with pre-calculated flow settings for patients with at least 6 L/hour liver citrate clearance. BMC Nephrol. 2021 Jul 2;22(1):244
10.Zarbock A., Kullmar M., Kindgen-Milles D.et al.Effect of regional citrate anticoagulation vs systemic heparin anticoagulation during continuous kidney replacement therapy on dialysis filter life span and mortality among critically ill patients with acute kidney injury: a randomized clinical trial. JAMA. 2020; 324: 1629-1639

Interactive Case Discussion

Ashita Tolwani MD
5:15-6:00
Tuesday, March 28

Educational Objectives:
•Apply the concepts learned throughout the workshop to interactive clinical case scenarios
•Understand the decision-making process for controversial or challenging cases

Content Description:
This interactive session is designed to provide participants with the knowledge and understanding for decision making for the practical utilization of CRRT in specific case scenarios. The case scenarios will highlight complex

patient situations. Participants will review the scenarios and answer the questions during the session. The panel of faculty will participate in the discussion.

Suggested Reading:

Claure−Del Granado, Rolando, and William R. Clark. "Continuous Renal Replacement Therapy Principles." Seminars in Dialysis, vol. 34, no. 6, Wiley Subscription Services, Inc, 2021, pp. 398–405, https://doi.org/10.1111/sdi.12967.

Connor MJ Jr, Karakala N. Continuous Renal Replacement Therapy: Reviewing Current Best Practice to Provide High-Quality Extracorporeal Therapy to Critically Ill Patients. Adv Chronic Kidney Dis. 2017 Jul;24(4):213-218. doi: 10.1053/j.ackd.2017.05.003. PMID: 28778360.

Jang, Soo Min, and Linda Awdishu. "Drug Dosing Considerations in Continuous Renal Replacement Therapy." Seminars in Dialysis, vol. 34, no. 6, Wiley Subscription Services, Inc, 2021, pp. 480–88, https://doi.org/10.1111/sdi.12972.

Juncos, Luis A., et al. "Vascular Access, Membranes and Circuit for CRRT." Seminars in Dialysis, vol. 34, no. 6, Wiley Subscription Services, Inc, 2021, pp. 406–15, https://doi.org/10.1111/sdi.12977

Kovvuru, Karthik, and Juan C. Q. Velez. "Complications Associated with Continuous Renal Replacement Therapy." Seminars in Dialysis, vol. 34, no. 6, Wiley Subscription Services, Inc, 2021, pp. 489–94, https://doi.org/10.1111/sdi.12970.

Legrand, Matthieu, and Ashita Tolwani. "Anticoagulation Strategies in Continuous Renal Replacement Therapy." Seminars in Dialysis, vol. 34, no. 6, Wiley Subscription Services, Inc, 2021, pp. 416–22, https://doi.org/10.1111/sdi.12959.

Macedo, Etienne, and Jorge Cerdá. "Choosing a CRRT Machine and Modality." Seminars in Dialysis, vol. 34, no. 6, Wiley Subscription Services, Inc, 2021, pp. 423–31, https://doi.org/10.1111/sdi.13029.

Neyra, Javier A., and Ashita Tolwani. "CRRT Prescription and Delivery of Dose." Seminars in Dialysis, vol. 34, no. 6, Wiley Subscription Services, Inc, 2021, pp. 432–39, https://doi.org/10.1111/sdi.12974.

Neyra JA, Yessayan L, Thompson Bastin ML, Wille K, Tolwani AJ. How to prescribe and troubleshoot continuous renal replacement therapy: A case-based review. Kidney360 December 2020, 10.34067/KID.0004912020; DOI: https://doi.org/10.34067/KID.0004912020

Teixeira JP, Neyra JA, Tolwani A. Continuous KRT: A Contemporary Review. Clin J Am Soc Nephrol. 2023 Feb 1;18(2):256-269.

Yessayan, Lenar T., et al. "Management of Dysnatremias with Continuous Renal Replacement Therapy." Seminars in Dialysis, vol. 34, no. 6, Wiley Subscription Services, Inc, 2021, pp. 472–79, https://doi.org/10.1111/sdi.12983.

Patient Selection

Jorge Cerda MD, MS, FACP, FASN,
8:00-8:20
Wednesday, March 29

Educational Objectives:
1. At the end of the presentation, attendees will be able to identify the most important characteristics of patients who would benefit from treatment with CRRT
2. Attendees will be able to describe the key findings of current literature in terms of choice and timing among the different modalities of RRT
3. Attendees will be able to apply RRT initiation criteria to individual patient circumstances

Content Description:
SUMMARY
This presentation will summarize the most important points for the clinician at the time of selecting the most appropriate modality of renal replacement therapy (RRT) for a patient with severe AKI.
The main points to be discussed will include a discussion of the patient characteristics that define the appropriate time of initiation of RRT, and the modality of choice depending on the clinical context and hemodynamic stability. In terms of timing, we will discuss the current difficulties in defining what "timing" is, and the results of the most recently completed and ongoing trials. We will discuss the concept of finding the optimal ratio between the demands imposed on the patient by disease, and the patient's ability to deal with that demand.
In terms of modality, we will discuss the patient and RRT modality characteristics that permit to make consensus recommendations in each case. Results of ongoing and completed trials will be discussed. Moreover, we will emphasize the need to individualize RRT choice depending on important clinical situations, such as fluid overloaded patients, patients with dysnatremias and the importance of RRT impact on brain function and risk.

Suggested Reading:
1. Cerda J, Baldwin I, Honore PM, et al. Role of Technology for the Management of AKI in Critically Ill Patients: From Adoptive Technology to Precision Continuous Renal Replacement Therapy. Blood Purif 2016; 42: 248-265.

2. Cerda J, Liu KD, Cruz DN, et al. Promoting Kidney Function Recovery in Patients with AKI Requiring RRT. Clin J Am Soc Nephrol 2015; 10: 1859-1867.

3. Cerda J, Ronco C. Modalities of continuous renal replacement therapy: technical and clinical considerations. Semin Dial 2009; 22: 114-122.

4. Neri M, Villa G, Garzotto F, et al. Nomenclature for renal replacement therapy in acute kidney injury: basic principles. Crit Care 2016; 20: 318.

Management of Dysnatremias

Lenar Yessayan MD, MS
8:40-9:00
Wednesday, March 29

Educational Objectives:
Understand the critical determinants of serum sodium changes during renal replacement therapy.
Understand the application of a variety of techniques to achieve controlled correction of serum sodium in cases of severe dysnatremia:
1. Adjustment of replacement fluid (RF) or dialysate composition
2. Regulation of CRRT dose based on kinetic modeling
3. The use of separate electrolyte infusion (s)

Content Description:
Disorders of serum sodium concentration are common in critically ill patients who may have concomitant acute kidney injury, chronic kidney disease or end-stage kidney disease. Many of these patients may require customized sodium level management with dialysis which, if not strictly controlled, can lead to significant complications. Thus, controlled correction of the serum sodium level is necessary to avoid the development of osmotic demyelination syndrome in hyponatremic patients and dialysis disequilibrium syndrome in hypernatremic patients. Continuous kidney replacement therapy offers unique benefits through the ability to slowly and safely correct dysnatremias that can be tailored to specific patient needs and should be considered in select patients.

Suggested Reading:
1. Yessayan L, Szamosfalvi B, Rosner M. H. (2021). Management of dysnatremias with continuous renal replacement therapy. Semin Dial. 2021; 34(6): 472-9.
2. Yessayan L, Yee J, Frinak S, Szamosfalvi B. Continuous Renal Replacement Therapy for the Management of Acid-Base and Electrolyte Imbalances in Acute Kidney Injury. Adv Chronic Kidney Dis. 2016;23(3):203-10.
3. Yessayan L, Yee J, Frinak S, Szamosfalvi B. Treatment of severe hyponatremia in patients with kidney failure: role of continuous venovenous hemofiltration with low-sodium replacement fluid. Am J Kidney Dis. 2014;64(2):305-10.
4. Paquette F, Goupil R, Madore F, Troyanov S, Bouchard J. Continuous venovenous hemofiltration using customized replacement fluid for acute kidney injury with severe hypernatremia. Clin Kidney J. 2016;9(4):540-2.

Management of Acid-Base Disorders

Lenar Yessayan MD, MS
10:20-10:40
Wednesday, March 29

Educational Objectives:
1. Understand the principles of acid-base management with buffers and RRT
2. Understand the role and limitation of RRT in lactic acidosis.
3. Understand the role of RRT in select cases of drug poisoning associated with metabolic acidosis.

Content Description:

The modern intensive care unit is a place where complex acid–base disorders are prevalent. Although the majority of acid–base disorders are mild and self-limiting, extremes of blood pH in either direction can have significant consequences on organ systems, and potentially increase mortality. The talk will address acid base management in critically ill patients with AKI (1), and RRT approaches in states associated with acid-base disorders (2-4).

Suggested Reading:

1. Jaber S, Paugam C, Futier E, Lefrant JY, Lasocki S, Lescot T, et al. Sodium bicarbonate therapy for patients with severe metabolic acidaemia in the intensive care unit (BICAR-ICU): a multicentre, open-label, randomised controlled, phase 3 trial. Lancet. 2018;392(10141):31-40.
2. Cerda J, Tolwani AJ, Warnock DG. Critical care nephrology: management of acid-base disorders with CRRT. Kidney Int. 2012;82(1):9-18.
3. Yessayan L, Yee J, Frinak S, Szamosfalvi B. Continuous Renal Replacement Therapy for the Management of Acid-Base and Electrolyte Imbalances in Acute Kidney Injury. Adv Chronic Kidney Dis. 2016;23(3):203-10.
4. Yessayan L, Yee J, Frinak S, Kwon D, Szamosfalvi B. Treatment of Severe Metabolic Alkalosis with Continuous Renal Replacement Therapy: Bicarbonate Kinetic Equations of Clinical Value. ASAIO J. 2015;61(4):e20-5.

Implementing Therapy Delivery, Dose Adjustments, Fluid Balance

Javier Neyra MD, MS
2:00-2:20
Wednesday, March 29

Educational Objectives:

-Discuss key aspects of harmonized CRRT delivery and monitoring
-Practice-based examples of CRRT dose adjustments and fluid management with CRRT

Content Description:

In this session, we will discuss the importance and key aspects of harmonized CRRT delivery and monitoring. We will provide practice-based examples of CRRT dose adjustments and fluid management with CRRT.

Suggested Reading:

Ruiz EF, Ortiz-Soriano VM, Talbott M, Klein BA, Thompson Bastin ML, Mayer KP, Price EB, Dorfman R, Adams BN, Fryman L, Neyra JA; University of Kentucky CRRT Quality Assurance Group. Development, implementation and outcomes of a quality assurance system for the provision of continuous renal replacement therapy in the intensive care unit. Sci Rep. 2020 Nov 26;10(1):20616. doi: 10.1038/s41598-020-76785-w. PMID: 33244053; PMCID: PMC7692557.

Beaubien-Souligny W, Trott T, Neyra JA. How to Determine Fluid Management Goals during Continuous Kidney Replacement Therapy in Patients with AKI: Focus on POCUS. Kidney360. 2022 Jul 19;3(10):1795-1806. doi: 10.34067/KID.0002822022. PMID: 36514727; PMCID: PMC9717662.

CRRT Equipment Demonstrations - Simultaneous

Ashita Tolwani MD
4:00-4:45
Wednesday, March 29

Educational Objectives:
1. Review the Hardware and basic functionality of the Baxter Prismaflex/PRISMAX devices, including Modality Selection, Circuit Modifications, Therapy Dosing, Fluid management, Monitoring, Troubleshooting Alarms and Adjustments for Targeted Interventions.
2. Review the Hardware and basic functionality of the Fresenius NxStage/Multifiltrate devices, including Modality Selection, Circuit Modifications, Therapy Dosing, Fluid management, Monitoring, Troubleshooting Alarms and Adjustments for Targeted Interventions.
3. Review the Hardware and basic functionality of Pediatric Systems, including Modality Selection, Circuit Modifications, Therapy Dosing, Fluid management, Monitoring, Troubleshooting Alarms and Adjustments for Targeted Interventions.

Content Description:
These sessions will have adult and pediatric tracks to familiarize attendees with the available CRRT machines. Participants will be guided on user inter-faces, learn how to set up for different modalities and adjust and monitor for therapy delivery based on the prescription. Machines connections for combination
therapies with ECMO, apheresis and adsorption techniques will be shown.

Suggested Reading:
Battista J, De Luca D, Eleni Dit Trolli S, Allard L, Bacchetta J, Bouhamri N, Enoch C, Faudeux C, Guichoux J, Javouhey E, Kolev K, Regiroli G, Ranchin B, Bernardor J. CARPEDIEM® for continuous kidney replacement therapy in neonates and small infants: a French multicenter retrospective study. Pediatr Nephrol. 2023

Bell M, Broman M, Joannes-Boyau O, Ronco C. Comparison of the Accuracy of the Novel PrisMax Continuous Renal Replacement Therapy System to the Classic Prismaflex System. Blood Purif. 2019;47(1-3):166-170.

Continuous renal replacement therapy machines. Health Devices. 2008 Jun;37(6):157-84. PMID: 18771210.

Macedo E, Cerdá J. Choosing a CRRT machine and modality. Semin Dial. 2021 Nov;34(6):423-431. doi: 10.1111/sdi.13029. Epub 2021 Oct 26. PMID: 34699085.

Interactive Clinical Case (Decision Making)

Ashita Tolwani MD
4:45-5:15
Wednesday, March 29

Educational Objectives:
•Apply the concepts learned throughout the workshop to interactive clinical case scenarios
•Understand the decision-making process for controversial or challenging cases

Content Description:
This interactive session is designed to provide participants with the knowledge and understanding for decision

making for the practical utilization of CRRT in specific case scenarios. The case scenarios will highlight complex patient situations. Participants will review the scenarios and answer the questions during the session. The panel of faculty will participate in the discussion.

Suggested Reading:

Claure−Del Granado, Rolando, and William R. Clark. "Continuous Renal Replacement Therapy Principles." Seminars in Dialysis, vol. 34, no. 6, Wiley Subscription Services, Inc, 2021, pp. 398–405, https://doi.org/10.1111/sdi.12967.

Connor MJ Jr, Karakala N. Continuous Renal Replacement Therapy: Reviewing Current Best Practice to Provide High-Quality Extracorporeal Therapy to Critically Ill Patients. Adv Chronic Kidney Dis. 2017 Jul;24(4):213-218. doi: 10.1053/j.ackd.2017.05.003. PMID: 28778360.

Jang, Soo Min, and Linda Awdishu. "Drug Dosing Considerations in Continuous Renal Replacement Therapy." Seminars in Dialysis, vol. 34, no. 6, Wiley Subscription Services, Inc, 2021, pp. 480–88, https://doi.org/10.1111/sdi.12972.

Juncos, Luis A., et al. "Vascular Access, Membranes and Circuit for CRRT." Seminars in Dialysis, vol. 34, no. 6, Wiley Subscription Services, Inc, 2021, pp. 406–15, https://doi.org/10.1111/sdi.12977

Kovvuru, Karthik, and Juan C. Q. Velez. "Complications Associated with Continuous Renal Replacement Therapy." Seminars in Dialysis, vol. 34, no. 6, Wiley Subscription Services, Inc, 2021, pp. 489–94, https://doi.org/10.1111/sdi.12970.

Legrand, Matthieu, and Ashita Tolwani. "Anticoagulation Strategies in Continuous Renal Replacement Therapy." Seminars in Dialysis, vol. 34, no. 6, Wiley Subscription Services, Inc, 2021, pp. 416–22, https://doi.org/10.1111/sdi.12959.

Macedo, Etienne, and Jorge Cerdá. "Choosing a CRRT Machine and Modality." Seminars in Dialysis, vol. 34, no. 6, Wiley Subscription Services, Inc, 2021, pp. 423–31, https://doi.org/10.1111/sdi.13029.

Neyra, Javier A., and Ashita Tolwani. "CRRT Prescription and Delivery of Dose." Seminars in Dialysis, vol. 34, no. 6, Wiley Subscription Services, Inc, 2021, pp. 432–39, https://doi.org/10.1111/sdi.12974.

Neyra JA, Yessayan L, Thompson Bastin ML, Wille K, Tolwani AJ. How to prescribe and troubleshoot continuous renal replacement therapy: A case-based review. Kidney360 December 2020, 10.34067/KID.0004912020; DOI: https://doi.org/10.34067/KID.0004912020

Teixeira JP, Neyra JA, Tolwani A. Continuous KRT: A Contemporary Review. Clin J Am Soc Nephrol. 2023 Feb 1;18(2):256-269.

Yessayan, Lenar T., et al. "Management of Dysnatremias with Continuous Renal Replacement Therapy." Seminars in Dialysis, vol. 34, no. 6, Wiley Subscription Services, Inc, 2021, pp. 472–79, https://doi.org/10.1111/sdi.12983.

Post Course Test and Wrap-up

Ashita Tolwani MD
5:15-5:30
Wednesday, March 29

Educational Objectives:
•To measure a starting point or the amount of pre-existing knowledge on CRRT
•To measure the learning as a result of the CRRT course experience
•To discuss the answers and provide explanations

Content Description:
At the beginning of the workshop, the participants will be given a 5 question pre-test as part of a power point presentation and audience response system. Participants will also be given a hard copy of the test to work on throughout the day. The same test will be administered again at the end of the workshop to assess improvement in the participant's knowledge base. The answers will be discussed and explanations provided.

Suggested Reading:
Claure−Del Granado, Rolando, and William R. Clark. "Continuous Renal Replacement Therapy Principles." Seminars in Dialysis, vol. 34, no. 6, Wiley Subscription Services, Inc, 2021, pp. 398–405, https://doi.org/10.1111/sdi.12967.

Connor MJ Jr, Karakala N. Continuous Renal Replacement Therapy: Reviewing Current Best Practice to Provide High-Quality Extracorporeal Therapy to Critically Ill Patients. Adv Chronic Kidney Dis. 2017 Jul;24(4):213-218. doi: 10.1053/j.ackd.2017.05.003. PMID: 28778360.

Jang, Soo Min, and Linda Awdishu. "Drug Dosing Considerations in Continuous Renal Replacement Therapy." Seminars in Dialysis, vol. 34, no. 6, Wiley Subscription Services, Inc, 2021, pp. 480–88, https://doi.org/10.1111/sdi.12972.

Juncos, Luis A., et al. "Vascular Access, Membranes and Circuit for CRRT." Seminars in Dialysis, vol. 34, no. 6, Wiley Subscription Services, Inc, 2021, pp. 406–15, https://doi.org/10.1111/sdi.12977

Kovvuru, Karthik, and Juan C. Q. Velez. "Complications Associated with Continuous Renal Replacement Therapy." Seminars in Dialysis, vol. 34, no. 6, Wiley Subscription Services, Inc, 2021, pp. 489–94, https://doi.org/10.1111/sdi.12970.

Legrand, Matthieu, and Ashita Tolwani. "Anticoagulation Strategies in Continuous Renal Replacement Therapy." Seminars in Dialysis, vol. 34, no. 6, Wiley Subscription Services, Inc, 2021, pp. 416–22, https://doi.org/10.1111/sdi.12959.

Macedo, Etienne, and Jorge Cerdá. "Choosing a CRRT Machine and Modality." Seminars in Dialysis, vol. 34, no. 6, Wiley Subscription Services, Inc, 2021, pp. 423–31, https://doi.org/10.1111/sdi.13029.

Neyra, Javier A., and Ashita Tolwani. "CRRT Prescription and Delivery of Dose." Seminars in Dialysis, vol. 34, no. 6, Wiley Subscription Services, Inc, 2021, pp. 432–39, https://doi.org/10.1111/sdi.12974.

Neyra JA, Yessayan L, Thompson Bastin ML, Wille K, Tolwani AJ. How to prescribe and troubleshoot continuous renal replacement therapy: A case-based review. Kidney360 December 2020, 10.34067/KID.0004912020; DOI: https://doi.org/10.34067/KID.0004912020

Teixeira JP, Neyra JA, Tolwani A. Continuous KRT: A Contemporary Review. Clin J Am Soc Nephrol. 2023 Feb 1;18(2):256-269.

Yessayan, Lenar T., et al. "Management of Dysnatremias with Continuous Renal Replacement Therapy." Seminars in Dialysis, vol. 34, no. 6, Wiley Subscription Services, Inc, 2021, pp. 472–79, https://doi.org/10.1111/sdi.12983.

Neural Control of Inflammation in AKI/CKD

Mark D. Okusa MD
8:00-8:20
Wednesday, March 29

Educational Objectives:
1. To describe neural circuits that control of inflammation in AKI
2. To discuss neural circuits that control inflammation in CKD

Content Description:
Acute kidney injury (AKI) poses a significant burden to clinicians and patients worldwide. This disorder can arise in a variety of settings and induces an inflammatory component that is likely instrumental in its pathogenesis. No approved pharmacological agents are available for the treatment and prevention of acute kidney injury (AKI) and few exist for the treatment of chronic kidney disease. The nervous system has been reported to play an important role, directly or indirectly via the immune system, in the pathophysiology of AKI and CKD. Neuromodulation, such as vagus nerve stimulation and pulsed ultrasound, is emerging as an innovative therapeutic treatment for various diseases including AKI and CKD. This presentation focuses on the role of nervous system in control inflammation in AKI/CKD

Suggested Reading:
Tanaka S, Abe C, Abbott SBG, Zheng S, Yamaoka Y, Lipsey JE, et al. Vagus nerve stimulation activates two distinct neuroimmune circuits converging in the spleen to protect mice from kidney injury. Proc Natl Acad Sci U S A. 2021;118(12).
2. Gigliotti JC, Huang L, Ye H, Bajwa A, Chattrabhuti K, Lee S, et al. Ultrasound prevents renal ischemia-reperfusion injury by stimulating the splenic cholinergic anti-inflammatory pathway. J Am Soc Nephrol. 2013;24(9):1451-60.
3. Abe C, Inoue T, Inglis MA, Viar KE, Huang L, Ye H, et al. C1 neurons mediate a stress-induced anti-inflammatory reflex in mice. Nature Neurosci. 2017;20(5):700-7.
4. Inoue T, Abe C, Sung SS, Moscalu S, Jankowski J, Huang L, et al. Vagus nerve stimulation mediates protection from kidney ischemia-reperfusion injury through alpha7nAChR+ splenocytes. J Clin Invest. 2016;126(5):1939-52.
5. Inoue T, Abe C, Kohro T, Tanaka S, Huang L, Yao J, et al. Non-canonical cholinergic anti-inflammatory pathway-mediated activation of peritoneal macrophages induces Hes1 and blocks ischemia/reperfusion injury in the kidney. Kidney Int. 2019;95(3):563-76.
6. Cai J, Nash WT, and Okusa MD. Ultrasound for the treatment of acute kidney injury and other inflammatory conditions: a promising path toward noninvasive neuroimmune regulation. Am J Physiol Renal Physiol. 2020;319(1):F125-F38.

Mitochondrial DNA in Systemic Inflammation and Lung Injury due to AKI

Mark Hepokoski MD
8:40-9:00
Wednesday, March 29

Educational Objectives:
1. Demonstrate evidence for AKI as a source of increased extracellular mitochondrial DNA concentrations in the critically ill
2. Describe the mechanisms of systemic inflammation and lung injury due to extracellular mitochondrial DNA
3. Describe strategies to decrease mortality in AKI by targeting mitochondrial DNA

Content Description:
Increased concentrations of circulating cell free mitochondrial DNA are associated with increased morbidity and mortality in the critically ill. The exact source of circulating cell free mitochondrial DNA in the critically ill has not been established. This session will outline a rationale for AKI as a major source of mitochondrial injury and mitochondrial DNA release during critical illness. Systemic inflammation and multiple organ failure, particularly lung injury, are leading causes of mortality in AKI, and this session will provide evidence for kidney mitochondrial DNA as a mediator of these processes during AKI. This session will conclude by outlining opportunities for novel interventions focused on mitigating systemic inflammation and lung injury during AKI by targeting mitochondrial DNA.

Suggested Reading:
1. Hepokoski M, Wang J, Li K, et al. Altered lung metabolism and mitochondrial DAMPs in lung injury due to acute kidney injury. Am J Physiol Lung Cell Mol Physiol 2021.

2. Tsuji N, Tsuji T, Ohashi N, et al. Role of Mitochondrial DNA in Septic AKI via Toll-Like Receptor 9. J Am Soc Nephrol 2016; 27: 2009-2020.

3. Zhang Q, Raoof M, Chen Y, et al. Circulating mitochondrial DAMPs cause inflammatory responses to injury. Nature 2010; 464: 104-107.

4. West AP, Khoury-Hanold W, Staron M, et al. Mitochondrial DNA stress primes the antiviral innate immune response. Nature 2015; 520: 553-557.

5. Nakahira K, Kyung SY, Rogers AJ, et al. Circulating mitochondrial DNA in patients in the ICU as a marker of mortality: derivation and validation. PLoS Med 2013; 10: e1001577; discussion e1001577.

6. Whitaker RM, Stallons LJ, Kneff JE, et al. Urinary mitochondrial DNA is a biomarker of mitochondrial disruption and renal dysfunction in acute kidney injury. Kidney Int 2015; 88: 1336-1344.

7. Hepokoski ML, Odish M, Lam MT, et al. Absolute quantification of plasma mitochondrial DNA by droplet digital PCR marks COVID-19 severity over time during intensive care unit admissions. Am J Physiol Lung Cell Mol Physiol 2022; 323: L84-L92.

Metabolism and Nutrition in Sepsis

Sarah Huen MD, PhD
10:35-10:55
Wednesday, March 29

Educational Objectives:
1. Describe the host defense mechanisms of disease resistance and disease tolerance.
2. Describe examples of context dependent metabolic adaptation to inflammation.
3. Describe aspects of fasting metabolism that could provide disease tolerance in bacterial sepsis.

Content Description:
Sepsis is a significant cause for mortality among critically ill patients. Many treatments have been tried and have largely failed to significantly improve mortality in sepsis. Recent trials on glycemic control and nutritional management have questioned intensive glucose control and optimal nutritional intervention in critically ill patients. Alterations in metabolism during sepsis are multifaceted and are incompletely understood as distinguishing the difference between protective and pathophysiologic responses is difficult. Acute anorexia during infection is an evolutionary conserved response, suggesting a protective role of anorexia in the host response to infection. We will discuss an example from rodent models of infectious inflammation that suggest that adaptive metabolic programs activated in the setting of infectious stimuli are context specific. Fasting metabolic programs such as Fibroblast Growth Factor-21 and ketogenesis are associated with improved survival in animal models of bacterial inflammation. Associated fasting metabolic pathways such as fatty acid oxidation and autophagy are also implicated in preventing acute kidney injury. Altered kidney metabolism is known to contribute to septic acute kidney injury. We will discuss how global metabolic changes during sepsis and current clinical nutritional and metabolic interventions can potentially affect disease tolerance mechanisms, modify risk of acute kidney injury, and affect overall survival. Specific examples of glucose supplementation and resultant increased insulin requirements as well as excess dietary protein exposures could potentially interfere with adaptive metabolic programs activated to improve host survival.

Suggested Reading:
1. Mongardon N & Singer M. The evolutionary role of nutrition and metabolic support in critical illness. Crit Care Clin 2010 Jul;26(3):443-50.
2. Medzhitov R, Schneider D, Soares, M. Disease Tolerance as a Defense Strategy. Science 2012;335(6017):936-941.
3. Wang A, Huen SC, Luan HH, Yu S, Zhang C, Gallezot JD, Booth CJ, Medzhitov R. Opposing Effects of Fasting Metabolism on Tissue Tolerance in Bacterial and Viral Inflammation. Cell 2016 Sep 8;166(6):1512-1525.e12.
4. Huen SC, Wang A, Feola K, Desrouleaux R, Luan HH, Hogg R, Zhang C, Zhang QJ, Liu ZP, Medzhitov R. Hepatic FGF21 preserves thermoregulation and cardiovascular function during bacterial inflammation. J Exp Med 218(10), e20202151 (2021).
5. Gomez H, Kellum JA, Ronco C. Metabolic reprogramming and tolerance during sepsis-induced AKI. Nat Rev Nephrol 2017;13:143–151.
6. Van Wyngene L, Vandewalle J, Libert C. Reprogramming of basic metabolic pathways in microbial sepsis: therapeutic targets at last? EMBO Mol Med. 2018 Aug;10(8). pii: e8712.

Angiopoietins as Biomarkers in AKI

Sherry Mansour MD, MS
11:15-11:35
Wednesday, March 29

Educational Objectives:
1. Describe the association between Angiopoietins and long term outcomes in hospitalized patients with AKI.
2. Describe the interplay of vascular biomarkers with Angiopoietins in risk stratifying patients for poor long term outcomes after AKI.
3. Describe the role of Angiopoietins in kidney transplant recipients and long term outcomes.

Content Description:
Vascular health may explain the link between acute kidney injury (AKI) and poor long-term outcomes including heart failure, kidney disease progression and death.

As a measure of vascular health after kidney injury we measured Angiopoietins in different clinical settings to assess their utility in predicting long-term outcomes in hospitalized patient and kidney transplant recipients.

This talk will include both published and unpublished data, which showcase the vital role of Angiopoietins in explaining the development of heart failure, cardiovascular disease, kidney disease progression and mortality in hospitalized patients with and without AKI as well as kidney transplant recipients.

Understanding the link between AKI and poor long-term outcomes, specially cardiovascular outcomes, is crucial to improving kidney patient outcomes.

Suggested Reading:
Perry HM, Okusa MD. Endothelial Dysfunction in Renal Interstitial Fibrosis. Nephron. 2016;134:167-171.

Zuchi C, Tritto I, Carluccio E, Mattei C, Cattadori G, Ambrosio G. Role of endothelial dysfunction in heart failure. Heart Fail Rev. 2020;25:21-30.

Holgado JL, Lopez C, Fernandez A, et al. Acute kidney injury in heart failure: a population study. ESC Heart Fail. 2020;7:415-422.

Odutayo A, Wong CX, Farkouh M, et al. AKI and Long-Term Risk for Cardiovascular Events and Mortality. Journal of the American Society of Nephrology : JASN. 2017;28:377-387.

Mansour SG, Bhatraju PK, Coca SG, et al. Angiopoietins as Prognostic Markers for Future Kidney Disease and Heart Failure Events after Acute Kidney Injury. Journal of the American Society of Nephrology : JASN. 2022;33:613-627.

Kidney Microphysiological Models for Nephrotoxicity Assessment

SeJoong Kim, Professor
11:35-11:55
Wednesday, March 29

Educational Objectives:
1. Discuss unmet needs for advanced alternative tests, including the micro physiological systems (MPS).
2. Describe the representative examples of nephrotoxicity assessment using MPS.
3. Discuss the future nephrotoxic models using MPS.

Content Description:
Current drug discovery models, including 2D in vitro culture and in vivo experiments, must improve their efficiency and limitations in predicting human responses. Microphysiological systems may be superior for advanced alternative tests to overwhelm these limitations.

MPS is modeling human tissues in micro physiologically relevant chips. Three common causes of AKI are ischemia, drug nephrotoxicity, and infection/sepsis. We mimic several nephrotoxic models using gentamicin, colistin, and radiocontrast media. We also developed ischemic and LPS-induced injury models in kidney chips.

Future nephrotoxic models may guide organ-organ interactions such as liver and kidney, lung and kidney, or intestine and kidney.

Suggested Reading:
1. Three-Dimensional Kidney-on-a-Chip Assessment of Contrast-Induced Kidney Injury: Osmolality and Viscosity.
Kim K, Jeong B, Lee YM, Son HE, Ryu JY, Park S, Jeong JC, Chin HJ, Kim S*.
Micromachines (Basel). 2022 Apr 28;13(5):688.

2. Gut-Kidney Axis on Chip for Studying Effects of Antibiotics on Risk of Hemolytic Uremic Syndrome by Shiga Toxin-Producing Escherichia coli.
Lee Y, Kim MH, Alves DR, Kim S*, Lee LP, Sung JH, Park S.
Toxins (Basel). 2021 Nov 2;13(11):775.

3. Potential of Drug Efficacy Evaluation in Lung and Kidney Cancer Models Using Organ-on-a-Chip Technology.
Hwang SH, Lee S, Park JY, Jeon JS, Cho YJ, Kim S*.
Micromachines (Basel). 2021 Feb 21;12(2):215.

4. Kidney on chips.
Lee J, Kim K, Kim S*.
Methods Cell Biol. 2018;146:85-104.

5. Kidney-on-a-Chip: A New Technology for Predicting Drug Efficacy, Interactions, and Drug-induced Nephrotoxicity.
Lee J, Kim S*.
Curr Drug Metab. 2018;19(7):577-583.

6. Pharmacokinetic profile that reduces nephrotoxicity of gentamicin in a perfused kidney-on-a-chip.
Kim S*, LesherPerez SC, Kim BC, Yamanishi C, Labuz JM, Leung B, Takayama S.
Biofabrication. 2016 Mar 24;8(1):015021.

7. Organ-on-a-chip and the kidney.
Kim S*, Takayama S.
Kidney Res Clin Pract. 2015 Sep;34(3):165-9

8. Role of Human Primary Renal Fibroblast in TGF-β1-Mediated Fibrosis-Mimicking Devices.
Hwang SH, Lee YM, Choi Y, Son HE, Ryu JY, Na KY, Chin HJ, Jeon NL, Kim S*.
Int J Mol Sci. 2021 Oct 5;22(19):10758.

9. Roles of fluid shear stress and retinoic acid in the differentiation of primary cultured human podocytes.
Yang SH, Choi JW, Huh D, Jo HA, Kim S*, Lim CS, Lee JC, Kim HC, Kwon HM, Jeong CW, Kwak C, Joo KW, Kim YS, Kim DK.
Exp Cell Res. 2017 May 1;354(1):48-56.

10. Application of microfluidic perfusion culture for assessment of colistin nephrotoxicity
Kim K, Lee A, Ryu JY, Son HE, Chin HJ, Na KY, Chae DW, Khan A, Kim SJ, Kim S*
Rom Biotechnol Lett. 2020; 25(4): 1724-1730.

Bone Dysregulation in AKI and Critical Illness

Orson Moe MD
1:15-1:35
Wednesday, March 29

Educational Objectives:
1. Be aware of the very limited preclinical and clinical data on AKI and bone complications.
2. Many endocrine and metabolic changes in AKI can theoretically affect bone but there is clearly paucity of data
3. Three ways to conceptualize bone complications in AKI: a) Acute short-term effects on bone. b) Chronic long-term effects on bone despite apparent AKI recovery. c) AKI-to-CKD transition and bone disease of CKD.

Content Description:
please limit to 300 words
Bine complications in AKI have not been studied in any detail. There is limited epidemiologic data indicating that there is several fold increased risk of fracture post AKI recovery. Rodent models of AKI also demonstrated abnormal bone parameters after recovery from AKI. There is a wide range of hormonal and metabolic changes during AKI that can all have impact on bone health. These include adiponectin, parathyroid hormone, fibroblast growth factor 23, vitamin D, and Klotho. These theoretical considerations will be reviewed as potential pathophysiologic intermediates. More clinical data is needed to prove or refute the relevance of these hormonal changes on bone health.

Suggested Reading:
please limit to 10 references

The Impact of Acute Kidney Injury With Temporary Dialysis on the Risk of Fracture. Wang et al. Journal of Bone and Mineral Research, Vol. 29, No. 3, pp 676–684, 2014.

Acute Kidney Injury and Pediatric Bone Health. Hegde et al. Frontiers in Pediatrics. 8:1-7, 2021.

Novel Therapeutics in AKI: Can Hydrogels Work in Humans?

Danielle Soranno MD
1:55-2:15
Wednesday, March 29

Educational Objectives:
1. Describe the basic properties of a hydrogel and potential clinical uses.

2. Describe the potential routes of hydrogel delivery to treat kidney disease.

3. Describe the various therapeutics that can be delivered via hydrogels for sustained local delivery.

Content Description:
Hydrogels are water-swollen polymers that can be made from a variety of natural and synthetic polymers. Numerous chemistries can be utilized to formulate hydrogels that are injectable, enabling facile in situ delivery of therapeutics such as cytokines or cells. Cells delivered via injectable hydrogels survive injection better than cells injected in saline/media suspension. Hyaluronic acid (HA) can be chemically modified using guest-host interactions to formulate an injectable hydrogel. The chemistry can be modified such that the hydrogels degrade quickly or slowly in vivo. HA hydrogels have been used to deliver interleukin-10, anti-TGFβ, and mesenchymal stem cells in various models of kidney disease. Numerous studies have demonstrated that HA hydrogel therapy alone reduces inflammation and fibrosis. Transcutanous measurements of glomerular filtration rate have demonstrated that delivery of the hydrogel under the kidney capsule does not impair measured kidney function.

Suggested Reading:
1. Lu, H.D., et al., Secondary photocrosslinking of injectable shear-thinning dock-and-lock hydrogels. Adv Healthc Mater, 2013. 2(7): p. 1028-36.
2. Soranno, D.E., et al., Immunotherapy with injectable hydrogels to treat obstructive nephropathy. J Biomed Mater Res A, 2014. 102(7): p. 2173-80.
3. Rodell, C.B., et al., Local immunotherapy via delivery of interleukin-10 and transforming growth factor beta antagonist for treatment of chronic kidney disease. J Control Release, 2015. 206: p. 131-139.
4. Soranno, D.E., et al., Delivery of interleukin-10 via injectable hydrogels improves renal outcomes and reduces systemic inflammation following ischemic acute kidney injury in mice. Am J Physiol Renal Physiol, 2016. 311(2): p. F362-72.
5. Soranno, D.E., et al., Measurement of glomerular filtration rate reveals that subcapsular injection of shear-thinning hyaluronic acid hydrogels does not impair kidney function in mice. J Biomed Mater Res A, 2022. 110(3): p. 652-658.
6. Gao, J., et al., The use of chitosan based hydrogel for enhancing the therapeutic benefits of adipose-derived MSCs for acute kidney injury. Biomaterials, 2012. 33(14): p. 3673-81.

Sympathetic Nerve Activation in AKI

Kent Doi MD
2:35-2:55
Wednesday, March 29

Educational Objectives:
To investigate the role of sypathetic nervous system in AKI and cardiorenal syndrome.

Content Description:
The interactions between kidney and heart are well studied and frequently lumped together as cardio-renal syndromes. It is believed that the sympathetic nervous system (SNS) and renin-angiotensin-aldosterone system (RAS) are involved in cardiac dysfunction after AKI. SNS and RAS are activated during AKI, and can induce myocyte hypertrophy, apoptosis and necrosis, and up-regulation of genes promoting fibrosis. These results support the view that the activation of SNS and RAS may contribute to cardiorenal syndrome, but direct evidence is still lacking. Recently, several studies demonstrated the protective role of SNS against cardiorenal syndrome and AKI. We elucidate the effect of pre-existing heart failure with reduced ejection fraction (HFrEF) on kidney via sympathetic activity, using the combining models of transverse aortic constriction (TAC) and unilateral renal ischemia reperfusion (IR). The evaluation of acute (24 hours) and chronic (2 weeks) phases of renal injury following IR eight weeks after TAC in C57BL/6 mice revealed that the development of renal fibrosis in chronic phase was significantly attenuated in TAC mice, but not in non-TAC mice, whereas no impact of pre-existing heart failure was observed in acute phase of renal IR. Expression of transforming growth factor-beta, monocyte chemoattractant protein-1, and macrophage infiltration were significantly reduced in TAC mice. We performed renal sympathetic denervation two days prior to renal IR, which abrogated attenuation of renal fibrosis in TAC mice. Collectively, the protective effect of pre-existing HFrEF on long-term renal ischemic injury. Renal sympathetic nerve may contribute to this protection.

Suggested Reading:
1. Matsuura R, Yamashita T, Hayase N, et al. Preexisting heart failure with reduced ejection fraction attenuates renal fibrosis after ischemia reperfusion via sympathetic activation. Sci Rep. 2021;11(1):15091. doi:10.1038/s41598-021-94617-3
2. Hasegawa S, Inoue T, Nakamura Y, et al. Activation of Sympathetic Signaling in Macrophages Blocks Systemic Inflammation and Protects against Renal Ischemia-Reperfusion Injury. J Am Soc Nephrol. 2021;32(7):1599-1615. doi:10.1681/ASN.2020121723

Tubular Dysfunction Predicts MAKE

Alex L Bullen MD
3:50-4:10
Wednesday, March 29

Educational Objectives:
1. Describe the role of kidney tubular function markers and MAKE
2. Discuss potential future directions in the study of kidney tubular function markers

Content Description:
The kidney tubules perform multiple functions, including protein reabsorption, electrolyte balance, acid-base homeostasis, secretion, and endocrine functions. However, serum creatinine (and its derivative eGFR) and albuminuria are the primary markers for assessing acute kidney injury and chronic kidney disease, but they do not

capture these functions. In this session, we will discuss recent studies evaluating the role of kidney tubular function markers and major adverse kidney events.

Suggested Reading:
1. Ix, JH and Shlipak MG. The Promise of Tubule Biomarkers in Kidney Disease: A Review. AJKD Vol 78. Iss 5. November 2021.

2. Zhang WR and Parikh CR. Biomarkers of Acute and Chronic Kidney Disease. Annu. Rev. Physiol. 2019. 81:30933

3. Wen Y and Parikh CR. Current concepts and advances in biomarkers of acute kidney injury. Critical Reviews in Clinical Laboratory Sciences 2021. Vol 58. No. 5, 354-368

Nephrotoxin Stewardship

Sandra Kane Gill PharmD
4:10-4:30
Wednesday, March 29

Educational Objectives:
1. Summarize the goals of nephrotoxin stewardship.

2. Discuss in detail at least one patient care strategy applied to nephrotoxin stewardship.

3. Create a plan for coordinated patient care strategies of nephrotoxin stewardship.

Content Description:
Drug associated acute kidney injury (D-AKI) contributes to 20-30% of kidney related events in intensive care units (ICU). Drugs are a modifiable exposure offering the opportunity for interventions to prevent AKI occurrence or ameliorate AKI severity. "Nephrotoxin stewardship is a set of coordinated patient care management strategies to improve the use of nephrotoxins, renally eliminated drugs and kidney disease treatments with the goal of enhancing patient outcomes through safe medication use, ensuring kidney health and avoiding unnecessary costs." (PMID: 33752857) Identifying renally eliminated drugs and nephrotoxins to target for surveillance and standardizing the lists for adoption is the first step in risk assessment and prevention. Nephrotoxin stewardship extends beyond single drugs for surveillance to consideration of drug burden and drug-drug interactions. The next step in nephrotoxin stewardship is hypervigilant surveillance of risk and impending harm using traditional functional biomarkers and novel damage biomarkers. Approaches that have been used to identify risk for D-AKI are three drug nephrotoxin alerting (drug burden) and use of stress/damage biomarkers indicating risk before overt damage with a rise in serum creatinine. Strategies for nephrotoxin stewardship should be implemented in a cost-conscious manner. The key to preventing D-AKI is a coordinated nephrotoxin stewardship strategy.

Suggested Reading:
1. Kane-Gill SL. Nephrotoxin Stewardship. Crit Care Clin. 2021 Apr;37(2):303-320. PMID: 33752857.

2. Griffin BR, Wendt L, Vaughan-Sarrazin M, et al. Nephrotoxin Exposure and Acute Kidney Injury in Adults. Clin J Am Soc Nephrol. 2023 Feb 1;18(2):163-172. PMID: 36754005.

3. Goldstein SL, Dahale D, Kirkendall ES, et al. A prospective multi-center quality improvement initiative (NINJA) indicates a reduction in nephrotoxic acute kidney injury in hospitalized children. Kidney Int. 2020

Mar;97(3):580-588. PMID: 31980139.

4. Williams VL, Smithburger PL, Imhoff AN, et al. Interventions, Barriers, and Proposed Solutions Associated With the Implementation of a Protocol That Uses Clinical Decision Support and a Stress Biomarker Test to Identify ICU Patients at High-Risk for Drug Associated Acute Kidney Injury. Ann Pharmacother. 2023 Apr;57(4):408-415. PMID: 35962583.

MEET THE EXPERT
How do I Dose Volume During CRRT?

Raghavan Murugan MD, MS, FRCP
7:00-8:00
Thursday, March 30

Educational Objectives:
1. To learn when to start volume removal during CRRT.

2. To learn what is net fluid removal and how to set net fluid removal during CRRT.

3. To learn about emerging evidence showing an association between net fluid removal rate and clinical outcomes.

Content Description:
Fluid overload is associated with morbidity and mortality in critically ill patients with AKI. Although the fluid is frequently removed (i.e., net ultrafiltration) during CRRT, the best method to remove fluid is unclear. Both slower and faster rates of fluid removal have risks and benefits. This session will provide an overview of when to start fluid removal, and how to determine and set the net ultrafiltration rate in the CRRT machine using the body weight. This session will also provide an overview of emerging evidence between net ultrafiltration rate and clinical outcomes.

Suggested Reading:
1. Bouchard J, Soroko SB, Chertow GM, et al. Fluid accumulation, survival and recovery of kidney function in critically ill patients with acute kidney injury. Kidney Int. 2009;76(4):422-427.
2. Mehta RL, Pascual MT, Soroko S, Chertow GM, Group PS. Diuretics, mortality, and nonrecovery of renal function in acute renal failure. JAMA. 2002;288(20):2547-2553
3. Prowle JR, Echeverri JE, Ligabo EV, Ronco C, Bellomo R. Fluid balance and acute kidney injury. Nat Rev Nephrol. 2010;6(2):107-115.
4. Balakumar V, Murugan R. Kidney Replacement Therapy for Fluid Management. Critical Care Clinics. 2021
5. Murugan R, Balakumar V, Kerti SJ, et al. Net ultrafiltration intensity and mortality in critically ill patients with fluid overload. Crit Care. 2018;22(1):223.PMC6151928
6. Murugan R, Bellomo R, Palevsky PM, Kellum JA. Ultrafiltration in critically ill patients treated with kidney replacement therapy. Nat Rev Nephrol. 2021;17(4):262-276
7. Murugan R, Hoste E, Mehta RL, et al. Precision Fluid Management in Continuous Renal Replacement Therapy. Blood Purif. 2016;42(3):266-278
8. Murugan R, Kerti SJ, Chang CH, et al. Association of Net Ultrafiltration Rate With Mortality Among Critically Ill Adults With Acute Kidney Injury Receiving Continuous Venovenous Hemodiafiltration: A Secondary Analysis of the Randomized Evaluation of Normal vs Augmented Level (RENAL) of Renal Replacement Therapy Trial. JAMA Netw Open. 2019;2(6):e195418.PMC6563576
9. Murugan R, Kerti SJ, Chang CH, et al. Association between Net Ultrafiltration Rate and Renal Recovery among Critically Ill Adults with Acute Kidney Injury Receiving Continuous Renal Replacement Therapy: An Observational Cohort Study. Blood Purif. 2021:1-13
10. Murugan R, Ostermann M, Peng Z, et al. Net Ultrafiltration Prescription and Practice Among Critically Ill Patients Receiving Renal Replacement Therapy: A Multinational Survey of Critical Care Practitioners. Crit Care Med. 2020;Feb;48(2):e87-e97

Morning Symposium A - Plasma Exchange in Critically Ill Patients: Who, When and How

Akash Deep Professor
7:00-8:00
Thursday, March 30

Educational Objectives:

1. Describe the indications/cohort of critically ill patients who would benefit from plasma exchange
2. Discuss the practical and technical issues in providing plasma exchange to critically ill patients
3. Discuss the timing of initiation of plasma exchange in the trajectory of a patient's illness
4. Discuss the use of plasma exchange in patients with fulminant hepatic failure and in those with septic shock

Content Description:
Extracorporeal therapies in critically ill patients play an important role in removing toxins, fluid and immune modulation. Therapeutic apheresis encompasses the removal of plasma (plasmapheresis) or blood cells (cytapheresis, i.e., erythrocytes, leukocytes, or platelets) from the patient's blood. If plasma is removed not for donation but for therapeutic purposes and is replaced by donor plasma, colloid, or crystalloids or a mixture thereof, it defines therapeutic plasma exchange (TPE) TPE serves to remove pathogenic substances (e.g., autoantibodies or toxic agents) and/or to administer deficient substances present in plasma of healthy donors. The indications for TPE have been refined over time. Many patients who require TPE are critically ill needing admission to the intensive care unit (ICU). TPE is an invasive procedure with often emergent indications, demanding its execution as soon as possible. Thus, a rapid response by experienced staff, with specific equipment, close monitoring, and multidisciplinary management are essential. In this symposium, we discuss the indications of TPE in critically ill patients, techniques (how to) used in performing TPE either alone or in combination with CRRT; complications and trouble shooting. We will discuss the role of TPE in specific conditions like fulminant hepatic failure and septic shock.

Presentation Outline:

1. Review of Principles of plasma exchange – plasma filtration; plasmapheresis
2. Approaches to delivering plasma exchange – stand-alone versus in tandem with CRRT (parallel and series)
3. Practical Issues for delivering Plasma exchange - Prescription; equipment; personnel; toxin removal; monitoring; complications
4. Indications of plasma exchange in critically ill patients
5. Role of plasma exchange in patients with fulminant hepatic failure

Suggested Reading:
1. Reeves HM, Winters JL (2014) The mechanisms of action of plasma exchange. Br J Haematol 164:342–351. https:// doi. org/ 10. 1111/ bjh. 12629

2. Padmanabhan A, Connelly-Smith L, Aqui N, et al (2019) Guidelines on the use of therapeutic apheresis in clinical practice—evidence-based approach from the Writing Committee of the American Society for Apheresis: the eighth special issue. J Clin Apher 34:171–354. https:// doi. org/ 10. 1002/ jca. 21705

3. Abe T, Matsuo H, Abe R, Abe S, et al (2021) The Japanese Society for Apheresis clinical practice guideline for therapeutic apheresis. Ther Apher Dial 25:728–876. https:// doi. org/ 10. 1111/ 1744- 9987. 13749

4. Pham HP, Schwartz J (2019) Therapeutic plasma exchange in Guillain- Barre Syndrome and chronic inflammatory demyelinating polyradiculoneuropathy. Presse Med 48:338–346. https:// doi. org/ 10. 1016/j. lpm. 2019. 03. 016

5. Chevret S, Hughes RA, Annane D (2017) Plasma exchange for Guillain- Barr. syndrome. Cochrane Database Syst Rev 2:CD001798. https:// doi. org/ 10. 1002/ 14651 858. CD001 798. pub3

6. Gilhus NE (2016) Myasthenia gravis. N Engl J Med 375:2570–2581. https:// doi. org/ 10. 1056/ NEJMr a1602 678

7. Barth D, Nabavi Nouri M, Ng E, Nwe P, Bril V (2011) Comparison of IVIg and PLEX in patients with myasthenia gravis. Neurology 76:2017–2023.
https:// doi. org/ 10. 1212/ WNL. 0b013 e3182 1e5505

8. Alexander EC, Deep A. Therapeutic plasma exchange in children with acute liver failure (ALF): is it time for incorporation into the ALF armamentarium? Pediatr Nephrol. 2022 Aug;37(8):1775-1788. doi: 10.1007/s00467-021-05289-0. Epub 2021 Oct 14. PMID: 34647173; PMCID: PMC9239959.

Morning Symposium B
Personalized Management of Shock: How to use Biomarkers, Vasopresssors and Fluids?

Sean Bagshaw MD, MSc
7:00-8:00
Thursday, March 30

Educational Objectives:
1. Discuss approaches to the individualized assessment and diagnosis of shock.

2. Appraise recent randomized trials on the integration of clinical examination and biomarkers for the diagnosis and response to interventions in shock.

3. Provide illustrate cases representing the spectrum of application of clinical markers for the diagnosis and management of shock.

Content Description:
TBD.

Suggested Reading:
1. Zampieri FG, Damiani LP, Bakker J, Ospina-Tascón GA, Castro R, Cavalcanti AB, Hernandez G. Effects of a Resuscitation Strategy Targeting Peripheral Perfusion Status versus Serum Lactate Levels among Patients with Septic Shock. A Bayesian Reanalysis of the ANDROMEDA-SHOCK Trial. Am J Respir Crit Care Med. 2020 Feb 15;201(4):423-429. doi: 10.1164/rccm.201905-0968OC.
2. Hernández G, Ospina-Tascón GA, Damiani LP, Estenssoro E, Dubin A, Hurtado J, Friedman G, Castro R, Alegría L, Teboul JL, Cecconi M, Ferri G, Jibaja M, Pairumani R, Fernández P, Barahona D, Granda-Luna V, Cavalcanti AB, Bakker J; The ANDROMEDA SHOCK Investigators and the Latin America Intensive Care Network (LIVEN). Effect of a Resuscitation Strategy Targeting Peripheral Perfusion Status vs Serum Lactate Levels on 28-Day Mortality Among Patients With Septic Shock: The ANDROMEDA-SHOCK Randomized Clinical Trial. JAMA. 2019 Feb 19;321(7):654-664. doi: 10.1001/jama.2019.0071.

Morning Symposium B
Personalized Management of Shock: How to use Biomarkers, Vasopresssors and Fluids?

Michael Joannidis Professor, MD
7:00-8:00
Thursday, March 30

Educational Objectives:
1- Discuss principles of fluid therapy on an individualised basis
2- Appraise recent randomized trials on the integration of selction of fluid type (crystalloids, collids) and fluid strategies (conservative versus liberal)
3- Provide illustrate cases representing the spectrum of application of clinical markers for the guidance of fluid therapy

Content Description:
The administration of fluids is one of the most common interventions in the ICU. The effects and side effects of intravenous fluids depend on the amount administered and their specific composition. Intravenous fluid solutions are either considered crystalloids (for example 0.9% saline, lactated Ringer's solution) or colloids (artificial colloids such as gelatins, and albumin). This presentation will summarize the physiological principles of fluid therapy and reviews the most important studies on crystalloids, artificial colloids, and albumin in the context of critically ill patients.

Suggested Reading:
1. Shapiro NI, Douglas IS, Brower RG, Brown SM, Exline MC, Ginde AA, Gong MN, Grissom CK, Hayden D, Hough CL et al: Early Restrictive or Liberal Fluid Management for Sepsis-Induced Hypotension. The New England journal of medicine 2023, 388(6):499-510.
2. Mayerhöfer T, Shaw AD, Wiedermann CJ, Joannidis M: Fluids in the ICU: which is the right one? Nephrology, dialysis, transplantation : official publication of the European Dialysis and Transplant Association - European Renal Association 2022.
3. Meyhoff TS, Hjortrup PB, Wetterslev J, Sivapalan P, Laake JH, Cronhjort M, Jakob SM, Cecconi M, Nalos M, Ostermann M et al: Restriction of Intravenous Fluid in ICU Patients with Septic Shock. New England Journal of Medicine 2022, 386(26):2459-2470.

Morning Symposium B
Personalized Management of Shock: How to use Biomarkers, Vasopresssors and Fluids?

Kianoush Kashani MD, MS
7:00-8:00
Thursday, March 30

Educational Objectives:
1- Discuss approaches to the individualized assessment and diagnosis of shock
2- Appraise recent randomized trials on the integration of clinical examination and biomarkers for diagnosis and response to interventions in shock; the selection of fluid type (crystalloids, colloids) and fluid strategies (conservative versus liberal); the timing and selection of vasopressor agents for restoring macrohemodynamics and shock resolution.
3- Provide illustrate cases representing the spectrum of application of clinical markers for the diagnosis and management of shock

Content Description:
The administration of fluids is one of the most common interventions in the ICU. However, intravenous fluids' effects and side effects depend on the amount administered and their specific composition. Intravenous fluid solutions are either crystalloids (0.9% saline, lactated Ringer's solution) or colloids (artificial colloids such as gelatins and albumin). The physiological principles of fluid therapy will be summarized, and the most critical studies on crystalloids, artificial colloids, and albumin in the context of critically ill patients will be reviewed.

Suggested Reading:
1. Kislitsina ON, Rich JD, Wilcox JE, Pham DT, Churyla A, Vorovich EB, Ghafourian K, Yancy CW: Shock - Classification and Pathophysiological Principles of Therapeutics. Curr Cardiol Rev 2019, 15(2):102-113.
2. Jentzer JC, van Diepen S, Barsness GW, Henry TD, Menon V, Rihal CS, Naidu SS, Baran DA: Cardiogenic Shock Classification to Predict Mortality in the Cardiac Intensive Care Unit. Journal of the American College of Cardiology 2019, 74(17):2117-2128.
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4. Jansen TC, van Bommel J, Schoonderbeek FJ, Sleeswijk Visser SJ, van der Klooster JM, Lima AP, Willemsen SP, Bakker J, group Ls: Early lactate-guided therapy in intensive care unit patients: a multicenter, open-label, randomized controlled trial. American journal of respiratory and critical care medicine 2010, 182(6):752-761.
5. Liu V, Morehouse JW, Soule J, Whippy A, Escobar GJ: Fluid volume, lactate values, and mortality in sepsis patients with intermediate lactate values. Ann Am Thorac Soc 2013, 10(5):466-473.
6. Suetrong B, Walley KR: Lactic Acidosis in Sepsis: It's Not All Anaerobic: Implications for Diagnosis and Management. Chest 2016, 149(1):252-261.
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9. Jeyaraju M, McCurdy MT, Levine AR, Devarajan P, Mazzeffi MA, Mullins KE, Reif M, Yim DN, Parrino C, Lankford AS et al: Renin Kinetics Are Superior to Lactate Kinetics for Predicting In-Hospital Mortality in Hypotensive Critically Ill Patients. Critical care medicine 2022, 50(1):50-60.
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11. Sacha GL, Lam SW, Wang L, Duggal A, Reddy AJ, Bauer SR: Association of Catecholamine Dose, Lactate, and Shock Duration at Vasopressin Initiation With Mortality in Patients With Septic Shock*. Crit Care Med 2022, 50(4).
12. Jones AE, Shapiro NI, Trzeciak S, Arnold RC, Claremont HA, Kline JA, Emergency Medicine Shock Research Network I: Lactate clearance vs central venous oxygen saturation as goals of early sepsis therapy: a randomized clinical trial. JAMA 2010, 303(8):739-746.
13. Kraut JA, Madias NE: Lactic acidosis. N Engl J Med 2015, 372(11):1078-1079.
14. Monnet X, Malbrain MLNG, Pinsky MR: The prediction of fluid responsiveness. Intensive Care Med 2022.
15. Rosner MH, Ostermann M, Murugan R, Prowle JR, Ronco C, Kellum JA, Mythen MG, Shaw AD, Group AXI: Indications and management of mechanical fluid removal in critical illness. Br J Anaesth 2014, 113(5):764-771.
16. Seymour CW, Angus DC: Making a pragmatic choice for fluid resuscitation in critically ill patients. JAMA 2013, 310(17):1803-1804.
17. Russell JA: Vasopressor therapy in critically ill patients with shock. Intensive care medicine 2019, 45(11):1503-1517.

18. Zarbock A, Nadim MK, Pickkers P, Gomez H, Bell S, Joannidis M, Kashani K, Koyner JL, Pannu N, Meersch M et al: Sepsis-associated acute kidney injury: consensus report of the 28th Acute Disease Quality Initiative workgroup. Nat Rev Nephrol 2023.
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20. Mayerhöfer T, Shaw AD, Wiedermann CJ, Joannidis M: Fluids in the ICU: which is the right one? Nephrology, dialysis, transplantation : official publication of the European Dialysis and Transplant Association - European Renal Association 2022.
21. Meyhoff TS, Hjortrup PB, Wetterslev J, Sivapalan P, Laake JH, Cronhjort M, Jakob SM, Cecconi M, Nalos M, Ostermann M et al: Restriction of Intravenous Fluid in ICU Patients with Septic Shock. New England Journal of Medicine 2022, 386(26):2459-2470.

Hepato Renal Syndrome or Hepato CardioRenal Syndrome

Amir Kazory MD, FASN, FACC
8:30-8:45
Thursday, March 30

Educational Objectives:
1. Discuss cirrhotic cardiomyopathy and its temporal relationship with AKI in HRS
2. Discuss the significant cardiac impact of TIPS and albumin administration in HRS
3. Discuss the pathophysiologic mechanisms linking the heart, the liver, and the kidney in hepatorenal syndrome

Content Description:
Accumulating evidence on the pathophysiology of hepatorenal syndrome has challenged the conventional model of liver-kidney connection. While liver cirrhosis is traditionally considered the origin of a cascade of pathophysiologic mechanisms directly affecting other organs such as the kidney, emerging data point to the heart as the potential mediator of the untoward renal effects. In this lecture, we briefly review the often-overlooked contribution of the heart to circulatory dysfunction in hepatorenal syndrome and put forward evidence arguing for the involvement of systemic inflammation and endothelial dysfunction in this setting. The temporality of cardiorenal interactions in hepatorenal syndrome and the observed beneficial effects of portosystemic shunting on these pathways lend further support to the notion that cardiac involvement plays a key role in the development of renal dysfunction in severe cirrhosis. The disturbances traditionally bundled within hepatorenal syndrome could represent a hepatic form of cardiorenal syndrome whereby the liver affects the kidney in part through cardiorenal pathways. This new model has practical implications and calls for a shift in the focus of diagnostic and therapeutic approaches to renal dysfunction in advanced cirrhosis.

Suggested Reading:
1) Møller S, Bendtsen F. Cirrhotic Multiorgan Syndrome. Dig Dis Sci 2015;60(11):3209-25
2) Izzy MJ, VanWagner LB. Current Concepts of Cirrhotic Cardiomyopathy. Clin Liver Dis 2021;25(2):471-481
3) Krag A, Gluud LL: Cross-talk between the Liver, Heart and Kidney – another Piece in the Puzzle. J Gastrointestin Liver Dis. 2014;23(2):119-121
4) Kazory A, Ronco C. Hepatorenal Syndrome or Hepatocardiorenal Syndrome: Revisiting Basic Concepts in View of Emerging Data. Cardiorenal Med 2019;9(1):1-7
5) Møller S, Henriksen JH. Cardiovascular complications of cirrhosis. Gut 2008;57(2):268-278
6) Solà E, Ginès P. Renal and circulatory dysfunction in cirrhosis: current management and future perspectives. J Hepatol 2010;53(6):1135-1145
7) Schrier RW, Arroyo V, Bernardi M, Epstein M, Henriksen JH, Rodés J. Peripheral arterial vasodilation hypothesis: a proposal for the initiation of renal sodium and water retention in cirrhosis. Hepatology 1988;8(5):1151-1157
8) Salerno F, Gerbes A, Ginès P, Wong F, Arroyo V. Diagnosis, prevention and treatment of hepatorenal syndrome in cirrhosis. Gut 2007;56(9):1310-1318
9) Møller S, Krag A, Bendtsen F. Kidney injury in cirrhosis: pathophysiological and therapeutic aspects of hepatorenal syndromes. Liver Int 2014;34(8):1153-1163
10) Bosch J, Abraldes JG, Fernández M, García-Pagán JC. Hepatic endothelial dysfunction and abnormal angiogenesis: new targets in the treatment of portal hypertension. J Hepatol 2010;53(3):558-67

Metabolic Measurement in Sepsis

Kent Doi MD
8:45-9:00
Thursday, March 30

Educational Objectives:
To realize the significance of VCO2 and VO2 measurement by indirect calorimetry in sepsis.

Content Description:
Hemodynamic management in patients with sepsis is important for providing a sufficient amount of oxygen to the organs and preventing the development of multiple organ dysfunction. Measuring blood lactate level and its temporal changes (lactate clearance) and monitoring central venous oxygen saturation (SCVO2) have been applied in the clinical management of sepsis. Sepsis is characterized by altered cellular metabolism and impaired oxygen usage despite adequate oxygen delivery (DO2). Monitoring carbon dioxide production (VCO2) and oxygen extraction (VO2) is expected to help detect the progression of sepsis exacerbation, especially impaired oxygen usage in the mitochondria. Because indirect calorimetry (IC) can simultaneously and noninvasively measure VCO2 and VO2. IC will provide information not only for estimated nutritional requirements but also for tissue metabolism. Adult patients with sepsis who required mechanical ventilation in the intensive care unit (ICU) of our hospital between September 2019 and March 2020 were prospectively enrolled. Continuous measurement of VCO2 and VO2 using IC for 2 h was conducted within 24 h after tracheal intubation, and the changes in VCO2 and VO2 over 2 h were calculated as the slopes by linear regression analysis. Furthermore, temporal lactate changes were evaluated. Thirty-four patients with sepsis were enrolled, 26 of whom survived (76%). Significant differences in the slope of VCO2 (−1.412 vs. −0.446) ($p = 0.012$) and VO2 (−2.098 vs. −0.851) ($p = 0.023$) changes were observed between non-survivors and survivors. Of note, all eight non-survivors and 17 of the 26 survivors showed negative slopes of VCO2 and VO2 changes. For these patients, 17 survivors had a median lactate of −2.4% changes per hour (%/h), whereas non-survivors had a median lactate of 2.6%/hr ($p = 0.023$).
In conclusions, the non-survivors in this study showed temporal decreases in both VCO2 and VO2 along with lactate elevation. Monitoring the temporal changes in VCO2 and VO2 along with blood lactate levels may be useful in predicting the prognosis of sepsis.

Suggested Reading:
1. Fink MP: Bench-to-bedside review: Cytopathic hypoxia. Crit Care 2002, 6(6):491-499.
2. Hoeyer-Nielsen AK, Holmberg MJ, Grossestreuer AV, Yankama T, Branton JP, Donnino MW, Berg KM: Association Between the Oxygen Consumption: Lactate Ratio and Survival in Critically Ill Patients With Sepsis. Shock 2021, 55(6):775-781.
3. Hirayama I, Asada T, Yamamoto M, Hayase N, Hiruma T, Doi K. Changes in carbon dioxide production and oxygen uptake evaluated using indirect calorimetry in mechanically ventilated patients with sepsis. Crit Care. 2021 Dec 4;25(1):416.

SPECIAL LECTURE
ADQI 28 REPORT: Sepsis Associated AKI

Lui Forni MD PhD JFICMI
10:00-10:30
Thursday, March 30

Educational Objectives:
1) Overview of sepsis associated AKI
2) Outline current ADQI reccomendations
3) HIghlight areas for research

Content Description:
This will be a whistle stop tour of the latest ADQI guidelines published in Nature Reviews Nephrology

Suggested Reading:
The article is available on line!

A01
Biomarker Enhanced Management of AKI and RRT (C, N, AP)

Jay Koyner MD
11:00-12:30
Thursday, March 30

Educational Objectives:
1) To understand how currently available biochemical and electronic biomarkers of acute kidney injury (AKI) (beyond serum creatinine and urine output) can be used to improve patient care.
2) To understand how biochemical, functional and electronic biomarkers of AKI can serve different roles in the differential diagnosis and prognosis of AKI
3) To define and describe the utility of biomarkers in the initiation and cessation of RRT.

Content Description:
This case- based session we will walk the audience through the stages of AKI and the utility of biomarkers at every stage across the AKI spectrum. While we will acknowledge the role of traditional biomarkers (serum creatinine, urine output) we will focus other tools. We will explore the role of several markers in AKI risk prediction (including but not limited to artificial intelligence risk score, TIMP*IGFBP7 and NGAL) – we will be looking at this across a variety of clinical settings (sepsis, cardiac surgery…) Following this we will discuss the role of these and other biomarkers (urine microscopy, volume assessment, furosemide stress test and CCL-14) in the differential diagnosis and prognosis of AKI. Then we will transition to talk about the role of biomarkers in the starting, maintaining and stopping dialysis. We will close by talking about the AKI biomarker composite (ABC) a paradigm that uses multiple biomarkers of kidney function to improve the care of patients with AKI. The ABC allows the physician to think about AKI as an analogy to respiratory failure and the arterial blood gas, where multiple measures are integrated over time to assess the patient; this is in stark contrast to prior models which sought to use the troponin / acute myocardial infarction model.

Over the course of our session we will follow our AKI case throughout the course of AKI, we will attempt to highlight several papers that were published in the last year , as well as, seminal papers published over the last 10 years. We will also work to engage the audience and "flip the classroom" by engaging the audience around which resources they have as well as asking them which biomarkers they have versus which ones they want to have.

Suggested Reading:
https://pubmed.ncbi.nlm.nih.gov/33832791/
https://pubmed.ncbi.nlm.nih.gov/35919538/
https://pubmed.ncbi.nlm.nih.gov/32025755/
https://pubmed.ncbi.nlm.nih.gov/30745052/
https://pubmed.ncbi.nlm.nih.gov/34491355/
https://pubmed.ncbi.nlm.nih.gov/34515166/
https://www.ncbi.nlm.nih.gov/pubmed/31725154
https://www.ncbi.nlm.nih.gov/pubmed/31343478
https://www.ncbi.nlm.nih.gov/pubmed/31221200
https://www.ncbi.nlm.nih.gov/pubmed/31174170
https://www.ncbi.nlm.nih.gov/pubmed/30035208
https://www.ncbi.nlm.nih.gov/pubmed/31922998
https://www.ncbi.nlm.nih.gov/pubmed/31202596
https://www.ncbi.nlm.nih.gov/pubmed/28110412

B02
Citrate Anticoagulation for CRRT: How to Use it?

Ashita Tolwani MD
11:00-12:30
Thursday, March 30

Educational Objectives:
1.Review the principles of regional citrate anticoagulation (RCA) for CRRT rationale, mechanism, and metabolic effects/complications.
2.Discuss the practical issues for citrate implementation: prescription, monitoring, and troubleshooting acid-base complications.
3.Discuss lessons learned from RCA in the pediatric population.

Content Description:
Regional citrate anticoagulation (RCA) has been shown to prolong circuit life while reducing the incidence of hemorrhagic complications and lowering transfusion needs. Citrate is infused into the blood at the beginning of the extracorporeal circuit and provides anticoagulation by chelating ionized calcium and thus preventing the progression of the coagulation cascade. About 50% of the calcium-citrate is removed via the filter. The remainder enters the systemic circulation of the patient, where it is diluted and metabolized by the liver to bicarbonate, releasing ionized calcium back to the circulation. Since a portion of the calcium-citrate complex is filtered across the hemofilter and lost in the effluent, a systemic calcium infusion is usually necessary. Anticoagulation is limited to the circuit by maintaining normal levels of ionized calcium in the systemic circulation. Citrate has metabolic effects, too. It can cause both, metabolic alkalosis and metabolic acidosis, depending on whether it is metabolized in liver and muscle, or accumulates (ie. liver failure, cardiovascular shock). In children, especially infants and those with liver disease, RCA prescription and monitoring is associated with unique and significant challenges,but is feasible to perform safely.

Guided by a case-based approach, this workshop will discuss the best approaches for utilizing RCA for CRRT, including how to trouble-shoot the metabolic consequences of RCA in both the adult and pediatric population.

Suggested Reading:
1.Buccione E, Bambi S, Rasero L, Tofani L, Piazzini T, Della Pelle C, El Aoufy K, Ricci Z, Romagnoli S, Villa G. Regional Citrate Anticoagulation and Systemic Anticoagulation during Pediatric Continuous Renal Replacement Therapy: A Systematic Literature Review. J Clin Med. 2022 May 31;11(11):3121.
2.Li R, Gao X, Zhou T, Li Y, Wang J, Zhang P. Regional citrate versus heparin anticoagulation for continuous renal replacement therapy in critically ill patients: A meta-analysis of randomized controlled trials. Ther Apher Dial. 2022 Dec;26(6):1086-1097.
3.Mann, K. G., et al. "Citrate Anticoagulation and the Dynamics of Thrombin Generation." Journal of Thrombosis and Haemostasis: JTH, vol. 5, no. 10, Oct. 2007, pp. 2055–61. PubMed, doi:10.1111/j.1538-7836.2007.02710.x.
4.Morabito S, Pistolesi V, Tritapepe L, Fiaccadori E, et al. Regional citrate anticoagulation for RRTs in critically ill patients with AKI. Clin J Am Soc Nephrol 2014; 9(12):2173.
5.Oudemans-van Straaten HM, Ostermann M. Bench-to-bedside review: Citrate for continuous renal replacement therapy, from science to practice. Crit Care. 2012 Dec 7;16(6):249.
6.Ricci, Davide, et al. "Citrate Anticoagulation during Continuous Renal Replacement Therapy." Contributions to Nephrology, vol. 190, 2017, pp. 19–30. PubMed, doi:10.1159/000468833.
7.Schneider AJ, Journois D, Rimmelé T. Complications of regional citrate anticoagulation: accumulation or overload? Critical Care (2017) 21:281
8.Szamosfalvi, Balazs, et al. "Automated Regional Citrate Anticoagulation: Technological Barriers and Possible Solutions." Blood Purification, vol. 29, no. 2, 2010, pp. 204–09. PubMed, doi:10.1159/000245648.
9.Wang PL, Meyer MM, Orloff SL, Anderson S. Bone resorption and "relative" immobilization hypercalcemia

with prolonged continuous renal replacement therapy and citrate anticoagulation. Am J Kidney Dis 2004;44:1110-1114
10.Zarbock A,et a.; RICH Investigators and the Sepnet Trial Group. Effect of Regional Citrate Anticoagulation vs Systemic Heparin Anticoagulation During Continuous Kidney Replacement Therapy on Dialysis Filter Life Span and Mortality Among Critically Ill Patients With Acute Kidney Injury: A Randomized Clinical Trial. JAMA. 2020 Oct 27;324(16):1629-1639. doi: 10.1001/jama.2020.18618. PMID: 33095849; PMCID: PMC7585036.
11.Davis et al. Citrate Anticoagulation During Continuous Renal Replacement Therapy in Pediatric Critical Care. Pediatric Critical Care Medicine. 2014. 15:471-485.
12.Bunchman et al. Pediatric Convective Hemofiltration: Normocarb Replacement Fluid and Citrate Anticoagulation. American Journal of Kidney Disease. 2003. 42: 1248-1252
13.Liet et al. Regional citrate anticoagulation for pediatric CRRT using integrated citrate software and physiological sodium concentration solutions. Pediatric Nephrology. 2014. 29: 1625-1631
14.Yessayan L, Sohaney R, Puri V, Wagner B, Riddle A, Dickinson S, Napolitano L, Heung M, Humes D, Szamosfalvi B. Regional citrate anticoagulation "non-shock" protocol with pre-calculated flow settings for patients with at least 6 L/hour liver citrate clearance. BMC Nephrol. 2021 Jul 2;22(1):244

B02
Citrate Anticoagulation for CRRT: How to Use it?

Michael Joannidis Professor, MD
11:00-12:30
Thursday, March 30

Educational Objectives:
Practical issues for citrate implementation: Prescription, monitoring, troubleshooting complications (discussing citrate load, vs citrate dose, vs citrate rate)

Content Description:
When used in CRRT Citrate is not only a potent anticoagulant but also a major determinant of acid base homeostasis.

Acid base disturbances during regional citrate anticoagulation (RCA) will manifest as metabolic alkalosis or acidosis.

Metabolic alkalosis usually reflects an over substitution of citrate due to increased substitution rates or impaired citrate elimination rates via the hemofilter. Bicarbonate content of replacement fluids may be another factor to consider.

Metabolic acidosis may be the result of insufficient citrate delivery to the patients of incapacitated citrate metabolism by liver and other organs (e.g. citrate accumulation in severe shock). Since these two conditions require opposite interventions careful differential diagnosis is required in that case.

Important parameter to be included are iCa, total serum calcium and calcium substitution rates. A increasing rate of hypocalcaemia requiring increased calcium substitution and a iCa/totCa > 2.5 are highly suspicious for citrate accumulation. On the other hand, increasing iCa levels may be observed in some patients during longer duration of RCA, which may reflect hyperparathyroidism or paraneoplastic effects.

Suggested Reading:
Schneider AG, Journois D, Rimmelé T: Complications of regional citrate anticoagulation: accumulation or overload? Critical care (London, England) 2017, 21(1):281.

C03

Focus on POCUS: Assessment of Fluid Responsiveness, Hemodynamic Monitoring and Targets

Kianoush Kashani MD, MS
11:00-12:30
Thursday, March 30

Educational Objectives:

1. To understand the assessment of fluid deficiency, replacement, and responsiveness in children and adults with critical illness with or without acute kidney injury.
2. To learn how fluid management differs in different stages of shock management.
3. To understand the use of fluid responsiveness and tolerance assessment tools, including a focus on the use of point of care ultrasonography (POCUS).

Content Description:

Fluid resuscitation is necessary for critically ill patients across a heterogeneous population of children and adults and disease states. Achieving appropriate volume management requires knowledge of the underlying pathophysiology, evaluating volume status, selecting a proper solution for volume repletion, and maintaining and modulating tissue perfusion and cellular injury. This workshop will describe fluid management principles across all age ranges and discuss using novel diagnostic techniques to assess fluid responsiveness. We will use case studies to represent each of these components.

Presentation Outline:

1. Review the assessment of the following in adults:
a. Fluid deficiency
b. Fluid responsiveness
c. Hemodynamic management
2. Review the assessment of the following in children:
a. Fluid deficiency and fluid responsiveness using POCUS
b. Hemodynamic management
3. Discuss the issues of fluid tolerance in adults
a. Use of ultrasound in the assessment of fluid tolerance
4. Discussion

Suggested Reading:

1. Alobaidi R, Morgan C, Basu RK, Stenson E, Featherstone R, Majumdar SR, Bagshaw SM: Association Between Fluid Balance and Outcomes in Critically Ill Children: A Systematic Review and Meta-analysis. JAMA Pediatr 2018, 172(3):257-268.
2. Gan H, Cannesson M, Chandler JR, Ansermino JM: Predicting fluid responsiveness in children: a systematic review. Anesthesia and analgesia 2013, 117(6):1380-1392.
3. Joannidis M, Forni LG, Klein SJ, Honore PM, Kashani K, Ostermann M, Prowle J, Bagshaw SM, Cantaluppi V, Darmon M et al: Lung-kidney interactions in critically ill patients: consensus report of the Acute Disease Quality Initiative (ADQI) 21 Workgroup. Intensive Care Med 2019.
4. Maitland K, Kiguli S, Opoka RO, Engoru C, Olupot-Olupot P, Akech SO, Nyeko R, Mtove G, Reyburn H, Lang T et al: Mortality after fluid bolus in African children with severe infection. N Engl J Med 2011, 364(26):2483-2495.
5. Silversides JA, Fitzgerald E, Manickavasagam US, Lapinsky SE, Nisenbaum R, Hemmings N, Nutt C, Trinder TJ, Pogson DG, Fan E et al: Deresuscitation of Patients With Iatrogenic Fluid Overload Is Associated With Reduced Mortality in Critical Illness. Crit Care Med 2018, 46(10):1600-1607.
6. Beaubien-Souligny W, Bouchard J, Desjardins G, Lamarche Y, Liszkowski M, Robillard P, Denault A: Extracardiac Signs of Fluid Overload in the Critically Ill Cardiac Patient: A Focused Evaluation Using Bedside Ultrasound. Can J Cardiol 2017, 33(1):88-100.
7. Tang WH, Kitai T: Intrarenal Venous Flow: A Window Into the Congestive Kidney Failure Phenotype of Heart Failure? JACC Heart Fail 2016, 4(8):683-686.

8. Iida N, Seo Y, Sai S, Machino-Ohtsuka T, Yamamoto M, Ishizu T, Kawakami Y, Aonuma K: Clinical Implications of Intrarenal Hemodynamic Evaluation by Doppler Ultrasonography in Heart Failure. JACC Heart Fail 2016, 4(8):674-682.
9. Maheshwari K, Turan A, Makarova N, Ma C, Esa WAS, Ruetzler K, Barsoum S, Kuhel AG, Ritchey MR, Higuera-Rueda C et al: Saline versus Lactated Ringer's Solution: The Saline or Lactated Ringer's (SOLAR) Trial. Anesthesiology 2020.
10. Miller TE, Myles PS: Perioperative Fluid Therapy for Major Surgery. Anesthesiology 2019, 130(5):825-832.
11. Lipcsey M, Castegren M, Bellomo R: Hemodynamic management of septic shock. Minerva Anestesiol 2015, 81(11):1262-1272.
12. Kattan E, Ospina-Tascon GA, Teboul JL, Castro R, Cecconi M, Ferri G, Bakker J, Hernandez G, Investigators A-S: Systematic assessment of fluid responsiveness during early septic shock resuscitation: secondary analysis of the ANDROMEDA-SHOCK trial. Critical care 2020, 24(1):23.
13. Alobaidi R, Basu RK, DeCaen A, Joffe AR, Lequier L, Pannu N, Bagshaw SM: Fluid Accumulation in Critically Ill Children. Critical care medicine 2020, 48(7):1034-1041.
14. Beaubien-Souligny W, Rola P, Haycock K, Bouchard J, Lamarche Y, Spiegel R, Denault AY: Quantifying systemic congestion with Point-Of-Care ultrasound: development of the venous excess ultrasound grading system. The Ultrasound Journal 2020, 12(1):16.
15. Tokunaga K, Nakamura K, Inokuchi R, Hayase N, Terada R, Tomioka Y, Ikeda T, Kobayashi E, Okazaki H, Sakuma I et al: Cardiac Variation of Internal Jugular Vein as a Marker of Volume Change in Hemorrhagic Shock. Shock 2020, 54(6):717-722.
16. de Lima Carioca F, Mendes de Souza F, Belata de Souza T, et al. Point-of-care Ultrasonography to predict fluid responsiveness in children: a systematic review and Meta-analysis. Pediatric Anesthesia 2022, 33(1):24-37.

D04
Managing Patients with Combined Kidney and Liver Failure

Akash Deep Professor
11:00-12:30
Thursday, March 30

Educational Objectives:
1. Describe the various liver diseases in which AKI occurs
2. Distinguish between acute on chronic liver failure syndrome and acute decompensated liver disease
3. Discuss the criteria to diagnose AKI in patients with cirrhosis
4. Discuss diagnosis, pathophysiology, treatment and prognosis of AKI in chronic liver disease with special reference to hepato-renal syndrome
5. Describe the use of RRT in patients with liver failure

Content Description:
This workshop is designed to provide attendees the best practices to approach patients with AKI in the setting of acute and chronic liver failure and describe the best practices for differential diagnosis and therapy including when and how to use RRT or extracorporeal liver assist device.

Content Description:
Acute kidney injury (AKI) is a common accompaniment in patients with liver disease. The causes, risk factors, manifestations and management of AKI in these patients vary according to the liver disease in question (acute liver failure, acute on chronic liver failure, post-liver transplantation or metabolic liver disease). AKI in acute liver failure is common and indications of starting RRT in this group of patients are different from classic AKI in non-liver disease patients.
There is a distinct entity called the acute on chronic liver failure syndrome (ACLF) which is different from the acute decompensated cirrhosis; this has distinct prognostic significance. In this workshop, we would discuss this difference to understand the implications on the occurrence of AKI in chronic liver disease.
There are multiple causes of AKI in patients with liver disease-pre-renal, acute tubular necrosis, post-renal, drug

induced renal failure and hepatorenal syndrome(HRS). Definitions of AKI in liver failure have been periodically revised and updated, As our understanding of the pathophysiology of liver disease and renal involvement has improved, treatment modalities have become more advanced and rationalized. Treatment includes reversing precipitating factors like infections and gastrointestinal bleeding, volume expansion, paracentesis and vasoconstrictors. This approach has been tried and tested in adults. A paediatric tailored approach is still lacking due to lack of adequate number of patients, difference in causes of AKI and paucity of literature. We will be covering both adult and pediatric issues in this workshop.

In this workshop, we would attempt to explore the pathophysiological basis, treatment modalities and controversies in the diagnosis and treatment of AKI in patients with chronic liver disease and discuss the common practice for this condition. Though HRS is not a very commonly encountered entity in patients with liver disease , it has specific diagnostic criteria and treatment modalities that differs from other causes of AKI in patients with chronic liver disease; hence amongst the etiologies of kidney injury in patients with chronic liver disease, we will focus on HRS.

Presentation outline:

1. Case vignette
2. Review of different kinds of liver diseases leading to AKI
3. Discuss AKI and Extra-corporeal liver assist device/RRT in acute liver failure
4. Diagnosis of AKI in patients with liver disease and discuss how these criteria are different from patients with non-liver disease
5. Pathophysiology of Acute decompensated cirrhosis and acute-on chronic liver failure syndrome
6. Hepatorenal syndrome-diagnosis, pathophysiology and treatment options
7. Future directions

Suggested Reading:

1. Bellomo R, Ronco C, Kellum JA, Mehta RL, Palevsky P; Acute Dialysis Quality Initiative workgroup. (2004). Acute renal failure: definition, outcome measures, animal models, fluid therapy and information technology needs: the second international consensus conference of the acute dialysis quality initiative (ADQI) group. Crit Care. 8:R204–212
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3. Lopes JA, Jorge S (2013 Feb). The RIFLE and AKIN classifications for acute kidney injury: a critical and comprehensive review. Clin Kidney J. 1;6(1):8–14.
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with cirrhosis. J Hepatol 52(4):605–613
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15. Nadim MK, Kellum JA, Davenport A, Wong F, Davis C, Pannu N, Tolwani A, Bellomo R, Genyk YS; ADQI Workgroup(2012). Hepatorenal syndrome: the 8th International Consensus Conference of the Acute Dialysis Quality Initiative (ADQI) Group. Crit Care. Lond Engl. 9;16(1):R23
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C07
Starting, Transitioning and Stopping RRT for AKI: Science and Art

Sean Bagshaw MD, MSc
2:00-3:30
Thursday, March 30

Educational Objectives:
1. Describe the factors affecting timing of initiation and stopping of RRT in critically ill patients.
2. Compare various approaches and practical aspects for initiating and stopping RRT.
3. Discuss the principles and evidence for timely intervention with RRT in the ICU.

Content Description:
One important and still controversial aspect of the management of critically ill patients is the selection, timing of initiation, and cessation of acute renal replacement therapy (RRT).(1-3) The lack of consensus on what parameters should guide the decision to start RRT has led to a wide practice variation. Selected studies have suggested that "early" RRT could improve outcomes in AKI. However, there are disparate definitions for what constitutes “early” or “delayed” or “late” initiation. The parameters used to assess kidney function are neither sensitive nor specific and do not constitute reliable markers alone on which to base intervention.(4) While timely intervention with RRT can provide opportunity for improvement in clinical, physiologic and biochemical parameters, there is risk of subjective patients to acute RRT with its known risk profile when this may not have been necessary. Observational studies, which are at risk of bias, and one randomized trial (ELAIN) suggested that early RRT initiation may have a beneficial effect on survival (5, 6); however, more recent multi-center randomized trials (7) have not shown patient or kidney outcome benefit with early RRT initiation. In the small single center ELAIN trial, mortality was lower at 90 days for patients allocated to early RRT (CRRT) within 8 hrs of reaching at stage 2 AKI compared with who were allocated to delayed RRT initiation, defined as within 12 hrs of reaching stage 3 AKI. In contrast, the AKIKI(8), IDEAL-ICU (9) and STARRT-AKI (10) trials all showed no difference in the primary outcome of mortality at 60-90 days between early (accelerated) and delayed (standard) RRT initiation strategies.

These trials also all showed that a substantial proportion of patients allocated to the delayed (standard) RRT initiation strategy did not receive RRT, largely due to early death or kidney recovery from AKI. Moreover, in the STARRT-AKI trial, patients allocated to early (accelerated) RRT were significant more likely to remain dialysis dependent at 90-days and were more likely to experiences adverse events, largely hypotension and electrolyte abnormalities. The further build on this, there has been a paucity of evidence published to guide clinicians on when to attempt a liberation trial of RRT in critically ill patients.(11) This represents a major knowledge gap in our understanding of how best to apply RRT to critically ill patients. This workshop will aim to provide context to this evolving literature and present illustrative cases on the principles for patient selection, optimal timing for initiation, RRT modality, and on strategies for assessing when to trial stopping RRT in critically ill patients.

Suggested Reading:

1. Wald R, Beaubien-Souligny W, Chanchlani R, Clark EG, Neyra JA, Ostermann M, et al. Delivering optimal renal replacement therapy to critically ill patients with acute kidney injury. Intensive Care Med. 2022;48(10):1368-81.
2. Ostermann M, Bagshaw SM, Lumlertgul N, Wald R. Indications for and Timing of Initiation of KRT. Clin J Am Soc Nephrol. 2022.
3. Ostermann M, Bellomo R, Burdmann EA, Doi K, Endre ZH, Goldstein SL, et al. Controversies in acute kidney injury: conclusions from a Kidney Disease: Improving Global Outcomes (KDIGO) Conference. Kidney Int. 2020;98(2):294-309.
4. Lumlertgul N, Peerapornratana S, Trakarnvanich T, Pongsittisak W, Surasit K, Chuasuwan A, et al. Early versus standard initiation of renal replacement therapy in furosemide stress test non-responsive acute kidney injury patients (the FST trial). Crit Care. 2018;22(1):101.
5. Karvellas CJ, Bagshaw SM, McDermid RC, Stollery DE, Gibney RT. Acetaminophen-induced acute liver failure treated with single-pass albumin dialysis: report of a case. Int J Artif Organs. 2008;31(5):450-5.
6. Zarbock A, Kellum JA, Schmidt C, Van Aken H, Wempe C, Pavenstadt H, et al. Effect of Early vs Delayed Initiation of Renal Replacement Therapy on Mortality in Critically Ill Patients With Acute Kidney Injury: The ELAIN Randomized Clinical Trial. JAMA. 2016;315(20):2190-9.
7. Gaudry S, Hajage D, Benichou N, Chaibi K, Barbar S, Zarbock A, et al. Delayed versus early initiation of renal replacement therapy for severe acute kidney injury: a systematic review and individual patient data meta-analysis of randomised clinical trials. Lancet. 2020;395(10235):1506-15.
8. Gaudry S, Hajage D, Schortgen F, Martin-Lefevre L, Pons B, Boulet E, et al. Initiation Strategies for Renal-Replacement Therapy in the Intensive Care Unit. N Engl J Med. 2016;375(2):122-33.
9. Barbar SD, Clere-Jehl R, Bourredjem A, Hernu R, Montini F, Bruyere R, et al. Timing of Renal-Replacement Therapy in Patients with Acute Kidney Injury and Sepsis. N Engl J Med. 2018;379(15):1431-42.
10. STARRT-AKI Investigators, Bagshaw SM, Wald R, Adhikari NKJ, Bellomo R, da Costa BR, et al. Timing of Initiation of Renal-Replacement Therapy in Acute Kidney Injury. N Engl J Med. 2020;383(3):240-51.
11. Katulka RJ, Al Saadon A, Sebastianski M, Featherstone R, Vandermeer B, Silver SA, et al. Determining the optimal time for liberation from renal replacement therapy in critically ill patients: a systematic review and meta-analysis (DOnE RRT). Crit Care. 2020;24(1):50.

D08 Managing Patients with Sepsis: Modifying the Course with (ECOS)

Peter Pickkers MD PHD, Thomas Rimmele MD PHD, and Raj Basu MD MS
2:00-3:30
Thursday, March 30

Educational Objectives:

1. Describe the physiologic rationale and evidence for ECOS in Sepsis
2. Discuss the potential prescriptive approaches to CRRT, HVHF, VHVHF, alternative filtration techniques
3. Identify a strategy to escalate or modulate the septic patient based on response.

Content Description:

The pathophysiologic state of shock, as a manifestation of a progressed systemic inflammatory response syndrome (SIRS), is often secondary to shock. In this state, a patient's homeostatic balance to maintain adequate oxygen delivery and extraction is compromised by a precarious balance of pro- and anti- inflammatory mediators, as well as the host response(s) to the offending pathogen. Over many decades, a hypothetical benefit has been theorized for the removal of said mediators, however, robust evidence is lacking to support a standard deployment or integration of such therapy. Extracorporeal organ support (ECOS) has, however, become much more sophisticated, reliable, and nuanced in the domain of [1-15]therapeutic delivery – asking the question – is modification of the course more 'possible' now? This workshop will describe the numerous arguments for integration of hemofiltration, via various techniques, in the setting of shock. Using vignettes to illustrate rationale, modalities, and precision – the presenters will the past, present, and potential future of ECOS in the septic patient.

Presentation Objectives:
1. Delineate the bio/pathophysiologic rationale for extracorporeal organ support in sepsis and septic shock
2. Identify the risk-benefit balance in the delivery of hemofiltration – via technique and filter
3. Develop a pragmatic approach to modulation of ECOS and hemofiltration for the patient and time

Attendees should be prepared to engage in participation based survey responses and questions and offer real-world experience for their approach to patients presented.

Suggested Reading:

1. Brouwer WP, Duran S, Ince C: Improved Survival beyond 28 Days up to 1 Year after CytoSorb Treatment for Refractory Septic Shock: A Propensity-Weighted Retrospective Survival Analysis. Blood Purif 2021, 50(4-5):539-545.
2. Ning B, Ye S, Lyu Y, Yin F, Chen Z: Effect of high-volume hemofiltration on children with sepsis. Transl Pediatr 2020, 9(2):101-107.
3. Sik G, Demirbuga A, Gunhar S, Nisli K, Citak A: Clinical Features and Indications Associated with Mortality in Continuous Renal Replacement Therapy for Pediatric Patients. Indian J Pediatr 2019, 86(4):360-364.
4. Schwindenhammer V, Girardot T, Chaulier K, Gregoire A, Monard C, Huriaux L, Illinger J, Leray V, Uberti T, Crozon-Clauzel J et al: oXiris(R) Use in Septic Shock: Experience of Two French Centres. Blood Purif 2019, 47 Suppl 3:1-7.
5. Ricci Z, Romagnoli S, Ronco C, La Manna G: From Continuous Renal Replacement Therapies to Multiple Organ Support Therapy. Contrib Nephrol 2018, 194:155-169.
6. Premuzic V, Basic-Jukic N, Jelakovic B, Kes P: Differences in CVVH vs. CVVHDF in the management of sepsis-induced acute kidney injury in critically ill patients. J Artif Organs 2017, 20(4):326-334.
7. Ronco C: Continuous Renal Replacement Therapy: Forty-year Anniversary. Int J Artif Organs 2017, 40(6):257-264.

8. Villa G, Neri M, Bellomo R, Cerda J, De Gaudio AR, De Rosa S, Garzotto F, Honore PM, Kellum J, Lorenzin A et al: Nomenclature for renal replacement therapy and blood purification techniques in critically ill patients: practical applications. Crit Care 2016, 20(1):283.
9. Joannidis M: Continuous renal replacement therapy in sepsis and multisystem organ failure. Semin Dial 2009, 22(2):160-164.
10. Lins RL, Elseviers MM, Van der Niepen P, Hoste E, Malbrain ML, Damas P, Devriendt J, investigators S: Intermittent versus continuous renal replacement therapy for acute kidney injury patients admitted to the intensive care unit: results of a randomized clinical trial. Nephrol Dial Transplant 2009, 24(2):512-518.
11. du Cheyron D, Bouchet B, Bruel C, Daubin C, Ramakers M, Charbonneau P: Antithrombin supplementation for anticoagulation during continuous hemofiltration in critically ill patients with septic shock: a case-control study. Crit Care 2006, 10(2):R45.
12. Ronco C, Bellomo R, Ricci Z: Continuous renal replacement therapy in critically ill patients. Nephrol Dial Transplant 2001, 16 Suppl 5:67-72.
13. Kes P: Slow continuous renal replacement therapies: an update. Acta Med Croatica 2000, 54(2):69-84.
14. Sieberth HG, Kierdorf HP: Is cytokine removal by continuous hemofiltration feasible? Kidney Int Suppl 1999(72):S79-83.
15. Silvester W: Mediator removal with CRRT: complement and cytokines. Am J Kidney Dis 1997, 30(5 Suppl 4):S38-43.

Emerging Findings from the Kidney Precision Medicine Project

Raghavan Murugan MD, MS, FRCP
4:00-4:15
Thursday, March 30

Educational Objectives:
1. To provide an overview of Kidney Precision Medicine Project (KPMP).
2. To provide an overview of emerging and early findings from KPMP.

Content Description:
The Kidney Precision Medicine Project (KPMP) is an ambitious, multi-year project funded by the NIDDK with the purpose of understanding and finding new ways to treat acute kidney injury (AKI) and chronic kidney disease (CKD). Together with our patient representatives, researchers, and clinicians, the KPMP consortium is committed to meet the goals of the study and the needs of the kidney disease community. The study uses kidney biopsies to make multiple maps of the kidney (called the Kidney Tissue Atlas). These maps will show important cells, regions, and disease pathways that lead to chronic kidney disease (CKD) and acute kidney injury (AKI). Ultimately, KPMP research hopes to find new markers and treatment targets that make personalized, effective, and safe treatments possible for kidney diseases.

Suggested Reading:
1. De Boer I, Alpers CE, El-Achkar T et. al. Rationale and design of the Kidney Precision Medicine Project. Kidney International 2021;99(3):498-510.
2. Kimmel PL, Jefferson N. Norton JM. et. al. How Community Engagement is Enhancing NIDDK research. Clin J Am Soc Nephrol 2019;14(5);768-770.
3. Butler CR, Appelbaum PS, Ascani H. et. al. A Participant-Centered Approach to Understanding Risks and Benefits of Participation in Research Informed by the Kidney Precision Medicine Project. American Journal of Kidney Diseases, December 2021.
4. Menon R, Bomback AS, Lake BB et. al. Integrated single cell sequencing and histopathological analyses reveal diverse injury and repair responses in a participant with acute kidney injury: A clinical-molecular pathologic correlation. Kidney International March 2022.

Magnesium: A Role in Cisplatin-AKI?

Shruti Gupta MD, MPH
5:15-5:30
Thursday, March 30

Educational Objectives:
1)Describe how hypomagnesemia may potentiate cisplatin-AKI in preclinical models
2)Discuss the safety of high-dose magnesium in different populations
3)Elaborate on the challenges of designing interventional randomized clinical trials

Content Description:
The pathophysiology of cisplatin-induced AKI is complex, and involves direct epithelial cell toxicity, oxidative stress, vasoconstriction, and inflammation. One potential mechanism for cisplatin-associated nephrotoxicity is reduced expression and function of magnesium (Mg) transporters in the kidneys. Urinary Mg wasting occurs in over 50% of patients with cisplatin-induced AKI, and the subsequent hypomagnesemia may exacerbate the nephrotoxicity via immunomodulatory effects. In vitro studies have suggested that Mg deficiency is associated with an in-

creased risk of kidney injury, while animal models found that prophylactic administration of IV Mg attenuates AKI in various models. Mg deficiency has been shown to increase renal platinum accumulation in proximal tubular cells by downregulating transporters expressed on the apical side of these cells. These transporters (including multidrug resistance protein [MRP]4 and MRP6) are responsible for secreting cisplatin into the tubular lumen. Given this compelling preclinical data, we are conducting a randomized clinical trial testing whether high doses of IV magnesium reduce the risk of cisplatin-AKI in mesothelioma patients getting heated intraoperative chemotherapy with cisplatin.

Suggested Reading:

1. Lajer H, Kristensen M, Hansen HH, et al. Magnesium depletion enhances cisplatin-induced nephrotoxicity. Cancer Chemother Pharmacol. 2005. doi:10.1007/s00280-005-1010-7
2. Solanki MH, Chatterjee PK, Gupta M, et al. Magnesium protects against cisplatin-induced acute kidney injury by regulating platinum accumulation. Am J Physiol Physiol. 2014. doi:10.1152/ajprenal.00127.2014
3. Solanki MH, Chatterjee PK, Xue X, et al. Magnesium protects against cisplatin-induced acute kidney injury without compromising cisplatin-mediated killing of an ovarian tumor xenograft in mice. Am J Physiol - Ren Physiol. 2015. doi:10.1152/ajprenal.00096.2015
4. Kumar G, Solanki MH, Xue X, et al. Magnesium improves cisplatin-mediated tumor killing while protecting against cisplatin-induced nephrotoxicity. Am J Physiol - Ren Physiol. 2017. doi:10.1152/ajprenal.00688.2016
5. Bussière FI, Gueux E, Rock E, et al. Increased phagocytosis and production of reactive oxygen species by neutrophils during magnesium deficiency in rats and inhibition by high magnesium concentration. Br J Nutr. 2002. doi:10.1079/bjn2001498
6. Petrault I, Zimowska W, Mathieu J, et al. Changes in gene expression in rat thymocytes identified by cDNA array support the occurrence of oxidative stress in early magnesium deficiency. Biochim Biophys Acta - Mol Basis Dis. 2002. doi:10.1016/S0925-4439(01)00089-8

Men are From Mars and Women are fromVenus: Does it Matter for AKI?

Lui Forni MD PhD JFICMI
5:30-6:00
Thursday, March 30

Educational Objectives:
Outline the potential complications of gender/sex on AKI diagnosis

Content Description:
I have the poison chalice of taking on the it doesnt matter presentation so will try and defend that position!

Morning Symposium C
Optimization of the CRRT Program to Improve Outcomes

Javier Neyra MD, MS
7:00-8:00
Friday, March 31

Educational Objectives:
-To discuss the utility and feasibility of implementation of key performance indicators of CRRT delivery
-To dicuss the importance of a team-based approach for CRRT delivery and how a multidisciplinary team can make a difference
-To discuss how to incorporate multimodal data for CRRT quality improvement and bedside decisions

Content Description:
In this morning symposium, we will review key aspects of CRRT quality assurance. In our first talk, we will review key performance indicators of CRRT delivery and how to feasibly monitor them. Later, we will discuss why and how a multidisciplinary team can make a difference in the practice of CRRT. Finally, we will discuss how multimodal data (from the machine and the EHR) can assist both quality assurance and clinical decisions at the bedside.

Suggested Reading:
Neyra JA, Nadkarni GN. Continuous Kidney Replacement Therapy of the Future: Innovations in Information Technology, Data Analytics, and Quality Assurance Systems. Adv Chronic Kidney Dis. 2021 Jan;28(1):13-19. doi: 10.1053/j.ackd.2021.03.020. PMID: 34389132.

Neyra JA, Kashani K. Improving the quality of care for patients requiring continuous renal replacement therapy. Semin Dial. 2021 Nov;34(6):501-509. doi: 10.1111/sdi.12968. Epub 2021 Apr 3. PMID: 33811790.

Ruiz EF, Ortiz-Soriano VM, Talbott M, Klein BA, Thompson Bastin ML, Mayer KP, Price EB, Dorfman R, Adams BN, Fryman L, Neyra JA; University of Kentucky CRRT Quality Assurance Group. Development, implementation and outcomes of a quality assurance system for the provision of continuous renal replacement therapy in the intensive care unit. Sci Rep. 2020 Nov 26;10(1):20616. doi: 10.1038/s41598-020-76785-w. PMID: 33244053; PMCID: PMC7692557.

A09
Onco Nephrology: Managing AKI in the Patient with Cancer

Shruti Gupta MD, MPH
8:15-9:45
Friday, March 31

Educational Objectives:
1. To classify the mechanism of methotrexate-associated AKI (MTX-AKI)
2. To evaluate the role of renal replacement therapy in MTX-AKI
3. To describe the evidence for or against the use of glucarpidase for MTX-AKI

Content Description:
Methotrexate is a conventional chemotherapy that has been used for osteosarcomas, head and neck cancers, lymphomas, and leukemias. It can be associated with considerable nephrotoxicity, with AKI occurring due to intratubular cystalline precipitation, particularly at an acidic pH. The mainstay of prevention and management of methotrexate-AKI has been alkalinization of the urine and leucovorin. Glucarpidase is approved for the use of methotrexate-AKI in patients with high methotrexate levels and AKI, yet its use is controversial due to high cost and lack of data. There are minimal data supporting the use of renal replacement therapy in the absence of traditional indications for dialysis.

Suggested Reading:
Christensen AM, Pauley JL, Molinelli AR et al. "Resumption of High-Dose Methotrexate after Acute Kidney Injury and Glucarpidase Use in Pediatric Oncology Patients." Cancer 118 no. 17 (Jan 2012): 4321-30.

Flombaum CD and Meyers PA. "High-Dose Leucovorin as Sole Therapy for Methotrexate Toxicity." J Clin Oncol 17 no. 5 (May 1999):1589-94.

Goldman ID & Matherly LH. "The Cellular Pharmacology of Methotrexate." Pharmacol Ther 28 no. 1 (1985):77.

Howard SC, McCormick J, Pui C et al. "Preventing and Managing Toxicities of High-Dose Methotrexate." Oncologist 21 no. 12 (Dec 2016):1471-82.

Jahnke K, Korfel A, Matus P et al. "High-Dose Methotrexate Toxicity in Elderly Patients with Primary Central Nervous System Lymphoma." Ann Oncol 16 no. 3 (March 2005):445-9.

Mallipattu SK and Ross MJ. "Methotrexate in the Urine." Kidney Int 80 no. 2 (July 2011):226.

May J, Carson KR, Butler S et al. "High Incidence of Methotrexate Associated Renal Toxicity in Patients with Lymphoma: A Retrospective Analysis." Leuk Lymphoma 55 no. 6 (Jun 2014): 1345-9.

Ramsey LB, Balis FB, O'Brien MM et al. "Consensus Guideline for Use of Glucarpidase in Patients with High-Dose Methotrexate Induced Acute Kidney Injury and Delayed Methotrexate Clearance." Oncologist 23 no. 1 (Oct 2018): 52-61.

B10
Personalized Fluid Management with CRRT

Raghavan Murugan MD, MS, FRCP
8:15-9:45
Friday, March 31

Educational Objectives:
1. Describe the principles of fluid management with CRRT techniques
2. Discuss the practical issues for achieving desired fluid balance and regulation
3. Discuss the concept of precision CRRT integrating different domains of fluid management to achieve patient goals of care based on case presentations

Content Description:
Fluid resuscitation to treat intravascular hypovolemia is a frequent intervention in critically ill patients with sepsis. Increased fluid volume coupled with decreased fluid elimination in the presence of acute kidney injury results in fluid overload. When fluid overload is refractory to diuretics, continuous kidney replacement therapy (CRRT) is frequently used for volume control. Achieving an appropriate level of volume control requires knowledge of the underlying cardiovascular pathophysiology, evaluation of volume status, selection of an appropriate solution for volume repletion and maintenance and modulation of the tissue perfusion and cellular injury. CRRT techniques offer a significant advantage over intermittent RRT for fluid control, however, if not carried out appropriately it can result in major complications. In order to utilize these therapies for their maximum potential it is necessary to recognize the factors which influence fluid balance and understand the principles of fluid management with these techniques. This workshop will describe the basic methods for fluid management with CRRT and provide an approach to integrate the different domains of fluid management for targeted intervention in critically ill patients. We will use case studies to describe various approaches for achieving plasma homeostasis, fluid removal and regulation with CRRT.

Presentation Outline
1. Review principles of fluid management with CRRT
2. Outline various approaches to fluid management
   a. Fluid removal vs. fluid regulation
   b. Weight-based volume dosing and net ultrafiltration
   c. Importance of net ultrafiltration rate on outcomes
3. Practical issues for precision CRRT
   a. Prescription, implementation (prescribed vs. achieve fluid management goal), monitoring and charting
   b. Prevention of complications

Suggested Reading:
1. Bouchard J, Soroko SB, Chertow GM, et al. Fluid accumulation, survival and recovery of kidney function in critically ill patients with acute kidney injury. Kidney Int. 2009;76(4):422-427
2. Mehta RL, Pascual MT, Soroko S, Chertow GM, Group PS. Diuretics, mortality, and nonrecovery of renal function in acute renal failure. JAMA. 2002;288(20):2547-2553
3. Prowle JR, Echeverri JE, Ligabo EV, Ronco C, Bellomo R. Fluid balance and acute kidney injury. Nat Rev Nephrol. 2010;6(2):107-115
4. Balakumar V, Murugan R. Kidney Replacement Therapy for Fluid Management. Critical Care Clinics. 2021
5. Murugan R, Balakumar V, Kerti SJ, et al. Net ultrafiltration intensity and mortality in critically ill patients with fluid overload. Crit Care. 2018;22(1):223.PMC6151928
6. Murugan R, Bellomo R, Palevsky PM, Kellum JA. Ultrafiltration in critically ill patients treated with kidney replacement therapy. Nat Rev Nephrol. 2021;17(4):262-276
7. Murugan R, Hoste E, Mehta RL, et al. Precision Fluid Management in Continuous Renal Replacement Therapy.

Blood Purif. 2016;42(3):266-278
8. Murugan R, Kerti SJ, Chang CH, et al. Association of Net Ultrafiltration Rate With Mortality Among Critically Ill Adults With Acute Kidney Injury Receiving Continuous Venovenous Hemodiafiltration: A Secondary Analysis of the Randomized Evaluation of Normal vs Augmented Level (RENAL) of Renal Replacement Therapy Trial. JAMA Netw Open. 2019;2(6):e195418.PMC6563576
9. Murugan R, Kerti SJ, Chang CH, et al. Association between Net Ultrafiltration Rate and Renal Recovery among Critically Ill Adults with Acute Kidney Injury Receiving Continuous Renal Replacement Therapy: An Observational Cohort Study. Blood Purif. 2021:1-13
10. Murugan R, Ostermann M, Peng Z, et al. Net Ultrafiltration Prescription and Practice Among Critically Ill Patients Receiving Renal Replacement Therapy: A Multinational Survey of Critical Care Practitioners. Crit Care Med. 2020;Feb;48(2):e87-e97

B10
Personalized Fluid Management with CRRT

Ravindra L. Mehta, MBBS, MD, DM, FACP, FRCP
8:15-9:45
Friday, March 31

Educational Objectives

1. Describe the principles of fluid management with CRRT techniques
2. Discuss the practical issues for achieving desired fluid balance and regulation using a case-based presentation.
3. Discuss the concept of precision CRRT integrating different domains of fluid management to achieve patient goals of care.

Content description

Fluid resuscitation to treat intravascular hypovolemia is a frequent intervention in critically ill patients with sepsis. Increased fluid volume coupled with decreased fluid elimination in the presence of acute kidney injury results in fluid overload. When fluid overload is refractory to diuretics, continuous kidney replacement therapy (CRRT) is frequently used for volume control. Achieving an appropriate level of volume control requires knowledge of the underlying cardiovascular pathophysiology, evaluation of volume status, selection of an appropriate solution for volume repletion and maintenance and modulation of the tissue perfusion and cellular injury. CRRT techniques offer a significant advantage over intermittent RRT for fluid control. In order to utilize these therapies for their maximum potential it is necessary to recognize the factors which influence fluid balance and understand the principles of fluid management with these techniques. This workshop will describe the basic methods for fluid management with CRRT and provide an approach to integrate the different domains of fluid management for targeted intervention in critically ill patients. We will use case studies to describe various approaches for achieving plasma homeostasis, fluid removal and regulation with CRRT.

Presentation Outline

1. Outline various approaches to fluid management using a case presentation.
   a. When to start fluid removal.
   b. How to prescribe fluid removal using weight and volume-based approaches.
   c. Various methods of accomplishing fluid removal including varying ultrafiltration rate and replacement fluid rates.
   d. Evidence linking rate of fluid removal and outcomes.

Suggested Reading

1. Bouchard J, Soroko SB, Chertow GM, et al. Fluid accumulation, survival and recovery of kidney function in critically ill patients with acute kidney injury. Kidney Int. 2009;76(4):422-427
2. Mehta RL, Pascual MT, Soroko S, Chertow GM, Group PS. Diuretics, mortality, and nonrecovery of renal function in acute renal failure. JAMA. 2002;288(20):2547-2553
3. Prowle JR, Echeverri JE, Ligabo EV, Ronco C, Bellomo R. Fluid balance and acute kidney injury. Nat Rev Nephrol. 2010;6(2):107-115
4. Balakumar V, Murugan R. Kidney Replacement Therapy for Fluid Management. Critical Care Clinics. 2021
5. Murugan R, Balakumar V, Kerti SJ, et al. Net ultrafiltration intensity and mortality in critically ill patients with fluid overload. Crit Care. 2018;22(1):223.PMC6151928
6. Murugan R, Bellomo R, Palevsky PM, Kellum JA. Ultrafiltration in critically ill patients treated with kidney replacement therapy. Nat Rev Nephrol. 2021;17(4):262-276
7. Murugan R, Hoste E, Mehta RL, et al. Precision Fluid Management in Continuous Renal Replacement Therapy. Blood Purif. 2016;42(3):266-278
8. Murugan R, Kerti SJ, Chang CH, et al. Association of Net Ultrafiltration Rate With Mortality Among Critically Ill Adults With Acute Kidney Injury Receiving Continuous Venovenous Hemodiafiltration: A Secondary Analysis of the Randomized Evaluation of Normal vs Augmented Level (RENAL) of Renal Replacement Therapy Trial. JAMA Netw Open. 2019;2(6):e195418.PMC6563576
9. Murugan R, Kerti SJ, Chang CH, et al. Association between Net Ultrafiltration Rate and Renal Recovery among Critically Ill Adults with Acute Kidney Injury Receiving Continuous Renal Replacement Therapy: An Observational Cohort Study. Blood Purif. 2021:1-13
10. Murugan R, Ostermann M, Peng Z, et al. Net Ultrafiltration Prescription and Practice Among Critically Ill Patients Receiving Renal Replacement Therapy: A Multinational Survey of Critical Care Practitioners. Crit Care Med. 2020;Feb;48(2):e87-e97

D12
Managing the Heart Failure Patient with Worsening Renal Function (WRF)

Amir Kazory MD, FASN, FACC
8:15-9:45
Friday, March 31

Educational Objectives:
1. Describe the mechanisms and implications of worsening renal function (or rise in serum creatinine) and prognostic value of congestion in heart failure
2. Discuss the principles of diuretic therapy in heart failure and provide an update on current strategies for children and adults
3. Discuss the indications, outcomes and updates on the use of renal replacement therapy in patients with heart failure

Content Description:
Patients with acute decompensated heart failure (ADHF) often develop rise in serum creatinine (RSC). Cardiorenal interactions represent a complex pattern in these patients rendering their care a challenge that needs to be addressed by multidisciplinary approaches. Congestion, the hallmark of acute decompensated heart failure, represents the primary reason for hospitalization and the driver of adverse outcomes in these patients. Diuretic-based medical regimens remain the mainstay of management of ADHF. However, it is often difficult to determine

which subset of patients can be managed with diuretic therapy, and which patient population may benefit from renal replacement therapy. This workshop will provide an overview of the underlying mechanisms and implications of RSC in ADHF as well as prognostic value of congestion in this setting. We will discuss the decongestive strategies proposed for management of ADHF and cardiorenal syndrome in children and adults. We will also describe mechanical removal of excess fluid through ultrafiltration therapy and discuss the key clinical findings of the most recent landmark trials, their implications, and their shortcomings followed by selected practical considerations and recommendations.

Suggested Reading:

McCallum W, Tighiouart H, Kiernan MS, Huggins GS, Sarnak MJ. Relation of kidney function decline and NT-proBNP with risk of mortality and readmission in acute decompensated heart failure. Am J Med (2019), 10.1016/j.amjmed.2019.05.047

Ahmad T, Jackson K, Rao VS, et al. Worsening renal function in patients with acute heart failure undergoing aggressive diuresis is not associated with tubular injury. Circulation; 137 (2018): 2016-2028

Kazory A, Ronco C. Are we barking up the wrong tree? Rise in serum creatinine and heart failure. Blood Purif 2019; 19:1-3

Gist KM, Kwiatkowski DM, Cooper DS. Acute kidney injury in congenital heart disease. Curr Opin Cardiol. 2018; 33: 101-107

Ricci Z, Raggi V, Marinari E, Vallesi L, Di Chiara L, Rizzo C, Gist KM. Acute Kidney Injury in Pediatric Cardiac Intensive Care Children: Not All Admissions Are Equal: A Retrospective Study. J Cardiothorac Vasc Anesth 2021; S1053-0770(21)00341-4

Kazory A, Ronco C. Ultrafiltration therapy for acute decompensated heart failure: lessons learned from 2 major trials. Am Heart J 2013; 166:799-803

Kazory A, Costanzo MR. Extracorporeal Isolated Ultrafiltration for Management of Congestion in Heart Failure and Cardiorenal Syndrome. Adv Chronic Kidney Dis 2018; 25: 434-44

Kazory A, Sgarabotto L, Ronco C. Extracorporeal Ultrafiltration for Acute Heart Failure. Cardiorenal Med. 2022 Nov 2. doi: 10.1159/000527204. Online ahead of print

Koratala A, Ronco C, Kazory A. Diagnosis of Fluid Overload: From Conventional to Contemporary Concepts. Cardiorenal Med. 2022;12(4):141-154. doi: 10.1159/000526902. Epub 2022 Sep 12.

Nassiri AA, Ronco C, Kazory A. Resurgence of Urgent-Start Peritoneal Dialysis in COVID-19 and Its Application to Advanced Heart Failure. Cardiorenal Med. 2021;11(1):1-4. doi: 10.1159/000513496. Epub 2021 Jan 7.

Jentzer JC, Bihorac A, Brusca SB, Del Rio-Pertuz, et al. Contemporary Management of Severe Acute Kidney Injury and Refractory Cardiorenal Syndrome: JACC Council Perspectives. J Am Coll Cardiol. 2020 Sep 1;76(9):1084-1101. doi: 10.1016/j.jacc.2020.06.070

Volume Management in the Critically Ill: To Fill or Not to Fill?

Amir Kazory MD, FASN, FACC
10:15-10:30
Friday, March 31

Educational Objectives:
1) Recognize the potential systemic adverse effects of fluid overload
2) Demonstrate understanding of the cardiovascular and renal targets during fluid resuscitation and removal
3)Apply the knowledge gained from the discussed literature and clinical cases to improve patient care

Content Description:
Growing data point to the association of fluid overload with an increased risk of adverse outcomes in patients that are critically ill. The two key challenges in this field are objective assessment of volume status and optimal fluid management strategies.

In this session, we focus on fluid management in the critically ill and the impact of the timing and volume of the fluid in this patient population. We review the landmark trials in this field and also provide an overview of the relationship between renal outcomes with fluid management.

Suggested Reading:
1. Vincent JL, De Backer D: Circulatory shock. N Engl J Med 369: 1726–1734, 2013
2. Bentzer P, Griesdale DE, Boyd J, MacLean K, Sirounis D, Ayas NT: Will This hemodynamically unstable patient respond to a bolus of intravenous fluids? JAMA 316: 1298–1309, 2016
3. Ostermann M, Liu K, Kashani K: Fluid management in acute kidney injury. Chest 156: 594–603, 2019
4. Sharfuddin AA, Molitoris BA: Pathophysiology of ischemic acute kidney injury. Nat Rev Nephrol 7: 189–200, 2011
5. Zarbock A, K€ullmar M, Ostermann M, Lucchese G, Baig K, Cennamo A, Rajani R, McCorkell S, Arndt C, Wulf H, Irqsusi M, Monaco F, Di Prima AL, Garc_ıa Alvarez M, Italiano S, Miralles Bagan J, Kunst G, Nair S, L'Acqua C, Hoste E, Vandenberghe W, Honore PM, Kellum JA, Forni LG, Grieshaber P,
Massoth C, Weiss R, Gerss J, Wempe C, Meersch M: Prevention of cardiac surgery-associated acute kidney injury by implementing the KDIGO guidelines in high-risk patients identified by biomarkers: The PrevAKI-multicenter randomized controlled trial. Anesth Analg 133: 292–302, 2021
6. Beaubien-Souligny W, Bouchard J, Desjardins G, Lamarche Y, Liszkowski M, Robillard P, Denault A: Extracardiac signs of fluid overload in the critically ill cardiac patient: A focused evaluation using bedside ultrasound. Can J Cardiol 33: 88–100, 2017
7. Squara P, Hollenberg S, Payen D: Reconsidering vasopressors or cardiogenic shock: Everything should be made as simple as possible, but not simpler. Chest 156: 392–401, 2019
8. De Backer D, Orbegozo Cortes D, Donadello K, Vincent JL: Pathophysiology of microcirculatory dysfunction and the pathogenesis of septic shock. Virulence 5: 73–79, 2014
9. Saito S, Uchino S, Takinami M, Uezono S, Bellomo R: Postoperative blood pressure deficit and acute kidney injury progression in vasopressor-dependent cardiovascular surgery patients. Crit Care 20: 74, 2016
10. Chen KP, Cavender S, Lee J, Feng M, Mark RG, Celi LA, Mukamal KJ, Danziger J: Peripheral edema, central venous pressure, and risk of AKI in critical illness. Clin J Am Soc Nephrol 11: 602–608, 2016

Bicarbonate: The Good, the Bad and the Ugly

Lui Forni MD PhD JFICMI
11:15-11:30
Friday, March 31

Educational Objectives:
1) Outline the potential drawbacks of using sodium bicarbonate
2) Discuss the benefits of sodium bicarbonate
3) Consider future trials

Content Description:
This will discuss some of the theories underpinning the use of sodium bicarbonate. I will touch on paradoxical acidosis and show some old experimental work debunking this theory.

Suggested Reading:
please limit to 10 references

Interpreting Timing of Dialysis Trials: What Criteria Should We Use?

Sean Bagshaw MD, MSc
5:00-5:15
Friday, March 31

Educational Objectives:
1. Describe recent randomized trials focused on timing of initiation renal-replacement therapy (RRT) in critically ill patients.

2. Consider the eligibility criteria and triggers for RRT initiation across recent randomized trials.

3. Discuss the practical application of recent randomized trials to bedside clinical practice.

Content Description:
A substantial proportion of critically ill patients with acute kidney injury (AKI) and multi-organ dysfunction will receive acute renal-replacement therapy (RRT).(1, 2) The selection, circumstance, and timing of initiation of RRT has long been controversial.(3, 4) Several high-profile randomized trials aimed to inform and guide clinical practice on starting RRT in critically ill patients have now been published.(5-9) However, there has been challenges with interpretation and bedside translation of these trials.(2) This would appear to stem from residual doubt and may be driven by differences in design, settings, case-mix and eligibility criteria, along with definitions for the timing of the intervention (i.e., early vs. delayed) and interventions received in the delayed (standard) strategies to mitigate the use of RRT.(2, 3) As such, this likely continues to contribute to some clinical uncertainty and practice variation.(10) This presentation will aim to explore the nuances of these trials and provide context on optimal patient selection and timing for RRT initiation.

Suggested Reading:
1. Pickkers P, Ostermann M, Joannidis M, Zarbock A, Hoste E, Bellomo R, et al. The intensive care medicine agenda on acute kidney injury. Intensive Care Med. 2017;43(9):1198-209.
2. Wald R, Beaubien-Souligny W, Chanchlani R, Clark EG, Neyra JA, Ostermann M, et al. Delivering optimal

renal replacement therapy to critically ill patients with acute kidney injury. Intensive Care Med. 2022;48(10):1368-81.
3. Ostermann M, Bagshaw SM, Lumlertgul N, Wald R. Indications for and Timing of Initiation of KRT. Clin J Am Soc Nephrol. 2022.
4. Ostermann M, Bellomo R, Burdmann EA, Doi K, Endre ZH, Goldstein SL, et al. Controversies in acute kidney injury: conclusions from a Kidney Disease: Improving Global Outcomes (KDIGO) Conference. Kidney Int. 2020;98(2):294-309.
5. Barbar SD, Clere-Jehl R, Bourredjem A, Hernu R, Montini F, Bruyere R, et al. Timing of Renal-Replacement Therapy in Patients with Acute Kidney Injury and Sepsis. N Engl J Med. 2018;379(15):1431-42.
6. Gaudry S, Hajage D, Benichou N, Chaibi K, Barbar S, Zarbock A, et al. Delayed versus early initiation of renal replacement therapy for severe acute kidney injury: a systematic review and individual patient data meta-analysis of randomised clinical trials. Lancet. 2020;395(10235):1506-15.
7. Gaudry S, Hajage D, Schortgen F, Martin-Lefevre L, Pons B, Boulet E, et al. Initiation Strategies for Renal-Replacement Therapy in the Intensive Care Unit. N Engl J Med. 2016;375(2):122-33.
8. STARRT-AKI Investigators, Bagshaw SM, Wald R, Adhikari NKJ, Bellomo R, da Costa BR, et al. Timing of Initiation of Renal-Replacement Therapy in Acute Kidney Injury. N Engl J Med. 2020;383(3):240-51.
9. Zarbock A, Kellum JA, Schmidt C, Van Aken H, Wempe C, Pavenstadt H, et al. Effect of Early vs Delayed Initiation of Renal Replacement Therapy on Mortality in Critically Ill Patients With Acute Kidney Injury: The ELAIN Randomized Clinical Trial. JAMA. 2016;315(20):2190-9.
10. Wald R, Bagshaw SM, Investigators S-A. Integration of Equipoise into Eligibility Criteria in the STARRT-AKI Trial. Am J Respir Crit Care Med. 2021;204(2):234-7.

Morning Symposium E.
Innovations in Caring for Patients with Dysnatremias

Lenar Yessayan MD, MS
7:00-8:00
Saturday, April 1

Educational Objectives:
1. Understand the critical determinants of serum sodium changes during renal replacement therapy
2. Understand the application of a variety of techniques to safely correct severe dysnatremias through:
-Adjustment of replacement fluid (RF) or dialysate composition
-Regulation of CRRT dose based on kinetic modeling
-The use of separate electrolyte infusion (s)

Content Description:
Disorders of serum sodium concentration are common in critically ill patients who may have concomitant acute kidney injury, chronic kidney disease or end-stage kidney disease. Many of these patients may require customized serum sodium level management with dialysis which, if not strictly controlled, can lead to significant complications. Thus, controlled correction of the serum sodium level is necessary to avoid the development of osmotic demyelination syndrome in hyponatremic patients and dialysis disequilibrium syndrome in hypernatremic patients. Continuous kidney replacement therapy offers unique benefits through the ability to slowly and safely correct dysnatremias that can be tailored to specific patient needs and should be considered in select patients. This symposium will discuss the practical issues for management of severe dysnatremias with RRT.

Suggested Reading:
1. Yessayan L, Szamosfalvi B, Rosner M. H. (2021). Management of dysnatremias with continuous renal replacement therapy. Semin Dial. 2021; 34(6): 472-9.
2. Yessayan L, Yee J, Frinak S, Szamosfalvi B. Continuous Renal Replacement Therapy for the Management of Acid-Base and Electrolyte Imbalances in Acute Kidney Injury. Adv Chronic Kidney Dis. 2016;23(3):203-10.
3. Yessayan L, Yee J, Frinak S, Szamosfalvi B. Treatment of severe hyponatremia in patients with kidney failure: role of continuous venovenous hemofiltration with low-sodium replacement fluid. Am J Kidney Dis. 2014;64(2):305-10.
4. Paquette F, Goupil R, Madore F, Troyanov S, Bouchard J. Continuous venovenous hemofiltration using customized replacement fluid for acute kidney injury with severe hypernatremia. Clin Kidney J. 2016;9(4):540-2.

Morning Symposium F.
Optimizing Fluid Management in the ICU: Fit for Purpose?

Lui Forni MD PhD JFICMI
7:00-8:00
Saturday, April 1

Educational Objectives:
Outline monitoring fluid status
Outline different choices
Discuss why we need to resuscitate!!

Health System Perspectives in AKI: Commitment to Kidney Health

Sandra Kane Gill PharmD
8:45-9:00
Saturday, April 1

Educational Objectives:
Discuss a deliberate commitment by health systems to optimize kidney health and outcomes of patients who are at risk for or develop acute kidney injury (AKI) during hospitalization.

Assess your institutions level of commitment to kidney health

Content Description:
There is a need to identify patients at high-risk for kidney disease development and progression, active surveillance methods to ensure timely identification, and offering better follow-up care after an episode of AKI. A strategic approach to determining the health systems level of commitment and a plan for organizational change is needed. Items for consideration of impactful change are structuring sound implementation projects and selecting implementation interventions. Clinical interventions to consider for implementation include use of clinical decision support for detecting patients with AKI, novel biomarkers to determine patients at high-risk for AKI and nephrotoxin stewardship. Deliberate change that is sustainable and scalable should be considered by all health systems.

Suggested Reading:
Kane-Gill SL. Health system perspectives in acute kidney injury: commitment to kidney health and planning implementation interventions. Curr Opin Crit Care. 2021 Dec 1;27(6):593-603. PMID: 34757995.

Selby NM, Casula A, Lamming L, et al. An Organizational-Level Program of Intervention for AKI: A Pragmatic Stepped Wedge Cluster Randomized Trial. J Am Soc Nephrol. 2019;30(3):505-15.

Colquhoun HL, Squires JE, Kolehmainen N, et al. Methods for designing interventions to change healthcare professionals' behaviour: a systematic review. Implement Sci. 2017;12(1):30.

Chawla LS, Bellomo R, Bihorac A, et al. Acute kidney disease and renal recovery: consensus report of the Acute Disease Quality Initiative (ADQI) 16 Workgroup. Nat Rev Nephrol. 2017;13(4):241-57

Kane-Gill SL. Nephrotoxin Stewardship. Crit Care Clin. 2021;37(2):303-20

Epidemiology of AKI: The UK Experience

Samira Bell Dr
9:45-10:00
Saturday, April 1

Educational Objectives:
1. Describe the current definitions for AKI/AKD and how variations in application affect epidemiology.
2. Understand the characteristics of AKI in high income countries and how these compare to characteristics of AKI in low to middle income countries.
3. Describe the epidemiology of AKI in different settings and associated patient outcomes.

Content Description:
Acute Kindy Injury (AKI) is common and associated with adverse outcomes. Over the last decade the epidemiology of AKI has become better understood with the advent of a universally accepted definition. However, variation in interpretation and application of this definition can affect study findings. The characteristics of AKI in high income countries differ compared with the characteristics of AKI in low to middle income countries. In this session, some of the variations in definition with a focus on studies examining epidemiology and outcomes in the UK will be covered. We will also examine how AKI incidence and risk factors vary by setting including perioperative, hospitalised and community acquired AKI and associated patient outcomes.

Suggested Reading:
1. Norbert H. et al. Harmonizing acute and chronic kidney disease definition and classification: report of a Kidney Disease: Improving Global Outcomes (KDIGO) Consensus Conference. Kidney International 2021 100. 516-526.

2. Mehta RL et al. International Society of Nephrology's 0by25 initiative for acute kidney injury (zero preventable deaths by 2025): a human rights case for nephrology, The Lancet, 385 (9987) 2015 2616-2643.

3. Hoste EAJ et al. Global epidemiology and outcomes of acute kidney injury. Nat Rev Nephrol. 2018 Oct;14(10):607-625.

4. Sawhney S et al. Harmonization of epidemiology of acute kidney injury and acute kidney disease produces comparable findings across four geographic populations. Kidney International: 101 (6) 2022, 1271-1281.

5. Bell S et al. Optimizing peri-operative care to prevent acute kidney injury, Nephrology Dialysis Transplantation, 34 (5) 2019, 757–759.

6. Hapca S et al. The Relationship between AKI and CKD in Patients with Type 2 Diabetes: An Observational Cohort Study. JASN 32(1):p 138-150, January 2021.

7. Wang, H et al. Patient outcomes following AKI and AKD: a population-based cohort study. BMC Med 20, 229 (2022).

AKI and CRRT Trends in South Korea

SeJoong Kim Professor
10:15-10:30
Saturday, April 1

Educational Objectives:
1. Describe global trends of AKI and CRRT
2. Compare global trends and South Korean trends of AKI and CRRT
3. Discuss the main reasons for recent changes in Korea

Content Description:
Global incidences of AKI are twice within decades.
It may be because of an increasing number of older people, a growing number of ICU patients with AKI, and an increased incidence of sepsis.

In South Korea, similar trends have happened. AKI incidence is still growing. Korea will go to a superaged society in 2026. During the COVID pandemic, major hospitals expanded the number of ICU facilities and CRRT ma-

chines, which the government partially supported.

As a result, the accessibility of the elderly to the ICU has improved. Patient outcomes have also improved, but the medical burden increased thrice within a decade. In the future, Korea should develop local guidelines for CRRT to control the total cost of medical burden.

Suggested Reading:
Acute and Critical Care 2022 August 37(3):372-381; Intensive Care Med (2017) 43:1319–1328

KIDNEY360 3: 1099–1104, 2022

Kidney Res Clin Pract 37:119-129, 2018(2)

Update from Ongoing and Late Breaking Trials
The RELIEVE-AKI Trial

Raghavan Murugan MD, MS, FRCP
11:30-12:35
Saturday, April 1

Educational Objectives:
To review the association of slow and fast net ultrafiltration rate with outcomes
To provide overview of RELIEVE-AKI clinical trial

Content Description:
Management of fluid overload is one of the most challenging problems in the care of critically ill patients with oliguric acute kidney injury. Various clinical practice guidelines support fluid removal using ultrafiltration during kidney replacement therapy. However, ultrafiltration is associated with considerable risks. Emerging evidence from observational studies suggests that
both slow and fast rates of net fluid removal (that is, net ultrafiltration (UFNET)) during continuous kidney replacement therapy are associated with increased mortality compared with moderate UFNET rates. In addition, fast UFNET rates are associated with an increased risk of cardiac arrhythmias.
Experimental studies in patients with kidney failure who were treated with intermittent haemodialysis suggest that fast UFNET rates are also associated with ischaemic injury to the heart, brain, kidney and gut. The UFNET rate should be prescribed based on patient body weight in millilitres per kilogram per hour with close monitoring of patient haemodynamics and fluid balance.Dialysate cooling and sodium modelling may prevent haemodynamic instability and facilitate
large volumes of fluid removal in patients with kidney failure who are treated with intermittent haemodialysis, but the effects of this strategy on organ injury are less well studied in critically ill patients treated with continuous kidney replacement therapy. Randomized trials are required to examine whether moderate UFNET rates are associated with a reduced risk of haemodynamic
instability, organ injury and improved outcomes in critically ill patients.

Suggested Reading:
Murugan R, Bellomo R, Palevsky PM, Kellum JA. Ultrafiltration in critically ill patients treated with kidney replacement therapy. Nat Rev Nephrol. 2021;17(4):262-276

Murugan R, Kerti SJ, Chang CH, et al. Association of Net Ultrafiltration Rate With Mortality Among Critically Ill

Adults With Acute Kidney Injury Receiving Continuous Venovenous Hemodiafiltration: A Secondary Analysis of the Randomized Evaluation of Normal vs Augmented Level (RENAL) of Renal Replacement Therapy Trial. JAMA Netw Open. 2019;2(6):e195418.PMC6563576

Murugan R, Kerti SJ, Chang CH, et al. Association of Net Ultrafiltration Rate With Mortality Among Critically Ill Adults With Acute Kidney Injury Receiving Continuous Venovenous Hemodiafiltration: A Secondary Analysis of the Randomized Evaluation of Normal vs Augmented Level (RENAL) of Renal Replacement Therapy Trial. JAMA Netw Open. 2019;2(6):e195418.PMC6563576

Update from Ongoing and Late Breaking Trials
The predARRT Trial

Christian Nusshag MD
11:30-12:35
Saturday, April 1

Educational Objectives:

Content Description:
Background:
Acute kidney injury (AKI) secondary to sepsis results in poor outcomes and conventional kidney function indicators lack diagnostic and prognostic value. Soluble urokinase plasminogen activator receptor (suPAR) is an innate-immune derived signaling molecule implicated in inflammatory organ damage. Proenkephalin A (penKid) is a new kidney function biomarker with potentially improved diagnostic abilities compared to established kidney function biomarkers. We characterized the diagnostic ability of suPAR and penKid levels in blood to predict the severity and course of sepsis-associated AKI (SA-AKI) and compared their diagnostic performance with a number of established kidney biomarkers.
Methods:
Blood levels of suPAR, penKid, serum creatinine (SCr), neutrophil gelatinase-associated lipocalin (NGAL), kidney injury molecule-1 (KIM-1) and proteinuria, albuminuria, and urinary levels of tissue inhibitor of metalloproteinases 2 * Insulin-like growth factor-binding protein 7 (TIMP2*IGFBP7) were assessed in 200 critically ill patients who met Sepsis-3 criteria.
Results:
Serum suPAR levels provided a robust classification of individual kidney disease severity and outcomes with improved prediction of need for renal replacement therapy (RRT) and patient mortality at any time in the disease course. Patients with suPAR levels >12.7 ng/mL were at highest risk for RRT or death, with an adjusted odds ratio of 7.48 (95% CI, 3.00-18.63). After the start of standardized sepsis therapy, plasma penKid levels indicated therapy-related improvement in kidney function 24 to 48 hours earlier than SCr. Combining functional and damage/immune biomarkers further improved predictive performance for RRT or death, with penKid in combination with suPAR providing the highest diagnostic accuracy. When stratified by biomarker quartiles, the combination of penKid and suPAR showed the most favorable diagnostic profile after 24 hours of sepsis therapy.
Conclusion:
suPAR levels allow for an innate-immune derived and kidney function independent staging of SA-AKI and offers improved longitudinal risk stratification compared to the use of traditional kidney markers. Compared with SCr, the course of penKid levels allows earlier identification of responders and non-responders to sepsis therapy. Combining functional biomarkers with markers of kidney injury or inflammation provides superior diagnostic value, leading to improved clinical decision making, such as in the timing of RRT.

Suggested Reading:

1. Ostermann M, et al. Recommendations on Acute Kidney Injury Biomarkers From the Acute Disease Quality Initiative Consensus Conference. Jama Netw Open 2020;3(10):e2019209.

2. Zarbock A, et al. Sepsis-associated acute kidney injury: consensus report of the 28th Acute Disease Quality Initiative workgroup. Nat Rev Nephrol 2023;1–17.

3. Nusshag C, et al. suPAR links a dysregulated immune response to tissue inflammation and promotes sepsis-induced acute kidney injury. JCI Insight 2023 (accepted & currently in production)

4. Beunders R, et al. Proenkephalin Compared to Conventional Methods to Assess Kidney Function in Critically Ill Sepsis Patients. Shock 2020;54(3):308–314.

Update from Ongoing and Late Breaking Trials
RCA for ECCO2R

Thiago Reis MD
11:30-12:35
Saturday, April 1

Educational Objectives:
Discuss the bleeding risks and neutral outcomes in trials with ECCO2R.
Discuss potential complications of high load of citrate.

Content Description:
Rationale and mathematical explanation of a protocol for ECCO2R with regional citrate anticoagulation.

Suggested Reading:

McNamee, James J et al. "Effect of Lower Tidal Volume Ventilation Facilitated by Extracorporeal Carbon Dioxide Removal vs Standard Care Ventilation on 90-Day Mortality in Patients With Acute Hypoxemic Respiratory Failure: The REST Randomized Clinical Trial." JAMA vol. 326,11 (2021): 1013-1023. doi:10.1001/jama.2021.13374

Reis T, Ramos de Freitas GR, Reis F, et al. Regional Hypertonic Citrate Anticoagulation in Membrane Therapeutic Plasma Exchange: A Case Series. Can J Kidney Health Dis. 2021;8:20543581211054736. Published 2021 Nov 7. doi:10.1177/20543581211054736

EPIDEMIOLOGY AND OUTCOMES FROM AKI

1

An Unusual Case Of Hyperammonemia After An ABO Incompatable Renal Transplant

Mahesh Kota[1], Rajasekara Chakravarthi M, Vijay Varma[1]

[1]*Renown Clinical Services,Yashoda Hospitals*

ABSTRACT
Hyperammonemia syndrome, with high levels of ammonia and neurologic dysfunction, is a syndrome with high mortality that may occur after solid organ transplantation. We describe a rare case of hyperammonemia syndrome due to Ureaplasma infection after an ABO incompatable kidney transplantation. Our patient rapidly recovered after being subjected to extracorporeal ammonia removal ,hemodiafiltration with PMMA filter and specific antibiotic treatment. It is important to consider these infections in the differential diagnosis for encephalopathy in a critically ill post-transplant, as these organisms often do not grow using routine culture methods and polymerase chain reaction testing is typically required for their detection. This is particularly critical after renal transplantation, where a number of other etiologies may be considered as a cause of hyperammonemia syndrome.

DISCUSSION
The development of hyperammonemia after renal transplantation is a challenging problem. There are several potential etiologies for development of hyperammonemia after renal transplantation surgery like new onset of infection due urease producing organism, allograft dysfunction causing decreased ability to excrete ammonia, inborn errors of metabolism. Elevated BUN, post renal transplant may occur for multiple reasons including poor allograft function, use of high-dose steroids, hypovolemia, and gastrointestinal bleeding. In addition, urea is also the end-product of ammonia metabolism and therefore elevation of ammonia may lead to high BUN levels in patients with at least a partially working urea cycle.
As our patient had completely normal liver function during pre-transplant workup and the entire course of illness, inborn errors of urea metabolism was not evaluated, however it is worth to check inborn errors of metabolism in any patient with hyperammonemia as any derangements in urea metabolism can precipitate pre-existing inborn errors of urea metabolism which may lead to hyperammonemia.

CONCLUSIONS
Our case highlights the importance of considering elevated blood ammonia level in any patient with altered sensorium in particular with pre-existing renal dysfunction,considering Ureaplasma infections in patients with elevated ammonia levels,specifically testing for them by PCR and empiric specific antimicrobial treatment should be strongly considered for post-transplant patients with hyperammonemia syndrome.

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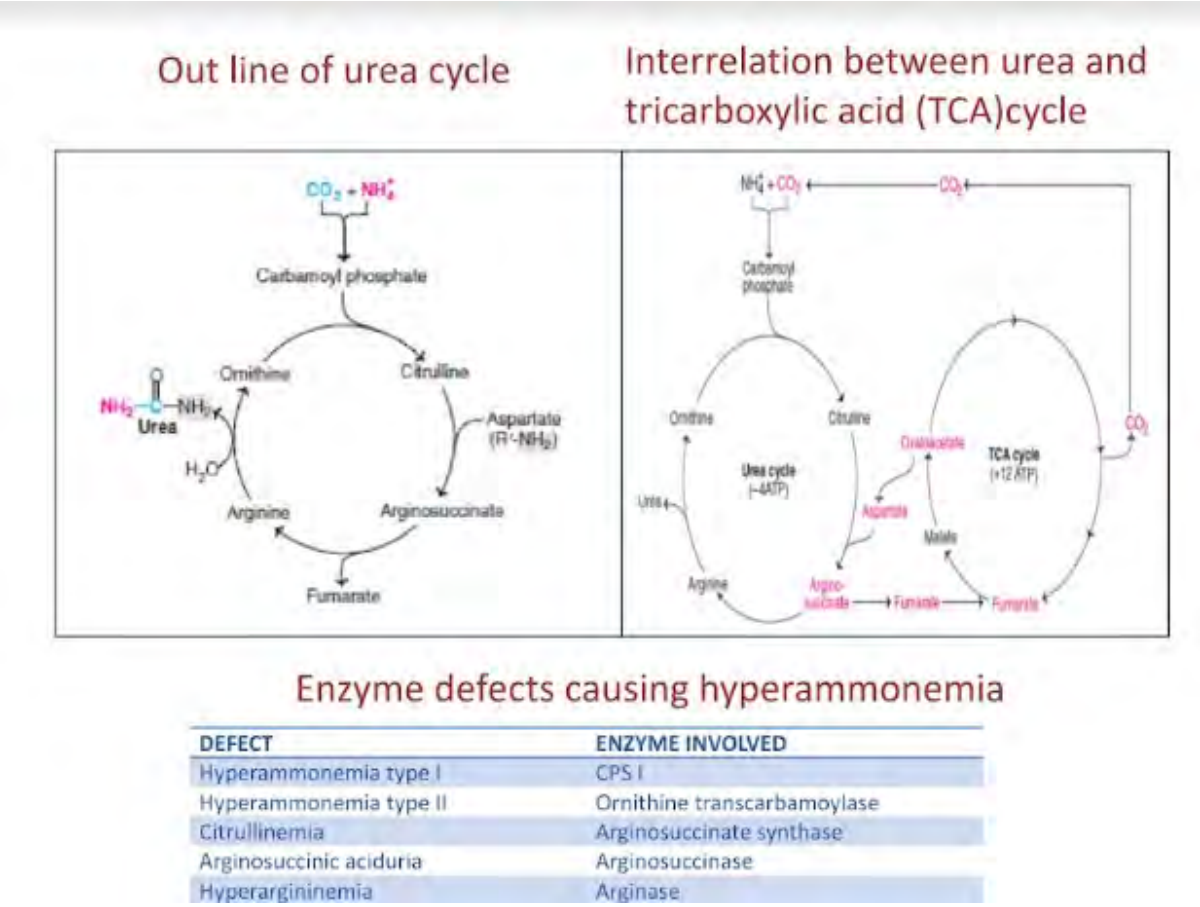

Enzyme defects causing hyperammonemia

DEFECT	ENZYME INVOLVED
Hyperammonemia type I	CPS I
Hyperammonemia type II	Ornithine transcarbamoylase
Citrullinemia	Arginosuccinate synthase
Arginosuccinic aciduria	Arginosuccinase
Hyperargininemia	Arginase

2

Analysis of changed in dialysis-related treatment practices using data from the Health Insurance Review and Assessment Service of Korea

Yu Bum Choi[1], Hyung Jong Kim[2], Mi Jung Lee[2], Sang Hyun Jung[2]

[1]*Dong Su--won Hospital, Su-won, Kyung-gi, South Korea,* [2]*CHA Bundang Medical Center, Seong-nam, Kyung-gi, South Korea*

Objective: In Korea, For domestic medical treatment, a medical treatment code according to medical treatment is submitted to the Health Insurance Review and Assessment Service to claim the number of insurance benefit items, and the Health Insurance Review and Assessment Service discloses these billing data to the Healthcare Big Data Hub. Based on this actual insurance fee claim data, we analyzed dialysis-related treatment behavior to find out the recent changes in dialysis-related treatment behavior.
Method : Using the health care data system, changes in dialysis-related treatment practices over the past five years (2016-2020) were analyzed. Dialysis-related treatments such as hemodialysis, peritoneal dialysis, arteriovenous fistula surgery, and peritoneal dialysis catheter insertion were analyzed using diseases and treatment codes listed in the cost of health insurance care benefits.
Results : Peritoneal dialysis catheter surgery behavior gradually decreased from 2,025 in 2016 to 1,404 in 2020. The number of arteriovenous fistula surgeries using autologous blood vessels gradually increased from 7,141 in 2016 to 8,817 in 2020. Arteriovenous fistula surgeries using artificial blood vessels increased from 3,221 in 2016 to 3,342 in 2019 and then decreased to 3,275 in 2020.

Conclusion : The data on the claim code of the Health Insurance Review and Assessment Service can be considered to be accurate as it was actually implemented as a medical practice. In the past five years, the number of peritoneal dialysis surgeries has been gradually decreasing, and arteriovenous fistula surgery for hemodialysis is increasing, and based on these results, it is thought that there should be a change in salary policy for dialysis-related treatment.

- **Peritoneal catheter insertion (Others)**

	2016 year			2017 year			2018 year			2019 year			2020 year		
Sex	Patients No.	Total usage	Treatment amount (1,000 won)	Patients No.	Total usage	Treatment amount (1,000 won)	Patients No.	Total usage	Treatment amount (1,000 won)	Patients No.	Total usage	Treatment amount (1,000 won)	Patients No.	Total usage	Treatment amount (1,000 won)
Total	2,025	2,343	360,671	1,736	2,062	334,339	1,686	1,969	359,571	1,597	1,922	163,596	1,164	1,777	452,391
Male	1,171	1,345	206,258	1,042	1,269	202,674	1,021	1,187	208,273	963	1,166	261,945	857	1,088	371,962
Female	854	998	154,713	694	812	132,265	668	782	164,267	634	757	161,801	547	689	180,489

- **Peritoneal catheter insertion (with greater omentectomy)**

	2016 year			2017 year			2018 year			2019 year			2020 year		
Sex	Patients No.	Total usage	Treatment amount (1,000 won)	Patients No.	Total usage	Treatment amount (1,000 won)	Patients No.	Total usage	Treatment amount (1,000 won)	Patients No.	Total usage	Treatment amount (1,000 won)	Patients No.	Total usage	Treatment amount (1,000 won)
Total	139	139	25,172	118	124	24,256	117	120	28,893	70	72	24,681	78	88	27,846
Male	91	96	16,262	67	70	13,388	67	69	16,494	40	42	14,224	47	53	16,905
Female	48	48	8,910	51	54	10,892	50	51	12,402	30	30	9,757	31	33	10,941

- **Arterio-Venous Shunt or Fistula formation for hemodialysis (Autologous vein)**

		2016 year			2017 year			2018 year			2019 year			2020 year	
Sex	OPD/Admission	Patients No.	Total usage	Treatment amount (1,000 won)	Patients No.	Total usage	Treatment amount (1,000 won)	Patients No.	Total usage	Treatment amount (1,000 won)	Patients No.	Total usage	Treatment amount (1,000 won)	Patients No.	Total usage	Treatment amount (1,000 won)
Total	Total	7,141	7,523	4,796,222	7,162	7,467	4,913,076	8,359	8,838	5,948,417	8,736	9,085	6,440,385	8,617	10,354	6,859,642
Male	Subtotal	4,417	4,648	2,959,726	4,438	4,628	3,042,588	5,163	5,428	3,662,308	5,502	6,181	4,647,272	5,693	6,524	4,219,505
Male	OPD	940	968	621,571	858	874	577,886	1,038	1,058	730,617	1,251	1,281	918,016	1,451	1,478	1,091,898
Male	Admission	3,513	3,679	2,337,757	3,603	3,753	2,464,702	4,150	4,370	2,931,660	4,285	4,900	3,730,027	4,180	5,046	3,127,607
Female	Subtotal	2,724	2,875	1,836,496	2,724	2,839	1,870,488	3,196	3,410	2,286,110	3,234	3,704	2,793,113	3,244	3,830	2,640,137
Female	OPD	534	537	345,177	496	504	332,577	577	594	410,436	717	756	577,861	806	823	618,175
Female	Admission	2,225	2,339	1,491,317	2,249	2,335	1,537,983	2,640	2,816	1,875,674	2,546	2,948	2,805,252	2,431	3,006	1,839,963

- **Arterio-Venous Shunt or Fistula formation for hemodialysis (Artificial vein)**

		2016 year			2017 year			2018 year			2019 year			2020 year	
Sex	OPD/Admission	Patients No.	Total usage	Treatment amount (1,000 won)	Patients No.	Total usage	Treatment amount (1,000 won)	Patients No.	Total usage	Treatment amount (1,000 won)	Patients No.	Total usage	Treatment amount (1,000 won)	Patients No.	Total usage	Treatment amount (1,000 won)
Total	Total	3,221	3,475	2,252,798	3,241	3,497	2,277,427	3,338	3,688	2,372,336	3,342	4,095	2,353,733	3,275	4,159	2,372,269
Male	Subtotal	1,865	1,921	1,182,555	1,859	1,974	1,196,342	1,775	1,957	1,266,907	1,703	2,077	1,204,862	1,776	2,280	1,278,559
Male	OPD	430	453	280,995	401	418	273,037	396	413	277,767	378	388	264,845	415	427	302,110
Male	Admission	1,374	1,367	870,560	1,262	1,356	883,304	1,298	1,544	989,840	1,346	1,689	940,017	1,385	1,834	974,449
Female	Subtotal	1,536	1,654	1,070,243	1,591	1,722	1,121,086	1,663	1,731	1,105,730	1,639	2,022	1,148,871	1,499	1,895	1,096,210
Female	OPD	404	420	265,844	347	354	229,667	336	348	227,799	356	376	254,504	400	412	299,332
Female	Admission	1,146	1,235	784,399	1,208	1,368	891,386	1,240	1,331	877,931	1,296	1,652	904,367	1,115	1,486	805,878

- **Continuous veno-venous hemodialysis with catheter insertion (first day)**

	2016 year			2017 year			2018 year			2019			2020		
Sex	Patients No.	Total usage	Treatment amount (1,000 won)	Patients No.	Total usage	Treatment amount (1,000 won)	Patients No.	Total usage	Treatment amount (1,000 won)	Patients No.	Total usage	Treatment amount (1,000 won)	Patients No.	Total usage	Treatment amount (1,000 won)
Total	10,259	11,591	6,545,138	10,301	11,592	5,533,584	12,316	13,926	6,681,610	12,151	14,231	11,497,094	10,241	12,536	11,663,661
Male	6,319	7,135	2,802,662	6,281	7,016	3,109,687	7,465	8,437	5,386,518	7,364	8,600	6,974,687	6,169	7,499	7,039,152
Female	3,939	4,453	1,747,477	4,020	4,576	2,023,876	4,853	5,491	3,495,093	4,787	5,631	4,522,407	4,072	5,037	4,624,509

- **Continuous veno-venous hemodialysis (next day)**

	2016 year			2017 year			2018 year			2019 year			2020 year		
Sex	Patients No.	Total usage	Treatment amount (1,000 won)	Patients No.	Total usage	Treatment amount (1,000 won)	Patients No.	Total usage	Treatment amount (1,000 won)	Patients No.	Total usage	Treatment amount (1,000 won)	Patients No.	Total usage	Treatment amount (1,000 won)
Total	10,324	59,676	11,538,069	10,344	58,585	11,681,201	12,681	73,884	15,836,249	13,051	77,991	16,845,111	11,088	70,581	16,240,301
Male	6,394	37,332	7,219,739	6,305	35,848	7,133,265	7,678	45,884	9,839,889	7,878	48,436	11,706,176	6,735	44,011	11,417,544
Female	3,930	22,344	4,318,330	4,039	22,738	4,547,935	5,003	27,980	5,996,360	5,173	29,555	7,138,941	4,353	26,570	6,822,757

- **Hemodialysis (per episode)**

		2016 year			2017 year			2018 year			2019 year			2020 year	
Sex	OPD/Admission	Patients No.	Total usage	Treatment amount (1,000 won)	Patients No.	Total usage	Treatment amount (1,000 won)	Patients No.	Total usage	Treatment amount (1,000 won)	Patients No.	Total usage	Treatment amount (1,000 won)	Patients No.	Total usage	Treatment amount (1,000 won)
Total	Total	66,937	6,791,752	641,354,556	63,626	7,167,681	680,151,922	68,584	7,964,461	767,358,311	71,569	8,128,150	817,600,064	74,638	8,568,691	877,151,513
Male	Subtotal	39,429	3,891,800	369,161,960	37,928	4,117,420	390,986,815	39,924	4,413,962	426,372,017	41,909	4,606,928	472,862,261	43,833	4,971,471	509,763,025
Male	OPD	28,872	3,456,948	327,666,821	30,543	3,649,510	354,754,956	32,384	3,890,220	385,739,363	34,269	4,147,877	418,915,434	36,335	4,406,568	454,166,811
Male	Admission	21,993	441,352	41,495,039	22,433	467,910	44,803,859	25,113	523,732	50,632,653	25,365	549,049	53,746,787	26,393	564,902	55,617,915
Female	Subtotal	25,504	2,899,951	272,192,596	25,697	3,050,261	289,164,907	28,660	3,550,499	340,985,294	29,660	3,521,222	344,737,803	30,805	3,597,220	367,387,488
Female	OPD	20,073	2,466,695	232,868,642	21,170	2,573,059	250,383,420	22,213	2,719,680	269,745,516	23,245	2,863,772	283,271,713	24,327	3,016,421	310,584,469
Female	Admission	16,157	442,256	41,723,954	16,592	477,126	45,262,887	16,484	530,829	50,940,777	16,221	568,358	56,086,889	16,301	580,799	57,083,328

- **Hemodialysis (per episode) ; Fixed-Fee Review Records of hemodialysis (outpatient)**

	2016 year			2017 year			2018 year			2019 year			2020 year		
	Claims	Medical expenses per visit (won)	Medical expenses (1,000 won)	Claims	Medical expenses per visit (won)	Medical expenses (1,000 won)	Claims	Medical expenses per visit (won)	Medical expenses (1,000 won)	Claims	Medical expenses per visit (won)	Medical expenses (1,000 won)	Claims	Medical expenses per visit (won)	Medical expenses (1,000 won)
Total	1,906,534	146,076	278,482,604	1,888,028	146,106	275,844,641	2,013,511	146,103	294,179,080	2,127,220	146,047	310,671,497	2,253,542	146,371	329,899,908

3

A rare case of Acute Kidney Injury secondary to bilateral obstructing ureteric stones

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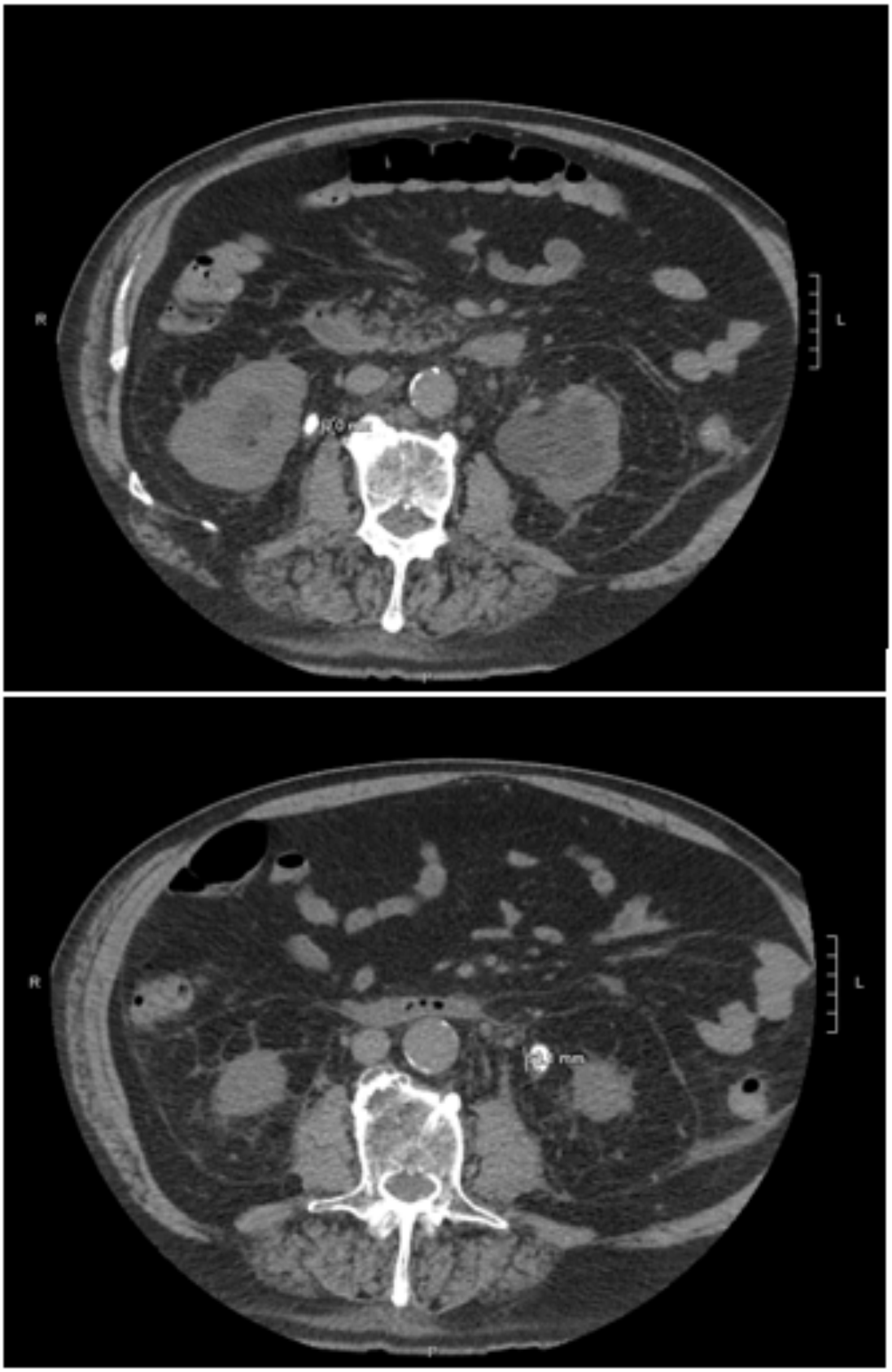
Background
Kidney stone disease is a common medical problem with a rising prevalence in the United States. Patients typically present with classic renal colic symptoms, including flank pain, hematuria, dysuria, urinary frequency, and urgency. Kidney stones can also cause urinary tract obstruction, leading to acute kidney injury (AKI). However, bilateral synchronous kidney stones resulted in obstructive uropathy, and AKI is uncommon and considered a urologic emergency.

Case presentation
A 75-year-old man presented to the emergency department at Marshfield Clinic with a 4-day history of anuria, loss of appetite, and fatigue. He also experienced intermittent episodes of hematuria while oliguric for the past three weeks. His past medical history was significant for dyslipidemia, gout, renal colic due to distal ureteral stone treated by shock wave lithotripsy, atrial fibrillation, and pulmonary thromboembolism requiring anticoagulation with warfarin. Upon examination, except for tachycardia (atrial flutter with rapid ventricular response on ECG), other findings were unremarkable. Initial Laboratory investigations revealed elevated serum creatinine (20.3 mg/dL) and BUN (174 mg/dL), mild leukocytosis (WBC 11.7 ×103/μL, 86□ neutrophil), hyponatremia (Na 129 mmol/L), hyperkalemia (K 7 mmol/L) and mild hypochloremia (Cl 95 mmol/L). Abdominopelvic CT scan without IV contrast (Figure 1) indicated bilateral obstructing stones with the size of 1.3 cm in the proximal right ureter and 1.5 cm in the proximal left ureter and a non-obstructing 5mm stone in left renal calculus. In addition to hyperkalemia management with Insulin, dextrose, and calcium gluconate, he was admitted to the ICU as he required a higher level of care. Following urology consultation, two double J stents were placed bilaterally. Subsequently, he became polyuric (7 L/day), and creatinine and BUN decreased within 72 hours to 2 mg/dL and 36 mg/dL, respectively.

Conclusion
In this case report, we presented a patient with AKI due to bilateral obstructing ureteric stones who underwent double J stents via ureterostomy leading to rapid recovery and kidney function restoration. Thus, considering kidney stone as a differential diagnosis and performing early investigations, particularly in acute onset anuria without typical signs or symptoms of renal colic, would benefit patients.

Figures on following page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4

Hemolytic Uremic Syndrome and CRRT. First Case in Our Institution

Alfred Ibrahimi[1], Saimir Kuci[1], Ilirjana Bakalli[2], Durim Sala[2], Ermela Celaj[2], Inva Gjeta[2], Marsela Goga[1], Altin Veshti[2], Ermira Kola[2]

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Background. Hemolytic uremic syndrome (HUS) is characterized by the classic triad of microangiopathic hemolytic anemia, thrombocytopenia, and acute renal failure. More than 90% of the cases occur after an infectious process caused by strains of Escherichia coli, which produce the Shiga-like toxin.
Case description. 2 years old girl with an initial weight of 10 kg, presented in the hospital and was diagnosed with Idiopathic HUS. Lab tests showed severe anemia Hg 5mg/dl, low platelets (15,000 / mm3), hypertensive state, and anuria. Treated initially with furosemide, nitroglycerin for hypertension, blood, and platelet transfusion, she gained weight until 14 kg. Despite the onset of intermittent dialysis, the clinical situation did n improve. CVVHD was started with these parameters. BP 50 ml /hour, PBP 50ml/hour, dialysate 400 ml/hour, PFR 40 ml/hour in first two days and 80 ml in remaining days. Baxter Prismaflex HF 20 set was used. Hemodynamic parameters were stabilized, and everyday weight loss was 400mg. Hg – 8mg/dl, and platelets 100. 000 mm3. The patient was maintained for 8 days in CVVHD, the filter was changed one more time (after 96 hours). On the 13th day, the urine output improved (2ml/kg/hour) and CVVHD was interrupted. The patient was discharged to the nephrology ward for further treatment. She left the hospital after 30 days with normal renal parameters Conclusion. The success of this treatment is related to the use of CVVHD since through it, it was possibly better management of fluid balance and prevention of dialysis disequilibrium syndrome

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5

Post-acute Kidney Disease Kidney Function Associated with Long-term Adverse Outcomes in Survivors of Acute Kidney Injury Requiring Renal Replacement Therapy: A Population-based Study

Heng-Chih Pan[1], Nai-Chi Teng[2], Fang-Yu Yeh[3], Chun Yin See[4], Chiao-Yin Sun[1], Vin-Cent Wu[3], Likwang Chen[2]

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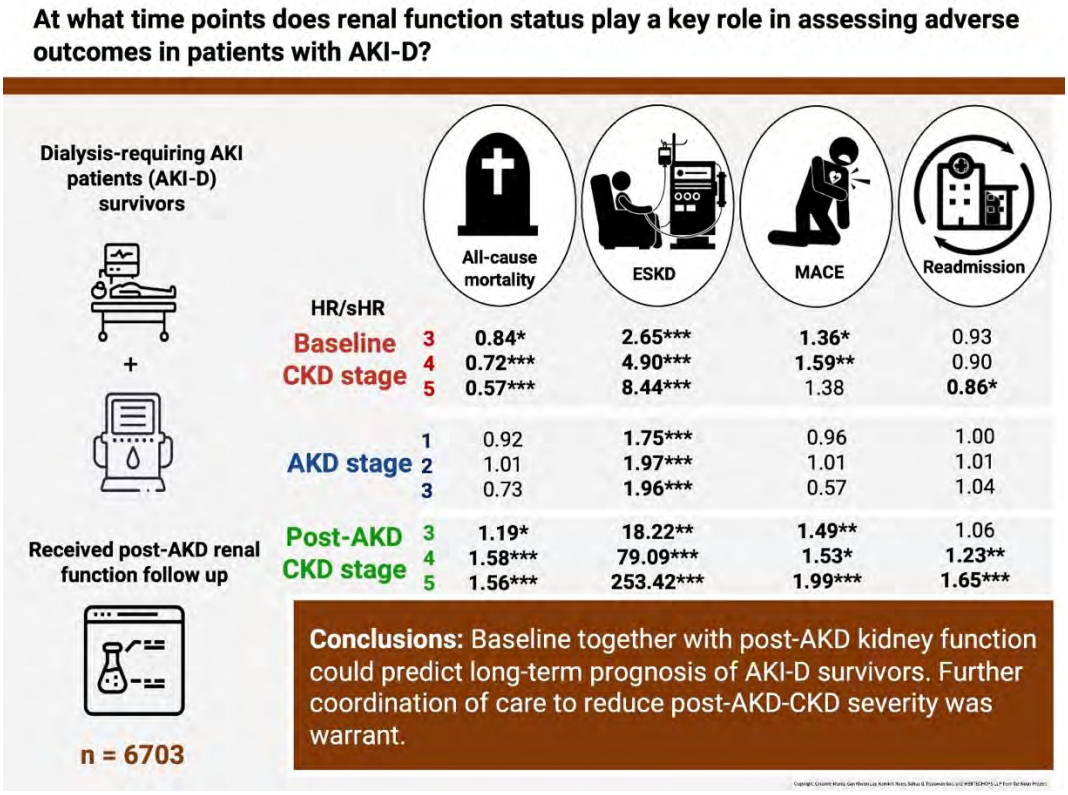
Background: Acute kidney injury (AKI) is a complex clinical problem associated with significant risks of long-term mortality and morbidity. The aim of this study was to investigate the relationships among baseline kidney function, severity of acute kidney disease (AKD), post-AKD kidney function and their associations with mortality, end-stage kidney disease (ESKD), and major adverse cardiac events (MACEs).
Methods: We enrolled 6703 dialysis-requiring AKI (AKI-D) survivors with post-AKD kidney function follow-up data between January 1, 2015 and December 31, 2018 from the National Health Insurance Research Database in Taiwan. The primary study endpoints were all-cause mortality and the incidence of ESKD and incident MACEs.
Results: After a mean 1.2 years of follow-up, the all-cause mortality rate was 28.3%, and the incidence rates of ESKD and MACEs were 16.7% and 11.1%, respectively. After adjusting for known covariates, post-AKD kidney function and baseline renal function, but not AKD severity, were independent predictors of all-cause mortality, ESKD, MACEs and readmission. In addition, worsening post-AKD kidney function was associated with progressive and significant increases in the risk of adverse outcomes. For the patients with post-AKD chronic kidney disease (CKD) stages 3/4/5, the hazard ratio (HR) for mortality were 1.19/1.58/1.56; the sub-distribution HR (sHR) for ESKD were 18.22/79.09/253.42; the sHR

for MACE were 1.49/1.53/1.99; and the sHR for readmission were 1.06/1.23/1.65. The interaction of post-AKD kidney function and baseline kidney function was associated with adverse events in a disease severity-dependent manner. Conclusions: Over a quarter of the AKI-D survivors died after 1 year of follow-up in this study. Baseline and post-AKD kidney function could predict the long-term prognosis of AKI-D survivors. Further coordination of care to reduce post-AKD-CKD severity is important.



6

Long-term Clinical Impact of Acute Kidney Disease in Patients Receiving Extracorporeal Membrane Oxygenation

Ming-Jen Chan[1], Pei-Chun Fan[1], Cheng-Chia Lee[1], Jia-Jin Chen[1], Shao-Wei Chen[1], Chih-Hsiang Chang[1]

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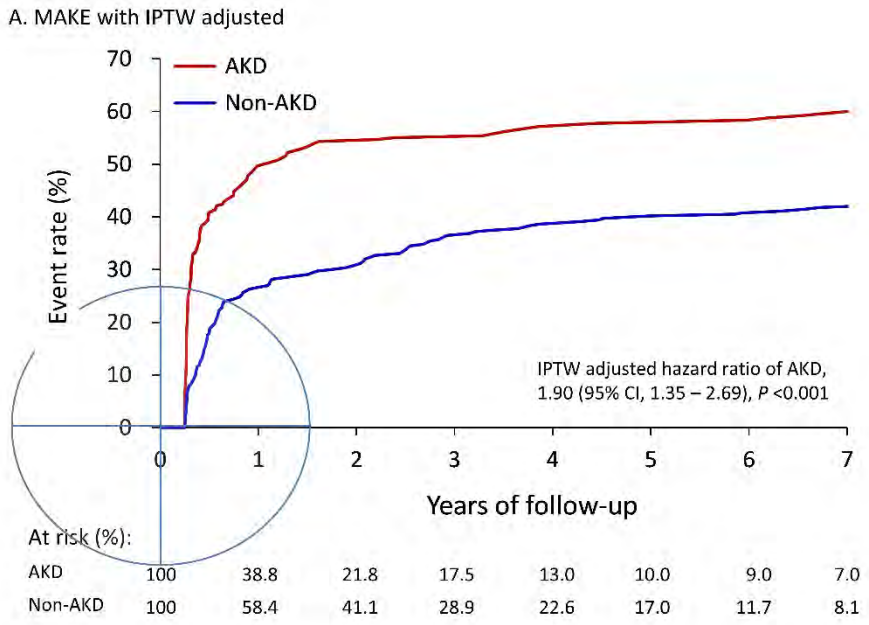
Introduction
Extracorporeal membrane oxygenation (ECMO) is increasingly used worldwide, however, current study focusing on long-term outcome of ECMO is scarce. We aim to exam the impact of acute kidney disease (AKD) during ECMO on long-term clinical outcomes.
Method
We retrospectively collect electronic data from a multi-centered clinical database between 2009 and 2018. Acute Disease Quality Initiative 16 Workgroup consensus using creatinine was used to diagnose AKD. Three hundred and nighty-five patients eventually met the inclusion criteria and were divided into two groups according to their AKD status during 7 to 90 days of ECMO initiation. We used inverse probability treatment weighting to control confounding factors. The primary outcomes were major adverse kidney events (MAKE) and major adverse cardiovascular events (MACE). The secondary outcomes were all-cause readmission, sepsis readmission, infection readmission, and dementia.

Result
One hundred and sixty patients (40.5%) developed AKD during 8 to 90 days of initiation of ECMO. Compared with non-AKD patients, AKD patients was associated with a higher risk of MAKE (hazard ratio [HR]: 1.90; 95% confidence interval [CI]: 1.35-2.69; p <0.001); but this association was not statically significant for MACE (HR: 1.29; 95% CI: 0.84–1.98; p = 0.241). When compared to the subgroups of AKD and non-AKD, patients received venousvenous ECMO were associated with highest risk of MAKE.
AKD survivors are more likely to readmit to hospital due to any cause, infection, and sepsis (HR: 1.41, 2.84 and 1.77; p= 0.027, 0.008, and 0.013, respectively). There is no difference in developing dementia between AKD and non AKD group.
Conclusions
AKD was associated with an increased risk of long-term MAKE in ECMO survivors, but not MACE. AKD also increase all cause, infection related and sepsis related readmission.



7

Impact of Acute Kidney Disease on the Incidence of Acute Kidney Injury and Patient Outcome in the Intensive Care Unit

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Introduction
Acute kidney disease (AKD) is a kidney dysfunction sustained more than seven days and less than 90 days, and chronic kidney disease (CKD) is a kidney dysfunction sustained more than 90 days. CKD is a traditional risk factor for incident acute kidney injury (AKI) at intensive care unit (ICU) whereas the influence of AKD had not been fully studied.
Method
This is a multi-center retrospective cohort study of critically ill patients admitted to ICU at the 3rd affiliated hospitals from January 2011 to December 2020. Patients without serum creatinine data before hospital admission or end-stage

kidney disease were excluded. We divided patients into three groups based on the kidney health status within 1 year of hospital admission; no kidney disease (NKD), AKD, and CKD. AKI was defined as KDIGO serum creatinine criteria. The influence of baseline AKD on the incidence of AKI at ICU and in-hospital mortality rate was analyzed by cox-proportional hazard model.

Results

During the study period, 48,834 were admitted to ICU and a total of 7,153 (14.6%) were eligible for analyses. In 7,153 included patients, baseline NKD, AKD, and CKD were seen in 4,792 (66.6%), 926(12.9%), and 1,465(20.5%), respectively. The population was all Asian, median age of 67 (18-110) years, and 57.6% were male. In all, AKI was observed in 2461(34.4%) patients. Referenced by NKD, AKD had 2.354(1.996-2.776) fold higher risk of incident AKI, similar as seen in CKD (HR 2.347(2.028-2.716)). During the median of 16(9, 23) days of hospital stay, 819(11.4%) died in hospital. In patients without AKI, AKD was a risk factor for in-hospital mortality (HR 2.176(1.625-2.915)) compared in NKD. In patients with AKI, AKD and NKD had similar impact whereas CKD (HR 0.754 (0.593-0.960)) was protective.

Conclusion

AKD was observed in 12.9% of ICU admitted patients, and it was associated with higher risk for incident AKI and in-hospital mortality. This study implies the significance of recognizing AKD in the management of ICU patients.

8

The Incidence and Outcomes of Sepsis Associated AKI in ICU Patients with Sepsis: a Systematic Review and Meta-analysis

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Purpose

To describe pooled estimates of the incidence and outcomes of sepsis associated acute kidney injury (SAKI) in ICU patients with sepsis, and to explore sources of variation in these estimates.

Methods

We performed a systematic review and meta-analysis of randomized clinical trials (RCTs) and cohort studies of ICU patients with sepsis and/or SAKI. The primary outcome was the proportion of study participants with sepsis who developed acute kidney injury (AKI). We collected study level data relating to definitions of AKI and sepsis, as well as proportions with risk factors for AKI. We assessed for potential heterogeneity based on study type and differing definitions of AKI and sepsis. Secondary outcomes included the proportion of patients diagnosed with SAKI with major adverse kidney events at ICU and hospital discharge and longest available follow-up. We assessed for the influence of risk factors on the incidence of SAKI and its outcomes. Study quality was assessed against pre-defined criteria for risk of bias.

Results

We identified 116 studies that reported an incidence of SAKI including 135,463 participants. The pooled estimated incidence of SAKI was 40% (95% CI 37-43%) with a high degree of heterogeneity (I2 99.31). There was significant variation in the estimated incidence of SAKI depending on the definition of AKI used (p value for between group heterogeneity, $p<0.005$), with an estimated incidence of 26% (95%CI 23-28%) when defined as the receipt of renal replacement therapy (RRT), and 54% (95%CI 45-63%) when defined by KDIGO consensus definition of AKI criteria

(Stage 1,2 or 3). Randomised controlled trials reported a significantly lower incidence of SAKI (35%, 95% CI 31-39%) than cohort studies (43%, 95%CI 39%-47%, p=0.01).

We identified 52 studies including 26,994 patients that reported at least one listed outcome following the diagnosis of SAKI in the ICU. At final follow-up, 50% of patients diagnosed with SAKI had died (95% CI 45-56%, I2 98.57%), 28% (95% CI 14-42%, I2 98.26%) had persisting new kidney dysfunction, and 6% (95%CI 3-8%, I2 92.78%) remained on RRT.

Conclusion
Sepsis associated AKI is common amongst ICU patients, and carries a high risk of death and persisting kidney impairment at final follow-up. The incidence of SAKI varies significantly depending on the definition of AKI used. Studies reporting an incidence of AKI based on renal replacement therapy alone may under-report this prognostically important complication.

9

Practices Among Healthcare Providers Taking Care of Critically Ill Patients with Acute Kidney Injury: A survey

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[1]*West Virginia University,* [2]*Wingate University,* [3]*VCUHealth,* [4]*Duke University ,* [5]*Mayo Clinic*

Background: The management and workup of critically ill patients with acute kidney injury (AKI) have evolved due to the emergence of new AKI Management Tools, novel biomarkers, and point-of-care ultrasound (POCUS). Our objectives were to determine the potential barriers to utilizing these tools in practice.

Methods: This was a survey of multidisciplinary healthcare providers taking care of critically ill patients who are members of the Society of Critical Care Medicine.

Results: There were 365 responders to our survey (2.6% response rate). There were 230 (63%) intensivists; the rest represented other multidisciplinary critical care team members. The type of intensive care units (ICU) that responders practiced in varied, i.e., surgical (41%), medical (32%), cardiovascular/thoracic (23%) ICUs. The most common nephrology consultation for AKI was renal replacement therapy 267 (73%). Use of a formal kidney ultrasound was <25% of the time by 35% (N=127) of the responders and always by only 8% (N=29). The use of POCUS varied depending on the organ surveyed. About two-thirds of the responders (N=246) reported minimal utilization of POCUS for the lungs in managing critically ill patients with AKI. Only 55 (15%) reported using novel biomarkers in the diagnosis of AKI, with Cystatin C being the most reported biomarker to be used by 72% (N=40). Only 20 (6%) and 22 (6%) responders reported using prediction models to identify patients at high risk of developing AKI and an integrated clinical decision support system, respectively.

Conclusion: There is a significant variation in the management and workup of critically ill patients with AKI. Although perceived as valuable by some, there is currently underutilization of novel biomarkers, prediction models, and integrated clinical decision support systems.

10

Incidence, Outcomes And Creation Of An Outpatient Clinic For The Follow-up Of Acute Kidney Injury In Hospitalized Patients: The AKI Project Of The Italian Society Of Nephrology (SIN_AKI).

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Background and aims:
AKI increases mortality risk, length of hospital stay and adverse outcomes such as progression toward Chronic Kidney Disease (CKD). Aims of this study were: 1) evaluation of AKI incidence in 2 centers (hub/spoke); 2) analysis of AKI distribution among wards and its association with in-hospital outcomes; 3) establishment of an outpatient clinic.
Methods:
AKI incidence was calculated matching laboratory (serum creatinine) and administrative data of 33.053 admissions in 1 year. KDIGO algorithms were applied for AKI grading. After discharge, AKI stage 2-3 patients were enrolled in the outpatient clinic (from September 2022) to evaluate after 3-12 months: eGFR, urine sediment, 24-h proteinuria, biomarkers for CKD-transition (NGAL, CCl-14, DKK-3 and urinary extracellular vesicles (EVs) expressing the stem cell marker CD133 and the anti-senescent molecule Klotho.
Results:
According to administrative data alone, in-hospital AKI incidence was 3.2%. In contrast, after matching laboratory with administrative data, the real AKI incidence was globally 11% (6% KDIGO 1, 3% KDIGO 2, 2% KDIGO 3): in the hub-university center AKI incidence was 17.3% (9.8% KDIGO 1, 4.9% KDIGO 2, 2.6% KDIGO 3), while in the spoke center was 6.6% (3.6% KDIGO 1, 1.9% KDIGO 2, 1.1% KDIGO 3). This discrepancy may be ascribed to the higher number of ICU beds in the hub center. Age ≥70 years was 44.5% in non-AKI group and 71% in AKI group with a prevalence of males (52.3%). In-hospital mortality was 3.56% in non-AKI group vs. 18.37% in AKI group (10.63% KDIGO 1, 20.13% KDIGO 2, 24.36% KDIGO 3). The OR for mortality was 3.77 in AKI vs. non-AKI (3.22-4.43); the OR for mortality was 2.57 in AKI stage 2-3 vs. stage 1 (2.02-3.28). Of note, AKI was a frequent finding also outside the ICU, in particular in medical wards (40.33% of all AKI episodes). After normalization for death, the re-hospitalization rate was more frequent in the AKI population (4.6% KDIGO 1, 2.1% KDIGO 2, 1.8% KDIGO 3). To date, 112 stage 2-3 AKI patients were enrolled in the SIN_AKI protocol with scheduled visits at 3 and 12 months.
Conclusions:
AKI is an underestimated disease, deeply associated with an increased risk of mortality and development of comorbidities especially in the frail and elderly population. In-hospital AKI patients should be followed in specific outpatient clinics in order to limit progression toward CKD.

11

Temporal Trends in Acute Kidney Injury in Hospitalizations from 2009 to 2018 in an Albertan Population

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[1]*University of Alberta, Edmonton, AB, Canada,* [2]*University of Calgary, Calgary, AB, Canada*

Importance: There are limited data on temporal trends in hospitalized acute kidney injury (AKI) rates using serum creatinine (SCr) based definitions.

Objective: To estimate trends in AKI rates using diagnostic codes and Kidney disease improving global outcomes (KDIGO) SCr based definitions, along with associated severity, attributable mortality, and demographic changes in the

hospitalized population over the study period.

Design, Setting, and Participants: This retrospective cohort study identified all adult patients admitted to hospital in Alberta, Canada from 2009 to 2018 using the Alberta Kidney Disease Network database.

Exposure/Measure: We identified people with AKI using validated KDIGO SCr based definitions and AKI diagnostic codes. Outcomes included in-hospital acute dialysis, in-hospital all-cause mortality, and 90-day post-discharge all-cause mortality. We used generalized linear models to estimate the unadjusted rates of AKI and in-hospital mortality by calendar year.

Results: Between January 2009 and December 2018, we identified 345,476 hospitalizations with an episode of AKI (12.9%). Unadjusted AKI rates as defined by KDIGO criteria increased from 117.0/1000 hospitalizations to 135.9/1000 hospitalizations ($p < 0.01$). While most patient populations demonstrated an increase in AKI rates using both KDIGO SCr based definitions and AKI diagnostic codes, patients with AKI >80 years showed a decrease in unadjusted rates of AKI (252.3 to 227.7/1000 hospitalizations, rate difference 9.9 [95% CI 9.4-11.4]). Stage 1 AKI was most frequent (unadjusted rates ranged from 84.0 to 98.7/1000 hospitalizations, rate difference 16.7 [95% CI 15.5-18]). There was an overall decrease in in-hospital mortality across all stages of AKI with the greatest decrease noted in stage 3 AKI (unadjusted rate decrease -80.2/1000 hospitalizations [95% CI 94.4,-66.1]). Similar trends were identified in 90-day mortality.

Conclusion: Our findings demonstrate that higher AKI rates in hospitalized patients are largely driven by mild forms of AKI. Despite this increase, there is an overall decrease in mortality, even in the most severe forms of AKI. Further studies are required to examine the significant decrease in mortality in the most severe forms of AKI.

12

Long-term Outcomes of Patients with Severe Acute Kidney Injury in an Intensive Care Unit of a Low-middle Income Country

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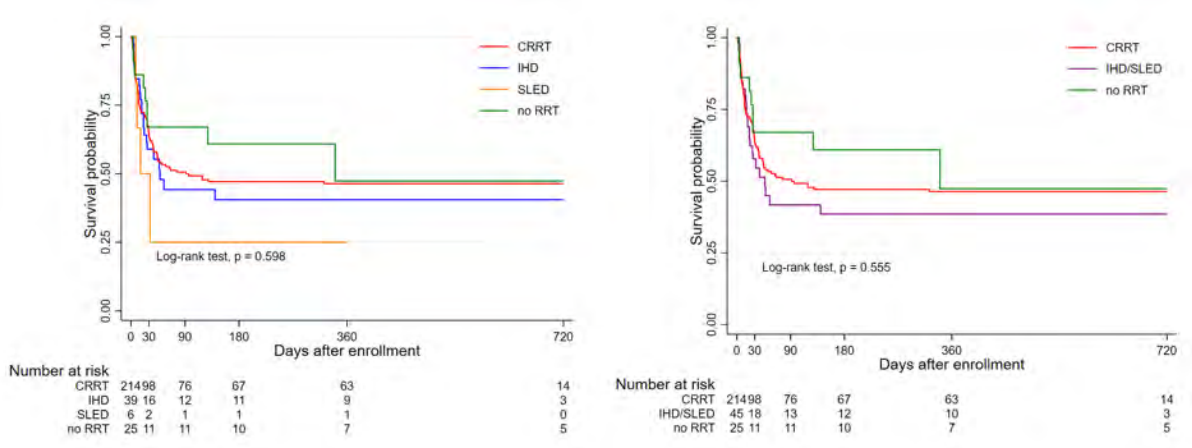
Introduction:
Severe acute kidney injury (AKI) is associated with substantial short-term and long-term mortality. While extensively described in developed countries, the long-term outcomes of severe AKI, particular AKI required renal replacement therapy (RRT), have not been well reported in resource-limited countries. The aim of this study was to evaluate the 2-year outcomes of severe AKI and the impacts of RRT modalities on mortality in a low-middle income country.
Methods:
This was a prospective observational study conducted in two intensive care units of a tertiary hospital from July 2019 to September 2021 in Viet Nam. All adult patients who were diagnosed with severe AKI according to KDIGO criteria and required intensive care unit (ICU) admission were enrolled and monitored until discharge, then followed up every 3 months within 2-year period. We performed multivariate Cox regression analysis to identify the independent factors associated with mortality. The Kaplan-Meier method was used to estimate the overall survival probability, stratified by modalities of RRT.
Results:
A total of 308 patients were included, 61% of the patients were male. 148 patients (48%) were lost to follow up at 2-year. 281 patients (91.2%) were treated with RRT, and 81/281 patients (28.8%) were switched from initial mode to another

mode of RRT. ICU and hospital length of stays were shorter in CRRT group (11 days and 20 days, respectively) compared to those in IHD (21 days and 29 days, respectively) (p=0.002). The mortality rates at hospital discharge and at 2-year were 34% and 85%, respectively. There were no significant differences in the 2-year mortality amongst the patients initially treated with CRRT, IHD or SLED (p=0,59). Surgery as a cause of ICU admission [HR 1.93 (1.25, 2.99), p=0.003], septic AKI [HR 1.97 (1.16,3.35), p=0.01], total bilirubin [HR 1.04 (1.01, 1.06), p=0.007] and vasopressor treatment in 28 days [2.77 (1.4, 5.46), p=0.003] were independently associated with increased 2-year mortality while obesity [HR 0.65 (0.43, 0.97), p=0.03] was associated with deceased mortality.
Conclusions:
Our study demonstrates that severe AKI in the ICU is associated with much worse 2-year mortality. While surgery, septic AKI, total bilirubin and vasopressor requirement were independent factors of death, obesity was associated with better survival and initial modalities of RRT did not change patients' survival.



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CRRT in Heart Arrhythmias Triggered by Hyperthermia After Cardiac Surgery

Alfred Ibrahimi[1], Saimir Kuci[1], Ermal Likaj[2], Selman Dumani[2], Altin Veshti[2], Andi Kacani[2], Marsela Goga[1], Ervin Bejko[1], Stavri Llazo[1], Arben Baboci[2]

[2]*Department of anesthesia and intensive care,* [2]*Cardiac Sugery Deparment*

Hyperthermia commonly accompanies cardiac surgery after cardiopulmonary bypass(CPB), due to a systemic inflammatory response (SIRS) and is associated with an increase in oxygen consumption, and sometimes with hemodynamic instability. We will present 5 cases of severe hyperthermia (>/=39.5 degrees C) that triggered severe life-threatening ventricular and supraventricular arrhythmias refractory to antiarrhythmic drugs. 5 cases were series aged 69.1±9.9 years operated under emergency conditions, one with interventricular defect post myocardial infarction, 2 with dysfunction of the mitral valve prosthesis, and the last one with acute myocardial infarction. The mean (CPB) was 135±17 min, ejection fraction was (EF<35%). Hemodynamic was maintained with the support of Intra Aortic Balloon and vasoactive drugs. On the second postoperative day, they developed high temperatures triggered in two cases of refractory ventricular tachycardia, third one-ventricular fibrillation, and 2 other cases with atrial fibrillation (AF) with a heart rate (HR) of 170 -200 min. The arrhythmia was treated with lidocaine, amiodarone, b blocker, but was refractory to therapy. The patients were shocked multiple times (16±4). The clinical situation deteriorated in cardiogenic and hyperkinetic shock. We failed to decrease the temperature with physical maneuvers and antipyretics drugs and decided to start CRRT. Initially, we used high-volume hemofiltration >45 ml/kg/hour and after the temperature was normalized continued with

35ml/kg/ hour. Immediately after initiation of CRRT, no one of the patients was electrically shocked for life-threatening arrhythmias. HR was normalized. The mean CRRT time was 48±6 hours. Four of the patients survived, and one died after 30 days. In conclusion, we strongly suggest early initiation of CRRT in refractory hyperthermic conditions accompanied by hemodynamic and cardiac rhythm instability after heart surgery with CPB.

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Renal Recovery Prediction of Acute Kidney Injury Requiring Dialysis in Critically Ill Adults by Artificial Intelligence Approach

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Purpose of the study:
Renal recovery after dialysis-requiring acute kidney injury (AKI-D) is a vital patient-centered and clinical outcome in critical care. However, a good model for AKI-D recovery is lacking. Therefore, we aimed to develop and validate models for predicting AKI-D recovery with predictors collected within 3 days after dialysis initiation by employing machine learning models.

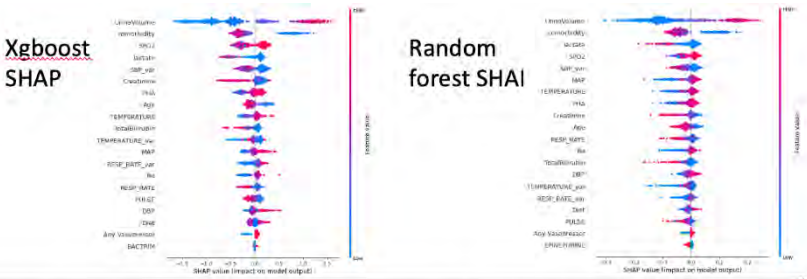
Methods:
In this retrospective cohort study in an academic medical center in Taiwan between January 2015 and December 2020, 1,389 patients experiencing AKI-D during ICU stays were enrolled. The cohort was partitioned into training (2015-2019) and temporal testing (throughout 2020) subsets. We developed and validated several models (eXtreme Gradient Boosting [XGBoost], random forest, logistic regression, and neural network) for predicting kidney recovery from dialysis (patients survived for more than 30 days after discontinuing dialysis before hospital discharge). The dataset included 79 routinely collected candidate variables known on or before the first 3 days of dialysis. In addition, we computed the predictor importance to the models.

Results:
We identified 1,138 eligible patients in the training cohort and 251 patients in the temporal testing dataset. Renal recovery at discharge was developed in 32.9% (n = 374/1138) and 29.5% (n = 74/251) of patients in the training and testing cohorts, respectively. Among the different algorithms, the random forest had the highest area under the receiver operating characteristic (AUROC) curve on the training and validation dataset (AUROC: 0.82). Features of urine volume, comorbidity, lactate value, and saturation of peripheral oxygen were vital drivers of the model's prediction. The performance of the models on the training and testing cohorts was indistinguishable. The calibration plot of the model showed excellent consistency between the prediction probability and the actual probability.

Conclusions:
We successfully applied early prediction models of renal recovery in ICU patients with AKI-D using data routinely obtained within three days after dialysis initiation. These findings may assist critical care physicians in prognostic stratification and resource allocation soon after patients survive the acute stage. External validation of this machine learning approach is required in future studies.

Figure on following page

Figure. Performance of the models and Top 20 predictors of renal recovery and their ranking of importance



	Classifier	Sens	Spec	Brier-Score	Accuracy	Percision_1	Percision_0	F score (2:1)	AUROC
Validation (2015-2019)	Xgboost	0.638±0.09	0.791±0.05	0.251±0.04	0.749±0.04	0.550±0.11	0.848±0.02	0.615±0.09	0.809±0.04
	RF	0.426±0.13	0.920±0.03	0.219±0.02	0.781±0.02	0.678±0.12	0.803±0.03	0.457±0.13	0.821±0.05
	LR	0.677±0.06	0.759±0.06	0.264±0.05	0.736±0.05	0.531±0.11	0.855±0.02	0.639±0.07	0.804±0.04
	NN	0.630±0.15	0.768±0.08	0.268±0.04	0.732±0.04	0.526±0.09	0.846±0.04	0.600±0.12	0.785±0.05
Testing (2020)	Xgboost	0.722	0.791	0.226	0.774	0.539	0.894	0.676	0.859
	RF	0.504	0.949	0.163	0.837	0.770	0.850	0.541	0.857
	LR	0.752	0.781	0.226	0.774	0.538	0.903	0.697	0.848
	NN	0.594	0.901	0.177	0.823	0.669	0.868	0.608	0.858

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Acute Kidney Injury In Patients Treated With Immune Checkpoint Inhibitors : A Retrospective Real-World Study

Nurul Z Nordin[1], Pietro Vassallo[1], Nina Seylanova[1], Natasha Lewis[1], Abigail Hobill[1], Luke Martin[1], Kittisak Weerapolchai[1], Nisha Shaunak[1], Marlies Ostermann[1], Nuttha Lumlertgul[1]

[1]*Guy's and St Thomas' NHS Foundation Trust*

Objectives

Immune checkpoint inhibitors (ICPi) have advanced cancer treatment. However, data from the past decade has highlighted the risk of immune-related side effects and ICPi – associated acute kidney injury (AKI). The aim of this study was to compare the epidemiology of ICPi-associated AKI and AKI not directly related to ICPi's in patients receiving ICPi therapy.

Methods

This was a retrospective analysis of all cancer patients who received ICPi therapy between December 2011 and August 2020 in a tertiary cancer center in the UK. AKI was defined by the KDIGO criteria and ICPi-associated AKI (ICPi-AKI) was determined using the Gupta/Leaf classification. The primary outcome was overall mortality. Secondary outcomes were the incidence of ICPi-AKI and AKI due to other causes, risk factors, and kidney outcomes up to 1 year after AKI diagnosis.

Results

1,039 patients were analysed. (Figure 1) The median age was 58, 60% were male, and 22% had chronic kidney disease (CKD) at baseline. The cumulative incidence of any type of AKI was 13.2%, and ICPi-AKI was 3.1%. CKD was a risk factor for ICPi-AKI [hazard ratio (HR) 2.53; 95% confidence interval (CI) 1.27-5.04, p = 0.009]. (Figure 2) ICPi-AKI

patients had a lower chance of complete kidney recovery (53% vs 78%, p = 0.009). The prevalence of CKD at one year after ICPi-AKI and other types of AKI was 62% and 38%, respectively (p = 0.022). Early steroid prescription (< 7 days) in those receiving steroids was associated with complete AKI recovery (p = 0.006). Of 12 patients rechallenged with ICPi after AKI, 5 (41%) developed recurrent AKI. Interestingly, ICPi-AKI was associated with a reduced risk of mortality (adjusted HR 0.50, 95% CI 0.29-0.84, p = 0.009) compared with no-AKI.

Conclusion

In cancer patients treated with ICPi therapy, the risk of AKI was 13%. ICPi-AKI was less common but associated with a higher risk of CKD at 1 year than AKI from other causes. There was no difference in mortality between both groups.

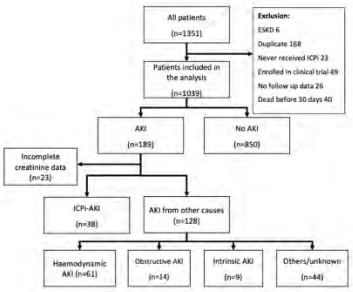

Figure 1 : Flow chart of patient inclusion and exclusion

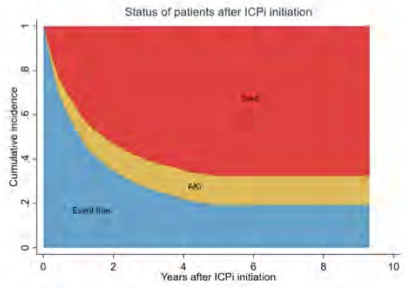

Figure 2 Cumulative acute kidney injury incidence after ICPi initiation accounted for competing risk of death

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A Comparison of Mortality Between Standard versus Low-Dose Continuous Kidney Replacement Therapy in Critically Ill Patients with Acute Kidney Injury

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Purpose of the study
Continuous kidney replacement therapy (CKRT) is an important intervention for acute kidney injury (AKI) patients in the intensive care unit (ICU). KDIGO guideline recommends 20–25 mL/kg/hr of delivered effluent dose (standard dose), and this recommendation is based on the evidence comparing standard and high-dose in several clinical trials. There is, however, no evidence of the effect of delivered effluent dose below standard dose. The purpose of this study is to assess a comparison of mortality between standard and low-dose CKRT in AKI patients.

Methods
We consecutively evaluated 603 patients who required CKRT in the medical and surgical ICU at Nara Medical University Hospital between 1/1/2012 and 12/31/2021. We excluded patients who were with end-stage kidney disease, died within 24 hours after ICU admission, underwent CKRT for extra-renal indication, and were on CKRT for more than 28 days. We stratified patients into 2 groups according to the median of the actual delivered effluent dose and compared survival using the Kaplan-Meier method with or without a propensity score matching. The primary outcome was all-cause mortality within 28 days after CKRT initiation.

Results
Of the 603 patients who were assessed for eligibility, 494 patients were included in this study. The median of the actual delivered effluent dose was 13.19 mL/kg/hr, and the patients were divided into 2 groups (247 patients with greater than 13.19 mL/kg/hr (standard-dose group) and 247 patients with less than 13.19 mL/kg/hr (low-dose group)). Figure 1a showed the Kaplan-Meier survival curves which presented no statistically significant difference in crude survival between the groups within 28 days after CKRT initiation (Log-rank P = 0.620). After propensity score matching, 182 patients (91 each for the groups) were selected. Figure 1b showed the Kaplan-Meier survival curves of the propensity score-matched cohort which revealed better survival of the standard-dose group compared to the low-dose group within 28 days after CKRT initiation (Log-rank P = 0.005). The hazard ratio for mortality in the standard-dose group was 0.504 [95% confidence interval 0.309–0.822, P = 0.006] in the propensity score-matched cohort.

Conclusion
In this study of AKI patients who required CKRT, the standard-dose group had better 28-day survival compared with the low-dose group in the propensity score-matched cohort.

Figure 1a.

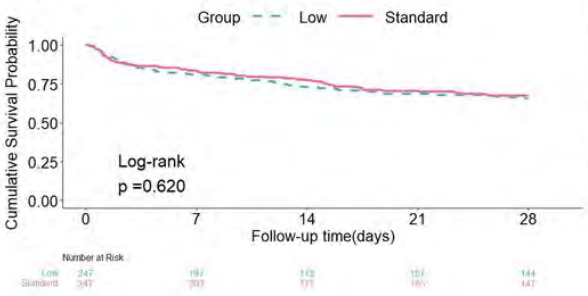
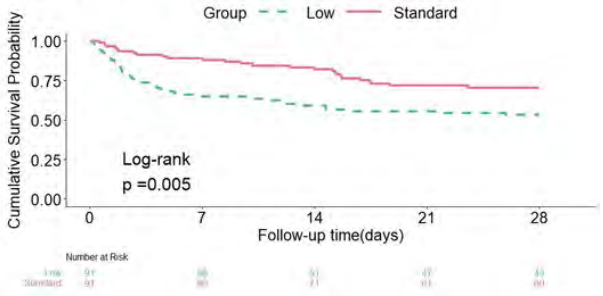


Figure 1b.



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Long-Term Prevalence of Chronic Kidney Disease following Pediatric Orthotopic Liver Transplant

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Purpose: Orthotopic liver transplant (OLT) recipients are at risk for chronic kidney disease (CKD) but data regarding long-term outcomes are scarce in pediatrics. We aimed to determine the long-term prevalence of CKD following pediatric OLT and secondarily assess risk factors associated with the development of CKD.

Methods: This is a retrospective cohort study conducted at Texas Children's Hospital between January 2011 and March 2018. CKD was defined as estimated glomerular filtration rate (eGFR) of <90 ml/min/1.73m2 at least 2 years post-OLT, using bedside Schwartz and CKiD whenever cystatin-C was available. We defined peri-operative AKI as creatinine >1.5x baseline from 3 days pre- to 7 days post-OLT.

Results: 232 subjects underwent OLT during the study period; 19 subjects were lost to follow-up, 19 died within 2 years, 1 received a combined liver-kidney transplant, leaving 193 subjects. The median age at OLT was 2.7 years (IQR 1.1-8.7 years). The most common primary diagnoses were biliary atresia (38%), genetic/metabolic conditions (27.5%), primary unresectable liver tumor (13%), and acute liver failure of indeterminate etiology (9.8%). Sixty-eight subjects (35%) developed peri-operative AKI, and 29 subjects (15%) required CRRT. The median time duration from OLT to follow-up was 4 years (IQR 2.9-5.1 years), with mean eGFR 126 ±39. Twenty-seven subjects (14%) had CKD. Among the 174 subjects with cystatin-c available at follow-up, the mean eGFR by combined equation was lower (90.1 ±23.4, p<0.0001), with more subjects reclassified as having CKD (16% vs 11% with creatinine alone, McNemar X2 = 0.0003). Peri-operative AKI was a significant predictor of future CKD (OR 2.6 (CI 1.13-5.9) though CRRT was not (OR 1.7 (CI 0.6-4.8). Older age at transplant was a significant risk factor for CKD (OR 1.008 (CI 1.004-1.01) p=0.004), and primary diagnosis of biliary atresia was associated with lower prevalence of CKD (OR 0.32 CI 0.12-0.95). Multivariable logistic regression revealed that only AKI was an independent predictor of CKD (OR 2.9 CI 1.21-7.01).

Conclusions: In this large study of pediatric OLT patients, we report a high prevalence of long-term CKD, with peri-operative AKI emerging as the most important determinant for the development of CKD. The use of cystatin-C led to a higher proportion of patients reclassified as having CKD, suggesting that cystatin-C, in addition to creatinine, is needed to accurately assess kidney function in these patients.

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Characteristics And Outcomes Of Critically Ill Patients With Severe Acute Kidney Injury And Liver Dysfunction: Results From InSEA-RRT Study

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Introduction Acute kidney injury (AKI) can occur in patients with acute or chronic liver diseases. Meanwhile, AKI can aggravate hepatic dysfunction and both entities can complicate critically ill patients with systemic diseases. We aimed to evaluate short-term and long-term outcomes in critically ill patients with concomitant severe AKI and liver dysfunction. Methods This was a secondary analysis from the InSEA RRT registry-a prospective cohort study. We included critically

ill patients with stage 3 AKI as defined by Kidney Disease: Improving Global Outcomes (KDIGO) and liver dysfunction at King Chulalongkorn Memorial Hospital. Liver dysfunction by primary liver disease included acute liver failure (ALF), acute-on-chronic liver failure (ACLF) and acute decompensated cirrhosis (AD). Secondary liver injury was defined as an acquired liver injury without underlying liver disease. The primary outcome was 28-day mortality. Secondary outcomes were MAKE365, a composite outcome of persistent kidney dysfunction, long-term dialysis, and all-cause mortality at day 365.
Results A total of 243 patients were included in the analysis. The mean age was 61 years (±18); 61% were male and 30% had baseline chronic kidney disease (CKD). Fifty-nine (22%) patients had primary liver disease; ALF (5.1%), ACLF (40.7%) and AD (54%), whereas 184 (75%) patients had secondary liver injury. Renal replacement therapy (RRT) was initiated in 209 (86%) patients. At 28 days, 147 (61%) patients died and 58 (60.4%) of survivors remained on dialysis. Multivariable analysis showed hepatic encephalopathy, RRT, low serum albumin, and low baseline serum creatinine to be associated with 28-day mortality. Extracorporeal liver support was performed in 13 (5%) patients, and only 3 patients received liver transplant. Cause of liver dysfunction was not associated with an increased risk of death (OR 0.74; 95%CI 0.36-1.52; p=0.412). In patients who receive continuous renal replacement therapy (n=186), non-survivors were likely to have a lower therapy time and receive no-anticoagulants than survivors. At 1 year, 208 (85.6%) developed MAKE365, comprising death (96.7%), RRT (0.5%), and doubling of serum creatinine (1.9%).
Conclusion Patients with concomitant AKI and liver dysfunction have poor kidney outcomes and high mortality within 1 year. In resource-limited settings, further studies are needed to determine optimal RRT-related factors to improve outcomes in this high-risk group of patients.

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Nonrenal Functional Outcomes in Pediatric Continuous Renal Replacement Therapy (CRRT)

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Purpose: Continuous renal replacement therapy (CRRT) is routinely used in the pediatric intensive care unit (PICU) for critically ill children with acute kidney injury (AKI). Reported outcomes of these patients are limited to mortality with risk factors of greater fluid overload (FO), multiple organ dysfunction, underlying disease, and younger age but data on other long-term morbidity and health related quality of life metrics are scarce. We have previously shown in a single center study worsening functional status and new morbidities at PICU and hospital discharge in CRRT patients. The Worldwide Exploration of Renal Replacement Outcomes Collaborative in Kidney Disease (WE-ROCK) is an international 32 center collaborative investigating outcomes of pediatric patients receiving CRRT. We aimed to validate our preliminary findings by evaluating functional outcomes of patients enrolled in this collaborative.
Methods: WE-ROCK collaborative includes patients age 0-25 who received CRRT for AKI or FO. 15 centers participated in Functional Status Scale (FSS) data collection between 2013-2021. Functional status was quantified using FSS at admission and hospital discharge in survivors. An increase in FSS by three or more defined new morbidity.
Results: Of 517 patients, there were 330 survivors. 180 of these survivors (52% male) with median age 9.8 years (IQR 2.8,15.0) had complete data for analysis. Premorbid FSS was 6 (IQR 6,6). 81% received mechanical ventilation, Pediatric Logistic Organ Dysfunction (PELOD) score at CRRT start was 5 (IQR 4,8). Discharge FSS was 8 (IQR 6,10). At hospital discharge, 50% of patients had worsening FSS with an increase in FSS by one or more points. 41(23%) patients acquired a new morbidity with a median FSS of 10 (IQR 10,12). Patients with new morbidity had higher incidence of sepsis on admission (63% vs 37% p=0.006), higher percent fluid overload at CRRT initiation (15.4 [IQR 6.4, 26.3] vs 7.1[IQR 2.4, 14.1] p = 0.001), and more CRRT days (9 [IQR 4,16] vs 5 [IQR 3,11] p = 0.049).
Conclusions: Despite good functional baseline, new morbidities are common at discharge in pediatric CRRT patients, confirming our preliminary findings that they are at risk for poor functional outcomes and might benefit from targeted follow up. We plan to examine functional status post hospital discharge to determine post-ICU morbidity trajectory in these patients.

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Temporal Relationship Between Acute Respiratory Distress Syndrome and the Development of Acute Kidney Injury – Systematic Review and Meta-Analysis

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Background: Acute kidney injury (AKI) affects above 45% of acute respiratory distress syndrome (ARDS) patients and is associated with adverse outcomes. Still, the literature on the spatiotemporal relationship between AKI and ARDS is limited. It remains unclear which one develops first or if the timing of developing AKI affects the patient outcomes. Knowing the temporal relationship between AKI and ARDS could lead to a better understanding of pathogenesis and is essential for identifying treatment options, better management, and prognostication in critically ill patients. This systematic review aims to assess the incidence, timing, and mortality of patients who developed AKI after diagnosis of ARDS.
Method: A literature review was conducted in six databases through June 2022. We included retrospective and prospective cohort studies that reported the development of AKI after ARDS. We excluded studies that did not clarify the timing of developing AKI related to ARDS onset time or only reported AKI before ARDS. The primary outcome was AKI incidence after ARDS, and the secondary outcome was AKI mortality.
Results: Out of 3,208 studies identified and screened, 15 studies with 9,337 ARDS patients met all eligibility criteria and were included in the data analysis. AKI developed in 3,698 (40%) patients after diagnosis of ARDS. The median time of developing AKI after ARDS was 2 days (IQR 1-5). Pooled Hazard Ratios (HRs) of mortality among ARDS patients who developed AKI was 1.86 (95%CI: 1.68 -2.07; 9 studies, I2 =50%). Mortality was high in all stages of AKI, with the highest in stage 2-3 AKI (HR: 2.08 95%CI: 1.47-2.55; 3 studies, I2 =42%) followed by stage 1 AKI (HR: 1.52 95%CI: 1.05 -2.21; 2 studies, I2 =26%). Data from only two studies allowed us to compare the mortality of AKI patients before and after developing ARDS. However, it did not show any significant difference, with OR 0.94 (95%CI: 0.68 -1.31; 2 studies, I2 =0%).
Conclusion: Our systematic review demonstrated that AKI frequently develops 2-3 days after ARDS. Development of AKI after ARDS is associated with increased mortality directly related to the AKI severity. We identified a significant knowledge gap in the literature regarding the spatiotemporal relationship between AKI and ARDS. More studies are required to address these gaps as understanding underlying risk factors and Lung-Kidney ‘cross-talk’ is essential to improving outcomes in these patients.

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Acute Kidney Injury after Lung Transplantation, outcomes of a multidisciplinary approach in a Single center in México.

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Introduction: Lung transplant (LT) is a young procedure, with a successful evolution and increasing of benefited patients. Few centers around the globe have a lung transplant program. The possible complications are many, most common associated to surgical moment, even thought, the post-surgical recovery is always the possibility to develop AKI. 20 to 90% of patients with LT could develop AKI and 15% need RRT. This complicate hospital evolution, time in ICU, risk of infections and increase mortality. One of the most worrying situation is the no renal recovery.

Material and Methods: Retrospective and Descriptive study. All patients 18y who performed a LT in Christus Muguerza Hospitals from January 2017 to August 2022. Excel and SPSS V21 were used. The confidentiality agreement for handling patient data is respected as the Helsinki declaration.
Results: 29 patients had LT, 68% were men, the average age is 54 years (Min 27- Max 67), average BMI 23kg/m2. Idiopathic pulmonary fibrosis was the most common diagnosis (58.6%) follow by COVID-19 (14%), 21 patients receive bi-pulmonary transplant. The survival rate is 62% at discharge. 11 patients developed AKI with the need of RRT (38%), all of them in CRRT as initial therapy only 2 need to migrate to HD transitory but both of them were discharge without RRT. The most common cause to initiate RRT was anuria follow by fluid overload. 4 patients with RRT dead few days after transplant, the other 7, where discharge with a complete renal recovery after RRT and with creatinine less than 1 mg/dl. 34% patients were in ECMO and 60% from these need CRRT. In the multivariate analysis of 30 days mortality of the selected variants according to the transplant team there was not a significant value of non of them, but there is a possible tendency that the CRRT is a protector factor of dead.
Discussion and Conclusion:
The kidney function is essential for the decision to go forward to LT, some patients develop AKI before surgical time, these should be evaluated from the crosstalk organ view, remembering that a high possibility of renal recovery exist if the lung recovery is successful. Our cohort demonstrate, not only this fact, besides that if the nephrology intervention is in time and a good communication and team work is carried out the patient can have renal recovery. The tendency of protector factor of dead could be related with less fluid overload and a better metabolic equilibrium in the first hours of the AKI.

KRT Type	Initial Modality	Filter	Days in KRT	Initial Dose	KRT Indication	Initial Creatinine	Final outcome
CKRT	HDFVVC	Oxiris	41	25 ml/kg/hr	Anuria, Fluid Overload	1.5	Live
CKRT	HDFVVC SCUF	Oxiris	13	28 ml/kg/hr	Uremia, Fluid overload	3	Live
CKRT	HDFVVC	Oxiris	8	30 ml/kg/hr	Oliguria Fluid overload Hiperkalemia	3.74	Live
CKRT	HDFVVC	ST-150	2	30 ml/kg/hr	AKI KDIGO 3/MAT/Sepsis	1.6	Dead
CKRT	HDFVVC	Oxiris	18	30 ml/kg/hr	AKI KDIGO 3/ Sepsis	1.8	Dead
CKRT	HDFVVC HDVVC	Oxiris	56	26 ml/kg/hr	Fluid Overload Metabolic Acidosis	2.72	Live
CKRT	HDFVVC HVVC SCUF	Oxiris	85	25 ml/kg/hr	Fluid Overload Oliguria	3.6	Live
CKRT	HDFVVC	Oxiris	5	30 ml/kg/hr	Fluid Overload Metabolic Acidosis	2.6	Live
CKRT	HDFVVC	ST-150	5	31 ml/kg/hr	Anuria, Uremia, Hiperkalemia	3.3	Live

	Dead		
Variable	Sí	No	P
Age	60 (53-63)	54 (46-62)	0.195
CRRT	4 (23.5%)	7 (58.3%)	0.065
TI right	319 (243-390)	306 (218-355)	0.467
TI left	308 (252-342)	334 (251-412)	0.605
Bleeding	4000 (1062-5000)	2850 (100-4912)	0.325

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The effects of muscle mass and quality on mortality of patients with Acute Kidney Injury requiring Continuous Renal Replacement Therapy

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Background: Sarcopenia which can lead to decline in physical ability has been known as risk factor on mortality and morbidity. However, little studies have found the effects of muscle mass on mortality of patients with Acute Kidney Injury (AKI) requiring Continuous Renal Replacement Therapy (CRRT).
Methods: We collected 2,221 AKI patients who received CRRT in 8 medical centers between 2006 and 2021. The skeletal muscle areas (SMA) with a threshold of −29 to 150 Hounsfield units from CT images at the level of the 3rd lumbar vertebra was obtained through automated software. SMA was further categorized in normal attenuation muscle area (NAMA) and low attenuation muscle area (LAMA) to assess the density of muscle. We used Cox proportional hazard model to investigate the association between mortality within 1, 3, and 30 days and skeletal muscle index (SMA, NAMA, and LAMA). In addition, stratified analyses were conducted by sex, age, the acute physiology and chronic health evaluation (APACHE II) score, and the sequential organ failure assessment (SOFA) score to assess the susceptible subgroups.
Results: More than half of the patients (60%) were male and the mean age of patient was 66.01 years. The 30-day mortality rate was 52% (n=1,155). An IQR increase of SMA (38.2cm2) was associated with decreased mortality risk (Hazard ratio [HR]: 0.79, 95% confidence interval [CI]: 0.65–0.97). In subgroup analyses on muscle quality, we identified the 24% decreased risk of LAMA on mortality (HR: 0.76, 95% CI 0.65–0.90) while non-significant effects were found in NAMA (HR:1.05, 95% CI: 0.85–1.29). Stronger protective effects of muscle mass index on mortality were found in male, those who aged over 65 years, and high score group of APACHE II.
Conclusion: We found the protective effects of muscle mass on mortality of AKI patients requiring CRRT. In addition, even if the density was low, the effect of muscle mass itself was significant determinant factors on lowering mortality.

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Diagnostic and Prognostic Roles of CRP, Procalcitonin and Presepsin in Patients Initiating CRRT.

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For high mortality rate of severe AKI patients initiating Continuous renal replacement therapy (CRRT), diagnosing and predicting prognosis is very essential. However, with reduced renal function, biomarker to diagnose and predict prognosis were not fully understood. This study is about CRRT initiating patients diagnosing sepsis and predicting prognosis. The study was a single center, retrospective study of patients initiating CRRT, which measured C-reactive protein (CRP), presepsin, and procalcitonin in the blood. Sepsis and non-sepsis groups were divided according to SEPSIS-3 criteria. Total of 127 patients and 90 patients were sepsis while 37 patients were non-sepsis. A 30-day survival analysis and Cox regression were performed to determine the association between biomarkers and survival. In the patients initiating CRRT, CRP and procalcitonin were superior diagnosing sepsis to presepsin. Presepsin was closely related to the eGFR (r=-0.251, p=0.004). The biomarkers (CRP, procalcitonin, and presepsin) were evaluated for prognostic marker in the patients

initiating CRRT with sepsis. Procalcitonin over 3ng/mL is associated higher all-cause mortality by drawing Kaplan-Meier curve. (log-rank test p=0.017). In addition, procalcitonin over 3ng/mL also associated with higher mortality according to univariate and multivariate cox proportional hazard model analysis. Higher Lactic acid, SOFA score and lower albumin, eGFR has prognostic value to predict mortality in the patients initiating CRRT with sepsis. Among CRP, procalcitonin, and presepsin, procalcitonin is a significant factor in predicting the survival of patients initiating CRRT with sepsis acute kidney injury.

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Initial Emergency Room 6-hour Urine Volume is an Important Factor for the Survival of Critically Ill Patients Undergoing Continuous Renal Replacement Therapy

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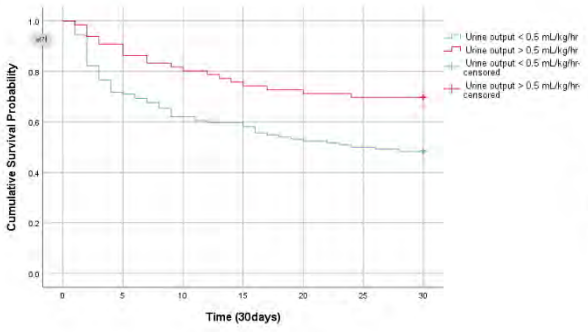
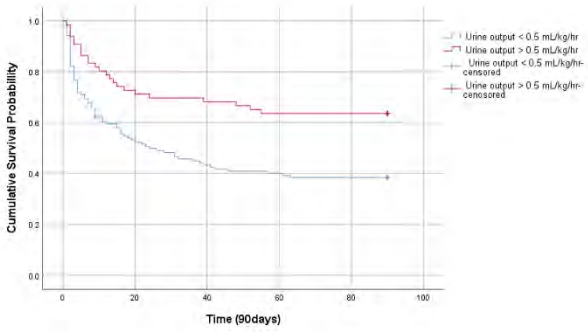
It has been little known whether initial emergency room (ER) factors affect survival or renal function in criti-cally ill patients undergoing CRRT. We examined whether initial factors in ER impact survival and renal recov-ery in critically ill patients undergoing CRRT. The study was a single-center, retrospective study of 332 patients for critically ill patients admitted to ICUs for CRRT via ER from March 1, 2018 to May 31, 2021. Clinical pa-rameters including urine output, eGFR, and serum NGAL were identified. The primary outcomes were the 30-day and 90-day mortality. Secondary outcomes were the 30-, and 90-day dialysis-free duration. Low urine out-put (LUO, defined as < 0.5 mL/kg/hr x 6 hours) group was significantly associated with 30-day mortality and 90-day mortality. Multivariable Cox regression analysis showed that LUO group was significantly more associ-ated with the increased risk of 30-day mortality and 90-day mortality (hazard ratio, 1.935 and 2.141, respec-tively) compared to high urine output (HUO, defined as ≥ 0.5 mL/kg/hr x 6 hours) group. There was no sig-nificant association between 30-day or 90-day mortality and initial estimated glomerular filtration rate (eGFR) plasma neutrophil gelatinase-associated lipocalin (NGAL) levels. In critically ill patients undergoing CRRT, HUO group and initial eGFR ≥ 30 ml/min/1.73m2 groups was associated with decreased 30-, and 90-day dial-ysis-free duration. However, serum NGAL had no significant relation with 30-, and 90-days RRT free dura-tions. In conclusion, during admission to ER, the initial 6 hour urine volume is an important factor for 30-day and 90-day mortality.





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Community Acquired AKI: An Observational Cohort Study

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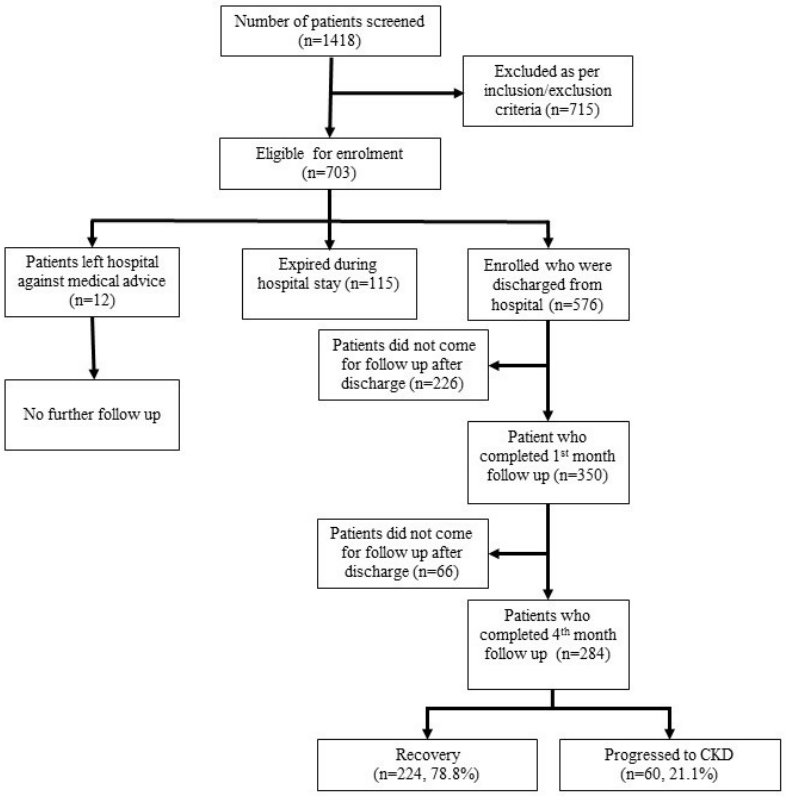
Introduction
The epidemiology of CA-AKI in developing regions is different as AKI secondary to infections, poisoning, toxic envenomations and pregnancy related complications are common. Kidney biopsy is seldom performed in these patients unless atypical clinical features are present. We have established a prospective cohort of patients with CA-AKI at the Postgraduate Institute of Medical Education and Research, Chandigarh in India.
Methods
The study is a single centre, prospective, observational cohort study of patients with CA-AKI. Patients aged >12 years and with a diagnosis of CA-AKI are eligible for enrolment. Patients with underlying CKD, urinary tract obstruction, COVID 19, malignancy or heart failure are excluded. Follow up visits are scheduled at 1 and 4 months after discharge. Renal recovery is defined as estimated GFR ≥60 ml/min/1.73m2 at >3 months after hospital discharge. Kidney biopsies are done only in those patients who have atypical clinical course or features (e.g. persistent kidney dysfunction despite other clinical improvement, strong clinical suspicion of dominant glomerular involvement or interstitial nephritis etc.). We present the observations that were recorded in study cohort till date.
Result: Till now, 703 patients have been included in the cohort. The leading causes of CA-AKI are sepsis (52%), obstetric complications (14%), envenomation (8%), nephrotoxic drugs (6%) and poisons (3%). 16% patients had died during index hospitalization. At ≥3 months after CA-AKI, 21.1% of patients with available follow up had not recovered completely with persistent eGFR <60 ml/min/1.73m2 (figure 1).
44 patients had undergone kidney biopsy in this cohort. Incomplete recovery, and clinical or diagnostic dilemmas were indications for doing kidney biopsy. Acute interstitial nephritis, acute tubular necrosis and acute cortical necrosis were most common histologic diagnoses (table 1). Combinations of various histologic features were not uncommon. Pigment casts were recorded in 13 patients. 4 patients had acute cortical necrosis, 2 being after post-partum AKI and one each due to acute gastroenteritis and unknown animal bite. Glomerular involvement were recorded in 8 patients (table 1).
Conclusions
Adverse outcomes (mortality or progression to CKD) are common after CA-AKI. Acute interstitial nephritis and acute tubular necrosis, alone or in combination with other findings, were the most common histologic diagnoses in indication kidney biopsies.

Table and Figure on following page

S.No	Diagnosis	Patients (n=44)
1	Acute interstitial necrosis	11
2	AIN with pigment casts	3
3	AIN with thrombotic microangiopathies	2
4	AIN with pigment casts and TMA	1
5	AIN with IRGN	1
6	Acute tubular necrosis with pigments casts	8
7	ATN	5
8	ATN with IRGN	1
9	ATN with podocytopathy	1
10	ATN with pigment casts and podocytopathy	1
11	Acute cortical necrosis	4
12	IRGN	1
13	Pauci-immune crescentic glomerulonephritis	1
14	TMA	1
15	Anti-glomerular basement membrane	1
16	Focal segmental glomerulosclerosis	1
17	Acute pyelonephritis	1

Figure 1: Study consort flowchart



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Impact of Fluid Overload on Patients Receiving Continuous Dialysis for Acute Kidney Injury

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Title Impact of Fluid Overload on Patients Receiving Continuous Dialysis for Acute Kidney Injury
Background Growing observational literature in the study of severe acute kidney injury (AKI) supports the association of fluid overload at the time of dialysis initiation with morbidity and mortality. These observations support the view that there is a survival benefit associated with fluid removal with dialysis. However, this view has not been fully explored in the available literature.
Methods We conducted a single-center retrospective cohort study among adult patients admitted to the intensive care unit (ICU) at University of Chicago Medical Center with AKI treated with continuous veno-venous hemodialysis (CVVHD) from April 1, 2016 to March 31, 2020. We collected information regarding demographics, daily fluid balances 72 hours prior to and 7 days subsequent to CVVHD initiation, and ICU outcomes. Cumulative fluid balance in liters (L) was calculated as a percentage of ICU admission weight in kilograms:
[(fluid balance (L in – L out)/weight (kg) at hospital admission] x 100
Positive volume balance was defined as cumulative fluid balance in excess of +5% ICU admission weight within 7 days. Negative volume balance was defined as cumulative fluid balance in excess of -5% ICU admission weight within 7 days.
Results We identified a total of 1,242 patients treated with CVVHD for AKI. Of these, 24% (305) were in negative volume balance, 46% (566) were in neutral volume balance, and 30% (371) were in positive volume balance at 7 days after CVVHD started. Baseline characteristics were compared across volume balance groups with significant differences across groups on the basis of sex, co-morbid CAD and CHF, and vasoactive use at the time of ICU admission. There was a graded association between volume balance and mortality with a near linear increase in mortality at every 5% increase in volume balance (Figure). The relationship between negative volume balance and mortality was significant in an adjusted Cox proportional hazards model compared to neutral balance (HR 0.51, 95% CI 0.36-0.71) while positive fluid balance (compared to neutral) was associated with increased mortality in the same adjusted model (HR 1.31, 95% CI 1.03-1.65).
Conclusions In a large single-center cohort of CRRT patients, we have found negative volume balance to be a significant and independent predictor of 90-day survival. Clinical trials to study ideal volume management targets are needed.

Table 1. Mortality by Seven Day Volume Balance

	< -10%	-10 to -5%	-5 to 0%	0 to 5%	5 to 10%	>10%	p-value
N	128	177	249	317	176	195	
7D Post Vol (L), med (IQR)	-12.36 (-14.84, -9.21)	-6.23 (-8.32, -5.22)	-1.90 (-3.39, -0.91)	1.79 (0.88, 3.07)	5.42 (4.36, 7.02)	12.38 (9.30, 18.41)	<0.001
90 Day Mortality	53 (41.4)	63 (35.6)	143 (57.4)	245 (77.3)	150 (85.2)	174 (89.2)	<0.001

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Fluid Correction Optimizes Interpretation of Serum Creatinine for Acute Kidney Injury Identification in Premature Neonates: Secondary Analysis of the PENUT Trial

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Background: Acute kidney injury (AKI) and disordered fluid balance (FB) are common in premature neonates. A positive FB dilutes and a negative FB concentrates serum creatinine (SCr) which may complicate AKI diagnosis. Correcting SCr for FB may improve AKI diagnosis by increasing the diagnostic accuracy of SCr.

Methods: Secondary analysis of Preterm Erythropoietin Neuroprotection Trial (PENUT), a Phase III randomized trial of erythropoietin in premature neonates (<28 weeks) in 30 United States NICUs from 2013–6. Exposure: fluid corrected AKI (FC-AKI) during the first 14 postnatal days, calculated using Fluid Corrected-SCr (FC-SCr, defined as measured SCr multiplied by FB divided by total body water). FB was calculated as percent change from birthweight. Outcome: Death, hospital length of stay, and respiratory outcomes.

Results: 923 premature neonates were included in this study. Correcting for FB significantly changed the shape and directionality of SCr curves during the first two postnatal weeks ($p<0.0001$) (Figure A).

215 neonates (23.3%) were diagnosed with AKI using uncorrected SCr. After SCr correction for FB, FC-AKI was diagnosed in 313 neonates (33.9%). After correction for FB, 202 with AKI and 597 without AKI remained unchanged. Thirteen neonates with AKI were reclassified as not having FC-AKI ("Over-Recognized AKI") and 111 previously without AKI reclassified as having FC-AKI ("Under-Recognized" AKI). Neonates with Under-Recognized AKI were similar in demographic and clinical characters to those with AKI (Figure B).

Compared to those without AKI, neonates with Under-Recognized AKI were more likely to require ventilation on post-natal day 14 ($p<0.001$) and to have a longer hospital stay ($p<0.001$). On multivariable analysis correction for FB strengthened the association with clinical outcomes, including ventilation (aOR2.23, 95% CI 1.56-3.18) and severe bronchopulmonary dysplasia (aOR 2.05, 95% CI 1.15-3.64) (Table).

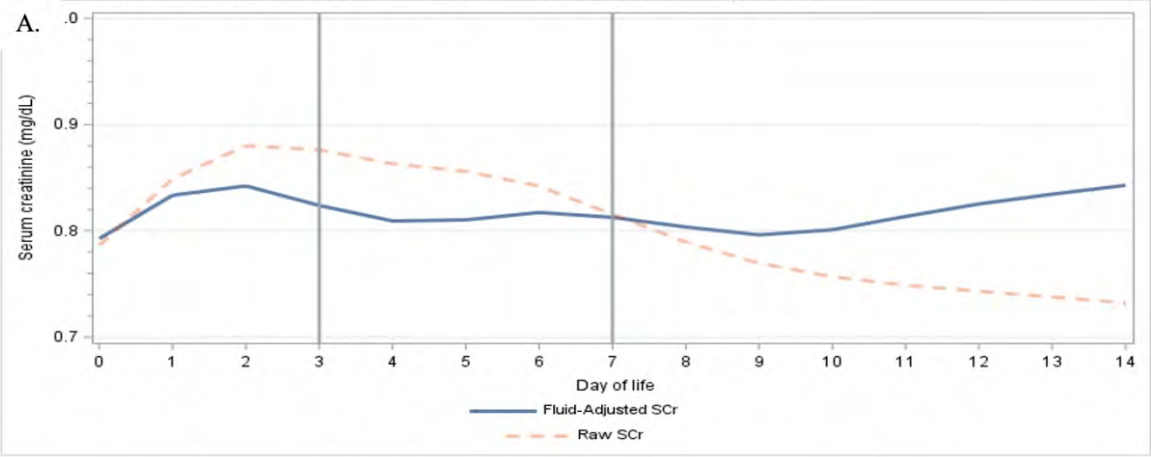
Conclusions: Fluid correction changed SCr curves and increased the number of premature neonates diagnosed with AKI. Neonates with Under-Recognized AKI had demographic and outcomes similar to those with AKI and were more likely to require ventilation and longer hospital stays than all other groups. Failing to correct SCr for FB underestimates the prevalence and impact of AKI in premature neonates. Future studies should consider adjusting AKI for FB to improve identification of neonates at high risk for poor outcomes.

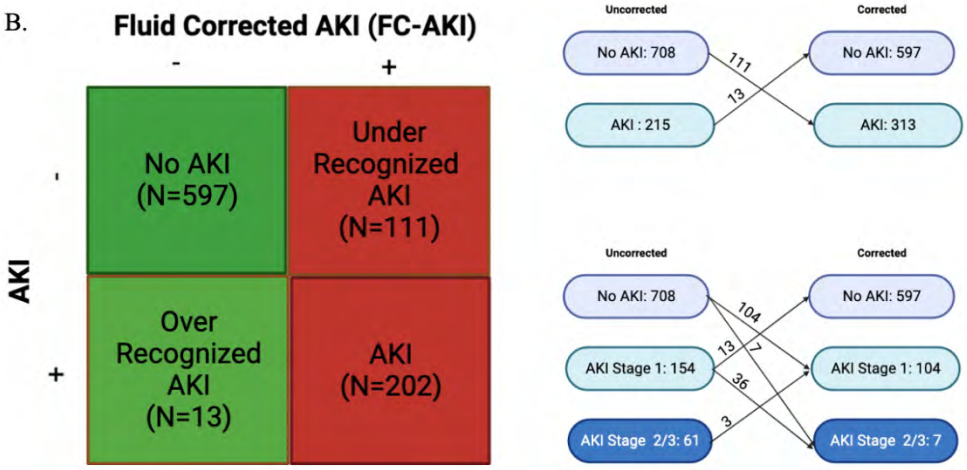
Figure on following page

Outcomes comparing AKI and FA-AKI

	AKI		FA-AKI	
	Crude Odds Ratio (95% CI)	Adjusted Odds[1] Ratio (95% CI)	Crude Odds Ratio (95% CI)	Adjusted Odds[1] Ratio (95% CI)
Mechanical Ventilation, DOL#14	2.90 (2.07-4.07)	1.75 (1.16-2.62)	3.25 (2.41-4.38)	2.23 (1.56-3.18)
Prolonged Hospital Stay[2]	1.44 (1.05-1.96)	1.01 (0.72-1.42)	1.56 (1.19-2.06)	1.19 (0.89-1.61)
Mortality	1.69 (1.07-2.67)	1.01 (0.59-1.71)	1.32 (0.86-2.04)	0.81 (0.49-1.34)
BPD[3]	1.27 (0.92-1.75)	0.90 (0.63-1.28)	1.22 (0.92-1.61)	0.92 (0.67-1.25)
Grade 3 BPD[3]	2.38 (1.31-4.32)	2.03 (1.08-3.80)	2.24 (1.30-3.88)	2.05 (1.15-3.64)

[1]GA, sex, SGA, 5-minute APGAR, intubation, epinephrine, chest compressions, necrotizing enteritis, sepsis and IVH.
[2] Hospital length of stay longer than median of 93 days
[3] BPD as defined as oxygen requirement on day 28 of age
[4] Grade 3 BPD as invasive mechanical ventilation at 36 weeks corrected gestational age





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Chronic Kidney Disease (CKD) Development Five Years Following Acute Kidney Injury (AKI) in Children

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Purpose: AKI survivors are at risk for CKD, but most studies assessing the AKI-CKD link are retrospective, based on a convenience sample of patients (pts) with relevant testing available, or based on administrative coding data. It is unclear how long AKI survivors should be followed if they have do not have CKD at different intervals. We follow children prospectively for up to 5 years after AKI at our center. Our aim was to determine risk of CKD development for pts without CKD in the first year following an AKI event.
Methods: Pts with severe AKI (sAKI), KDIGO Stage 2-3, for ≥ 48 hours were prospectively consented and enrolled. Serum creatinine (SCr) and Cystatin-C (CysC) were collected at all visits to estimate GFR (eGFR); the lower was used for analysis. Pts with sufficient data at 3M or 6M were evaluated for follow-up. Pts without follow up past 1Y were excluded. CKD was defined as eGFR<90. Pearson chi-square or Fischer's exact tests were used for all categorical data, with p-value <0.05 considered significant.
Results: Data from 118 sAKI pts from between 2011 and 2018 were analyzed. Of these, 105 had follow up data at 2Y, 83 at 3Y, 75 at 4Y, and 62 at 5Y. Pts without CKD at 3-6M were less likely to have CKD at 2-5Y after AKI (2/69 vs. 22/49. p<0.0001). 2/69 without CKD by 6M developed CKD by their last visit; one with Wilms tumor and the other with a heart transplant complicated by PTLD. 49 pts had CKD by 1Y; 22 persisted to the time of last visit. The negative predictive value was 97.1% (95%CI: 89.8-99.2%). Of the 24 pts with CKD at last visit, 10 had Stage 3, 5 had Stage 4 and 4 had Stage 5. Of the 4 with Stage 5 CKD at 5Y, 2 received transplants and 2 were receiving dialysis.
Conclusion: Pts without stage 2 CKD by 1Y post-sAKI are at very low risk of CKD development. We suggest CKD surveillance may be safely discontinued after 1Y in the absence of CKD presence or primary kidney disease.

Statistic	Value	95% CI
Sensitivity	91.67%	73.00-98.87%
Specificity	71.28%	61.02-80.14%
Positive Predictive Value	44.90%	36.69-53.39%
Negative Predictive Value	97.10%	89.83-99.22%

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Machine Learning Models to Predict AKI Recovery

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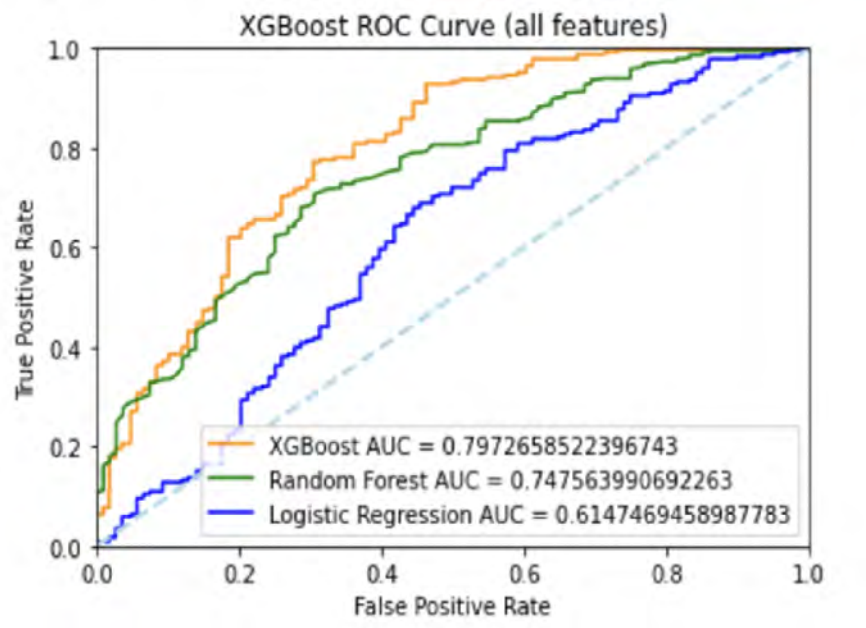
Purpose
Acute kidney injury (AKI) is a potentially lethal complication in critical patients admitted to intensive units (ICUs). AKI patients who have a kidney recovery have better outcomes compared to those who do not. However, how to predict 7 days' kidney recovery using the first days' clinical parameters was rarely discussed, which may be owing to poor predictive performance using conventional predictive methods. We conducted a retrospective cohort study using MIMIC-IV databased to identify relevant features predicting 7 days' AKI recovery.

Methods
MIMIC-IV was constructed for academic research. We identified patients admitted to ICUs with AKI or incident AKI within 7 days after ICU admission. Patients undergoing dialysis history were excluded. We identify patients with complete kidney recovery (returned to 110% baseline serum creatinine) and used conventional logistic regression, random forest, XGBoost and decision tree models to identify important features predicting recovery.

Results
A total of 2449 patients with 992 (40.5%) female and aged 66.6±15.4 years old. The area under curves (AUC) of XGBoost, random forest and logistic regression models to predict 7 days' recovery was 0.80, 0.75, and 0.61 respectively. Decision tree analysis found creatinine on AKI day 1, blood urea nitrogen, underlying kidney diseases, ages, and baseline creatinine help to identify patients with kidney recovery.

Conclusion
Machine learning models, especially XGBoost models, identify patients with potential to recovery on the 7th day of AKI and outperformed traditional models. This would help early risk stratification and timely intervention.



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Long-Term Kidney Outcomes in Pediatric Patients Following ECMO

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Background
Patients undergoing extracorporeal membrane oxygenation (ECMO) are susceptible to kidney injury from a variety of mechanisms, but the long-term kidney outcomes following ECMO remain unclear. We aimed to describe the frequency of kidney-related outcomes at follow up.

Methods
This was a retrospective cohort study of pediatric patients who underwent ECMO at a single center between 2009 and 2019. Patients were included if they survived at least three months following hospital discharge. Estimated glomerular filtration rate (eGFR) was calculated from serum creatinine based on the CKiD U25 equation (mL/min/1.73m2) and was used to define three kidney function outcomes: 1) occurrence of acute kidney injury (AKI), defined as an eGFR <60 on any occasion which subsequently improved to normal (≥90); 2) eGFR <90 at last follow-up; 3) chronic kidney disease (CKD) defined as eGFR <90 on at least two occasions separated by ≥90 days, without an intervening or subsequently normal eGFR. All available urinalyses and urine protein-to-creatinine measures were used to determine the presence of proteinuria.

Results
671 patients underwent ECMO during the 10-year period, 401 (60%) of whom survived three months after discharge. 42/401 (10%) saw nephrology in consultation at some point following their ECMO hospital admission.
265/401 (66%) had at least one creatinine value available post-discharge. 61/265 (23%) of patients had an abnormal eGFR at last follow-up creatinine measure, and 18/265 (7%) met criteria for CKD. Of patients meeting criteria for CKD, 7/18 (39%) had AKI events after discharge (range 1-6 episodes). Figure 1 demonstrates kidney function outcomes by follow-up time.

Of the 401 survivors, 150 (37%) had available urine data, and of those, 52/150 (35%) had evidence of significant proteinuria (urinalysis protein >=2+ or urine protein/creatinine >0.2).

Discussion
This study demonstrates the continued high burden of kidney disease in pediatric patients who survive hospitalization with ECMO. Previous work has demonstrated the high risk of kidney dysfunction while undergoing ECMO, however this study found a considerable incidence of subsequent AKI events, CKD, and proteinuria in this population. As optimal surveillance practice is not well-established, this work may inform future studies that follow patients post ECMO for kidney-related outcomes in a standardized fashion.

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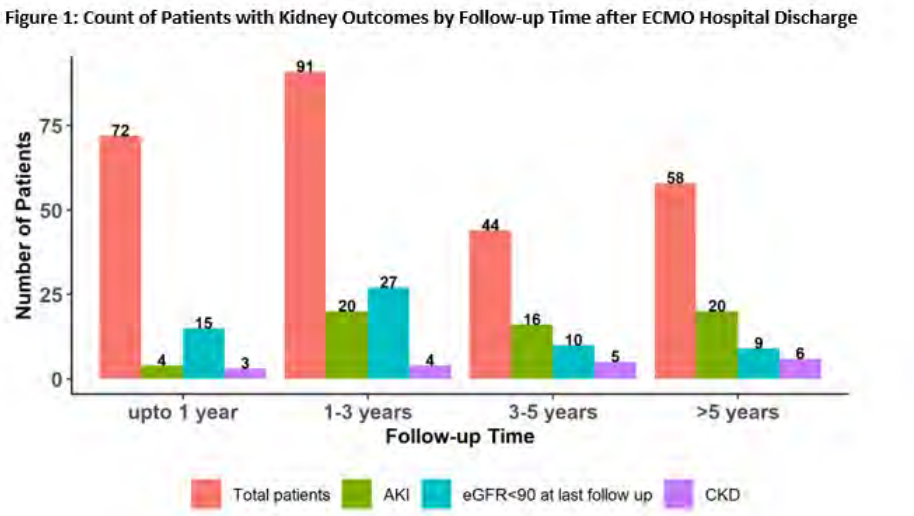

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A machine learning approach to develop a prediction score for in-hospital mortality in COVID-19 patients with acute kidney damage.

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Introduction:
Acute kidney injury (AKI), which is linked to COVID-19 can be a sign of the severity of the disease. The objective of this study was to create a predictive score for COVID-19 patients with AKI to predict in-hospital mortality.
Methodology:
All patients who were admitted to our hospital between January 2020 and November 2022 with COVID-19 infection, associated with AKI stage II or III were included in our analysis. Data about age, sex, ethnicity, comorbid conditions, length of hospital stay, and mortality were collected. We performed a survival decision tree-based analysis to create our prediction model. We divided the data into training and test dataset with a ratio 80:20. The model was trained on the training dataset and was evaluated on the test dataset. The evaluation criteria were Harrell C-Statistic for discrimination and integrated Brier score for calibration. We also assessed the AUC for overall performance

Results
2370 patients were included in our study. Harrell C statistic was 0.82, indicating adequate discriminative power, integrated Brier score was 0.09, indicating adequate calibration. AUCQ was 0.9, indicating adequate overall performance. The key player in our model was degree of acute kidney injury (importance factor=0.89).

Conclusion:
Our predictive model may help medical professionals identify COVID-19 hospitalised patients with AKI who may need more intensive monitoring and can be used to determine resource allocation. We developed a user friendly web application using our predictive model to facilitate its use.

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Clinical Profile and Outcomes of COVID-19 Patients with Acute Kidney Injury In A Tertiary Hospital in Baguio City: A Retrospective Cross-Sectional Study

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Objective: The study aimed to determine the clinical profile and renal outcome of confirmed COVID-19 patients to aid in screening and in improving therapeutic strategies to address the disease.
Participants: All admitted patients, aged 19 years old and above with confirmed COVID-19 infection and referred to nephrology service from January 2021 to January 2022 were reviewed in this study.
Methods: The research study used a retrospective cross-sectional study design that was conducted in a single tertiary training institution. A total of 130 patients were included in the study. Retrospective data from charts of eligible patients were recorded including the history, laboratory tests and treatment regimen. Clinical characteristics and outcomes (frequency, stage of AKI, renal recovery, and mortality) were measured using multiple statistical analyses. Descriptive statistics using frequency and percentages, chi-square tests and one-way analysis of variance (ANOVA) were employed to analyze the data. Results: Of the 538, 130 patients were referred to nephrology service. 42.3% and 41.5% were classified as mostly having Stage 1 and 3 respectively (r= 0.36). The subset of patients who developed acute kidney injury was higher among those with comorbidities such as hypertension, heart disease, and chronic kidney disease (p 0.00 and 95% CI). Patients with AKI stage 3 are more likely to be in critical cases necessitating the need for mechanical ventilation ; had higher levels of CRP, D-dimer, LDH, and ferritin, and proteinuria. 44 patients (33%) with AKI stage 3 received hemoperfusion (p 0.00 and 95% CI). The overall mortality rate was 26.2%, with most deaths in AKI stage 3 (16.9%). The mean length of hospital stay is 14 days with full renal recovery most noted in AKI stage 1 (95% CI; p = 0.00).
Conclusions: The development of AKI in COVID-19 patients is associated with comorbidities such as hypertension, heart disease, diabetes, chronic kidney disease, and obesity. The level of inflammatory markers and proteinuria can predict the severity of AKI . COVID-19 patients who developed AKI stage 3 had lower recovery rates necessitating continuation of dialysis after discharge. Highest hospitalization mortality rate was most noted in AKI stage 3.
Keywords: Acute kidney disease, acute kidney injury, coronavirus disease 2019 infection, renal recovery.

Table 7

Mortality, Length of hospitalization, and Renal Recovery of Confirmed COVID-19 patients with Acute Kidney Injury at Notre Dame De Chartres Hospital

AKI Stage	AKI Stage 1	AKI Stage 2	AKI Stage 3	TOTAL	Test Statistics P value
Outcome					0.001
Died	6 (4.6%)	6 (4.6%)	22 (16.9%)	34 (26.2%)	
Survived	49 (37.7)	15 (11.5)	32 (24.6)	96 (73.8)	
TOTAL				130	0.000
Mean Length of Hospital Stay in Days (SD)	13.20(6.34)	12.62 (7.00)	14.80 (12.95)	13.77 (9.70)	0.584
Renal Recovery (n=96)	49 (51.0%)	15 (15.6%)	32 (33.3%)	96 (100.0%)	0.000
Partial	12 (12.5)	9 (9.4)	9 (9.4)	30 (31.3)	
Full	36 (37.5)	5 (5.2)	2 (2.1)	43 (44.8)	
Needs dialysis after discharge	1 (1.0)	1 (1.0)	21 (21.9)	23 (24.0)	0.044

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A patient with severe metformin-associated lactic acidosis beats all the odds

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Background: Metformin-associated lactic acidosis (MALA) generally occurs in the context of renal dysfunction, either due to chronic kidney disease (CKD) or acute kidney injury (AKI), leading to impaired metformin elimination.

Case presentation: A 56-year old patient presented to our Emergency Department with an acute confusional state, disorientation, extreme fatigue, tachypnea, nausea, vomiting and anuria. She had a seven-day history of nausea, vomiting, abdominal pain and fatigue that had progressively worsened three days prior to admission. Her past medical history was significant for arterial hypertension, type II diabetes mellitus, peripheral artery disease and a total hip arthroplasty. She had been prescribed daily rectal indomethacin for pain management that she had used regularly in the past month, along with lercanidipine and irbesartan + hydrochlorothiazide and metformin.

Her laboratory findings included elevated serum levels of urea = 245 mg/dL, creatinine = 10.9 mg/dL, HGA - ph = 6.57, pCO2 = 17.9 mmHg, BE = -36.6 mmol/L, K = 8.04 mmol/L, lactate = 16.29 mmol/L. She was diagnosed with NSAID-induced acute kidney injury (AKI) and metformin-associated lactic acidosis. The patient was admitted to the ICU and she was started on intravenous fluid therapy, diuretics, calcium gluconate, sodium bicarbonate, and underwent an urgent hemodialysis session. At the end of the session both her clinical and laboratory parameters had improved with lactate levels dropping at 7 mmol/L. On her second day in the ICU, she had persistent altered mental status and tachypnea, thus she was placed on assisted ventilation and she underwent an additional session of continuous renal replacement therapy (CRRT) over 30 hours, to remove metformin and replete bicarbonates. Following CRRT, her clinical condition significantly improved, she was weaned from mechanical ventilation and her urine output progressively increased on her third day of her ICU stay. On discharge, her serum creatinine levels were 1.3 mg/dL.

Conclusion: Reported cases of severe metformin-associated lactic acidosis (MALA) with profoundly low blood pH levels (pH < 6.8), as in the case of our patient, are exceedingly rare and represent rapidly deteriorating, life-threatening conditions. A high index of clinical suspicion in patients on metformin, with risk factors for AKI is paramount in establishing a timely diagnosis and early initiation of renal replacement therapy, preventing fatal outcomes.

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Metabolomics Analysis and Classic Biomarkers to Predict Mortality in Patients with Acute Kidney Injury and Replacement Therapy

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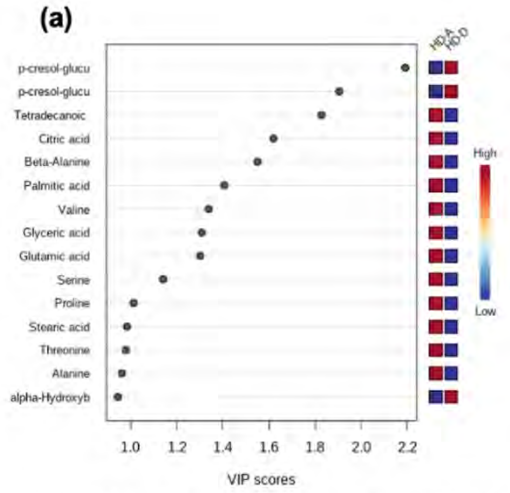
Acute kidney injury (AKI) requiring renal replacement therapy (RRT) is associated with mortality in critically ill patients. At the beginning of the RRT, serum metabolic biomarkers and markers of tubular damage might differentiate patients with a high risk of mortality.

In this study, we investigated the performance of 4 urinary biomarkers as well as metabolic analysis and 3 serum biomarkers in predicting mortality in patients with severe AKI and requiring renal replacement therapy (RRT).
Prospective cohort study of patients with critical COVID-19 in intensive care unit (ICU) with invasive mechanical ventilation (IMV) and who required RRT, admitted to our Institute in Mexico City (Mar 2020 - Feb 2022). Patients with CKD stages 4 or 5 and kidney transplant were excluded. SerpinA3, KIM-1, nGAL and HSP-72 were measured in urine on day 0 (start of RRT) and metabolomics analysis, IL-6, IL-10, and TNF-alpha in serum on day 0.
Sixty patients were included, 52% died before discharge. The mean age was 51 ± 12.2 for those who survived and 56 ± 12.2 for those who died. Sixty-nine percent of the living patients were men and 84% of the dead. The Charlson comorbidity index, as well as the severity scores, the laboratory parameters at the start of the RRT and the treatments received in the ICU were not different between the living and the dead. Of the urinary biomarkers studied, KIM-1 was the best mortality predictor (Fig.1a). The rest of the biomarkers had AUC minors (0.5-0.6) to predict this outcome. In the discriminant analysis of differential metabolites between the living (HD-A) and the dead (HD-D), p-cresol glucuronide was present in higher amounts in HD-D (Fig.1b).
In this study we observed that KIM-1 was the best predictor of mortality. In the metabolomics analysis, p-cresol glucuronide was the metabolite present in the highest amounts among the deceased.



(b)

Biomarker	AUC (95% CI)	p-value
Urine biomarker		
KIM-1, µg/mg	0.68 (0.53-0.84)	0.03
HSP-72, µg/mg	0.51 (0.34-0.68)	0.32
NGAL, µg/mg	0.63 (0.47-0.79)	0.12
SerpinA3*, DPI/mg	0.52 (0.36-0.69)	0.78
SerpinA3**, µg/mg	0.64 (0.48-0.80)	0.10
Urine output >500ml	0.51 (0.37-0.66)	0.86
Urine output >1L	0.59 (0.44-0.73)	0.25
Plasma biomarker		
IL-6, pg/ml	0.57 (0.43-0.72)	0.31
IL-10, pg/ml	0.64 (0.50-0.79)	0.06
TNF-alpha, pg/ml	0.52 (0.37-0.67)	0.83

Abb. AUC, area under the curve.

(a) VIP schematic scores of partial least squares-discriminate analyses (PLS-DA) for HD-A vs HD-D. (b) Area under the receiver-operating characteristics curve of biomarkers for predicting mortality.

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Quality of care during CRRT in a middle-income country, trying to follow the ADQI recommendations.

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[1]*Hospital Universitario of Monterrey "José Eleuterio González"*

Introduction
Safety and quality are important aspects in the critical care patients, particularly the ones that develop AKI, during the ADQI 22 consensus conference they recommended that acute RRT programs should integrate structure, process and outcome quality indicators. This seems to add more work load to healthcare professionals; so, what can we do in a center with middle income and limited personal to achieve these recommendations?

Objective: To evaluate at least one quality recommendation of outcome, structure and process in our center.

Methods and Materials.
We performed a single center retrospective analysis chart review of adults who required CRRT during the last 8 months in

the Hospital Universitario of Monterrey "Dr. José Eleuterio González" in Nuevo Leon, México. The quality assessments were: Patient prescribed dose, fluid management, filter life and small solute clearance which were compared to the ADQI quality care requirements. Data was extracted from the clinical records of the patients, and all of the patients that received CRRT in the period of time given were included; patients with incomplete clinical records were excluded Variables were tested for normality using the Shapiro-wilks test continuous normal data were summarized as means and standard deviation; non-normal data as median and interquartile ranges. Categorical data was presented as frequencies. The analysis was performed whit R version 4.0

Results / Conclusion

This is the first time our center perform quality metrics for CRRT patients in the ICU, this data will help us develop an improvement campaign in order to offer better quality and more security to our patients. In Latin America there are few healthcare centers with CRRT programs and even those who have them not often make quality measurements to know if what they are doing is correct or if they fully achieve ADQI goals. We should remember "that we cannot improve what we have not measure".

Results in the first 24 hrs

Characteristics	Results
Vascular Access	
Right jugular	41.66% (5)
Left jugular	25% (3)
Right Femoral	25% (3)
Right subclavius	8.3% (1)
Prescribed dose (Effluent)	2321.36 (±581.26)
UF Prescribed	50(50-65)ml/hr
UF Removed	82 (63.75-91.25) ml/hr
Small solute clereance	0.30(±0.26)
Filter life	58.16(±30.42)H
Anticoagulation	66.6 (8)%

Goals	Accomplished
Filter life first filter < 60 hours n=12	66.66%(8)
Filter life second filter <60 hours n=5	80%(4)
Filter life third filter <60 horas n=2	50%(1)
Small solute clereance n=10	90.90%(10)
Fluid management UF < 80%	41.66%(5)
Catheter Dysfunction	0%(0)

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Long-term Infectious Complications Among Critically Ill Children with AKI

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[1]*University of Pittsburgh*

Background: Several observational studies in select cohorts of hospitalized children have shown an association between acute kidney injury (AKI) and risk for de novo infection. While these findings support AKI as a clinically relevant immunocompromised state, little is understood about the duration of time at which AKI place children at risk for subsequent infection. The objective of this study was to explore long-term infectious complications among critically ill children with AKI.

Methods: We conducted a single-center retrospective cohort study of children admitted to the pediatric and cardiac intensive care units (ICUs) at a pediatric tertiary care center over a four-year period. The relationship between non-septic

AKI and the development of community-acquired infection in the two years following hospital discharge from the index hospitalization was assessed using Cox proportional-hazards models.

Results: Two-year follow-up data on 5248 children (92.2% of the initial cohort) showed higher cumulative rates of infection following hospital discharge among children with AKI during the index hospitalization compared to those without (18% vs. 15%, p=0.035). Following adjustment for key risk factors for infection, children with AKI during the index hospitalization had increased risk of infection in the two years following hospital discharge with a hazard ratio of 1.236 (95% CI 1.032-1.482, p=0.021). Other significant risk factors for infection in the multivariable model included surgery and occurrence of sepsis during the index hospitalization, history of solid-organ transplant and patient age. Evaluating source of infection, children with AKI had higher rates of bacteremia/sepsis (1.3% vs. 0.5%, p=0.011) and GI/hepatobiliary infection (2.5% vs. 1.6%, p=0.05). While overall rates of respiratory infections were similar in both groups, respiratory infections requiring hospital readmission were 2-times higher among children with prior AKI compared to those without at 30, 90 and 365 days after the index hospitalization.

Conclusion: AKI may lead to sustained immunomodulatory effects placing critically ill children at heightened risk for infection following hospital discharge.

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Experience of continuous renal replacement therapy in critically ill patients with acute kidney injury: a single-center retrospective exploratory study.

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Background: Acute kidney injury is a complication of critical patients that has been associated with a high risk of hospital mortality, where identifying modifiable and non-modifiable clinical variables at the start of dialysis that are associated with hospital survival can help, not only in prognosis, but also in clinical classification.
Whether this reflects the severity of the disease or is an independent risk factor is unknown. The objective of this study was to describe the severity and mortality in a group of critically ill patients with acute kidney injury who required continuous renal replacement therapy.

Methods: A descriptive, observational and retrospective study was carried out in patients with acute kidney injury requiring continuous renal support therapy in the intensive care units of a tertiary reference medical center, from January 2013 to March 2022. The primary outcome was hospital mortality.

Results: Of the 136 critically ill patients with acute kidney injury admitted to intensive care units, the mean age was 56.45 ± 19.81 years, with a predominance of men (61%) and the mean SOFA score was 11.8 ± 4.3 (table 1), starting CRRT in all patients.
The indications for CRRT were fluid overload (22%), acute kidney injury with oliguria and fluid overload (60%), acute kidney injury with oliguria (12%), acute kidney injury without oliguria (6%). Mean overload-adjusted serum creatinine before the start of CRRT was 3.37 ± 1.18 mg/dl, fluid overload was 12.56 ± 4.45 liters, with a percentage of 13.2 ± 6.4%. The most frequent causes of AKI were shock of any cause (72%) (of these were mainly due to cardiogenic shock (51%), septic shock (24%) and mixed shock (14%), postsurgical (12%) and syndrome (without shock) (7%), of the total number of patients, 82% required vasopressor support and 86% invasive mechanical ventilation, the most common modality of CRRT being continuous venovenous hemodiafiltration (CVVHDF) (72%), with a dose average effluent of 28.9412.34 ml/kg/hr and ultrafiltrate of 1.340.34 ml/kg/hr. The incidence of overall survival was 27%.

Conclusion: The results of our study suggest that acute kidney injury in patients undergoing continuous renal replacement therapy presents a high risk of in-hospital death. This increased risk cannot be explained solely by a more pronounced

severity of the disease. Our results provide strong evidence that acute kidney injury presents a specific and independent risk factor for poor prognosis.

Table 1. Demographic and clinical features

Variable	*n*=136 (total) mean ± SD	*n*=36 (survivor) mean ± SD	*n*=100 (non survivor) mean ± SD	*p*
Age (years)	56.45 ± 19.81	54.34 ± 17.15	58.12 ± 18.56	0.191
Male/female, n	83/53	22/14	61/39	0.094
Intubated, n(%)	117 (86)	17(47)	100 (100)	0.001
Vasopressor, n (%)	112 (82)	19 (52)	93 (93)	0.003
Fluid overload CRRT initiation, (%)	13.2 ± 6.4	5.2± 3.9	15.1± 7.2	0.004
SOFA	11.8 ± 4.3	6.7 ± 2.2	13.1 ± 5.1	0.04
Serum creatinine adjusted for overload (mg/dl)	3.37 ± 1.18	3.41 ± 1.21	2.88 ± 1.11	0.134
Effluent dose (ml/kg/hr)	28.94±12.34	26.14±10.21	30.87±11.31	0.093

RESEARCH IN AKI

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A Macrophage-Endothelial Immunoregulatory Axis Ameliorates Septic Acute Kidney Injury

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Purpose: The most common cause of acute kidney injury (AKI) in critically ill patients is sepsis. Kidney macrophages consist of both F4/80hi and CD11bhi cells. The role of macrophage subpopulations in septic acute kidney injury pathogenesis remains unclear. As F4/80hi macrophages are reported to contribute to immunomodulation following injury, we hypothesized that F4/80hi macrophages can limit septic acute kidney injury.

Methods: F4/80hi macrophages were depleted via diphtheria toxin injection in CD11cCre(+)/CX3CR1dtr/wt (F4/80 MKO mice) compared to CD11cCre(-)/CX3CR1dtr/wt (F4/80 MWT) mice. F4/80 MWT and F4/80 MKO mice were subjected to sham or cecal ligation and puncture (CLP) sepsis. Kidney injury was assessed by serum creatinine and blood urea nitrogen, histologic injury scoring, and KIM-1 staining by immunofluorescence microscopy. Cytokine mRNA and protein levels were measured by RT-PCR and ELISA. Fluorescent cell-sorting and single cell RNA sequencing with Nichenet analysis were used to profile gene expression and identify cell-specific ligand-receptor interactions following CLP in intra-renal cell lineages.

Results: Compared to F4/80 MWT mice, F4/80 MKO mice displayed worsened septic acute kidney injury at 24 hours as measured by serum creatinine (mean ± SD: 0.17 ±0.08 vs 0.41 ± 0.17 mg/dl, $p<0.001$), histologic injury scoring, and KIM-1 staining. F4/80 MKO kidneys elaborated higher interleukin-6 levels, specifically from kidney endothelial cells. Mechanistically, single cell RNA sequencing and fluorescent cell sorting identified a macrophage-endothelial cell immunoregulatory axis that underlies interleukin-6 expression: F4/80hi macrophages expressed interleukin-1 receptor antagonist that limited interleukin-6 expression in endothelial cells. In turn, both recombinant human interleukin 1 receptor antagonist and anti-interleukin-6 therapy ameliorated septic acute kidney injury in F4/80 MKO mice.

Conclusions: F4/80hi macrophages express interleukin-1 receptor antagonist and constrain interleukin-6 generation from endothelial cells to limit septic AKI, representing a targetable cellular crosstalk in septic AKI.

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The effect of prebiotics on intestinal flora and renal function: attempts to inhibit AKI

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The number of patients with chronic kidney disease (CKD) is increasing. Furthermore, the number of patients with CKD progression from acute kidney injury (AKI) is increasing. Thus, the establishment of a reliable treatment for kidney injury is an urgent issue. In this study, we investigated the effects of lactulose, prebiotics, on the intestinal flora and renal function in rat model of renal injury.

Renal injury was induced by 5/6 nephrectomized rats and fed with a diet supplemented with lactulose for 8 weeks. The

renal injury rats showed markedly increased albuminuria and decreased creatinine clearance compared to control rats. In contrast, these renal dysfunctions improved in the lactulose-treated group (Albuminuria, control; 73.3±31.3, Renal injury; 577.0±274.5, Renal injury + lacturose; 426.0±169.4 μg/mg creatinine. Creatinine clearance, control; 5.06±2.74, Renal injury; 2.24±0.73, Renal injury + lacturose; 3.24±1.14 mL/min/kg BW). In addition, renal injury rats showed glomerular hypertrophy, which was reduced in the lactulose-treated group. The results of analysis of bacterial DNA extracted from feces using a next-generation sequencer showed an increase Proteobacteria and Lentisphaerae of intestinal flora in the renal injury rats. On the other hand, the percentage of Bifidobacteria in the lactulose-treated group was markedly increased. These results suggest that there may be a protective mechanism for renal function through the increase of Bifidobacterium bifidum and improvement of intestinal flora by lactulose administration.

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Building a Prediction Model for Postoperative Acute Kidney Injury using Machine Learning: The CMC-AKIX Model

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Introduction: Postoperative acute kidney injury (AKI) is associated with increased mortality and morbidity in patients undergoing surgeries performed under general anesthesia. There are several models that predict postoperative AKI risk, but most are single-center studies that need external validation.

Methods: In this retrospective cohort analysis, we included noncardiac surgeries performed between 2009 and 2019 at 7 university hospitals in South Korea. Postoperative AKI was defined as an increase of serum creatinine at least 1.5 times the baseline value or initiation of renal replacement therapy within 30 days of the postoperative period. We tested 6 machine learning prediction models: deep neural networks (DNN), logistic regression, decision tree, random forest, light gradient boosting machine (GBM), and naïve Bayes, and compared model performance using the area under the curve (AUC) of the receiver-operating characteristic.

Results: A total of 239,267 surgeries were included, and 7,935 postoperative AKI events (3.3%) occurred. The 6 different statistical analysis methods were run on various combinations of 40 independent preoperative predictors that we had selected (Table 1). Model 1 included all variables, Model 2 included variables that had been significantly associated with postoperative AKI in previous studies, and Model 3 included variables that were found significant on multivariate analysis. Among them, Model 1 run on DNN (AUC = 0.821) and light GBM (AUC = 0.823) and Model 3 run on DNN (AUC = 0.807) demonstrated the best prediction performance.

Conclusions: We have developed a high-performance risk prediction system for postoperative AKI that can be easily applied using preoperative patient characteristics and laboratory data.

Key Words: acute kidney injury; general surgery; deep neural networks; machine learning; prediction model

Table on following page

Patient parameters	Surgical parameters	Laboratory parameters
Age	Department	White blood cell count
Sex	Operation duration	Hemoglobin
Systolic BP, mmHg	Weekday	C-reactive protein
Diastolic BP, mmHg		Glucose
Height		Urea nitrogen
Weight		Creatinine
BMI, kg/m2		eGFR
Chronic kidney disease		Total Protein
Diabetes mellitus		Albumin
Hypertension		AST
Cerebrovascular disease		ALT
Coronary artery disease		Sodium
COPD		Potassium
Liver cirrhosis		Chloride
Smoking		Calcium
Preoperative ACEi or ARB usage		Uric Acid
Preoperative NSAID usage		Creatine phosphokinase
		Lactic dehydrogenase
		Urine specific gravity
		Urine protein

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Kinase Inhibitors AZD5438 and Dabrafenib Alleviate Cisplatin-Induced Acute Kidney Injury and Hearing Loss

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Purpose of the study
Cisplatin is an effective chemotherapy agent for a wide variety of solid tumors, but its beneficial use is dose-limited by serious side effects including acute kidney injury (AKI) and hearing loss. There are currently no FDA-approved drugs to treat AKI and only one drug was approved to treat hearing loss in pediatric localized hepatoblastoma. Recently, two oral drugs, kinase inhibitor AZD5438, a Phase-2 clinical trial CDK2 inhibitor, and dabrafenib, an FDA-approved BRAF kinase inhibitor, were identified as protective against cisplatin-induced hearing loss in mice. Here, we hypothesized that similar cell stress and death pathways are activated in kidney and inner ear cells when exposed to cisplatin and tested if these drugs can also alleviate cisplatin-induced AKI.
Methods
AZD5438 and dabrafenib protective effects against cisplatin-induced cell death were tested initially in a human kidney tubular cells HK-2. Next, we examined the two drugs in an established AKI FVB adult mouse model, giving orally

AZD5438, 35 mg/kg, twice a day, and dabrafenib, 12 mg/kg, three times a day, for three consecutive days, to cisplatin-treated (25 mg/kg) mice. Protection of nephrotoxicity was evaluated by reduced levels of serum acute kidney injury markers- blood urea nitrogen (BUN), creatinine, renal neutrophil gelatinase-associated lipocalin (NGAL), histology markers, reduced levels of biomarkers PCNA and p-ERK, and suppression of cell death by TUNEL assay. In addition, we studied the CDK2 KO genetic mouse model as a system for CDK2 inhibition in cisplatin-induced AKI.
Results
The drugs reduced cisplatin-induced cell death in the HK-2 cell line, and attenuated cisplatin-induced AKI in mice when administered at doses that were in the range of those approved for human use. Drug treatments in mice reduced the levels of BUN, creatinine, NGAL, cell death, histopathology markers, and prolonged survival of animals. AZD5438 attenuated PCNA levels, and dabrafenib inhibited ERK1/2 phosphorylation. Moreover, germline CDK2 knockout mice were resistant to cisplatin-induced AKI compared to their wild-type littermates, at levels that phenocopied treatment with the CDK2 inhibitor AZD5438.
Conclusion
In summary, we show that similar cellular mechanisms can contribute to damage from cisplatin in the inner ear and kidney tissues, highlighting AZD5438 and dabrafenib as promising potential therapeutic candidates to treat cisplatin-induced kidney damage and hearing loss.

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Probiotics in septic acute kidney injury, a double blind, randomized control trial

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Introduction
In sepsis-induced acute kidney injury (AKI), AKI induces microbiota alteration in the gastrointestinal system, while gut dysbiosis also aggravates AKI. In this scenario, it is possible that modulating the intestinal microbiota with probiotics will favor kidney function recovery (KFR) and clinical outcomes.
Methods
In this double-blind clinical trial, patients with sepsis-induced AKI were randomized to receive probiotics or placebo for 7 days. The primary outcome was the rate of KFR by day 7. Secondary outcomes were mortality, kidney replacement therapy (KRT) requirements, urea reduction, modifications in urine volume, electrolyte abnormalities and treatment related adverse events.
Results
A total of 92 patients from February 2019 to March 2022 were randomized, 48 to probiotics and 44 to placebo. Compared to placebo, probiotics did not improve KFR by day 7(HR 0.93, 0.52-1.68, p = 0.81), mortality hazard ratio at 6 months was 0.57 (95%CI 0.32-1.04, p = 0.06). Urea (mg/dL) decreased significantly in the probiotic group from 154 to 80 mg/dl (p = 0.04) as compared to the placebo group (130 to 109 mg/dl (p=0.09). No significant differences were observed with respect to urinary volume, KRT requirement and electrolytes abnormalities. Adverse events were frequent and similar in both groups.
Conclusion
In septic-induced AKI, administration of probiotics for 7 days was safe; however, they did not improve KFR or reduce mortality.

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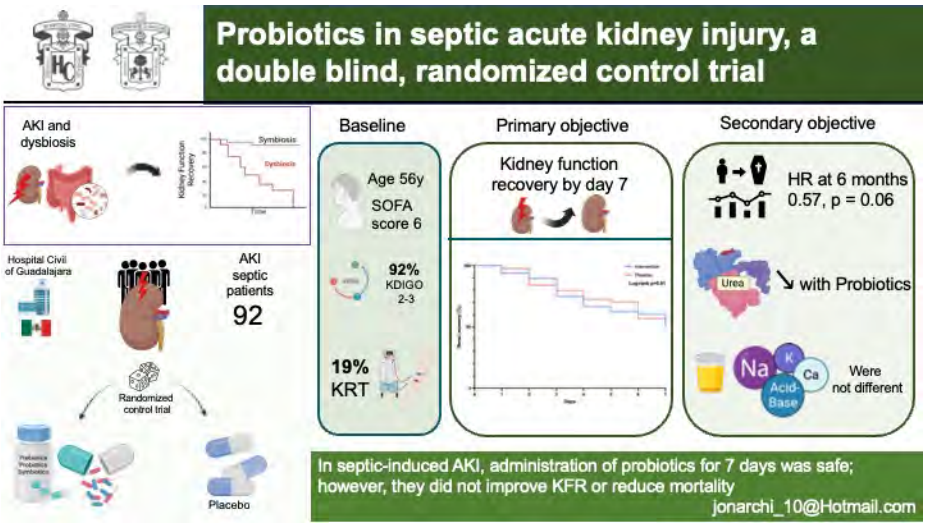

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Urea reduction in acute kidney injury and mortality risk

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Background
Urea is a toxin present in acute kidney injury (AKI). We hypothesize that reduction in serum urea levels might improve clinical outcomes. We examined the association between the reduction in urea and mortality.
Methods
In this retrospective cohort study, AKI patients admitted to the Hospital Civil de Guadalajara were enrolled. We create 4 groups of urea reduction (UrR) stratified by their decrease in urea from the highest index value in comparison to the value on day 10 (0%, 1-25%, 26-50% and >50%), death or discharge. Our primary endpoint was to observe the association between UrR and mortality. Secondary observations included determination of which types of patients achieved a UrR >50%, whether different kidney replacement therapy (KRT) modalities achieved contrasting changes in UrR, and if serum creatinine (sCr) value changes were similarly associated with patient mortality.
Results
A total of 651 AKI patients were enrolled. The mean age was 54.1 years, and 58.6% were male. AKI 3 was present in 58.5%, the mean admission urea was 154 mg/dL. KRT was started in 32.4%, and 18.9% died. A trend toward decreased risk of death was observed in association with the magnitude of UrR. The best survival (94.3%) was observed in patients with a UrR >50%, and the highest mortality (72.1%) was observed in patients achieving a UrR of 0%. After adjusting for age, sex, diabetes mellitus, CKD, antibiotics, sepsis, hypovolemia, cardio-renal syndrome, shock, and AKI stage, 10-day mortality was higher in groups that did not achieve a UrR of at least 25% (OR 1.20). Patients achieving a UrR >50% were those mostly likely to be diagnosed with the uremic syndrome, requiring dialysis therapy, and patients with obstructive nephropathy. Percentage changes in sCr were also proportionately associated with increased mortality risk.
Conclusions
In our retrospective cohort of AKI patients, the differences in UrR from admission were associated with a stratified risk of death. Patients with a UrR 25% was associated with the best outcome, and a greater magnitude in UrR was associated with improved patient survival.

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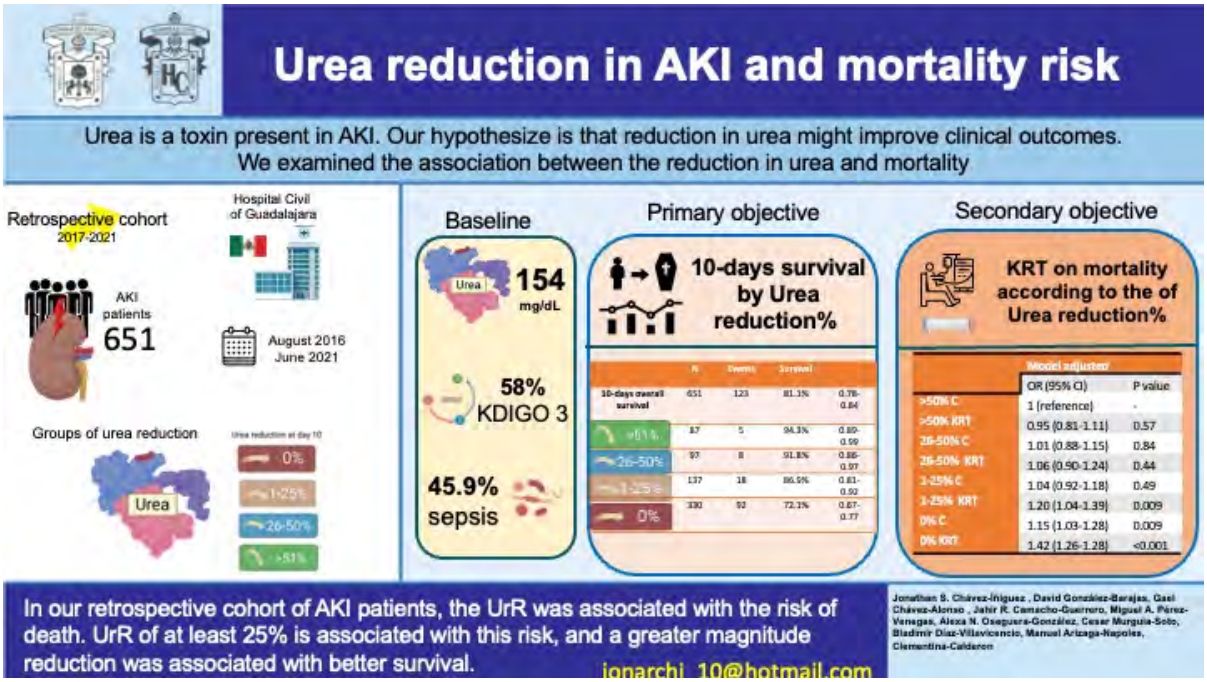

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Identification of Predictive Biomarkers for Antibiotic Associated Nephrotoxicity in Cystic Fibrosis

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Background: Individuals with cystic fibrosis (CF) suffer chronic lung infections requiring frequent antibiotic treatment. Aminoglycosides and polymyxins are used to treat multi-drug resistant organisms but are limited due to side effects, such as acute kidney injury (AKI). Despite the burden of kidney disease in CF, we lack effective methods for early detection of antibiotic associated AKI.
Objective: To discover novel urinary biomarkers of antibiotic associated AKI using an ex-vivo human microphysiological system (MPS) and to translate these findings to a prospectively enrolled population of patients with CF receiving aminoglycosides, polymyxin E or both.
Methods: We populated the MPS with primary human kidney proximal tubule epithelial cells from 3 donors and modeled nephrotoxin injury through exposure to 50, 75 and 100 µg/mL polymyxin E for 48 hours. We analyzed gene transcriptional responses by RNAseq and tested MPS effluents to determine if corresponding candidate biomarkers increased with MPS injury. We translated these biomarkers to a CF cohort via analysis of urine collected prior to antibiotics, during and 2 weeks after antibiotics. Renal function was monitored up to 3 years after antibiotic treatment.
Results: Among 7,641 differentially expressed genes between polymyxin E and control in the MPS, the pro-apoptotic Fas gene saw one of the most extreme increases in expression: log2 fold-change=0.69, FDR=7x10-5. Effluent analysis demonstrated an acute rise of soluble Fas (sFas) concentrations that correlated with cell injury after polymyxin E exposure. In 16 patients with CF, 2 patients developed AKI based on an increase of serum creatinine. In contrast, urinary sFas was significantly elevated during antibiotic treatment compared to baseline, regardless of AKI. Additional urinary

biomarkers of proximal tubular injury were also elevated during antibiotic treatment. Over 3 years of follow up, we identified 7 cases of incident chronic kidney disease (CKD) and urinary sFas concentrations during antibiotic treatment were significantly associated with subsequent development of incident CKD (RR=2.02, 95% CI=1.40, 2.90, p<0.001). Conclusions: Using an ex-vivo MPS, we identify a novel biomarker of proximal tubule epithelial cell injury, sFas. In a clinical cohort, urinary sFas concentrations significantly rise in patients with CF during treatment with nephrotoxic antibiotics and urinary sFas levels were associated with subsequent development of CKD.

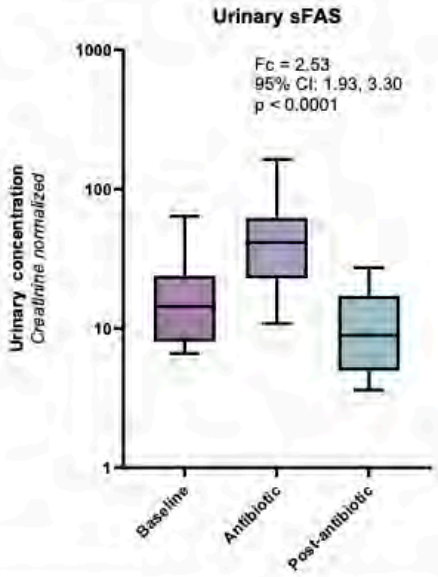

Figure 1 – Urinary sFas concentrations among 16 patients with CF at baseline, during antibiotics and then 2 weeks after antibiotic treatment. Box plots demonstrate that urinary sFas concentrations are significantly elevated during antibiotic treatment and return to baseline levels 2 weeks after completing of antibiotics. Urinary sFas concentrations are normalized for urinary creatinine to account for dilution of urinary samples. Fc is comparing sFas concentrations between baseline and antibiotic.

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Biomarkers for Predicting Progression to Chronic Kidney Disease after Acute Kidney Injury

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Background
Acute kidney injury (AKI) is a well-known risk factor for the development of chronic kidney disease (CKD). However, there were lack of biomarkers for predicting CKD progression in patients with AKI. Therefore, this study aims to identify novel biomarkers using proteomic techniques to predict the transition to CKD after AKI in children.

Methods
Among 807 children enrolled in a prospective AKI cohort study, we selected 10 patients suffering from AKI due to ischemic damage, of which 5 progressed to CKD (CKD group) and the others maintained normal kidney function (non-CKD group). Serum and urine samples were collected at the time of recovery from AKI and follow-up more than two years after AKI. The samples were analyzed using label-free quantitative proteomics analysis based on liquid chromatography-tandem mass spectrometry (MS) to identify protein biomarker candidates. Multiple sample test was performed using the Perseus software platform (http://www.perseus-framework.org) to compare the differences between CKD and non-CKD groups.

Results
A total of 18 serum and urine samples were analyzed. There was no statistically significant difference between CKD group and non-CKD group. In total, 1302 proteins from serum and 1690 proteins from urine samples were quantified. Five of the 13 differentially expressed proteins (DEPs) in the serum of patients correlated with CKD; gelsolin (GSN), heat shock protein family A (Hsp70) member 5 (HSPA5), phosphodiesterase 4D interacting protein (PDE4DIP), insulin-like growth factor binding protein 7 (IGFBP7), and complement C2 (C2). Protein levels of 7 out of 49 DEPs in the urine of patients were increased in CKD patients; Voltage-dependent calcium channel subunit alpha-2/delta-2 (CACNA2D2), Pappalysin-2 (PAPPA2), Hepatocyte growth factor-like protein (MST1), ADM;Adrenomedullin (ADM), Reticulon-4 receptor-like 2 (RTN4RL2), Vesicle-associated membrane protein 2 (VAMP3) and Melanotransferrin (MFI2). Therefore, we selected 12 candidate proteins from serum or urine samples with significantly elevated levels during recovery from AKI in CKD group.

Conclusions
Potential biomarkers identified in this study could provide a potential opportunity to predict AKI to CKD progression in pediatric patients.

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Ravulizumab for COVID-19 Kidney Injury

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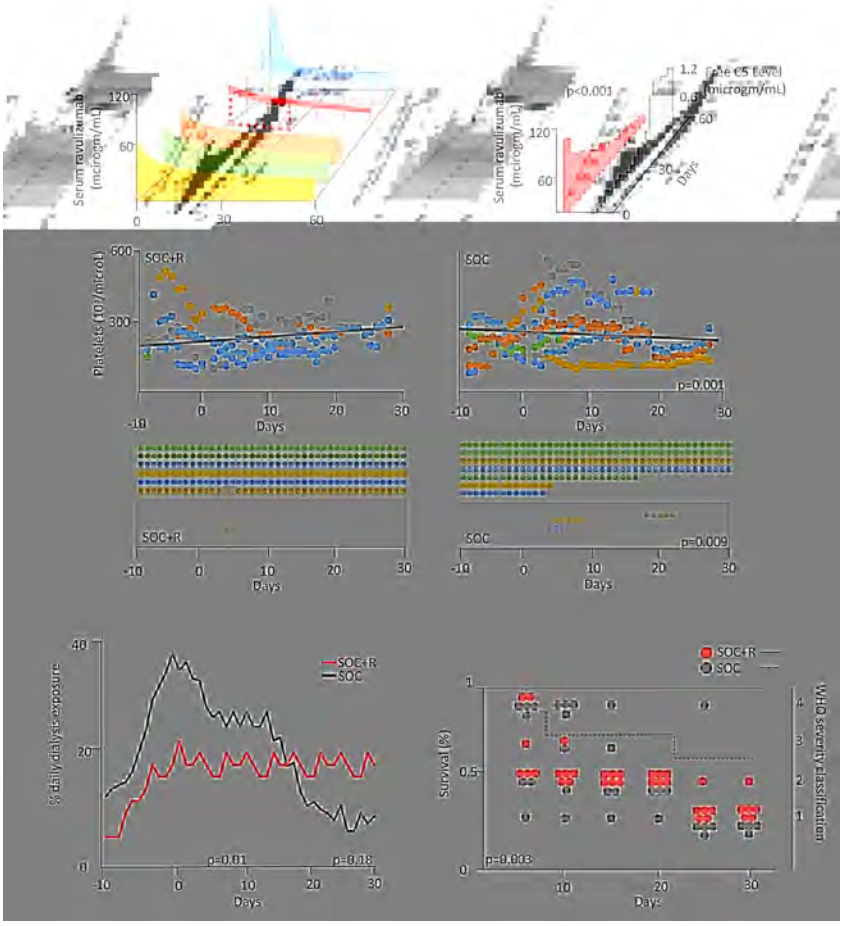
Background: The evidence suggests that the primary events in Acute kidney injury (AKI) occur on the luminal surface of the endothelial cells in the microvasculature of kidney. These findings can be explained by the activation of the complement resulting in endothelial injury. Ravulizumab inhibits the cleavage of C5 into C5a and C5b thus preventing endothelial dysfunction. In this study, we report the use of ravulizumab to treat AKI in the setting of COVID-19 infection with focus on a primary follow-up period of 30 days.

Methods: Patients were randomized 1:1 in a single-blind, placebo-controlled fashion and assigned to one of two groups. One group received placebo and standard care (SOC) while the second group received SOC and ravulizumab. Outcomes were assessed for 30 days after enrollment.

Results: 13 (11.4% of screened) patients identified to have COVID-19 infection were enrolled in the study. Six patients were randomized to receive ravulizumab in addition to standard of care (SOC+R) and seven patients were randomized to standard of care (SOC).Three patients randomized to the SOC group died after enrollment. Mean number of hospital free days 30 days after enrollment was 290±47 (SOC+R) vs 164±144(SOC) respectively. Free C5 levels increased over time following ravulizumab infusion and corresponded with decreasing ravulizumab blood levels over the same time interval (immediately following infusion)(p=0.001).During this same time period there was a decreased number of anuric days observed in the SOC+R compared to SOC (p=0.009). There was a reduced frequency of dialysis events in the SOC+R for ten days after enrollment (p=0.001).

Conclusion: Due to the recurrent impact of COVID-19 infection throughout the world, targeted therapies for concomitant kidney injury merit future investigations to reduce incidence of AKI and potentially reduce future prevalence of CKD.



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Mortality Prediction Value of Serum Presepsin in Patients with Sepsis requiring Continuous Renal Replacement Therap

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Purpose
Presepsin is a more specific and valuable biomarker of sepsis, and many research results have been reported recently. However, since presepsin is highly affected by kidney function, acute kidney injury (AKI), especially the situation requiring continuous renal replacement therapy (CRRT), has a significant impact on presepsin dynamics and has not been studied. This study analyzed the relationship between serum presepsin and mortality in patients undergoing CRRT due to AKI.

Methods
From April to September 2022, patients who underwent a presepsin test just before CRRT at Konyang University

Hospital were included, and patients who were undergoing chronic dialysis for end stage kidney disease were excluded. A total of 36 patients were enrolled, of which 25 were sepsis and 11 were non-sepsis. The predictive values of APACHE-II score, SOFA score, and serum presepsin for 28-day mortality were analyzed using receiver operating characteristics (ROC) curve analysis.

Results
In predicting 28-day mortality in the overall cohort, area under the ROC (AuROC) values of APACHE-II score, SOFA score, and serum presepsin were 0.719, 0.694, and 0.636, respectively, which the presepsin showed the lowest predictive value. However, in the analysis of only sepsis patients, the AuROC values of APACHE-II score, SOFA score, and serum presepsin were 0.708, 0.737, and 0.776, respectively, which the presepsin was the best predictive marker for 28-day mortality. Moreover, the AuROC value in the model combined with the SOFA score and serum presepsin increased to 0.833.

Conclusion
Presepsin was not a useful marker of 28-day mortality in overall CRRT patients, including non-sepsis. However, in patients with sepsis, it was observed as the best predictive marker of mortality, which is thought to be because presepsin is a very specific marker for sepsis. Presepsin may be helpful in clinical practice for predicting mortality in CRRT patients with clinically suspected sepsis.

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Renal Oxygenation in Critically Ill Preterm Neonates on Invasive and Non-Invasive Positive Pressure Ventilation

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Introduction: Preterm neonates frequently require positive pressure ventilation (PPV). Careful titration of mean airway pressure (MAP) is essential to avoid barotrauma and hemodynamic compromise that may lead to acute kidney injury (AKI). We hypothesized that increases in MAP result in decreases in kidney oxygenation measured by Near infrared spectroscopy (NIRS). monitoring has the potential to evaluate the effect of different MAPs by measuring renal regional tissue oxygenation (RrSO2).
Methods: A retrospective analysis of MAP and renal regional tissue oxygenation (RrSO2) was performed on preterm neonates <32 weeks' gestation who were enrolled in a prospective NIRS monitoring study. INVOS NIRS sensors were placed on neonates within 48 hours of age and monitored RrSO2 every 5 seconds until 7 days of age. Hourly MAP recordings from chart review were compared to hourly averages of RrSO2 at the corresponding time points. Statistical analysis included linear and binomial mixed-effect models, Mann-Whitney U tests, and Fisher's exact test.
Results: Of the 35 neonate cohort, 18 received invasive mechanical ventilation (IMV) and 20 received noninvasive ventilation (NIV) between 2-7 days of age. The average gestational age and birth weight was lower for the IMV group compared to the NIV group. A 1 cmH2O increase in MAP is associated with a 0.53 percentage point (ppt) reduction in average RrSO2 in the IMV group (Figure 1; 95% CI: 2.55 ppt reduction up to a 1.54 ppt increase; $p = 0.61$) and a 1.09 ppt reduction in the NIV group (95% CI: 2.99 ppt reduction up to a 0.88 ppt increase; $p = 0.28$). The odds ratio for an association between MAP and the odds of having RrSO2 $\geq$ 50% was 0.80 (95% CI: 0.63–1.04, $p = 0.09$) and 0.72 (95% CI: 0.53–0.99, $p = 0.05$) for the IMV and NIV groups, respectively.
Conclusion: In this pilot analysis, there was no consistent association between MAP and RrSO2 in both the IMV and NIV groups. These results highlight how the effect of MAP on kidney oxygenation is highly variable in premature neonates and demonstrates that NIRS monitoring may have a useful role in promoting kidney-mindful respiratory interventions. Further studies are needed to discern the mechanisms by which PPV affects kidney perfusion and oxygenation.

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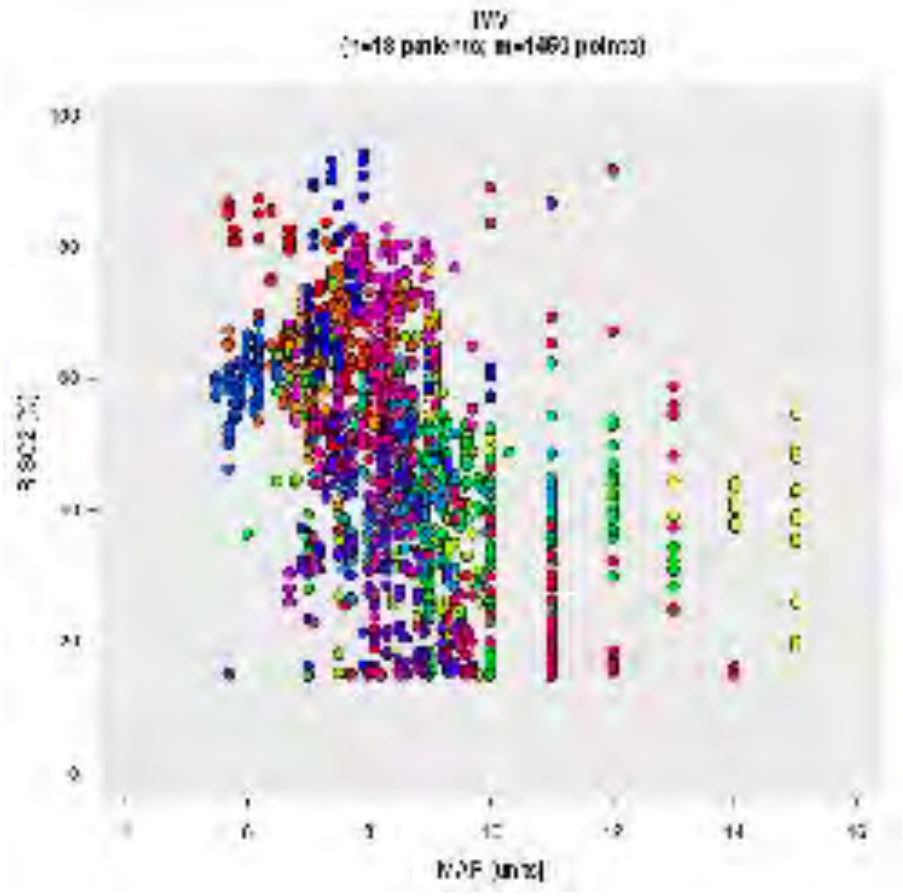

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Endothelial Cell Protein C Receptor as a Novel Prognostic Marker in Non-recovery Acute Kidney Injury

Chih-Hsiang Chang[1], Chen-Chia Lee[1], Yung-Chang Chen[1], Pao-Hsien Chu[2], Jau-Song Yu[3], Yi-Ting Chen[3]

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Acute kidney injury is a common and complex complication that has high morality and the risk for chronic kidney disease among survivors. The accuracy of current AKI biomarkers can be affected by water retention and diuretics. Therefore, we aimed to identify a non-recovery marker of acute kidney injury in patients with acute decompensated heart failure. We used the Isobaric Tag for Relative and Absolute Quantification technology to find a relevant marker protein that could divide patients into control, acute kidney injury with recovery, and acute kidney injury without recovery groups. An enzyme-linked immunosorbent assay of the endothelial cell protein C receptor (EPCR) was used to verify the results. We found that the EPCR was an outstanding marker for non-recovery renal failure in our setting. Further validation is needed to explore this possibility in different situations.

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RETROSPECTIVE REVIEW TO IDENTIFY RISK FAACTORS FOR AKI IN NON-CARDIAC, POSTSURGICAL PATIENTS

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Purpose
Acute kidney injury (AKI) is a common postsurgical complication that heavily impacts morbidity and mortality, which can lead to decreased quality of life. Despite the prevalence of AKI, the incidence and impact of AKI in non-cardiac, postsurgical patients has not been well documented. The aim of this study is to identify potential pharmacological risk factors for AKI in non-cardiac, postsurgical patients and evaluate a valid screening tool for the prediction of AKI. The goal is to add research to healthcare that decreases postsurgical AKI incidence.
Methods
This is a retrospective, case-control study of non-cardiac, postsurgical patients 18 years and older who were treated at a large, South Florida public hospital from July 2021 through June 2022. This study will include data collection from chart review analyses using the hospital's electronic
health records for 170 patients who underwent non-cardiac surgery during the hospital encounter, 85 with AKI as defined by the National Surgical Quality Improvement Program (NSQIP) and 85 without AKI. The primary outcome of this study is to determine if medications play a role in AKI, with a specific focus on pharmacologic classes. The secondary outcome will evaluate the Simple Postoperative AKI Risk (SPARK) classification tool as a predictor of AKI in
non-cardiac, postsurgical patients. This study will be analyzed using descriptive and correlation data.
Results and analysis are in progress and will be determined at a later date.

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UNI-494 Lowers Urine Beta-2-microglobulin in Rats

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Purpose of the Study: Mitochondrial dysfunction in renal cells play a critical role in the pathophysiology of acute kidney injury (AKI) and chronic kidney disease (CKD). The proximal tubule is the primary sensor and effector in CKD progression and AKI, and measurement of urine beta-2-microglobulin (beta-2M) is a sensitive assay for proximal tubule injury. Nicorandil, a selective mitochondrial ATP-sensitive potassium channel activator, may be a promising AKI treatment,5 but its clinical use is limited by serious gastrointestinal side effects and rapid absorption and elimination. UNI-494, a novel nicorandil prodrug designed to improve its pharmacologic properties, may increase the short half-life and improve the safety profile of nicorandil. We present efficacy data from a study of UNI-494 in a rat IR model.

Methods Used: 49 male Sprague-Dawley rats were randomly assigned to 4 groups to evaluate the in vivo efficacy of UNI-494 in a bilateral renal ischemia-reperfusion (I/R) model. Group 1 was the Sham group (n=10) and groups 2-4 (n=13 each) were established as the I/R models (45 minutes of bilateral occlusion). Group 1 received no treatment, Group 2 received a vehicle, Group 3 received 10 mg UNI-494/kg, and Group 4 received 20 mg UNI-494/kg. Treatments were administered as a single-dose on Day 0, 1 hour prior to modeling. Body weights were measured on Days -1, 0, and 1. Urine samples were collected within 24 hours after the surgery using metabolic cages. T-tests were used to evaluate

statistical differences between groups ($p<0.05$ was considered significant).

Summary of Results: Beta-2M levels were significantly lower for the 20 mg/kg UNI-494 dose group compared to the vehicle group, and beta-2M content in both UNI-494 dose groups (10 and 20 mg/kg) was significantly lower compared to the vehicle group. Beta-2M levels and content were lower for the 20 mg/kg UNI-494 dose group than for the 10 mg/kg dose group. There was no difference in body weight changes between the UNI-494 dose groups and the vehicle group.

Conclusions Reached: The lower levels of urine beta-2M levels in the higher UNI-494 dose group compared to the other groups indicate that the prodrug may have a renoprotective effect. Additionally, the lower levels of beta-2M in the higher dose group compared to the lower dose group indicate a dose-response trend. The mechanism of this potential renoprotective effect should be further investigated.

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Cost effectiveness of urinary C-C motif chemokine ligand 14 biomarker (CCL14) in predicting persistent severe acute kidney injury (AKI)

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Background
Persistent severe AKI (PS-AKI) defined as stage 3 AKI lasting ≥3 days or with death in ≤3 days, or stage 2 or 3 AKI with dialysis in ≤3 days, occurs in 25% of hospitalized patients with stage 2 or 3 AKI. PS-AKI leads to worse outcomes and higher costs. In patients with stage 2 or 3 AKI, CCL14 predicts PS-AKI, and interventions to prevent PS-AKI may improve clinical and economic outcomes. This study aims to assess the cost-effectiveness of using CCL14 in a hospital setting versus standard of care (SOC)
Methods
A de novo analysis combined a 90-day decision tree using CCL14 operating characteristics to identify PS-AKI patients and short-term clinical outcomes in a 66-year-old patient, and a Markov cohort estimating lifetime costs and quality-adjusted life years (QALYs). Cost and QALYs from index admission, 30-day readmission, critical care use, dialysis dependence, and death were compared in the CCL14 and SOC arms. A large retrospective cohort of US hospitals in the PINC AI Healthcare Database informed clinical and cost inputs. US lifetables and USRDS data informed SOC mortality and end-stage renal disease. Utilities were sourced from previous US economic evaluations of renal therapies. The efficacy and price of a hypothetical intervention were explored in scenario analyses. Results were reported as incremental cost-effectiveness ratios. Uncertainty was explored in deterministic and probabilistic sensitivity analyses
Results
Depending on selected costs and efficacy of a hypothetical intervention, the model predicted that using CCL14 to better inform clinical actions was associated with lower costs and more QALYs gained (dominating) or was cost-effective at a willingness to pay of $50,000 per QALY. Assuming the intervention would avoid 10% of PS-AKI complications in AKI stage 2 or 3 patients identified as true positives resulted in 0.08 additional QALYs and a $799 reduction in inpatient and dialysis costs. CCL14 use was associated with a 100% probability of being cost-effective at any willingness to pay. The results were robust to substantial variation of costs and efficacy of the intervention (Fig 1). This suggests CCL14 is likely to represent a cost-effective use of resources in the presence of an efficacious intervention such as KDIGO bundle
Conclusion
Under the premise that early intervention can reduce progression to PS-AKI, the model is supportive of CCL14 cost-effectiveness in identifying patients at risk of PS-AKI to guide clinical practice

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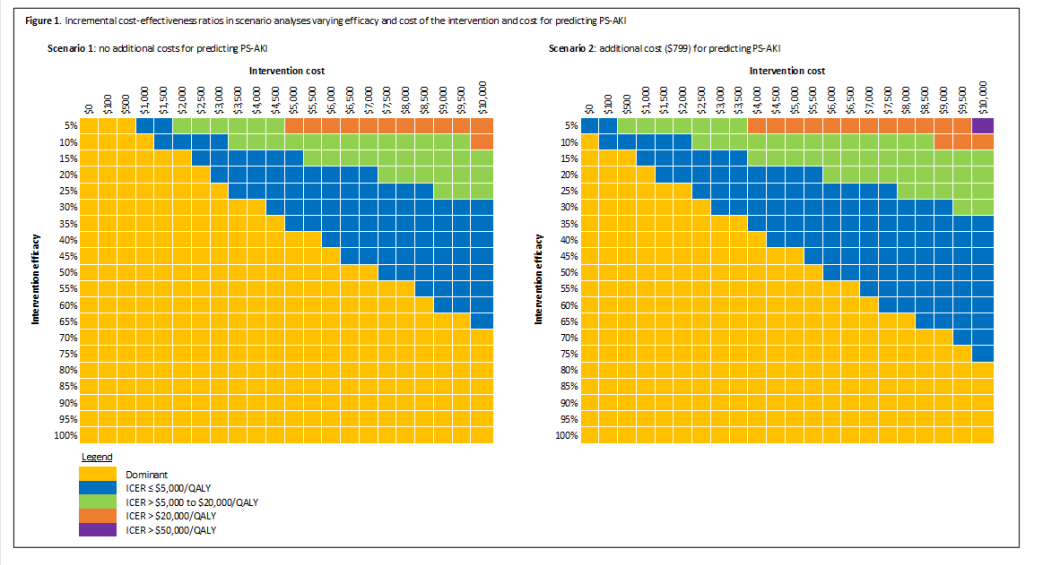

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Role of Immunomodulation Therapy with Selective Cytopheretic Device (SCD) in Reversing Acute on Chronic Liver Failure with Hepatorenal Syndrome and Multi-Organ Failure.

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Background
Alcohol associated liver disease (ALD) is on the rise and has become the leading indication for liver transplantation in United States. Acute on chronic liver failure (ACLF) is a clinical disorder characterized by acute clinical deterioration in patients with pre-existing chronic liver disease. ACLF appears to develop from systemic inflammation, often due to bacterial infections or alcoholic hepatitis, and progresses to multi-organ failure. Severe ACLF with ≥ 4 organ failure has a grave prognosis with a mortality rate at 28 days of 100%. Early liver transplant is the treatment of choice for those who are refractory to medical treatment. Intervention to modulate and lessen this systemic inflammatory state may alter the progression of multi-organ dysfunction and allow time for liver transplantation.
Methods
A male patient in his early 30s presented with acute alcohol associated hepatitis, acute on chronic liver failure, profound hepatic encephalopathy and hepatorenal syndrome. He had greater than four organ failures requiring vasopressors, mechanical ventilation, and continuous renal replacement therapy. He was enrolled into a clinical trial (NCT 04898010) to evaluate an extracorporeal immunomodulating device, SCD.
Results
Treatment with this device resulted in rapid improvement with discontinuation of vasopressors on day 2, extubation on day 4 and transitioned to intermittent hemodialysis on day 7. This treatment was associated with a decline in elevated blood cytokine concentrations and diminution of activation levels of circulating leukocytes (Table). On follow up he was alive on day 90 post treatment and being evaluated for liver transplantation.
Conclusion
The immunomodulation of the cellular elements of inflammation rather than removal or inhibition of soluble cytokines or chemokines of inflammation is the critical target for effective therapy. This first in human treatment of ACLF with SCD, if replicated, suggests a role of SCD for the management of HRS-AKI among those with ACLF as a bridge to liver transplantation.

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Table 1 Clinical and laboratory values

	Admission	Day 0	Day 2	Day 4	Day 6	End	120 hours Post-SCD	Follow-up Day 30	Follow-up Day 90
Absolute Complete Blood Counts									
WBC (10^3/mL)	15.4	20.8	15.9	32.1	35.4	29.9	23.9	23.3	22.6
Neutrophil (10^3/mL))	12.5	18.0	12.1	23	26.8	22.2	20.2	16.7	15.1
Monocyte (cells/mL)	1400	400	1100	4400	4100	3600	2600	2500	4300
Platelet count (10^3/mL)	177	106	45	47	71	93	171	318	234
Liver Function tests									
AST (units/L)	207	316	180	168	161	158	153	148	77
ALT (units/L)	114	115	112	114	38	24	11	105	62
Alkaline Phosphatase (units/L)	112	88	119	146	135	112	105	108	98
Bilirubin (mg/dL)	29.8	30.1	28.6	24.7	22.2	19.7	23.5	18.1	19.2
Albumin (g/dL)	1.9	2.3	2.4	2.4	2.2	2	2.2	1.7	1.7
INR	2.7	1.6	1.6	1.4	1.4	1.5	1.6	1.7	1.8
Immunologic Markers (pg/mL)									
IL-6 (normal 0-16)	NA	210	26	19	40	30	40	NA	NA
IL-8 (normal 24-39)	NA	300	152	91	121	67	121	NA	NA
IL-10 (normal 8-16)	NA	3.8	<1	<1	<1	<1	<1	NA	NA
IL-1RA (normal 178-558)	NA	12738	3815	2109	2984	1299	39	NA	NA
MCP-1 (normal 20-80)	NA	48	22	26	33	43	50	NA	NA

NA, Not Available; IL., Interleukin; RA, Receptor Antagonist; MCP, Monocyte Chemoattractant Protein

a. These samples were obtained immediately before CRRT-SCD initiation

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Aristolochic acid-induced nephropathy is aggravated by Western diet

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Aristolochic acid (AA) ingestion causes Balkan nephropathy, characterized by tubular injury and progression to chronic kidney disease (CKD). AA is taken up by proximal tubule cells and induces p53-mediated DNA damage, but little is known about modulating factors. The Western diet (WD) is rich in saturated fats, sugars, and salt and contributes to the development of metabolic disorders such as obesity and diabetes, but also to the progression of CKD. The aim of this study was to elucidate the impact of WD on AA-induced kidney injury. 5-week-old C57BL6 male mice were fed with WD or normal chow (NC) for 8 weeks, followed by administration of vehicle or AA every 3 days at a dose of 3 mg/kg for 3 weeks. Samples were collected after a 3-week recovery period (n=4/group for vehicle; n=7-8/group for AA). The AA-induced increase in plasma creatinine and the reduction of hematocrit were significantly greater in WD vs NC. This was associated with increased kidney gene expression in WD vs NC of markers of DNA damage (p53), injury (Kim1 and Ngal), and inflammation (Tnfa). The WD group had a greater body weight and, therefore, received a higher total dose of AA (0.73 and 0.6 mg), which may have worsened kidney injury. Therefore, in a second series, the same total dose of AA (0.9 mg) was administered to WD and NC groups. WD similarly increased the AA-induced fall in hematocrit and rise in plasma creatinine and renal p53, Kim1, Ngal, and Tnfa mRNA expression compared to the NC group. These findings suggest that WD increases the susceptibility to AA nephrotoxicity. This model may be useful for studying the mechanistic impact of Western diet on the development and progression of CKD caused by nephrotoxic agents.

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Development and Implementation of an Acute Kidney Injury Remote Patient Monitoring Program

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Background:
At least 30% of survivors of acute kidney injury (AKI) lack appropriate follow-up after hospital discharge. AKI survivors have a highly dynamic posthospital course that warrants close monitoring to prevent adverse outcomes. Remote patient monitoring (RPM) could improve the quality and efficiency of AKI survivor care. The objective was to describe the development and preliminary feasibility of an AKI RPM program.

Methods:
In October 2021, Mayo Clinic implemented an AKI RPM program for individuals who experienced stage 2/3 AKI and underwent nephrology consultation while hospitalized. Patients expected to discharge on dialysis, to a skilled nursing facility, or who were unable or unwilling to participate in the program were excluded. Upon enrollment in the AKI RPM program, AKI education was provided, and home monitoring technology distributed. Patients monitored vital signs, weight, and symptoms daily. Weekly serum creatinine and electrolyte evaluations were scheduled. Nurses evaluated the data daily and adhered to prespecified protocols for management and escalation of care if needed. The maximum program duration was three months. AKI RPM participants were eligible for graduation if they remained off dialysis, with stable creatinine for two consecutive weeks, and no urgent or emergent results in the preceding one-week interval. Post-graduation surveys gauged the patient experience.

Results:
Twenty patients were enrolled in AKI RPM in the first five months. Median [interquartile range (IQR)] age was 67 years (61, 72), 13 (65%) were men, and all identified as non-Hispanic Caucasians. Five patients (25%) required an ICU stay during the index hospitalization. Median creatinine concentrations were 1.5 (1.2, 1.7) mg/dL at baseline and 4.7 mg/dl (3.9, 5.4) mg/dl at peak. Fourteen patients (70%) were discharged from the hospital on diuretics. The median duration of AKI RPM participation was 36 (31, 40) days. Eight patients (40%) experienced an unplanned readmission or an emergency department visit, half (N = 4) of which were attributed to AKI and related circumstances. Of the nine post-graduation survey respondents, all were satisfied with the RPM program and 89% would recommend RPM to other patients with similar health conditions.

Conclusion:
Digital health solutions such as RPM offer a unique opportunity to bridge the care transition from hospital to home and increase access to quality care for the most vulnerable AKI survivors.

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Post-Acute Kidney Injury Clinic: Two-year Achievement And Outcomes

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Background:
Acute kidney injury (AKI) is associated with long-term morbidity and mortality. Therefore, follow-up of AKI survivors is essential. King Chulalongkorn Memorial Hospital (KCMH) has established a post-AKI clinic since 2018. Therefore, we aimed to assess the process of care and outcomes of the cohort in this clinic.

Methods:
This was an observational study at KCMH, Bangkok, Thailand. Patients who had AKI during admission and completed at least 2 follow ups between January 2020 and August 2022 were included. Patients who were enrolled in a clinical trial or had incomplete follow-up were excluded. The Post-AKI clinic pathway includes comprehensive care from multidisciplinary care team (MDCT), which consisted of nephrologists, nurses, nutritionists, and pharmacists. The primary outcome was major adverse kidney events at 1 year (MAKE365), comprising of death, new kidney replacement therapy (KRT) and 30% decline in estimated glomerular filtration rate (eGFR). Secondary outcomes included serial serum creatinine (SCr) concentrations, urine albumin/creatinine ratio (uACR), rate of readmission, and receiving of reno-protective drugs at 1 year.

Result:
A total of 191 patients were followed up at the post-AKI clinic, of which 80 patients were included in the final analysis. The mean age was 65.06 ± 1.77 years. 57.5% were male and 60% had chronic kidney disease. 52% of patients were admitted in intensive care units. There were 72.5%, 16.3% and 11.3% of AKI-KDIGO stage 1, 2 and 3, respectively. 51.9% received KRT during admission. At discharge, 2.5% were KRT-dependent and 48.8% had complete kidney recovery. The mean days from discharge to first visit was 47 ± 6 days. Within 1 year, 100% had SCr measurement and 88.75% had uACR measured at least once. During follow-up, 47.5% received renin-angiotensin aldosterone inhibitors; 57.3% received statins; and 13.8% received sodium glucose cotransporters (SGLT2s) inhibitors. The incidence of MAKE365 was 36.3%, consisting of 3.75% death, 5% ESKD and 32.5% eGFR decline. There was a 25% readmission rate (mostly cardiovascular cause and 3.8% from recurrent AKI). The prevalence of new CKD and CKD progression were 23.75% and 38.75%, respectively.

Conclusion:
There was a high prevalence of MAKE365 in AKI survivors. Our study shows high proportions of SCr and uACR monitoring in post-AKI survivors. Further studies are needed to determine outcomes of post-AKI clinic in real-world settings.

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The impact of C-reactive protein-to-albumin ratio on mortality in patients with acute kidney injury requiring continuous renal replacement therapy: A multicenter retrospective study

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Background: The C-reactive protein-to-albumin ratio (CAR) is a prognostic marker in various diseases that represents patients' inflammation and nutritional status. Here, we aimed to investigate the prognostic value of CAR in critically ill patients with severe acute kidney injury (AKI) requiring continuous renal replacement therapy (CRRT).
Methods: We retrospectively collected data from eight tertiary hospitals in Korea from 2006–2021. The patients were divided into quartiles according to CAR levels at the time of CRRT initiation. Cox regression analyses were performed to investigate the effect of CAR on in-hospital mortality. The mortality prediction performance of CAR was evaluated using the area under the curve (AUC), net reclassification improvement (NRI), and integrated discrimination improvement (IDI).
Results: In total, 3995 patients who underwent CRRT were included, and the in-hospital mortality rate was 67.3% during the follow-up period. The 7-day, 30-day, and in-hospital mortality rates increased toward higher CAR quartiles (all P<0.001). After adjusting for confounding variables, the higher quartile groups had an increased risk of in-hospital mortality (quartile 3: adjusted hazard ratio [aHR], 1.15, 95% confidence interval [CI], 1.02–1.30, P=0.023; quartile 4: aHR, 1.33; 95% CI, 1.18–1.50, P<0.001). CAR combined with APACHE II or SOFA scores significantly increased the predictive power compared to each severity score alone for the AUC, NRI, and IDI (all P<0.05).
Conclusions: A high CAR is associated with increased in-hospital mortality in critically ill patients requiring CRRT. The combined use of CAR and severity scores provides better predictive performance for mortality than the severity score alone.

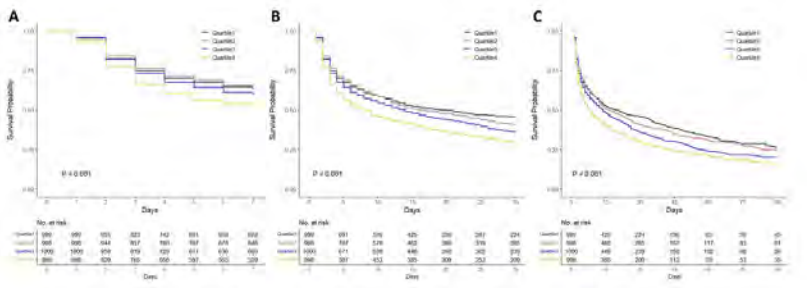

Figure 2. Kaplan–Meier curves for in-hospital mortality according to CAR quartiles. The (A) 7-day mortality, (B) 30-day mortality, (C) 90-day mortality are significantly different according to CAR quartiles (all $P < 0.001$).

Abbreviations: CAR, C-reactive protein-to-albumin ratio.

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Acute Kidney Injury In Patients With Liver Cirrhosis Who Were Admitted To Intensive Care Units

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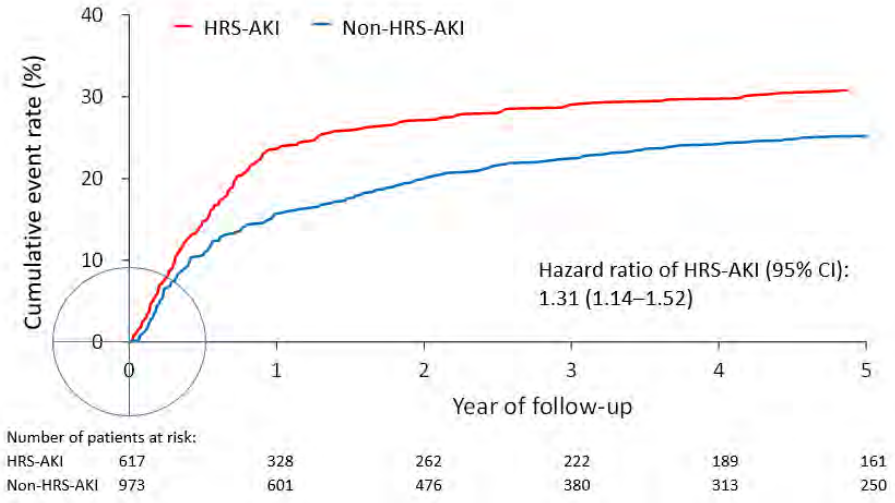
Background:
Acute kidney injury (AKI) is a common complication in patients with cirrhosis. After revised definition of AKI and hepatorenal syndrome (HRS), we aim to further access the association between the different classifications of HRS and clinical outcomes in patients with HRS in intensive care units (ICU).
Methods:
This retrospective cohort study was performed by identifying the cirrhotic patients who were admitted to ICU between January 1, 2007, and May 31, 2019, in Chang Gung Memorial Hospitals. Patients were divided into HRS-AKI and non-HRS-AKI groups. In-hospital outcomes were mechanical ventilator (MV) requirement, vasopressors requirement, length of ICU stay, in-hospital mortality, and ICU mortality. Outcomes after discharge were liver transplantation during follow-up and 5-year mortality.
Results:
A total of 3,119 patients were analyzed, of whom 1,721 and 1,398 patients were noted with and without HRS-AKI in ICU, respectively. The mean age was 59.3 years and male was predominant (71.1%). Forty-four (n = 1,364) percent of the patients had pre-existing chronic kidney disease. The risk of vasopressors requirement (70.5% vs. 49.9%; odds ratio [OR] 1.45, 95% CI 1.16–1.80), in-hospital mortality (64.1% vs. 30.4%; OR 1.43, 95% CI 1.12–1.83) and ICU mortality (41.3% vs. 15.7%; OR 1.34, 95% CI 1.02–1.75) was significantly greater in the HRS-AKI group. The 5-year mortality risk was significantly greater in patients with HRS-AKI than those without (30.8% vs. 25.2%; hazard ratio 1.31, 95% CI 1.14–1.52). However, the incidence of liver transplantation did not significantly differ between groups.
Conclusion:
Patients with HRS-AKI in ICU had higher vasopressor requirements and dose, higher ICU mortality, higher in-hospital mortality, and higher 5-year mortality than patients with Non-HRS-AKI without HRS-AKI. Moreover, whether temporal or continuous renal injury, patients in ICU with HRS-AKI were indicated to have a poor clinical outcome. If the patients with continuous renal injury, combined with HRS-AKI, HRS-AKD, and HRS-CKD, it represented the highest in-hospital mortality and 5-year mortality.



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Incidence, Risk Factors, Clinical Outcomes and Novel Biomarkers Of Sepsis-Associated AKI vs. Other Causes Of AKI In Intensive Care Unit

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Background and aims: Association between sepsis and AKI (SA-AKI) leads to an increased risk of death and progression toward chronic kidney disease (CKD). Study aims were to evaluate: 1) incidence, risk factors and clinical outcomes of SA-AKI vs. other causes of AKI (OC-AKI); 2) role of plasma Extracellular Vesicles (EV) as novel early biomarkers of SA-AKI.

Methods: 840 patients admitted to ICU in 2022 were enrolled in the study and divided according to Consensus Sepsis-3 and KDIGO AKI in the following groups: 1) Controls; 2) Sepsis; 3) OC-AKI; 4) SA-AKI. In all groups, EV were isolated from plasma samples and characterized for concentration/size (Nanotrack analysis-NTA) and for protein content (flow cytometry).

Results: 486/840 patients were excluded from the study (ICU stay <72 hr); 354/840 patients were classified as follows: 100 Controls (28.3%), 27 Sepsis (7.6%); 106 OC-AKI (29.9%); 121 SA-AKI (34.2%). Median age of SA-AKI group was 68.8 vs. 61.2 of OC-AKI, with a predominance of males (68.2%): SA-AKI showed an increased prevalence of risk factors such as hypertension, diabetes, cardiovascular diseases and cancer. In comparison to OC-AKI, SA-AKI patients presented higher serum creatinine levels (1.6 mg/dl) and lower eGFR values (61 ml/min) at admission. AKI globally increased the risk of death (OR 1.76; $p=0.023$) together with older age (OR 1.03; $p=0.001$): SA-AKI showed an increased risk of death in comparison to Controls (OR 3.2; $p<0.001$) and to OC-AKI (OR 1.95; $p=0.023$). The presence of stage 3 KDIGO AKI increased the risk to develop a persistent form of AKI (OR 8.19; $p<0.001$). Of note, stage 2 and particularly stage 3 KDIGO classes were more frequently found in SA-AKI vs. OC-AKI (stage 2: SA-AKI 22% vs. OC-AKI 17%; stage 3: SA-AKI 33% vs. OC-AKI 8%; $p<0.01$). NTA analysis revealed a significant increase of plasma EV concentration in the SA-AKI group in comparison to OC-AKI or Sepsis alone ($p<0.01$). In SA-AKI, EV carried on their surface an increased percentage of leukocyte (CD14, CD24, CD44, HLA-DR) and endothelial (CD31, CD105) markers as well as factors involved in coagulation (TF) and complement (C5b9) cascade activation.

Conclusions: Sepsis is the leading cause of AKI in ICU, particularly in older male patients. In comparison to OC-AKI, SA-AKI is associated with a worse outcome, need of RRT during hospitalization and progression toward CKD. Plasma EV phenotype could be used for an earlier detection of SA-AKI with conventional urinary biomarkers.

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suPAR inflames kidneys with T cells and aggravates septic acute kidney injury

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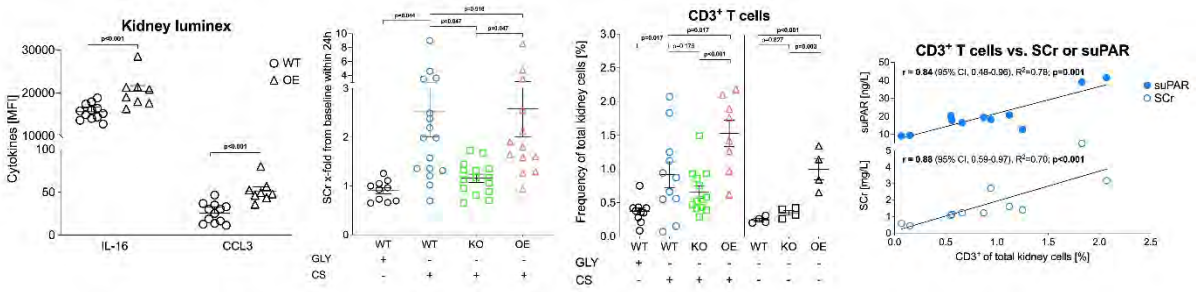
Background:
The soluble urokinase plasminogen activator receptor (suPAR) is an immune-derived glycoprotein implicated in the pathogenesis of acute kidney injury (AKI). Sepsis is a strong inducer of plasma suPAR levels and a known contributor to the development of AKI. We hypothesized that suPAR is involved in the pathophysiology of sepsis-related AKI.
Methods:
We used a polymicrobial model of sepsis in wild-type (WT), uPAR knockout (KO, suPAR deficient), and transgenic suPAR-overexpressing (OE) mice. We compared measures of kidney function, tissue damage, and tissue inflammation in septic and untreated mice. Kidney tissue inflammation was quantified by kidney flow cytometry, immunohistostaining, and kidney luminex assay.
Results:
Kidneys from untreated OE mice expressed high levels of interleukin-16 (IL-16) and C-C motif chemokine ligand 3 (CCL3); both involved in cell-mediated kidney injury and potent chemo-attractants for T and NK cells. Consistent with this expression pattern, we found significantly increased numbers of kidney T and NK cells in untreated OE mice, equaling numbers observed in septic WT mice. Further, high plasma suPAR aggravated sepsis-induced ultrastructural kidney damage, cellular apoptosis and kidney function impairment after 24h of sepsis. In contrast, KO mice showed a strong protective effect against AKI. Kaplan-Meier analysis revealed a survival benefit of KO over OE mice (87% vs. 50%, p=0.033). The composition of kidney immune cells in sepsis was strongly influenced by varying suPAR plasma levels. Especially, numbers of kidney T cells were strongly linked to the extent of systemic suPAR elevation and kidney function impairment, with significant higher numbers in septic OE mice compared to septic WT and KO mice.
Conclusions:
suPAR inflames the kidney with T cells potentially via local upregulation of IL-16 and CCL3. “SuPAR inflamed” kidneys react with increased kidney injury in sepsis which can potentially be improved by deleting suPAR. These findings hold great potential for new therapeutic strategies.



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Improving Mortality Prediction in Patients Undergoing CRRT

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Background: Mortality rates in pediatric intensive care units continues to decline despite the treatment of increasingly complex patients and diseases. Given this, there continues to be great interest in predicting outcomes for patients to both improve targeting for research trials and to select patients most appropriate for aggressive therapies; however, there still is not a uniform consensus definition of the sickest patients or the best way to quantify mortality risk. This retrospective analysis presents single center data of 21 patients who underwent CRRT and compares their respective PELOD-II, PRISM III, pRIFLE stratification and vasopressor infusion rates relative to mortality. The difficulty with utilizing PELOD-II, PRISM III and pRIFLE scores is the requirement of frequent laboratory monitoring along with the need for baseline laboratory values, while using vasopressor infusion rates is, in comparison, relatively easy, as it only requires accurate documentation within an electronic medical record.
Methods: Our group collected data of patients without a history of chronic renal disease admitted to a large, tertiary PICU between 2016-2021 who underwent CRRT. This analysis extracted PELOD-II and PRISM-III scores along with glomerular filtration rates and vasopressor infusion rates for these patients. From this data the sensitivity and specificity of mortality prediction is calculated and used in the generation of receiver operator characteristics and area under the curve values for mortality of each previously mentioned variable.
Outcomes: The data presented in this analysis demonstrates that all discussed variables perform similarly when predicting mortality.
Conclusions: While complex metrics such as PELOD-II and PRISM-III scores have been demonstrated to perform well when predicting mortality in pediatric patients admitted to pediatric intensive care units, our analysis demonstrates that initial and daily vasopressor requirements can perform just as well and may provide a more easily monitored measurement when considering which patients are most likely to perish during their hospitalization.

Mortality Prediction

Epinephrine Dose (mcg/kg/min)	Sensitivity	Specificity	AUC
0.05	0.8	0.65	1
0.1	0.75	0.65	1
0.15	0.75	0.65	1

Norepinephrine Dose (mcg/kg/min)	Sensitivity	Specificity	AUC
0.05	0.333	0.845	0.667
0.1	0.25	0.91	1
0.15	0.25	0.91	1
0.20	0.111	0.91	1

% Change in eGFR	Sensitivity	Specificity	AUC
≥ 25	1	0	1
≥ 50	1	0.18	1
≥ 75	0.88	0.64	1

PELOD II Score	Sensitivity	Specificity	AUC
≥ 5	0.88	0.18	0.43
≥ 10	0.4	0.91	1

PRISM III Score	Sensitivity	Specificity	AUC
≥ 5	0.75	0.18	0.37
≥ 10	0.50	0.18	0.56
≥ 15	0.25	0.64	0.63
≥ 20	0.13	0.73	1

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Use of Urine NGAL for AKI Screening Following Triggering of Baby NINJA

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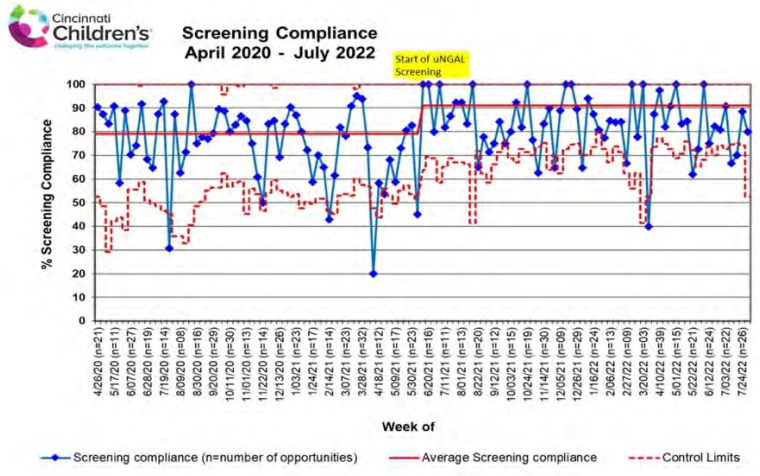
Background
Nephrotoxic medication exposure in neonates is common and a modifiable cause of acute kidney injury (AKI) in the neonatal intensive care unit (NICU). Nephrotoxic Injury Negated by Just-in-time Action in the NICU (Baby NINJA) is a quality improvement initiative aimed to reduce nephrotoxic medication (NTM) exposure, AKI prevalence and intensity, but requires daily serum creatinine (sCr) screening. Urine neutrophil gelatinase-associated lipocalin (uNGAL) has previously been associated with neonatal AKI and offers a less invasive alternative AKI screening mechanism.

Methods
This single center observational study observed use and outcomes in the first year of an alternative AKI screening pathway uNGAL in June 2021. For the alternative pathway providers are given the daily option for sCr monitoring or obtainment of uNGAL. If the uNGAL is >= 150 ng/mL, then screening is transitioned to daily sCr monitoring until 2 days following the end of NTM exposure or seven days. For comparison, the postimplementation era was compared to the 13 months prior when Baby NINJA was well established in our unit. Statistical analysis included descriptive statistics including median and interquartile range [IQR], Mann-Whitney U Test, and Kruskal-Wallis rank sum test.

Results
Increased compliance following initiation of the less invasive alternative screening was observed following implementation (78% vs. 84%, p= 0.003, Figure 1) with 37% of screening occurring by uNGAL. Of the 21 conversions to daily sCr monitoring, median uNGAL was 263 ng/mL [IQR: 195-825 ng/mL]. High-risk nephrotoxic medication exposure rates per 1000 NICU patient days decreased from 8% to 6%, p=0.0003. There was no statistical difference in AKI rates or intensity between the pre and post implementation eras. Following implementation, eight subjects experienced a combined total of 18 days of AKI, with five subjects experiencing AKI prior to baby NINJA trigger. The remaining two subjects were triggered by uNGALs of 498, 859 and 2835 ng/dL. Of those with AKI four had an outcome of death within 48 hours of meeting NINJA criteria. Clinical uNGAL was obtained in conjunction with daily sCr by the team with a median uNGAL concentration of 946 ng/mL [IQR: 594 – 2724 ng/mL].

Conclusion
Urine NGAL offers a less invasive AKI screening option for nephrotoxic medication exposure. Urine NGAL should not replace serum creatinine or urine output for diagnosis of AKI.



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Orally Administered UNI494 Is Well-Tolerated in Dogs

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Purpose of the Study: Nicorandil is a selective mitochondrial ATP-sensitive potassium channel activator that may be beneficial for several disease states, including acute kidney injury. However, its clinical use is limited by serious gastrointestinal (GI) side effects and rapid absorption and elimination. UNI494, a novel nicorandil prodrug, may increase the short half-life and improve the safety profile of nicorandil. We present safety data from a study of UNI494 in a dog model.

Methods Used: UNI494 was administered orally to 32 Beagle dogs over 28 days with a 14-day recovery period. Dogs were assigned to 4 groups: 0 (control), 5, 25, and 50 mg UNI494/kg/day. Each group contained 3 male and 3 female dogs, with 2 additional animals of each sex in the control and highest UNI494 dose groups to assess recovery. Safety parameters included in-life observations and measurements (e.g., morbidity/mortality checks, clinical signs, body weight, food consumption, ophthalmological examinations), post-treatment and post-recovery ECG and respiratory parameters, clinical chemistry, urinalysis, coagulation and hematology, toxicokinetic analysis and post-treatment and post-recovery organ weights, macroscopic findings, and histopathology.

Summary of Results: No adverse UNI494-related clinical signs, changes in body weight, food consumption, ophthalmological examinations, hematology, clinical chemistry, urinalysis, organ weight, or macroscopic observations were observed in the 5, 25, or 50 mg UNI494/kg dose groups. Microscopic changes consisting of vascular wall thickening/perivascular fibroplasia in the heart, acinar cell apoptosis/necrosis in the pancreas, and tubular degeneration in the kidney were observed in the 25 and 50 mg UNI494/kg/day groups. There were no unscheduled deaths. For nicorandil, a dose-proportional increase in AUC0-t and a trend toward a slightly less to roughly dose-proportional increase in Cmax was observed over the dose range of 5 to 50 mg UNI494/kg following both single and multiple doses for both sexes.

Conclusions Reached: Following administration, UNI494 was rapidly converted to nicorandil, which increased in a dose-proportional manner. UNI494 was well-tolerated, and the No Observed Effects Level (NOAEL) for UNI494 is 5 mg/kg/day. Based on the NOAEL in dogs, the maximum recommended starting dose in humans with a 10x safety margin is 16 mg. This information should be used to design further efficacy and safety studies of UNI494.

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Expansion And Characterization Of Regulatory T Cell Populations From Acute Kidney Injury Patients

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PURPOSE: Human acute kidney injury (AKI) is manifested by inflammation, and an early feature in the pathogenesis is the accumulation of immune cells in the kidney. Modulating the immune system's response to the proinflammatory signals produced in the injured kidney can have a profound effect on the extent of kidney dysfunction and tissue damage. Recent studies have begun to illuminate the role of regulatory T cells (Tregs), which suppress kidney inflammation and preserve kidney function. This study evaluated the distribution of Tregs and their effects in AKI patients.
METHODS: We enrolled 30 adult patients diagnosed with AKI at Kosin University Gospel Hospital from March to

December 2020. Heparinized blood samples were collected at the initiation of the study and 3 months afterwards. Differentiation and expansion of Tregs were studied by flow cytometry to compare the Tregs subpopulations. Tregs were defined as CD4+CD25highCD127low/-FoxP3+ cells. Severe AKI was considered as stage 2 or stage 3 AKI.
RESULTS: The mean age of the patients was 61.0 ± 6.2 years, and mean creatinine level was 2.0 ± 0.8 mg/dl. On average, the creatinine level at AKI was 0.4 mg/dl higher than the creatinine levels after 3 months (95% CI, 0.09-0.66, p = 0.011). Tregs were significantly higher in severe AKI patients than stage 1 AKI (9.7 ± 15.9 vs. 2.2 ± 2.8, respectively, p = 0.038). There was a significant decrease in the mean numbers of Tregs by 63.5 unit over 3 months. (95% CI, 26.8-100.2, p < 0.001).
CONCLUSION: In patients with AKI, the number of Tregs increased immediately after the decrease in kidney function, and the number of Tregs was normalized after the kidney function was restored. In the future, it is expected to reduce kidney damage by re-administering Tregs grown in vitro to the same patient.

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Utilization of Angiotensin II for Catecholamine-Resistant Shock in Children: A Single Center Descriptive Case Series

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Purpose: Catecholamine-resistant shock (CRS) is associated with high rates of morbidity and mortality in children, and no evidence-based recommendations exist for management. Angiotensin II (Ang II) is a novel vasoactive agent for CRS that has been demonstrated to be efficacious in adults, particularly in those with acute kidney injury (AKI) and presumed renin-angiotensin system (RAS) derangement as evidenced by increased serum renin. No data regarding the use of Ang II in children has been published. We aimed to describe the clinical characteristics and outcomes of children with CRS receiving Ang II.

Methods: We performed a single center (CCHMC) retrospective study of all children and young adults (0-25 years) who received Ang II for CRS from 01/2018-11/2022. Demographic, clinical and outcome data were assessed for each subject. Vasoactive inotropic scores (VIS) were examined pre- and post-initiation of Ang II to assess response to therapy.

Results: Among 20 patients, 19 (95%) had sepsis at initiation of Ang II, 18 (90%) had severe AKI, and 15 (75%) were requiring continuous renal replacement therapy (CRRT) (75%). Table 1 outlines clinical and outcome data. The median age was 10.2 years (range: 1 month-23 years). Median time from initiation of vasoactives to Ang II was 142 hours (IQR 18,350) and the median VIS at initiation was 64 (IQR 38,90). Median duration of Ang II therapy was 26.9 hours (IQR 4,73), with a decrease in VIS noted at 6 hours (-24.4%, IQR [-46,-1.4]) and at discontinuation (-19.6%, IQR [-82,14.4]). Subjects who initiated Ang II earlier (before median 142 hours) had greater decrease in VIS by discontinuation compared to those who started later (-50% [IQR -90, 4.5] vs. -3.7% [-46%,119%], p=0.15). 8 subjects had renin levels sent prior to initiation (median 3527 pg/ml, range: 918-6000). 14 (70%) suffered ICU mortality; those who died started Ang II later than those who survived (median time to Ang II 161 hours [IQR 28.9-387] vs. 109 hours [IQR 5.7-276], p=0.36).

Conclusions: Ang II appears to reduce vasoactive burden in children with refractory CRS, though outcomes remain poor. In this cohort, Ang II was initiated late in vasoactive course, and commonly in children with severe AKI and evidence of RAS derangement by serum renin. It appears earlier initiation of Ang II may be beneficial, and further study is needed to determine when and in whom its use is warranted.

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Table 1

	Cohort Data (n=20)
Demographics	
Age, years	10.2 (1.6-18)
Sex at birth (% female)	13 (65)
Immunocompromised, yes (%)	10 (50)
History of previous blood clot, yes (%)	10 (50)
Pre-Ang II Data (24 Hours Prior)	
Sepsis, yes (%)	19 (95)
Time from Initiation of Vasoactives to Ang II, hours	142 (18.1,350)
PELOD-2	9.5 (7.3,11)
Serum Renin, pg/ml*	3527 (1697,5571)
Urine NGAL, ng/ml**	3456 (763,15000)
VIS Score	64 (38,90)
Extracorporeal Support at Ang II Initiation, yes (%) - ECMO - CRRT	15 (75) 2 (10) 15 (75)
Severe AKI, yes (%)	18 (90)
Outcome Data	
Duration of Ang II Therapy, hours	26.9 (4.0-73.3)
% Change VIS - 6 hours - At discontinuation	 -24.4 (-45.7,-1.4) -19.6 (-81.6,14.4)
New Blood Clot on Ang II, yes (%)	1 (5)
ICU Mortality, yes (%)	16 (70)

Continuous data reported as median (IQR)
Ang II- angiotensin II; VIS- vasoactive-inotropic score
*8 patients with serum renin values obtained clinically prior to/at initiation
**7 patients with urine NGAL values obtained

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Impact of a Multidisciplinary Acute Kidney Injury Survivor Program on Discharge Summary Completeness

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Introduction
Incomplete hospital discharge summaries among acute kidney injury (AKI) survivors hinder handoff and follow-up at care transitions. To improve AKI survivor care, Mayo Clinic launched the AKI in Care Transition (ACT) Program to include pre-discharge patient education by nurses and coordination of post-discharge follow-up with a primary care provider and pharmacist within 14 days of discharge. As part of the program, ACT team members document the presence of AKI in hospital notes. This study aimed to determine if ACT participation was associated with improved discharge summary completeness.

Methods
ACT was a prospective pilot study conducted at Mayo Clinic, Rochester, MN, from April 2020 to November 2021 for patients who survived severe AKI (KDIGO Stage III) to discharge home without dialysis requirement. ACT deployment in phases allowed between-group comparisons (Usual care vs. ACT). Each hospital discharge summary was reviewed for several elements, including AKI documentation, etiology, course, follow-up, and care plan recommendations. Discharge summary completeness was treated as an all or none binary variable (primary endpoint) and compared using the Fisher's Exact test. Secondarily, we assigned a continuous score based on completed elements (total possible 5) which were compared between groups with the Wilcoxon Rank Sum test.

Results
Among the 110 candidate AKI survivors, 46 consented and were enrolled (31 Usual Care, 15 ACT). Only 7(15%)

discharge summaries included all five elements of AKI evaluation. Discharge summary completeness was similar between groups [All or none compliance: 5 (16%) Usual Care vs. 2 (13%) ACT; P = 0.99; One point for each element, total possible 5, median (IQR): 3 (2, 4) Usual Care vs. 4 (3, 4) ACT; P = 0.42]. The element most often missing in discharge summaries was care plan recommendations (e.g., 'avoid nephrotoxins, 'stay hydrated).

Conclusion
Despite focused education, documentation, and follow-up as part of the ACT program, a significant proportion of AKI survivors lacked the necessary information on their hospital discharge summaries. Interventions to improve handoff in AKI survivors are needed to facilitate a seamless transition from the acute to post-acute care setting.

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Ilofotase Alfa Exerts Renal Protective Effects in Patients with Sepsis-Associated Acute Kidney Injury.

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Sepsis-associated AKI (SA-AKI) is associated with mortality and long-term sequelae, but no pharmacological options are available. Ilofotase alfa is a human recombinant alkaline phosphatase with renoprotective effects that showed improved survival in SA-AKI patients in a Phase 2 study. 'REVIVAL', a large global phase 3 trial (NCT04411472), was conducted to confirm the efficacy and safety of Ilofotase alfa in patients with SA-AKI.

REVIVAL was conducted in SA-AKI patients (on vasopressor and <48hrs of AKI, according to KDIGO definition) recruited from 120 sites in Europe, North-America, Australia, New Zealand, and Japan. The primary endpoint was 28-day all-cause mortality. The key secondary endpoint was Major Adverse Kidney Events on day 90 (MAKE90). A pre-unblinding modified MAKE90 was defined as death up to Day 90, RRT through Day 28 and on Day 90, >25% drop in eGFR at Day 90, rehospitalization to Day 90.

The trial stopped for futility after 649 patients enrolled (Placebo n=319; ilofotase alfa n=330) following a planned interim analysis. The observed 28-day mortality is 27.9% on both arms in the modified intended to treat combined group (patients that received at least one dose). No safety concerns were identified. A beneficial effect on the modified MAKE90 was observed (p=0.031) (Figure 1), mainly driven by reduction of the number of patients receiving renal replacement therapy (RRT) (28.2% Ilofotase alfa vs 36.4% placebo). This effect was most pronounced in patients with pre-existent renal impairment.

In conclusion, ilofotase alfa exerts renoprotective effects in SA-AKI. Further research is required to confirm a role for treatment of SA-AKI in patients with pre-existent renal impairment.

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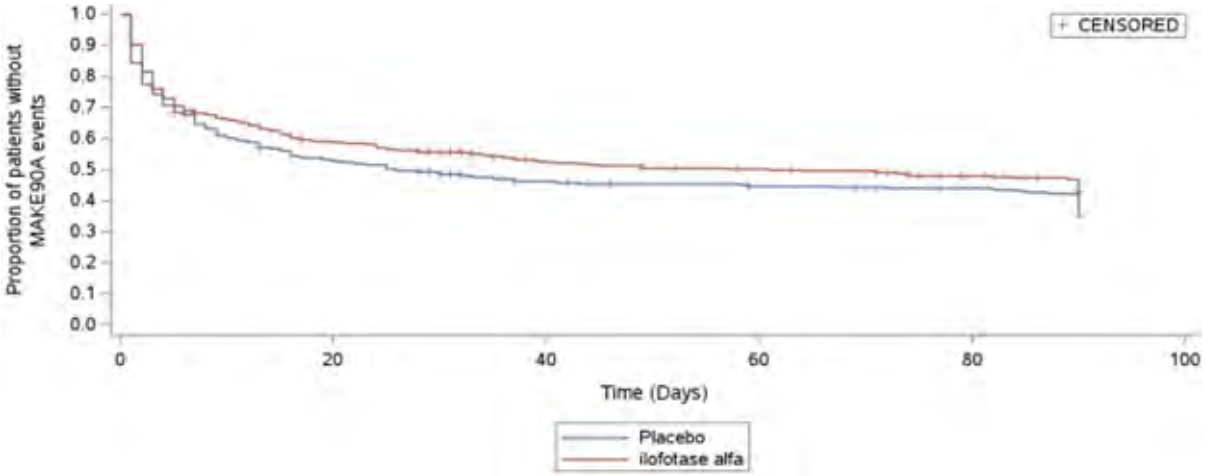
Figure 1: Proportion of patients without a MAKE90 at day 90. P-value for the probability difference of ilofotase alfa compared to placebo 0.031. All patient events prior to Day 90 are censored/counted on the date of the event, all patient events following



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Kidney Protective Effects of Acetazolamide for Patients Receiving High Dose Methotrexate: A Systematic Review and Meta-Analysis

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Background
Urine alkalization is one of the standard treatments to prevent acute kidney injury (AKI) in patients who receive high-dose methotrexate (HDMTX). Sodium bicarbonate has been used universally, and acetazolamide (AZL) is a promising substitute with many advantages. However, there is limited and incongruent evidence about the use of AZL in this population.
Objectives
We aimed to evaluate the efficacy and safety of AZL in patients with HDMTX in comparison with standard treatment (sodium bicarbonate...). The primary outcome was the efficacy of AZL for urine alkalization and its protective effect against HDMTX-related renal adverse events. The secondary outcome was the safety of AZL and the length of hospital stay (LOS).
Method
The protocol was registered at PROSPERO (CRD42022352802) in August 2021. Six databases searched for relevant articles that demonstrated the use of AZL in patients who underwent HDMTX chemotherapy. Statistical analysis was carried out using RevMan software (version 5).
Results
Among 198 articles retrieved from databases, we included six articles. Four studies with five datasets (totaling 558 patients/cycles) were then used in the meta-analysis. The results did not show a significant difference between AZL use with standard treatment versus standard treatment alone in the number of AKI events (MD =0.79, 95% CI 0.48–1.29, P=0.34). Similarly, no significant difference in AKI incidence resulted from a subgroup analysis of studies in which all patients were administered AZL via PO route (MD =0.7, 95% CI 0.38 to 1.31, P = 0.27), I2 = 10%. Regarding the change in time to urine pH goal, there was an insignificant difference between the two groups (MD =0.07, 95% CI −1.9 to 2.04, P

= 0.95), I2 = 25. Furthermore, our meta-analysis showed that AZL did not prolong LOS (MD = 0.75, 95% CI -0.8 to 2.31, P = 0.34), I2 = 0%. Noteworthy, AZL treatment is less expensive and less associated with increased weight than the standard treatment. The only reported side effect of AZL was hypokalemia in one study.
Conclusions
Our study suggests AZL treatment is a potential substitute for urine alkalization in patients with HDMTX. Furthermore, AZL appears to be a relatively safe drug. However, double-blind, randomized, controlled trials are required to confirm these findings.

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A novel combination for the treatment of Guillain-Barré syndrome (GBS): Experience at a Private Hospital in Puebla, Mexico.

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[1]*Hospital Angeles Puebla*

Backgrounds and aims: Therapeutic plasma exchange (TPE) has shown to hasten recovery in patients with GBS1. The Committee of the American Society for Apheresis (ASA) recommends TPE up to 6 sessions in severe cases of GBS (A1 recommendation), or Intravenous immunoglobulin (IVIG), or TPE followed by IVIG2. The study's objective was to show the outcome of disability grade and cost-effectiveness in a retrospective study of four selected patients with severe GBS, treated with TEP + IVIG at a private hospital in Puebla, Mexico.
Methods: The study retrospectively analyzed clinical data of four selected GBS patients who were treated with 3 TPE sessions (using apheresis system) + IVIG (low dose 0.5 g/kg/day for 5 consecutive days). Fluid replacement with Albumin 5%, and additional treatment with steroids. The medical records were analyzed for demographic data, indications for TPE, results of the treatment, costs and complications. In addition, the patient's muscle strength progress was video recorded.
Results: After 3 weeks, the treatment significantly decreased GBS disability score and improved Medical Research Council muscle strength scores (p=0.002). None adverse events were reported in any procedure. Difficulty in jugular venous access wasn't observed.
Conclusion: There was no difference in efficacy with 3 TPE sessions and the combination with IVIG in comparison to ASA recommendations. Both therapies combined showed potential benefits and cost effectiveness. A study with a higher number of patients is needed in order to strengthen the results and provide more accurate suggestions for patients.

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Continuous Veno-Venous hemodiafiltration with novel adsorbing membrane in Septic Shock Patients Requiring Renal Support: Experience at a Private Hospital in Puebla, Mexico.

Jesus Mier Naylor[1], Ruben Lopez Merino[1], Michele Bogetti Salazar[1]

[1]*Hospital Angeles Puebla*

Background: Excessive po-inflammatory and anti-inflammatory cyitokines are mediators for hemodynamic alterations and multi-organ failure in septic patients. Extracorporeal treatment with an hemofilter has been introduced to eliminate inflammatory response during sepsis-associated acute kidney injury. The aim of this study is to retrospectively review the medical records of septic patients submitted to continuous veno-venous hemodiafiltration (CVVHDF) high volume with a

new adsorbing membrane for endotoxin, cytokine and fluid/uremic toxin removal, and evaluate the safety and cardiorenal response.
Materials and methods: The medical records of 8 septic patients (7 men, 1 woman, age 54-90 y.o., with SOFA score >14) submitted to CVVHDF high volume with adsorbing membrane have been reviewed, from January 2021 to February 2022. The adsorbing membrane was used through continuous renal replacement therapy machines. At basal time, first 24 hr, and at the end of the treatment, the clinical data and the cytokines levels were analyzed.
Results: All of the 9 patients had acute kidney injury (AKI). Every CVVHDF treatment was at least 24 h, with a maximum of 168 h. No AE events were reported. The main cardiorenal and respiratory parameters improved with a decrease of the amine requirements. Cytokines and procalcitonin activity assay decreased. SOFA score decreased. All the patients were discharged from the hospital alive.
Conclusion: In septic shock patients with AKI, CVVHDF with this new adsorbing membrane may be safe and improves the cardiorenal - function and the clinical condition. The effect on cytokines and fluid restriction post resuscitation may explain in part these results.

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Extracorporeal Cytokine Hemoadsorption as Rescue Treatment in Critically ill Patients with COVID-19 Pneumonia.

Jesus Mier Naylor[1], Ruben Lopez Merino[1], Santiago Samuel Vargas Bello[1]

Backgrounds/aims: Cytokine storm plays an important role in the pathophysiology of COVID-19 disease. Extracorporeal hemadsorption (HA) is a potential adjunctive therapy in severe cases of COVID-19 associated pneumonia. In this retrospective study we report data from critically ill patients with HA during the first wave of the pandemic in a private hospital in Puebla, Mexico.
Methods: We retrospectively analyzed the medical records of critically ill patients with COVID-19 pneumonia, severe acute respiratory failure and hypercytokinemia were analyzed. All the patients underwent cytokine hemadsorption using an extracorporeal adsorber with advanced porous polymer sorbent bead technology. Clinical and laboratory data (D-dimer, Ferritin, C-reactive Protein and Lactic Dehydrogenase) were collected: on admission, before and after HA therapy.
Results: Cytokine storm plays an important role in the pathophysiology of COVID-19 disease. Extracorporeal hemadsorption (HA) is a potential adjunctive therapy in severe cases of COVID-19 associated pneumonia. In this retrospective study we report data from critically ill patients with HA during the first wave of the pandemic in a private hospital in Puebla, Mexico.
Conclusion: Critically ill patients with COVID-19 with severe acute respiratory failure and hypercytokinemia who received adjuvant treatment with cytokine hemadsorption showed a significant reduction in inflammation biomarkers levels. We found no mortality improvement in our study; this may be due to the delayed response of the specialists in the Intensive Care Unit department. Further studies are needed in order to improve early intervention, before cytokine storm.

RRT TECHNIQUE CHARACTERISTICS

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A Study of Dilution Modes and TMP under Different Operational Conditions in CVVH

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Introduction: An experimental study assessing specifically the effect of dilution modes on effective solute clearance in CRRT was investigated under CVVH mode, with pure post-dilution as the reference mode. The clearances for both small and middle molecules were measured for varying degrees of post/pre-dilution balance and different flow conditions. Materials and Methods: The Prismaflex (Baxter) machine was used to deliver replacement fluid at different dilution points [pre-blood pump dilution (PBP), PRE and POST]. Simulated treatment (N=3 for each condition) involved 6 l of bovine blood (Hct ~ 35%, 34oC-36oC) processed at zero net ultrafiltration for a duration of 240 minutes. A 1.4 m2 hemofilter (HF 1400; Baxter) was used. The three experimental conditions were: 1) blood flow rate (QB): 190 mL/min; replacement flow rate (QR): 2 L/hr (33 mL/min), 2) QB: 290 mL/min; QR: ~3 L/hr (50 mL/min, 3) QB: 380 mL/min; QR: ~4 L/hr (67 mL/min). These conditions were chosen to maintain filtration > 25% in POST. Solute clearance estimates at various time points were based on mass balance calculations. Results and Discussion: There were significant differences ($p < 0.001$) in urea and creatinine clearance for the different experimental conditions. There was a significant decrease ($p < 0.01$) in urea and vancomycin clearance from POST to PRE and from POST to PBP, although there were no significant differences between PRE and PBP for any of the solutes. Significant differences ($p < 0.001$) in inulin and vancomycin clearance in these 3 experimental conditions. No significant differences ($p > 0.05$) in inulin clearance between post-dilution and pre-dilution mode, post-dilution and pre-pump-dilution mode, and pre-dilution and pre-pump-dilution mode were observed. Decreases in MM SC and Clearance, in concert with increases in TMP. w/o changes in filter pressure over time. Conclusions: 1) SM solute clearance increased as the extent of Pre decreased 2) MM SC decreased substantially in POST with time, likely due to secondary membrane effects, evidenced by predictable pressure changes. 3) The data obtained by varying Pre- and Post-percentages are predictable for SM but not for MM. 4) Higher clearance values for MM can be achieved in Pre and PBP rather than in Post under low TMP. These results should be considered in the interpretation of recent CRRT dose/outcome studies.

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Extracorporeal cytokine adsorption in septic shock and severe coronavirus disease: A scoping review

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Introduction: Extracorporeal cytokine adsorption using modified membranes removes endotoxin molecules, pathogen- and damage-associated molecular patterns and removes inflammatory cytokines while modulating the dysregulated immune response in those with sepsis and multiple organ dysfunction. The objective of this scoping review is to explore the effectiveness of modified membranes in those with sepsis or severe coronavirus disease.

Methods: Data sources included PubMed from inception to November 2022. We screened titles and abstracts and potentially eligible full text reports to determine eligibility, and subsequently abstracted data. Eligible trials enrolled adult patients with sepsis, septic shock or severe coronavirus disease and randomized patients to receive continuous blood purification techniques (extracorporeal cytokine adsorption or hemoperfusion), or standard of care therapy alone. We excluded studies that employed extracorporeal cytokine adsorption without renal replacement therapy. We qualitatively synthesized the data.

Results: Our search yielded 19 eligible citations and 10 studies were eligible for full-text screening. 2 studies proved eligible. Broman et al. randomized 16 patients with septic shock-associated acute renal failure and showed endotoxin, tumor necrosis factor-alpha, interleukin-6, interleukin-8 and interferon gamma levels were lower in those who was dialyzed using modified membranes with the extracorporeal cytokine adsorption technique. Feng et al enrolled 16 patients with surgical septic shock and AKI. The study showed lower concentration of procalcitonin and interleukin-6 concentration in the modified membrane arm.

Conclusions: The studies reported reductions in inflammatory markers and vasopressor requirement with adjunctive hemadsorption.

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Rapid Implementation of an On-site CRRT Dialysate Production System during the COVID-19 Pandemic

Darren W Schmidt[1], Lisa Saa[1], Kevin A Kaucher[1], Ruben D Villanueva[1], Michelle Shieh[1], Namita Singh[1], Saeed K Shaffi[1], Jessica A Mitchell[1], Christos P Argyropoulos[1], J Pedro Teixeira[1]

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Introduction
The COVID-19 pandemic has profoundly impacted healthcare delivery. On 12/29/21, during the local delta wave, the stock of premanufactured CRRT solutions at our hospital was nearly exhausted with no resupply anticipated due to supply chain disruptions. Within hours, a backup plan, devised and tested 18 months prior, to generate locally produced CRRT dialysate (LPCD) was implemented.
Methods
This is an IRB-approved retrospective cohort study describing the implementation and outcomes of a LPCD production system. Data were obtained from the electronic medical record and hospital surveillance records. Equipment used included intermittent hemodialysis (IHD) machines (Gambro PHOENIX, Baxter, Deerfield, IL), sterile 3- and 4-L bags normally used for parenteral nutrition (Exactamix Empty EVA Bag, Baxter), and connecters made for purpose of 3D printed biocompatible rigid material (Figure 4 MED-WHT 10, 3D Systems, Rock Hill, SC) [Figure]. After obtaining permission from hospital leadership, the first patient was transitioned to CVVHD using LPCD later that afternoon, with all remaining patients transitioned that evening. A system of daily fluid production and inventory and serial testing of random fluid samples was rapidly devised and implemented.
Results
Ultimately, over the next 13 days 22 patients—20 with AKI, 2 with ESKD, and 11 with COVID-19—were treated with 3,645 L of LPCD over 2,024 CRRT hours. Mean dose was 20.0 mL/kg/h (28.0 mL/kg/h ideal body weight). Fluid sample testing revealed stable electrolyte composition, endotoxin level <0.01 EU/mL, and colony count <2 CFU/mL at 48h. No central line-associated bloodstream infections occurred within 7 days of exposure to LPCD and 1 occurred within 28 days, 13 days after exposure. Mortality was high at 81.8% in-hospital and 68.2% at 28 days, though illness severity was also high, with median SOFA score in 24h before LPCD exposure of 14.5 (range 6-19).
Discussion
Though producing CRRT fluid with IHD machines is not novel, this report represents the first description of the rapid and

successful implementation of a backup plan for LPCD production at a large academic medical center in the US during the COVID-19 pandemic. The program permitted us to sustain our CRRT program during a period when ICU bed occupancy was >100% in hospitals across the region and patient transfers were not feasible. Our experience could serve as a model for other centers navigating similar severe supply constraints in the future.

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Epidemiology and Outcomes of CRRT in Neonates and Infants weighing less than 10 kg: An analysis of the Worldwide Exploration of Renal Replacement Outcomes Collaborative in Kidney Disease (WE-ROCK)

Shina Menon[1], Michaela Collins[2], Michelle Starr[3], Mihaela Damian[4], Dana Fuhrman[5], Tennille Webb[6], Kelli Krallman[2], Huiayu Zang[2], Katja Gist[2], WEROCK Investigators[7]

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Background: There are limited studies of neonates and infants receiving continuous renal replacement therapy (CRRT). CRRT use in neonates and infants with AKI has been low because of technical challenges related to utilizing adapted adult devices and the accompanying higher risks of complications than in older children. The prospective pediatric Continuous Renal Replacement Therapy (ppCRRT) registry previously reported 43% survival in neonates and infants (<10 kg). We aimed to describe the current epidemiology and outcomes of these patients.

Methods: The Worldwide Exploration of Renal Replacement Outcomes Collaborative in Kidney Disease (WE-ROCK) study is a retrospective international multicenter study (32 centers, 7 nations) of patients aged 0-25 years treated with CRRT for Acute Kidney Injury (AKI) or Fluid Overload (FO) from 2018-2021. Patients with previous dialysis dependence, ECMO utilization, or who received CRRT for non-AKI/FO indication were excluded. Primary outcomes were survival to ICU discharge and MAKE-90 (composite of death, dialysis dependence or worsened kidney function at 90 days).
Results: 214 infants weighing <10 kg at hospital admission were included (43% female). Median (IQR) age was 0.53 (0.10, 0.95) years, with 47 (22%) less than 1 month of age. Median (IQR) weight was 6.45 (3.74, 8.68) kg, with 75 (35%) weighing less than 5 kg. Sepsis at ICU admission was present in 80 (37%), and comorbidities were seen in 174 (81%).

CRRT was initiated a median of 3 days (IQR 1,9) after ICU admission and lasted a median of 6 days (IQR 3, 17). Median FO at CRRT initiation was 16.41% (IQR 6.45, 32.98). CVVHDF was prescribed in 149 (70%) with citrate anticoagulation in 111 (52%). Median blood flow was 7.99 (IQR 5.94, 11.17) ml/min/kg. Median (IQR) CRRT dose was 2107.12 ml/1.72m2/hr (1569.31, 3078.72) or 63.85 ml/kg/hr (49.93, 88.73). 115 (54%) survived to ICU discharge. MAKE-90 occurred in 152 (71%). There were no differences in age, CRRT modality or FO between survivors and non survivors. Conclusions: This is the largest epidemiological report of neonates and infants receiving CRRT. There is an improvement in ICU survival compared to a historical cohort (54% vs 43% in ppCRRT); however, the proportion of patients developing MAKE-90 is very high. More detailed analyses are needed to evaluate the factors associated with adverse outcomes in this vulnerable population.

Variable	Overall, N = 214
Gender	
Female	92 (43%)
Admission Weight (kg)	6.45 (3.74, 8.68)
Weight category	
<5 kg	75 (35%)
5- 10	139 (65%)
Age (years)	0.53 (0.10, 0.95)
Age categories	
< 1 month	47 (22%)
1 month-1 year	121 (57%)
> 1 year	46 (21%)
Admission Category	
Shock/Infection/Major Trauma	66 (31%)
Respiratory Failure	47 (22%)
Post-surgical/minor trauma	18 (8.4%)
Primary Cardiac	38 (17.7%)
Other	45 (21.2%)
Sepsis at ICU admission	80 (37%)
PRISM-III Score at ICU Admission	14.0 (10.0, 19.0)
Vasopressor-Inotrope Score at CRRT initiation	6.0 (0, 20)
PELOD-2 Score at CRRT initiation	7.0 (5.0, 10.0)
% fluid overload (ICU admit to CRRT initiation)	16.41 (6.45, 32.98)
Time from ICU Admission to CRRT Initiation (days)	3 (1, 9)
Duration of CRRT (days)	6 (3, 17)
Initial Modality	
SCUF	3 (1.4%)
CVVH	30 (14%)
CVVHD	25 (12%)
CVVHDF	149 (70%)
mCVVH (CVVH with Aquadex)	7 (3.3%)
Anticoagulation	
None	21 (9.8%)
Citrate	111 (52%)
Heparin	67 (31%)
Other	15 (7.0%)
Calculated CRRT Dose mL per 1.73m^2/hr	2107.12 (1569.31, 3078.72)
Calculated CRRT Dose mL per kg/hr	63.85 (49.93, 88.73)

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Dosing Variation in CRRT Prescription in Neonates and Infants weighing less than 10 kg: An analysis of the Worldwide Exploration of Renal Replacement Outcomes Collaborative in Kidney Disease (WE-ROCK)

Shina Menon[1], Michaela Collins[2], Michelle Starr[3], Mihaela Damian[4], Dana Fuhrman[5], Tennille Webb[6], Kelli Krallman[7], Huiayu Zang[8], Katja Gist[2], WEROCK Investigators[1]

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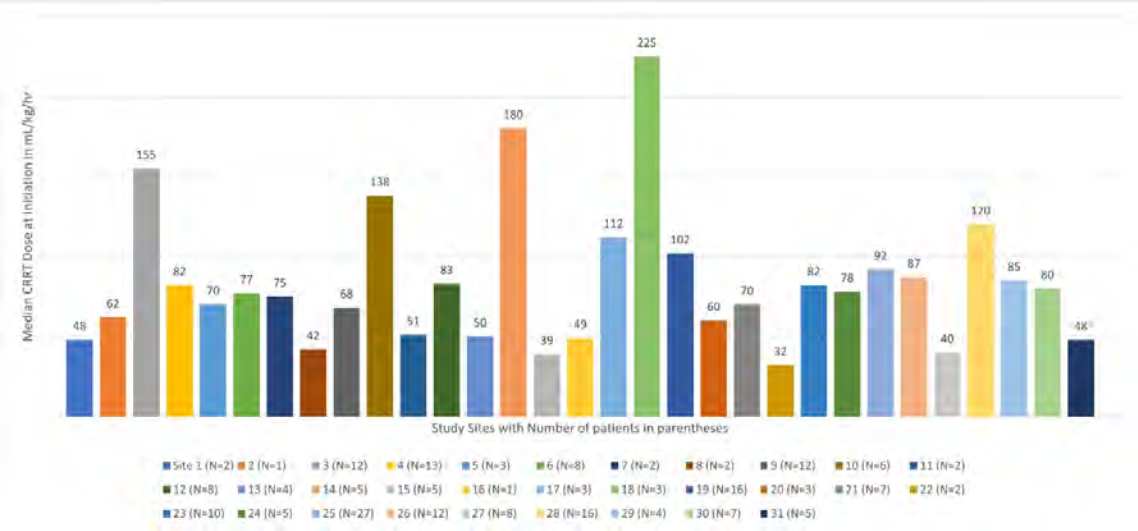
Background: CRRT prescriptions in neonates, infants and children are extrapolated from adults,and there are wide variations in clinical practice. Some pediatric centers dose CRRT in mL/kg/hr, and others normalize to body surface area (BSA) of 1.73m2. In adults, a prescribed dose of 25-30 mL/kg/hr is recommended, which typically approximates to 2000mL/hr/1.73m2. In infants and neonates, the nonlinear relationship between weight and BSA may result in a higher prescribed dose. We aimed to evaluate prescription variance in neonatal
and infant CRRT prescribing patterns, and if a higher dialysis dose is associated with worse outcomes.
Methods: The Worldwide Exploration of Renal Replacement Outcomes Collaborative in Kidney Disease (WE-ROCK) study is a retrospective international multicenter study (32 centers, 7nations) of patients aged 0-25 years treated with CRRT for Acute Kidney Injury (AKI) or Fluid Overload(FO) from 2018-2021. Patients with previous dialysis dependence, ECMO utilization, or who received CRRT for non-AKI/FO indication were excluded. For this analysis, neonates and children weighing <10 kg at hospital admission were assessed.
Results: Data from 214 infants were included (43% female), median (IQR) age of 0.53 (0.10, 0.95) years. Median(IQR) CRRT dose was 2107.12 ml/1.72m2/hr (1569.31, 3078.72) or 63.85 ml/kg/hr (49.93, 88.73). Most patients (n=179, 84%) received a dose > 40 mL/kg/hr. 115 (54%) survived to ICU discharge. There was no significant difference in median (IQR) CRRT dose at initiation between survivors and non survivors [60.00 (49.95, 85.78) mL/kg/hr vs 69.93 (49.30, 101.88) mL/kg/hr, p=0.2]. The prescribed dose increased over time and by Day 4 was significantly different between survivors and non survivors [63.59 (43.29, 90.80) mL/kg/hr vs 82.99 (55.19, 114.61) mL/kg/hr, p=0.02]. MAKE-90 (composite outcome of death, new dialysis, or worsened kidney function at 90 days) occurred in 152 (71%). There were no differences in CRRT dose between those with and without MAKE-90. There was significant variation in CRRT dosing across centers ranging from 32 mL/kg/hr to 225 mL/kg/hr (Figure 1)
Conclusions: This is the largest report of neonates and infants receiving CRRT. There is lack of standardized CRRT dosing across centers with neonates and infants receiving higher doses than what is recommended by KDIGO. It is unclear if higher dose negatively impacts outcomes. Prospective studies evaluating the prescribed and delivered dose are needed



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Does a Tincture of Time Change CRRT Practice and Improve outcomes: A comparison of the ppCRRT and WE-ROCK collaboratives

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Background: There are limited data regarding the epidemiology of pediatric patients receiving continuous renal replacement therapy (CRRT). The Prospective Pediatric CRRT(ppCRRT) Registry (13 centers in United States, n=344), which described practice patterns and outcomes almost two decades ago, was previously the largest cohort of children receiving CRRT. The Worldwide Exploration of Renal Replacement Outcomes Collaborative in Kidney Disease (WE-ROCK,
32 centers, 7 countries, n=992) registry was designed to update the current international practice patterns for pediatric CRRT. This study aims to evaluate changes in population characteristics and outcomes across these 2 cohorts.
Methods:Retrospective cohort analysis comparing patient characteristics, CRRT
prescription, and outcomes between ppCRRT and WE-ROCK. The WE-ROCK study included children aged 0-25 years treated with CRRT for AKI or FO, and patients with previous dialysis dependence, ECMO utilization, or who received CRRT for non-AKI/FO were excluded. For this analysis, patients with inborn errors of metabolism were excluded from the ppCRRT registry.
Results: Data from 992 children from WE-ROCK were compared with 329 from ppCRRT. There were no differences in the median age, sex or weight of patients between the cohorts (Table 1). The most common reason for admission was shock, infection, or major trauma (37.2% vs 37.4%). Sepsis was more common in the WE-ROCK cohort(45.4%) than ppCRRT cohort (32.7%, $p<0.01$). Although the median
fluid balance at CRRT initiation was not significantly different between the cohorts (7.4 vs. 9.2 WEROCK vs ppCRRT, p 0.09), fewer patients started CRRT with >20% fluid overload in the WE-ROCK cohort(22.5% vs 30.1%, $p<0.01$).
The prescribed CRRT dose was similar across the cohorts (2074 mL/1.73 m2/hour vs 2155).However the use of convective modalities was higher in the WE-ROCK cohort (88.1% vs 52%, $p<0.05$), as was the use of regional citrate anticoagulation (61.8% vs 50%, $p<0.05$). Survival to ICU discharge was seen in 64.4% of WEROCK cohort compared to 56.8% of ppCRRT ($p<0.05$)
Conclusion: Comparison of WE-ROCK with the older ppCRRT cohort shows changes in CRRT practice patterns and higher survival rates. This may be related to better recognition of fluid overload as the proportion of patients who had >20% FO at CRRT initiation has decreased. However given the retrospective nature of WEROCK, it is not possible to draw definitive conclusions and other causes need
to be studied

Figure on following page

Patient Characteristics	ppCRRT N=329	WEROCK N=992	p
Age, yrs	7.3 (1.98, 14.98)	8.7 (1.6, 15)	0.6
Age Category			
• < 1 mo	27 (8.2)	50 (5)	
• 1 mo-1 y	35 (10.6)	127 (12.8)	
• 1-5 y	71 (21.5)	226 (22.7)	
• 5-15 y	114 (34.6)	340 (34.2)	
• >15 y	82 (24.9)	249 (25.1)	
Female	136 (41.3)	451 (45.4)	
Weight, kg	26.5 (11.7, 52.9)	26.8 (11.5, 55)	0.7
Weight category			
• <5	34 (10.3)	78 (7.8)	
• 5-10	41 (12.4)	154 (15.5)	
• 11-20	68 (20.6)	207 (20.8)	
• 21-50	97 (29.4)	271 (27.3)	
• 51-70	52 (15.8)	152 (15.3)	
• >70	37 (11.2)	130 (13.1)	
Primary diagnosis categories			
• Shock/Infection/Major trauma	123 (37.4)	369 (37.2)	
• Respiratory failure	14 (4.2)	199 (20)	
• Other	29 (8.8)	119 (12.1)	
• Cardiac	37 (11.2)	136 (13.7)	
• Oncology/BMT	67 (20.3)	38 (3.5)	
• Liver Disease	23 (6.9)	34 (3.4)	
• CNS Dysfunction	2 (0.6)	41 (4.1)	
• Renal disease	34 (10.3)	56 (5.6)	
Sepsis at CRRT initiation	113 (32.7)	451 (45.4)	< 0.01
PRISM scores			
PRISM II for ppCRRT	14 (10, 18)		
PRISM III for WEROCK		12 (8, 19)	
Any Vasoactive at CRRT initiation	210 (63.8)	580 (58.3)	0.08
Mechanical ventilation	231 (70.2)	857 (86.3)	0.001
Fluid balance at onset	9.2 (2, 24.7)	7.4 (2.3, 18)	0.09
Fluid overload			<0.01
• <10%	165 (50.1)	575 (57.9)	
• 10-20%	54 (16.4)	185 (18.6)	
• >20%	99 (30.1)	224 (22.5)	
On diuretic at CRRT initiation	165 (50.1)	571 (57.5)	0.02
Serum Creatinine (mg/dL)	2.2 (1.2, 3.7)	1.7 (0.9, 3.2)	<0.01
eGFR (ml/min/1.73 m2)	19.82 (13.49,34.69)	26.11 (15.39 , 46.59)	<0.01
Modality			<0.05
• CVVHDF	83 (25.2)	759 (76.6)	
• CVVHD	157 (47.7)	99 (9.9)	
• CVVH	89 (27)	114 (11.5)	
• SCUF		12 (1.2)	
• CVVH with Aquadex		8 (0.8)	
Anticoagulation			<0.05
• Heparin	114 (34.6)	248 (25)	
• Citrate	166 (50.4)	613 (61.8)	
• Other		59 (5.9)	
• None	49 (14.8)	70 (7)	
CRRT Dose (Dialysate + Replacement) in mL/1.73m2/hr	2155 (1447, 2778)	2074 (1752, 2681)	0.6
Survival to ICU discharge	187 (56.8)	639 (64.4)	0.02
Duration of CRRT	6 (3, 12)	6 (3, 14)	0.14
All values: N (%) or median (interquartile range); Values, characteristics (except survival) are at CRRT initiation			

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Safety and Efficacy of Bivalirudin for CRRT and PIRRT in Pediatric Patients

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Background
Continuous Renal Replacement Therapy (CRRT) and Prolonged Intermittent RRT (PIRRT) in neonates and children necessitate the use of anticoagulation. Recently, the use of Bivalirudin (bival), a direct thrombin inhibitor, has gained traction for thrombus treatment and to anticoagulate extracorporeal circuits due to concerns for heparin resistance and heparin induced thrombocytopenia (HIT). Since 2019, we have treated 12 children on CRRT/PIRRT with bival. We describe its use and compare our experience to heparin anticoagulation at our institution over the same period.
Methods
We performed a retrospective chart review of the 12 patients who received bival for CRRT and/or PIRRT since 2019 at COA. For CRRT, we compare the 212 bival circuits with the 684 heparin circuits. For PIRRT, we compare the 17 bival circuits with the 129 heparin circuits. The initial bival dose used was 0.05 to 0.1 mg/kg/hr which was titrated to target ranges prescribed by the provider (usually PTT 50-70 seconds).
Results
Patient Data: In the 12 patients who received bival, the age range was 1 day to 17 years; 6 male and 6 female; 4 in CICU, 7 in NICU, and 1 in PICU; indications for RRT were congenital kidney failure in 8 and acute kidney injury (AKI) in 4. Of the 12 patients, 4 received bival prior to CRRT for other indications (2 on ECMO, 1 on LVAD, 1 for thrombus), 6 were started for possible HIT, and 1 for heparin resistance. The median (IQR) final bival dose used to achieve target PTT goal was 0.13 (range 0.05-0.2 mg/kg/hr). 7 patients survived and 5 died. None of the patients on bival suffered any adverse events related to bival anticoagulation.
CRRT Data: The median (IQR) filter life was similar between bival and heparin (Table 1). The reasons for circuit discontinuation did not differ between heparin vs. bival groups (p=0.58). Of the circuits that were not stopped for patient-related issues, the rates of achieving circuit life goal of 60 hours was higher in the bival than heparin circuits (Table 1).
PIRRT Data: None of the 17 bival or the 124 heparin circuits clotted. We did not find a statistically significant difference in the median (IQR) circuit life between bival and heparin (17.7 (17.2 – 18.4) vs. 17.7 (16.8– 19.3); p = 0.78).
Summary
Bival use in neonates and children who receive PIRRT/CRRT is effective and well tolerated. A starting dose of 0.1 mg/kg/hr is an appropriate dose for most patients to achieve a therapeutic PTT range of 50-70 seconds on RRT.

Table 1- Differences between bival vs heparin in CRRT circuits

	Bival N=212	Heparin N=679	p-value
Machine			p=0.31
Aquadex	180(85%)	556(81.9%)	
Prismaflex/Prismax	32(15%)	123(18.1%)	
Prime			p=<0.001
Albumin	1(0.5%)	27(3.9%)	
Blood	79(37.2%)	162(23.9%)	
Circ to circ	44(20.8%)	146(21.5%)	
Saline	88(41.5%)	344(50.7%)	
Reason for Discontinuation			p=0.58
Access issue/clotted	82(38.7%)	261(38.4%)	
Machine malfunction	2(0.9%)	13(1.9%)	
Patient related	26(12.3%)	100(14.7%)	
Routine change	102(48.1%)	305(45%)	
CRRT reason for stop category			p=0.07
Patient related	27(12.7%)	122(18%)	
Circuit related	185(87.3%)	557(82%)	
CRRT goal met >60 hours			p=<0.04
Goal met	102(55%)	293(52%)	
Goal not met	83(45%)	264(48%)	
Location			p=<0.001
CICU	52(24.5%)	110(16.3%)	
NICU	157(74%)	455(67%)	
PICU	3(1.5%)	114(16.7%)	
Hypotension Intervention			p=0.97
Yes	3(1.5%)	10(1.5%)	
No	209(98.5%)	669(98.5%)	
Blood Flow Rate(ml/min)	30(30,35)	35(30,40)	p=<0.001
Filter Life	65.1(28.0,71.5)	61.5(24.7,71.3)	p=0.68

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Optimal Timing of Continuous Renal Replacement Therapy Initiation from Initial Renal Insult

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Background: The optimal timing of initiation of continuous renal replacement therapy (CRRT) in critically ill pediatric patients has not been clearly elucidated. Published literature in adults demonstrated no mortality benefit between early or delayed initiation of dialysis. We aim to investigate how the time between meeting CRRT criteria and initiation impacts duration of therapy.

Methods: Single center retrospective study of critically ill pediatric patients admitted between 2014-2020 who required CRRT. Patients with end stage renal disease, chronic kidney disease, or inborn errors of metabolism were excluded. Primary outcome was CRRT free days censored at 30 days (30 days – duration of CRRT). Initial renal insult was classified as, AKI-Cr (> 2x baseline creatinine), AKI-UOP (<.5ml/kg/hr of UOP for 24h), and/or fluid overload (FO) >15%. These variables were obtained daily for the seven days prior to CRRT start.

Results: 233 patients with a median age of 55 months (IQR 11.5-155) and PELOD-2 score of 8 (7-10) received CRRT for a median of 13 (5-27) days. Sixty-five percent were on vasoactive support, and 85% of patients had renal injury (AKI-UOP (23%), AKI-Cr (18%), FO (18%) and combination (25%) in the seven days prior to CRRT start. The initial injury occurred 4 (1-7) days prior to CRRT start. The median number of CRRT free days was 17 (3-25).

No matter the initial injury (AKI-Cr, AKI-UOP, or FO) the duration between initial insult to CRRT start was associated with fewer CRRT free days (beta -0.9 (CI -1.3 to -0.4)). For every additional day between specific initial insult and CRRT start, patients had fewer CRRT free days (AKI-Cr beta -0.99 (CI -1.5 to -0.5)) (AKI-UOP beta -0.95 (CI -1.5 to -0.5)) (FO beta -0.45 (CI -0.9 to -0.01)).

Conclusion: We showed that occurrence and duration of renal insult (AKI-Cr, AKI-UOP, and FO) in the seven days prior to CRRT start is associated with fewer CRRT free days in pediatric patients. Our findings suggest that earlier initiation of CRRT in pediatric patients may decrease the duration of CRRT but need external validation in prospective studies.

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Therapeutic Plasma Exchange in Diffuse Alveolar Hemorrhage. Experience in The "Centro Médico Nacional 20 de Noviembre" Mexico City

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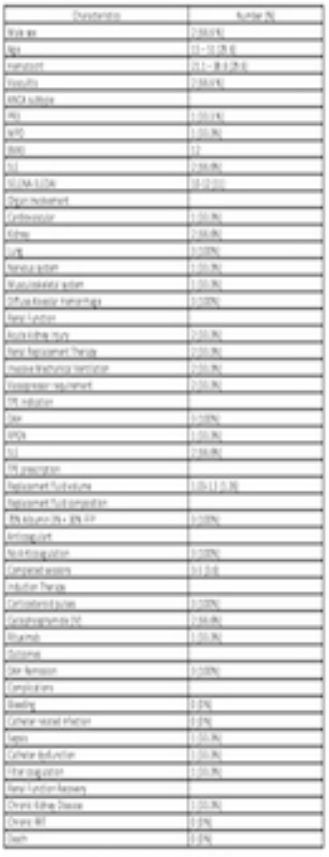
Introduction.
Therapeutic plasma Exchange (TPE) implies the removal of plasma and its replacement by fresh frozen plasma (FFP), colloid, crystalloids or a mixture of these; with the purpose of removing pathogenic substances or administer deficient plasma components.
Within the ASFA category I indications for TPE we find: glomerular diseases associated with diffuse alveolar hemorrhage (DAH), such as ANCA associated rapidly progressive glomerulonephritis (RPGN), anti-glomerular basement membrane (GBM) disease and catastrophic antiphospholipid syndrome (CAPS). Considering systemic lupus erythematosus (SLE)

with severe complications category II.
Purpose of the study.
Describe the experience with TPE in patients with DAH at “Centro Medico Nacional (CMN) 20 de Noviembre” a tertiary hospital in Mexico City.
Methods.
Retrospective, observational, longitudinal study. Patients with DAH who received TPE from January 2016 to August 2022 were included.
Results.
Data from 3 patients with ANCA associated RPGN and SLE were analyzed. Each received an average of 3.6 sessions, the mean replacement fluid was 1.26 times the plasma volume, it’s composition was a mixture of FFP, crystalloid and albumin, none received anticoagulation. Two developed stage 3 acute kidney injury (AKI) according to KDIGO, one evolved into stage 3A chronic kidney disease (CKD), all received corticosteroid pulses, 66.6% IV Cyclophosphamide and 33.3% Rituximab as induction.
All had sustained remission of DAH. Among the observed complications we found sepsis, catheter dysfunction, and filter coagulation, any patient died.
Conclusions.
TPE proved to be safe and effective in DAH secondary to autoimmune diseases. Combination of FFP and albumin as replacement fluid was not associated with adverse effects and it can lower treatment costs. Filter coagulation was associated with catheter dysfunction not to the lack of anticoagulation, therefore it is possible to avoid anticoagulant use to lower bleeding risk.

Table 1. Population Characteristics and Outcome



PRD: prednisone 3, MPO: myeloperoxidase, BVAS: Birmingham Vasculitis Activity Score, SLE: systemic lupus erythematosus, DAH: Diffuse Alveolar Hemorrhage, TPE: Therapeutic plasma exchange, FFP: fresh frozen plasma, RPGN: rapidly progressive glomerulonephritis, RRT: renal replacement therapy

RRT APPLICATIONS AND TARGETED INTERVENTION

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Influence of Mean Arterial Pressure on the Reasons for RRT Termination and In-hospital Mortality

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Background
Mean arterial pressure (MAP) at the initiation of continuous renal replacement therapy (CRRT) may influence the decision for CRRT termination, which may in turn be a strong risk factor for in-hospital mortality.
Methods
This prospective cohort study collected data for CRRT patients seen at the Third Affiliated Hospital from January 2016 to December 2020. We collected MAP data at the initiation of CRRT, reasons for CRRT termination, and in-hospital mortality data. We divided the patients into four groups based on quartiles of the initial MAP and used Cox proportional hazard models to determine the effects of initial MAP on the decision for CRRT termination and in-hospital mortality.
Results
A total of 2,346 patients with acute kidney injury (AKI) were included in this study. The median age of the participants was 68.0 (57.0–76.0) years, and 68% were male. The cut-offs for the MAP quartile were as follows: first (Q1), ≤ 69; second (Q2), 69.1–77.7; third, 77.8–89.0; and fourth (Q4), ≥ 89.1 mmHg. Renal recovery (36.8%) and death (36.6%) were the most common causes of CRRT termination, followed by the transition to hemodialysis (13.1%), a do-not-resuscitate (DNR) order (7.2%), unstable blood pressure (BP) (3.8%), and transfer to another nursing care facility (1.2%). The risk of "unfavorable reasons" for CRRT termination (death, DNR order, unstable BP) was higher in Q1 (hazard ratio [HR] 1.312 (1.032–1.669)) and Q2 (HR 1.306 (1.027–1.662)) compared in Q4. During the median hospital stay of 16 (interquartile range: 4, 37) days, 54.6% of the patients died. Multivariate analysis indicated that unfavorable reasons for CRRT termination strongly affected in-hospital mortality (HR 18.558 (14.086–24.451)) whereas the MAP quartiles at CRRT initiation did not.
Conclusions
A lower MAP at CRRT initiation was closely associated with a higher probability of terminating CRRT due to death, a DNR order, or unstable BP, and these reasons were strongly associated with in-hospital mortality.

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The Effects of Double-Filtration Plasmapheresis on Coagulation Profiles and Risk of Bleeding

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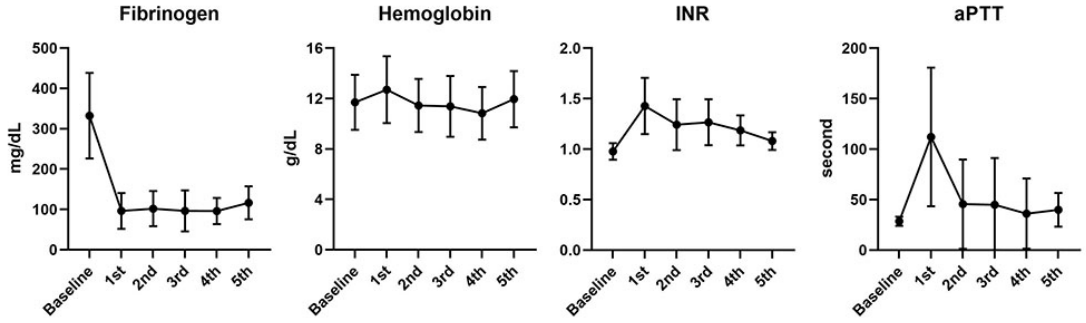
Background and Purpose:
Double-filtration plasmapheresis (DFPP) can be used to remove circulating pathogenic antibodies. DFPP reduces the need of albumin and plasma replacement during plasmapheresis by reclaiming the filtered small proteins such as albumin through the second filter. Large proteins such as fibrinogen were removed. We aim to study the effects of DFPP on coagulation factors and examine the risk of bleeding.

Methods:
We prospectively collected laboratory data and recorded bleeding events associated with DFPP treatment. DFPP treatment was standardized according to a protocol at National Taiwan University Hospital. Plasma separator of LF-050 (Informed)

and plasma fractionator of Evaflux 4A (Kawasumi Laboratories) were used. No replacement fluid was given during treatment. Blood samples were obtained before (baseline) and after each DFPP treatment session. Tests of fibrinogen, international normalized ratio (INR), activated partial thromboplastin time (aPTT), complete blood count, and albumin were performed. Prophylactic transfusion of cryoprecipitate or fresh frozen plasma (FFP) was instituted if serum fibrinogen level is below 100 mg/dL or if the level of either aPTT or INR is higher than 1.5 times of the upper limit of normal. Major bleeding was defined as clinically significant bleeding requiring transfusion of packed red blood cell (pRBC). Minor bleeding was defined as development of new ecchymoses without need of pRBC transfusion.

Results:
From February 1, 2022 to August 31, 2022, a total of 37 patients were included. Each patient received an average of 4.5 ± 1.5 (mean ± standard deviation) DFPP treatment sessions. The indications were antibody-mediated rejection of graft kidney, desensitization before kidney or liver transplantation, myasthenia gravis crisis, polyneuropathy, and others in 11 (30%), 7 (19%), 7 (19%), 8 (22%), and 4 (11%) of patients, respectively. The serial changes of fibrinogen, hemoglobin, INR, and aPTT were illustrated in Figure 1. Significant hypofibrinogenemia developed after the 1st session of treatment. No major bleeding event was recorded. Five (14%) patients had minor bleeding. An average of 5.9 ± 6.5 U of cryoprecipitate and 2.4 ± 2.1 U of FFP was transfused after each DFPP treatment session.

Conclusion:
DFPP treatment results in significant hypofibrinogenemia. Active monitoring of coagulation profiles and prophylactic transfusion of cryoprecipitate or FFP should be considered during DFPP treatment course.



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Monte Carlo Simulation-based Meropenem Dosing Recommendations for Critically ill Patients Receiving Five Kidney Replacement Therapy Regimens

Susan J Lewis[1], Bruce A Mueller[2]

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Purpose: The Tablo Hemodialysis System (Tablo) offers a range of kidney replacement therapy (KRT)options for critically ill patients requiring dialysis. The use of the wide variety of dialysate flow rates and treatment regimens available may clear drugs like meropenem differently than conventional devices. The purpose of this Monte Carlo Simulation (MCS) was to develop meropenem doses likely to attain therapeutic targets for a variety of dialysis prescriptions on Tablo.
Methods: One compartment, first-order pharmacokinetic models were built using relevant demographic information and pharmacokinetic variables to generate free meropenem plasma concentration over a week in 5,000 virtual anuric patients receiving 5 different KRTs. MCS was performed to assess the probability of target attainment (PTA) for various meropenem doses with 0.5-hour infusions (Table 1). The 2 pharmacodynamic targets were ≥40% free plasma concentrations above one time or four times the minimum inhibitory concentration [>40% fT>MIC or >40% fT>4xMIC] assuming Pseudomonas aeruginosa infection with the breakpoint MIC of 2 mg/L. Potential risk of neurotoxicity was also

evaluated using the proposed toxicity threshold of total trough concentration of >64 mg/L. Optimal doses were the smallest doses attaining PTA≥90% during 1-week of therapy.
Results: Meropenem doses attaining the desired pharmacodynamic (PD) targets in different Tablo settings are shown. None of the optimal meropenem doses yielded "toxic" trough concentrations.
Conclusions: MCS models suggest that different Tablo KRT regimens require different meropenem dosing strategies. Meropenem doses for sequential therapy were the same as daily HD regimens. More aggressive PD targets require higher doses to attain acceptable PTA, but do not appear to achieve concentrations associated with toxicity. These findings need clinical validation.

Table 1. Meropenem Dosing Recommendations in 5 Tablo KRT regimens

Setting	Type	Effluent Flow Rate (ml/min)	Duration (h	Frequency	Less Aggressive PD Target (40% fT>MICx1)	More Aggressive PD Target (40% fT>MICx4)
1	HD	Qd 300	4 hours	Mon-Wed-Fri	0.5g q24h post-HD	1g LD, then 0.5g q12h post-HD
2	HD	Qd 300	4 hours	Daily		
3	Sequential Therapy	Qd 300 then Quf 5	HD 4 hours, then UF 20 hours	Daily		
4	PIKRT	Qd 100	9 hours	Daily	0.5g q12h	0.5g q8h
5	Extended Therapy	Qd 50	24 hours	Daily	0.5g q12h	1g q12h

HD: Hemodialysis; UF: Ultrafiltration; PIKRT: Prolonged Intermittent Kidney Replacement Therapy
Qd: dialysate flow rate: Quf: ultrafiltrate flow rate; LD: loading dose
Sequential: HD with or without UF followed by isolated UF
All doses are started after HD ends in settings 1-3. All doses are given as 30-min infusions.

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Imipenem Dosing Recommendations for Critically ill Patients Receiving Five Kidney Replacement Therapy Regimens

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Purpose: The Tablo Hemodialysis System (Tablo) offers a range of kidney replacement therapy (KRT) options for critically ill patients with AKI. The use of the wide variety of dialysate flow rate and treatment duration & frequencies that are available may clear drugs like imipenem differently than conventional devices. The purpose of this Monte Carlo Simulation (MCS) was to develop imipenem doses likely to attain therapeutic targets for a variety of KRT treatment combinations on Tablo.
Methods: One compartment, pharmacokinetic models were developed using pertinent demographic data and pharmacokinetic parameters to predict imipenem exposure in 5,000 virtual patients receiving 5 different KRT regimens. All patients were assumed to be anuric. Imipenem dosing using 30-minute infusions were simulated to assess the probability of target attainment (PTA)(Table 1). Imipenem is co-formulated with cilastatin, but only imipenem was simulated. Usual and aggressive pharmacodynamic (PD) targets chosen were ≥40% free plasma concentrations above 1X OR 4X the minimum inhibitory concentration (>40% fT >MIC or >40% fT>4xMIC) with the breakpoint MIC of 2 mg/L for Pseudomonas aeruginosa. Additionally, the potential risk of neurotoxicity was assessed using an accepted safety threshold (fT >MICx8). The smallest doses attaining PTA≥90% during 1-week of therapy were considered optimal. Results appear in table.
Conclusion: Standard imipenem dosing (500 mg Q8-12 hrs) attains usual PD targets for all KRT regimens, including sequential therapy (setting 3). More aggressive PD targets will require higher imipenem doses. These higher doses increase the possibility of imipenem neurotoxicity. These findings need clinical validation.

Table on following page

Table 1. Imipenem Dosing Recommendations in 5 KRT regimens

Setting	Type	Effluent Flow Rate (ml/min)	Duration (h	Frequency	Usual PD Target (40% fT>MICx1)	More Aggressive PD Target (40% fT>MICx4)
1	HD	Qd 300	4 hours	Mon-Wed-Fri	500 mg q12h post-HD	750 mg q8h post-HD
2	HD	Qd 300	4 hours	Daily	500 mg q12h post-HD	
3	Sequential Therapy	Qd 300 then Quf 5	HD 4 hours, then UF 20 hours	Daily	500 mg q12h post-HD	
4	PIKRT	Qd 100	9 hours	Daily	500 mg q12h	1g q8h
5	Extended Therapy	Qd 50	24 hours	Daily	500 mg q8h	750 mg q6h

HD: Hemodialysis; UF: Ultrafiltration; PIKRT: Prolonged Intermittent Kidney Replacement Therapy
Qd: dialysate flow rate: Quf: ultrafiltrate flow rate; LD: loading dose
Sequential: HD with or without UF followed by isolated UF
All doses are started after a HD session in settings 1-3.

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Monte Carlo Simulation to Determine Cefepime Dosing in Critically ill Patients Receiving Five Kidney Replacement Therapy Regimens

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Purpose:
The Tablo Hemodialysis System (Tablo) offers a range of kidney replacement therapy (KRT) options for critically ill patients with AKI. The use of the wide variety of dialysate flow rate and treatment duration & frequencies that are available may clear drugs like cefepime differently than conventional devices. The purpose of this Monte Carlo Simulation (MCS) was to develop cefepime doses likely to attain therapeutic targets for a variety of KRT treatment combinations on Tablo.

Methods:
Published body weights and pharmacokinetic parameter estimates with variability were used to develop pharmacokinetic models and to generate free cefepime plasma concentrations in 5 different KRT regimens (Table). All patients were assumed to be anuric. MCS was performed to assess the probability of target attainment (PTA) of various cefepime dosing regimens with 0.5-hour infusions. Three efficacy targets used were 1) ≥60% free plasma concentrations above the minimum inhibitory concentration (≥60% fT >MIC), 2) 4 time above the MIC (≥60% fT >4xMIC), or 3) 100% fT >MIC with the breakpoint MIC of 8 mg/L for Pseudomonas aeruginosa. In addition, the safety of each dose was assessed using a total cefepime trough concentration associated with increased risk of potential neurotoxicity (20 mg/L). The smallest doses attaining PTA≥90% during 1-week of therapy were considered optimal.

Results:
Cefepime doses attaining the three different efficacy targets are in the 5 KRT settings are shown in Table. Optimal doses attaining the aggressive efficacy targets (60% fT>MICx4 or 100% fT>MIC) yielded total trough drug concentrations exceeding the safety threshold in most patients (62-99%).

Conclusions:
MCS analysis predicted that alterations in KRT parameters may necessitate different cefepime doses to attain efficacy targets, but recommended doses for thrice weekly HD, daily HD, and sequential HD and UF were all the same. Higher

cefepime doses were required to attain more aggressive pharmacodynamic targets but were likely to be associated with a higher risk of neurotoxicity, requiring vigilant monitoring. These findings need clinical validation.

Table. Cefepime Dosing Recommendations for 5 KRT Regimens

	KRT Regimen				Cefepime Dosing Recommendation		
	Type	Effluent Flow Rate	Duration	Frequency	60% *f*T>MIC	60% *f*T>4xMIC	100% *f*T>MIC
1	HD	Qd 300 ml/min	4 hours	Mon-Wed-Fri	2g LD, 1g q24h post-HD	3g LD, 2g q12h post-HD	2g q12h post-HD
2	HD	Qd 300 ml/min	4 hours	Daily			
3	Sequential Therapy	Qd 300 ml/min Quf 5 ml/min	HD 4 hours, then UF 20 hours	Daily			
4	PIKRT	Qd 100 ml/min	9 hours	Daily	1g q12h	3g LD, 1g q6h	2g LD, 1g q6h
5	Extended Therapy	Qd 50 ml/min	24 hours	Daily		2g q8h	2g q12h

HD: Hemodialysis; UF: Ultrafiltration; PIKRT: Prolonged Intermittent Kidney Replacement Therapy
Qd: dialysate flow rate: Quf: ultrafiltrate flow rate; LD: loading dose
Sequential: HD with or without UF followed by isolated UF
All doses are started after a HD session in settings 1-3.

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Validation of the prediction model for successful discontinuation of continuous renal replacement therapy from multicenter temporal and external cohorts

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Background: Continuous renal replacement therapy (CRRT) is a preferred modality of renal replacement therapy (RRT) in critically ill patients with acute kidney injury (AKI). However, the decision to discontinue CRRT is not based on a consensus criterion. By examining one temporal cohort and four external cohorts, we evaluated the usefulness of the prediction model developed in the previous study.
Methods: The validation included 1517 critically ill patients with AKI who received CRRT in five medical centers between 2018 and 2020. Patients who underwent CRRT for less than 3 days and died within 7 days after CRRT discontinuation were excluded. Successful discontinuation of CRRT was defined as not restarting any RRT for 7 days after CRRT discontinuation. The prediction model was composed of four variables: urine output (≥ 300 or < 300 mL/day, score 4 or 0) on the day before discontinuation and blood urea nitrogen (BUN < 35 or ≥ 35 mg/dL, score 2 or 0), serum potassium (< 4.1 or ≥ 4.1 mmol/L, score 1 or 0), and mean arterial blood pressure (50-78 mmHg or ≥ 78, score 1 or 0) on the discontinuation day.
Results: The prediction model showed an area under the curve of the receiver-operating characteristic (AUROC) of 0.74 (95% CI 0.71-0.76) in a pooled analysis of all cohorts. Overall differences between observed and predicted incidence rates were 3.0% (17.7% observed and 16.9% predicted probability), 3.6% (35.2% and 34.8%), and 2.0% (69.3% and 70.3%) in the low- (0-2 points), intermediate- (3-5 points), and high-score (6-8 points) groups, respectively. In an analysis of each cohort, four cohorts including one temporal cohort showed similar good discriminatory power (AUROC 0.770, 0.731, 0.735, and 0.725, respectively), while one cohort showed poor discriminatory power (AUROC 0.556).
Conclusions: Our prediction model for successful discontinuation of CRRT in critically ill patients showed good performance overall and in one temporal and three external cohorts, while poor performance in one external cohort. The results of this study support the need for protocols for proper CRRT operation.

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Euglycemic Ketoacidosis: An Underrecognized Complication of Continuous Renal Replacement Therapy

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INTRODUCTION
Euglycemic Ketoacidosis (EKA) is a rare presentation of diabetic ketoacidosis in patients with reduced caloric intake and those using newer antidiabetic medications such as sodium-glucose transporter-2 inhibitors. It is also seen in other settings where the body has to go to a ketogenic state due to reduced available glucose.

CASE
A 52-year-old woman with a history of hypertension and diabetes was admitted for necrotizing soft tissue infection of the lower extremity. Hospital course was complicated by septic shock and oliguric acute kidney injury. Continuous renal replacement therapy (CRRT) was started with a conventional solution leading to gradual improvement in patient's biochemical profile (Day 0). Nutrition was provided with low-glycemic carbohydrate along with intravenous insulin infusion. Two days later, CRRT solution was changed to a phosphate-containing solution to reduce the need for phosphate supplementation. This was followed by an unexplained progressive drop in serum bicarbonate levels in the face of normal serum lactate levels (anion gap metabolic acidosis [AGMA]) (Day 2). Since the phosphate-containing solution is glucose-free, there was a suspicion for development of ketosis; serum beta hydroxybutyrate was found to be as high as as 6.6 mmol/L (normal: ≤0.27) with stable glycemia confirming the diagnosis of EKA.

INTERVENTION
CRRT solution was changed back to a conventional glucose-containing solution leading to a gradual reduction in the level of ketones and normalization of serum bicarbonate concentrations (Day 4).

DISCUSSION
Since most patients on CRRT are critically ill and several of their biochemical parameters not within the normal range, EKA may remain unrecognized unless patients are screened for it. The diagnosis should be considered once there is progressive AGMA despite ongoing CRRT, in the absence of lactic acidosis, especially if a glucose-free solution is used.

Metabolic parameters during therapy

Serum	Day 1	Day 2	Day 3
Urea, mg/dl 6-21	108	11	10
Creatinine, mg/dl 0.38-1.02	3.5	0.4	0.3
Chloride, mmol/l 98-107	106	105	107
Bicarbonate, mmol/l 19-30	21	14	24
albumin, g/dl 3.6-4.7	1.6	1.8	1.9
Corrected Anion gap, mmol/l 8-16	18	21	11
Lactate, mmol/l 0.5-2.5	2.2	1.0	1.7
Glucose, mg/dl 65-99	140	117	200
B-Hydroxybutyrate, mmol/l ≤ 0.27	N/A	6.6	0.4
CVVHDF	Yes	Yes	Yes

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ACUTE KIDNEY INJURY IN A DOUBLE LIVER TRANSPLANT SUPPORTED BY CRRT AS A MULTIORGAN SUPPORT THERAPY

Juan Pablo Gomez-Villarreal[1], Rita Belinda Aguilar-Ortiz[1], Nayeli Nicte Lopez-Villa[1], Ricardo Abraham Garza-Treviño[1], Elisa Guerrero-Gonzalez[1], Lilia Rizo-Topete[1]

[1]*Hospital Universitario of Monterrey "José Eleuterio González"*

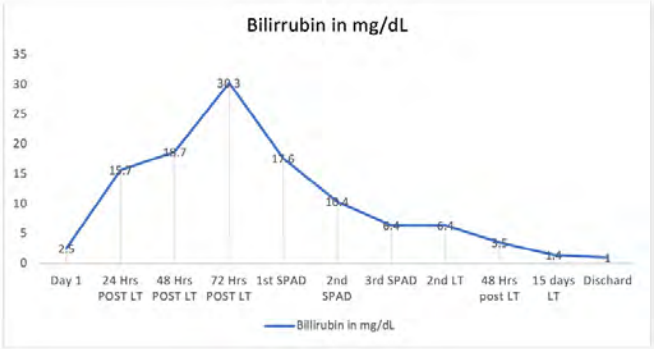
INTRODUCTION
Acute kidney injury (AKI) can be developed in up to 50% of the patients after a liver transplant (LT), of which at least 15% will require renal replacement therapy. The development of AKI will depend on multiple factors such as the recipient comorbidities, the characteristics of the donor and the immunosuppression regimen. The development of a post-LT AKI is associated with an increase in hospital stay, development chronic kidney disease as well as a higher mortality.

OBJECTIVE
Presentation of an AKI case in a patient with double liver transplant secondary to acute rejection.

CASE PRESENTATION
67-year-old woman with history of hypothyroidism, liver cirrhosis due to non-alcoholic steatosis (NAFLD) who underwent to liver transplant presented 48 hours later anuria, continuous renal replacement therapy (CRRT) was performed, at 72 hours she developed dysfunction of the graft and acute liver failure (ALF) with the following laboratories: Hgb 10.10 g/dL,Leu 5.5 K/uL, Plt 30.30 K/uL, TP 22 sec TTP 46 sec, Alb 3.2 g/dL, AU 24 mg/dL,TB 30.3 mg/dL,DB 20.5 Mg/dL,IB 9.8 mg/dL Cr 1.0 mg/dL, Therefore, it was decided to offer single pass albumin dialysis (SPAD) treatment with 3 sessions in order to improve Bilirrubin levels and try to arrive to a second liver transplant reported as an emergency 0, this occurred and LT was successful. Nevertheless the patient required 18 days of CRRT and then migrated to Intermittent Hemodialysis for 6 sessions with a partial renal recovery and no need of RRT.

DISCUSSION
Multiple comorbidities prior to LT are associated with AKI after transplant, some of them: Cr. 1.9 mg/dL, BUN < 27 mg/dL have a 3.6 greater risk of requiring RRT after transplant. Current evidence shows the efficiency of the SPAD system in the context of ALF, no significant differences have been found comparing with MARS System, it has been seen that SPAD induces a greater decrease in bilirubin compared to MARS and in vitro. There are not enough studies to compare both therapies, but their efficiency is similar.

CONCLUSION
AKI after LT has an impact on survival as well as on the development of CKD with a progression of up to 56.2% in those who present AKI. Renal dysfunction after LT is associated with a mortality of 15.5% at 28 days.Currently the patient is alive and, in a follow-up, free of replacement therapy, she has a filtration rate of 41 ml/min/7.3m2 classified as G3bA1 chronic kidney disease.



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Delayed CRRT in Children with multiple organ failure, consequences for late diagnosis of AKI

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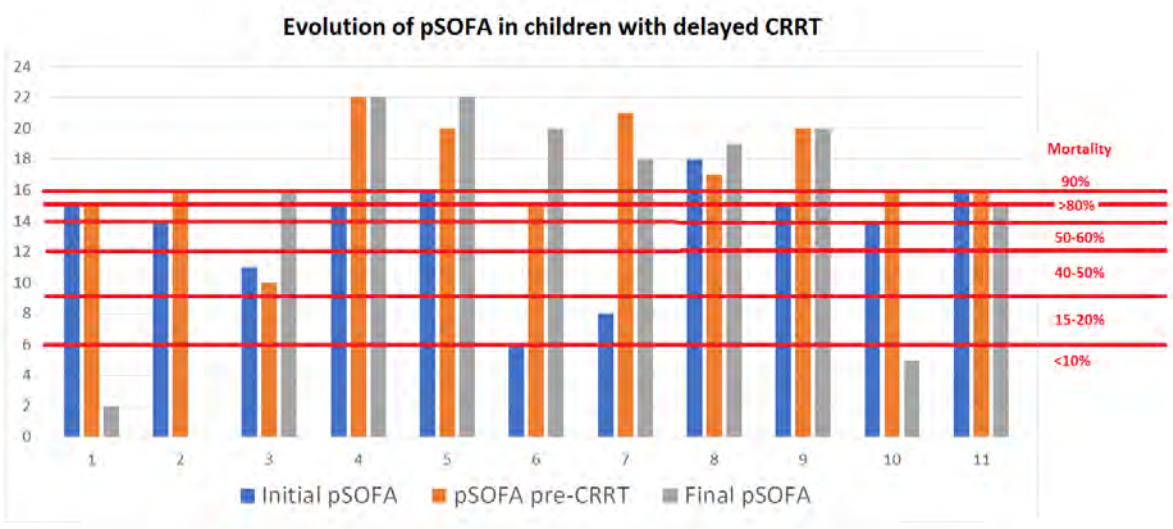
Purpose of the study: The diagnosis of Acute Kidney Injury (AKI) in the Pediatric Intensive Care Unit (PICU) in developed countries is often misdiagnosed; thus, managing it´s hard; Continuous Renal Replacement Therapy (CRRT) allows this treatment to be performed for the hemodynamically unstable patient with good results, but it´s not available all the time for many reasons, we analyzed the final status in children with Multiple Organ Failure (MOP) treated with delayed CRRT.

Methods: Retrospective and observational study of critically ill pediatric patients with MOP undergoing CRRT at the National Medical Center “20 de Noviembre” from January 2015 to December 2021, performing an analysis of clinical and biochemical evolution.

Results: We included 11 patients, 9 (3-17) years old, dry weight 42 (18-60) kg, and seven women (63%). The principal underlying diagnosis was hematopoietic malignancy (45.5%), and the main reason for admission was a septic shock (54.5%). The renal angina index was 24 (12-48) points in the first 24 hours of access; all the patients had high doses of diuretics with poor response, 27% received peritoneal dialysis, the fluid overload was 22 (5-50)%, all the patients have MOP before start CRRT, with pediatric Sequential Organ Failure Assessment (pSOFA) more than 15 points in ten patients (90%), final pSOFA was more than 15 points in eight patients (72%) all they died. The time to develop AKI to initiation of CRRT was 8 (4-31) days; all the patients have fluid overload, high values of blood urea (BUN), high creatinine (Cr) levels, anuria, and sepsis, in 45% have hyperkalemia; the modality used was CVVHDF, in all patient’s BUN, Cr, and potassium decreased significantly (p 0.008, 0.01, 0.033 respectively).

Conclusion: Delayed CRRT was effective in all critical pediatric patients, achieving survival of 27% against the expected 1%. The early diagnosis of AKI is crucial, as avoiding high doses of diuretics and fluids restrictions for many hours because the renal function still worsened; The therapy should be started early while the critical condition of the patient does not reach irreversibility to try to avoid a fatal outcome.



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Oxiris Membrane Performance In Patients With Septic Shock And Continuous Kidney Replacement Therapy Requirement: A Randomized Controlled Trial

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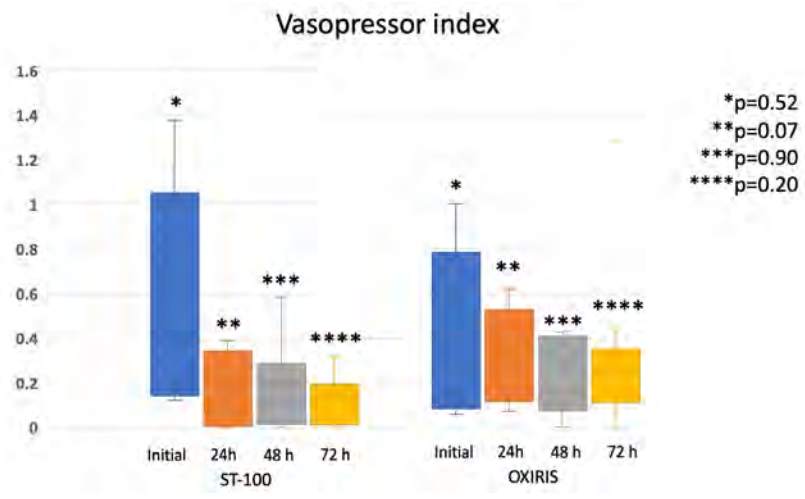
INTRODUCTION
The highly selective semipermeable Oxiris membranes have shown to provide endotoxin adsorption and removal of different inflammatory cytokines which could improve hemodynamic stability in patients with septic shock and continuous kidney replacement therapy (CKRT) requirement.
PURPOSE OF THE STUDY
The aim of this study was to compare the clinical efficacy of CKRT using an Oxiris membrane to maintain the mean arterial pressure (MAP) >65mmHg , after 72 hours of treatment, with a lower vasopressor dose than the use of a conventional AN69 standard membrane.
METHODS
Multicenter randomized controlled trial in critically ill patients with documented infection, on invasive mechanical ventilation, and the need of CKRT. Patients were randomized to receive continuous veno-venous hemodiafiltration using either an AN69 standard membrane or an AN69 Oxiris membrane. Regional citrate anticoagulation was used, all patients had a prescribed dose of 30mL/kg/h for 72 hours, and the filters were changed every 24h. Clinical variables were registered, and vasopressor dependency index was calculated to express the relationship between vasopressor dose and MAP.
RESULTS
Eighteen patients have been included, 10 (56%) in the Oxiris and 8 (44%) in the control group. The most common infection was pneumonia, 44% from COVID-19, and the mean initial SOFA score was 11 points. There was no difference in MAP between groups at 0, 24, 48 and 72 hours; 70 vs 67, 70 vs 75, 74 vs 78 and 79 vs 72 mmHg respectively (p=0.39). Vasopressor index was not different at baseline, 24, 48 and 72 hours as shown in Figure 1. Fluid removal tended to be greater in the control group than the Oxiris group with a median rate of 1.16 vs 0.68 (p=0.07) at 24h and 1.47 vs 1.16 at 48 h (p=0.63), and significantly greater in control group at 72 h with a rate of 1.67 vs 0.9 mL/kg/h (p=0.02). There were no differences in the daily fluid balance.
CONCLUSIONS
In this interim analysis there were no differences in vasopressor requirement to maintain hemodynamic stability in patients with septic shock and CKRT using the Oxiris membrane compared to the standard membrane.



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Continuous Renal Replacement Therapy In Children With Transplant-Associated Thrombotic Microangiopathy Post Hematopoietic Stem Cell Transplantation

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BACKGROUND: Transplant-associated thrombotic microangiopathy (TA-TMA) is a life-threatening complication that occurs early in the post hematopoietic cell transplantation (HCT) phase. Acute kidney injury is common in children who develop TA-TMA post-HCT, and ~15% will require renal replacement therapy. The outcome of children with TA-TMA post-HCT who require continuous renal replacement therapy (CRRT) hasn't been described. Our study aimed to describe the course and outcome of CRRT in critically ill children with TA-TMA post HCT.

METHODS: Retrospective review of all children admitted to the intensive care unit (ICU) with TA-TMA who received CRRT from 2019-2020.

RESULTS: Four patients (3 males and 1 female) underwent CRRT for TA-TMA related AKI after autologous (n=2) or allogeneic (n=2) HCT. Oncologic diagnosis was acute lymphoblastic leukemia (ALL) in 50%, and neuroblastoma in 50%. Invasive mechanical ventilation and vasopressor support was required in 75% of our cohort. All patients had stage 3 AKI at the time of TA-TMA diagnosis. The median time of onset TA-TMA was 18 days (range: 8-25) post-HCT. Median duration of CRRT courses was 5 days (3-21 days). Two patients (50%) survived and didn't require future renal replacement therapy. All patients received eculizumab with a median number of doses of 5 (range: 3-9).

CONCLUSION: CRRT can benefit children with AKI related to TA-TMA. Furthermore, children who survive their CRRT course didn't require further renal replacement therapy in our case series. Further prospective research studies are needed to improve the management and outcomes of TA-TMA.

Patient	Age	Race	Oncologic diagnosis	HCT	D from HCT to onset of TA-TMA	Vasopressor support	Mechanical ventilation	Duration of CRRT (D)	ICU length of stay (D)	ICU survival	AKI stage at onset of TMA	Total # of eculizumab doses
1	3	C	Neuroblastoma	Autologous	8	N	N	3	9	Y	3	7
2	3	C	ALL	Allogeneic	15	Y	Y	5	20	N	3	3
3	4	AA	Neuroblastoma	Autologous	21	Y	Y	21	70	Y	3	3
4	2	C	ALL	Allogeneic	25	Y	Y	5	52	N	3	9

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Efficacy of the Cytokine Adsorption Therapy in Patients with Severe COVID-19-Associated Pneumonia: Lesson Learned from a Prospective Observational Study

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Background: Severe COVID-19 pneumonia can activate cytokine storm. Hemoperfusion can reduce pro-inflammatory cytokines in sepsis, but still debated in COVID-19 setting. Thus, we sought to investigate the benefit of HA-330 cytokine adsorption through the clinical and laboratory outcomes.

Methods: We conducted a single-center prospective observational study in adults with severe COVID-19 pneumonia admitted in intensive care unit (ICU) at Chiang Mai University Hospital (Chiang Mai, Thailand). Patients with at least 1 of cytokine storm parameters including acute respiratory distress syndrome (ARDS) or high inflammatory markers was included. Patients treated with HA-330 device at least 1 session were classified as hemoperfusion group while the other without cytokine adsorption was classified as control group. We compared the clinical and laboratory outcomes at day 7 after treatment. The clinical parameters represented in APACHE II, SOFA score, and oxygenation (PaO2/FiO2). Laboratory parameters included inflammatory cytokines level and kidney function. We also evaluated 60-day mortality and its associated factors.

Results: A total of 112 patients who met the inclusion criteria were enrolled. Thirty-eight patients were treated with cytokine adsorption and 74 patients were not. The baseline cytokine storm parameters were comparable. Between intervention groups, the positive clinical and laboratory effects were demonstrated only in hemoperfusion group. In multivariate analysis, APACHE II, SOFA score, and PaO2/FiO2, hs-CRP, and IL-6 were associated with mortality and could improve after hemoperfusion. Although the 60-day mortality was no significant different between groups (adjusted hazard ratio 0.88, 95% CI 0.36-2.11, p = 0.766), however, hemoperfusion of at least 3 sessions could mitigate the mortality (adjusted odds ratio 0.25, 95% CI 0.03-0.33, p = 0.001).

Conclusions: The early initiation of HA-330 hemoperfusion could improve clinical and laboratory cytokine storm parameters of severe COVID-19 ARDS. At least 3 session of cytokine adsorption was associated with a 60-day survival.

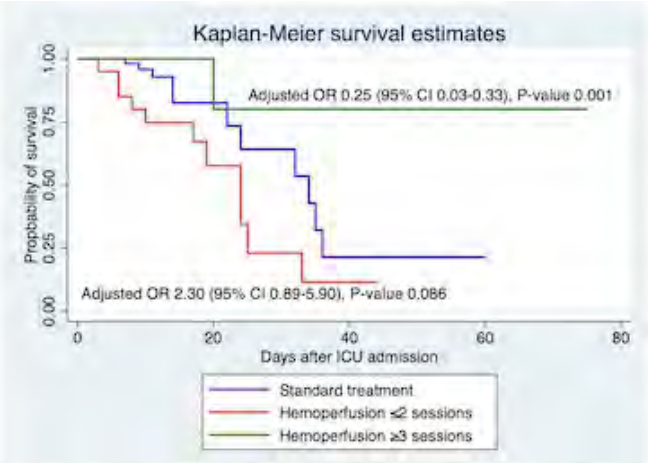

Fig. 4 Kaplan-Meier curves for 60-day survival based on number of hemoperfusion session compared with control group

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Decreasing the Citrate Load to CRRT Patients by Using a Leurlock to Allow for Lower Blood Flows

Deepak Chandramohan[1], Zachary Stello[1], Katrina Eggleston[2], Keith Willie[1], Javier Neyra[1], Ashita Tolwani[1]

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Purpose

Citrate is the preferred anticoagulant for CRRT. Citrate excess results in metabolic alkalosis, while citrate toxicity results in ionized hypocalcemia and metabolic acidosis. One way to mitigate these complications is to decrease the citrate load to the patient. The recommended concentration of citrate in the circuit for anticoagulation is 3-4mmol/L. The lower the blood flow (Qb), the less citrate is needed to maintain this concentration, and therefore less citrate enters the systemic circulation to cause metabolic derangements. Certain CRRT machines, such as the Prismaflex, trigger a "cannot detect return" alarm with Qb ≤ 120ml/min. To mitigate this issue, we placed an extra luerlock on the CRRT return line to increase the resistance in the venous line to allow for a lower Qb. We report our results with the luerlock and Qb 100ml/min.

Methods

We performed a prospective observational study of 18 patients admitted to the Cardio-Pulmonary ICU requiring CVVHDF at the University of Alabama, Birmingham from May 2022 to June 2022. Demographics, clinical and laboratory data were collected. Dialysate flow (Qd), effluent dose, access pressures, alarms, systemic ionized calcium (iCa) and post-filter iCa were monitored. RCA was deployed with Regiocit, which has 18mmol/L of trisodium citrate. Incidences of clotting and citrate excess or toxicity were recorded, as well as any complications from the luerlock.

Results

Median age of the cohort was 65 years. Of the 18 patients, 63% were male, 72% were white. 83% of patients had AKI; 17% had ESKD. The dialysis catheter was placed in the internal jugular vein in 89% and in the femoral vein in 11%. Median pre-blood pump citrate rate was 1100mL/h; median effluent dose was 26ml/kg/h. Median systemic iCa was 1.04-1.28mmol/L; median post-filter iCa was 0.36-0.52mmol/L. One third of patients were on ECMO; CRRT was run in-line with VV ECMO circuit in one patient. Filters were routinely changed every 72h. Only one clotting event occurred in total of 3654 CRRT patient-days. Post-filter iCa at the time of clotting was 0.55mmol/L.

Conclusions

Addition of a luerlock to the CRRT circuit prevented low return pressure alarms on the Prismaflex, allowing for lower blood flows. The potential advantages include decrease in the cumulative amount of citrate delivered to patients, decrease in the total volume of Regiocit solution used, and less frequent nursing changing of bags. Further studies are needed to validate these results.

	Median	25th %ile	75th %ile
Age(years)	65	58.25	69.75
Weight(Kg)	82.3	78.32	130.35
No. of days on CRRT	9.5	6	16.5
Pre blood pump (ml/hr)	1100	1000	1100
Qd(ml/hr)	1050	807	1400
Post filter(ml/hr)	200	200	200
Effluent dose(ml/kg/h)	26.07	22.6	37.4
Systemic iCa(mmol/L)	1.17	1.11	1.19
CRRT iCa(mmol/L)	0.41	0.40	0.44
Platelets(10^9/L)	89.8	62.5	176.8
INR	1.3	1.22	1.49

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A New Sorbent Device that Combine Convection, Diffusion and Adsorption for Multiple Clinical Purposes: Current Evidence at a Private Hospital in Mexico and Possible Future Directions.

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[1]*Hospital Angeles Puebla*

Backgrounds/aims: Adsorption is an extracorporeal technique utilized for blood purification, it also complements convection and diffusion for solute removal. Since 1991 we had used blood purification techniques, over the years, new adsorption cartridges had been developed, the new ones involving treatment for inflammatory conditions, chronic uremic symptoms and autoimmune diseases. . HA130, HA230, and HA330 (Jafron, Zhuhai City, China) are among the widely used adsorption cartridges in China. We report highlights of the use of hemoperfusion using HA130 cartridges in the Mexican population in order to support evidence of effectiveness and safety.
Methods: We retrospectively analyzed the medical records of 5 critically ill patients in the context of inflammatory conditions such as acute renal injury, pancreatitis and sepsis. Hemoperfusion in addition to standard therapy (fluid resuscitation, vasopressors, antimicrobial therapy and ventilatory support) resulted in the improvement of inflammatory levels when compared to standard therapy alone.
Results: HA 130 cartridges were found to be effective in reducing uremic symptoms in chronic hemodialysis patients, improvement of pruritus score and decreased parathyroid hormone and calcium phosphate product ($p<0.5$) when compared to HD alone. 66.6% of cost-effectiveness when compared to prismax.
Conclusion: The development in new cartridges technology allows more wide applications for renal patients. As we expand to involve other indications for this therapy there is cost-effectiveness improvement for the patients.More studies in different clinical settings are needed in order to achieve adsorption therapy national recommendations.

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CRRT in a patient with AKI on CKD, hypernatremia and cerebral edema; opportunity to review correction formulas

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[1]*Hospital San Lucas*

The presentation of severe AKI, in combination with dysnatremia in patients with cerebral edema is frequent and a challenge for treatment. The adequacy of dialysis beads is required to achieve a gradual correction of sodium.

• Presentation of the case, hypernatremia in AKI on CKD

A 63-year-old patient with stage 3 chronic kidney disease (CKD), secondary to diabetic nephropathy, presented with head trauma requiring neurosurgical treatment (August 2, 2020), during his stay in intensive care he developed severe hypernatremia (Na 167 mmol/L). as well as impaired glomerular filtration (creatinine 5.9 mg/dl).

• Treatment
Renal support was started by means of CRRT with modification of dialysis bags for a gradual correction of sodium. Anticoagulation was performed with citrate.

$$[Na+] \text{ replacement fluid} = \frac{\Delta [Na+] \text{ desired serum}}{(1 - e^{[-Clx24\ h)/V]})} + [Na+] \text{ initial serum}$$

Target serum Δ [Na+] = negative value in hypernatremia and positive in hyponatremia
e^x= Euler number
Cl= clearance. In CRRT example dose of 25 ml/kg/hr, in a 100 kg patient = (2 L/hr x24 h) /50 L = 0.96

• Evolution and results

The patient evolved favorably, with late recovery of renal function, for which she was discharged with maintenance dialysis therapy at her home (peritoneal dialysis). In her follow-up when she recovered renal function, she remained free of renal replacement therapy for a year.

Bibliography of adequacy formulas;
• CKJ, 2016, vol. 9, no. 4, 540–542
• Am J Kidney Dis 2014; 64: 305–310
• Contrib Nephrol. 2017;190:19-30.

date	Creatinine (mg/dl)	BUN (mg/dl)	Sodium (mol/L)	
25/07/2020	4,2	55	162	
27/07/2020	4,3	60	167	
29/07/2020	5	74	164	
31/07/2020	5,2	92	164	
01/08/2020	5,9	96	160	
02/08/2020	6	98	160	CRRT
03/08/2020	3,1	57	151	
04/08/2020	2,7	54	139	
05/08/2020	3,2	64	142	

NEW TECHNOLOGY

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Role Of Endotoxin Adsorption In Severe Gram Negative Sepsis After Covid 19 Infection In A Renal Transplant Recipient . A Case Report

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ABSTRACT

Sepsis and septic shock results in high morbidity and mortality. Surviving sepsis guidelines recommend to decrease the systemic inflammatory response to modulate organ dysfunctions. Endotoxin, derived from the membrane of Gram-negative bacteria, is considered as a major factor in the pathogenesis of sepsis. Endotoxin adsorption,if effective, has the potential to reduce the biological cascade of Gram-negative sepsis.

We present a case of a 30 year old man, post live related renal transplant recipient on immunosuppressive medication with severe Gram-negative sepsis/pneumonia, following Covid -19 infection. To reduce the amplitude of the general effects of endotoxins we used a novel device, the Alteco LPS Adsorber for lipopolysaccharide (LPS) adsorption.
The efficacy markers were: the overall haemodynamic profile, translated into decreased vasopressor requirements, the reduction in procalcitonin (PCT) levels,IL-6 level and C-reactive protein(CRP).
The clinical course following treatment was favorable for the hours immediately following the treatment.This was attributed to the removal of endotoxin from the systemic circulation.Patient condition improved well and got discharged in a hemodynamically stable condition.

Figure 1

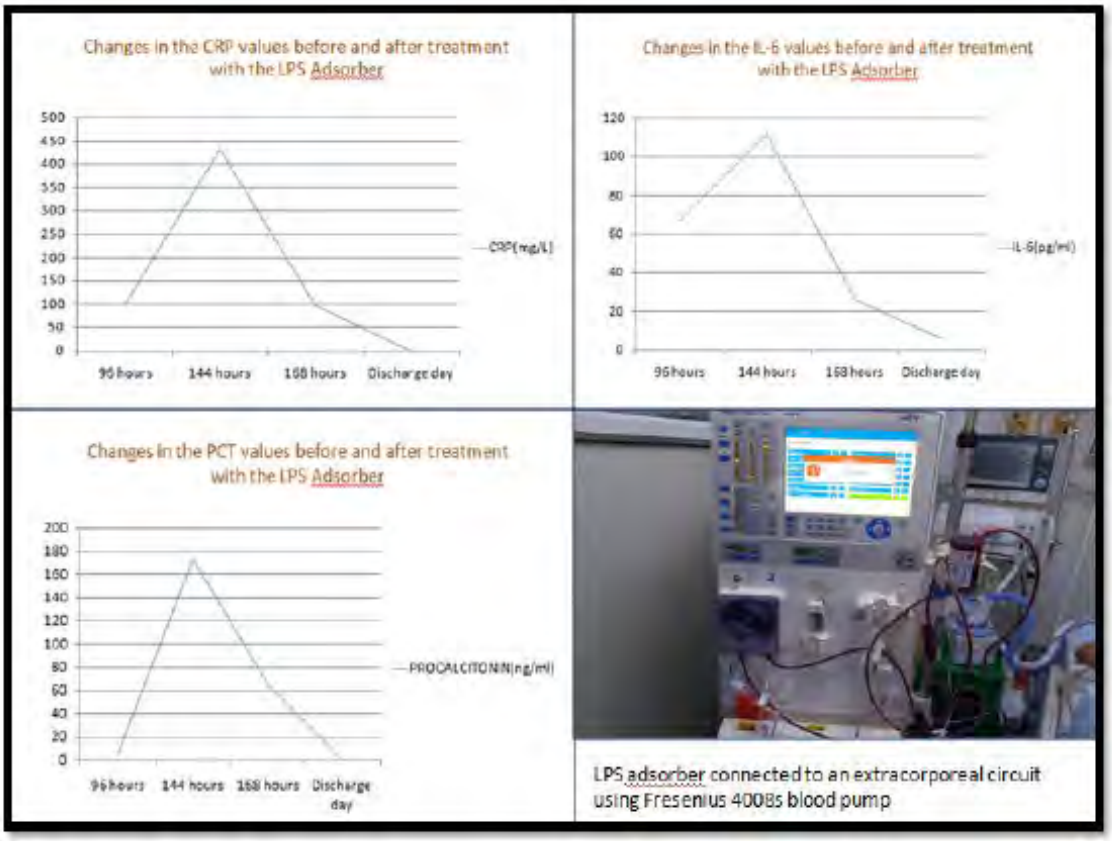
DISCUSSION

Extracorporeal blood purification can be used as an adjunct in the treatment of the sepsis. It targets either inflammatory mediators or bacterial endotoxins or both.
The Alteco LPS Adsorber is a class IIa medical extracorporeal device consisting of a rigid porous matrix, which significantly increases its blood contact area. Tailor-made synthetic peptides with a high affinity for endotoxins are connected to the surface of the polyethylene plates with a covalent bonding technique. However it is uncertain if the noted haemodynamic improvement is for a limited period or how often the endotoxin removal session should be repeated or if endotoxin
elimination has a significant impact on the ICU length of stay or ICU mortality. Further studies are necessary to solve these problems.

CONCLUSION

This case report highlights the efficacy of a new adsorptive therapy for the clearance of endotoxins in septic shock caused Gram negative bacterial infection.
Early application of an endotoxin adsorber showed a reduction of vasopressor requirements, elevation of blood pressure and a decrease in inflammatory markers.
Endotoxin elimination have a significant effect on the ICU length of stay or ICU mortality.

Figure on following page



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Efficacy And Safety Of Hemoadsorption With Ha-230 Adsorber In The Treatment Of Severe AKI Secondary To Methotrexate Toxicity In A Patient With B Lymphoblastic Leukemia

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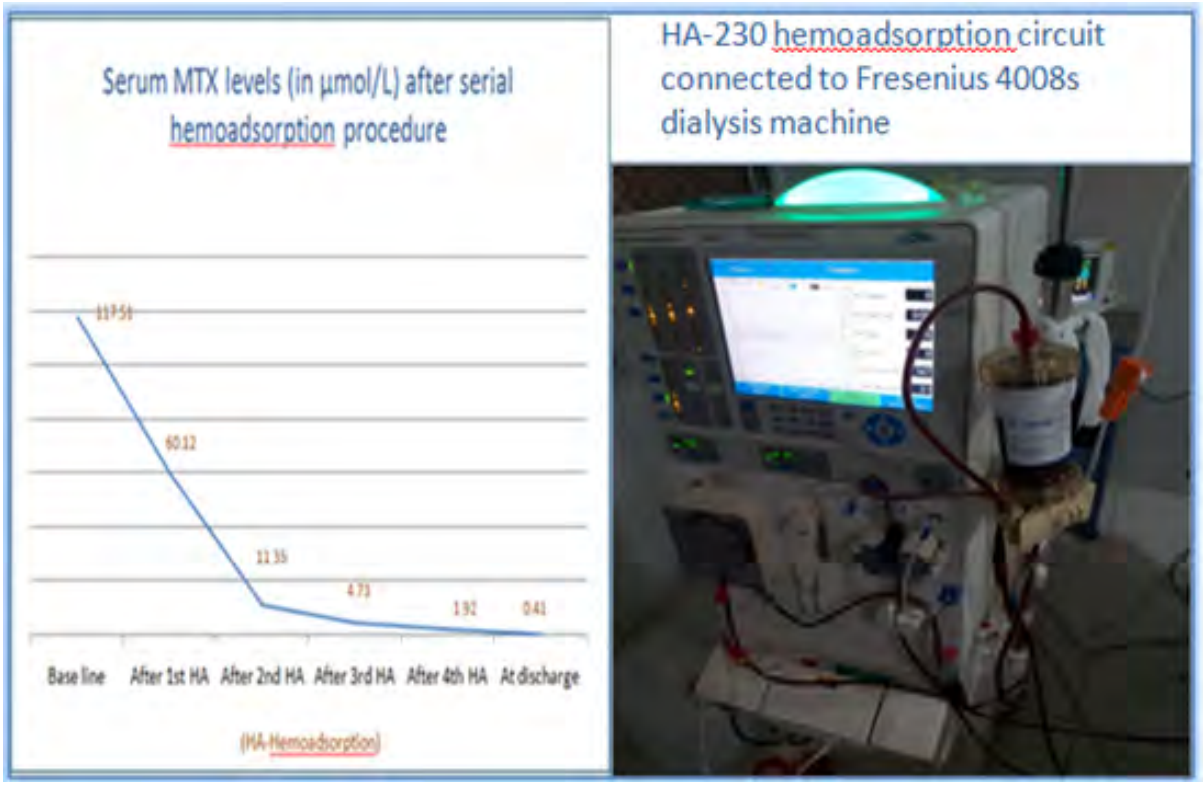
Back ground:
High-dose methotrexate (HDMTX) is known to cause nephrotoxicity with a number of other major organ side effects like hepatotoxicity, mucositis, and neurotoxicity. Multiple studies demonstrated the efficacy of extracorporeal detoxification methods such as plasma exchange, hemodialysis, hemofiltration, and hemoadsorption for the treatment of methotrexate (MTX) overdose. However, these methods are not effectively practiced due to lack of awareness about its effectiveness and fear about a procedure-related complications.

Case report
We report a case of 38 years old female,having B-lymphoblastic leukemia(CALLA). Started on GMALL (German

multicenter treatment of ALL) protocol. As upfront total leukocyte count was 90,000/mm3, steroids was added to GMALL protocol. As reassessment on day-8 was showed poor response to prednisolone with normal karyotype and phenotype negative, she was started on vincristine and daunorubicin (VCR+Dauno),after receiving two doses of (VCR+Dauno), she had neutropaenia and hence she received granulocyte macrophage colony-stimulating factor (GM-CSF), two doses of Peg L-Asparginase. As CSF (cerebro spinal fluid)cytology was negative for malignancy,she received intrathecal MTX. As post induction bone marrow aspiration and biopsy was suggestive of minimal residual disease, she was advised to go for bone marrow transplant or chemotherapy. As she opted for chemotherapy, she was started on HDMTX, after receiving third dose of HDMTX, she developed severe nausea, abdominal discomfort, oral mucosal redness and mild breathing difficulty. Laboratory reports were suggestive of high level of serum MTX 117.50µmol/L, serum creatinine of 3.6mg/dl (base line creatinine was 0.92 mg/dl),mild metabolic acidosis on blood gas analysis. She was subjected to extracorporeal therapy HA-230 hemoadsorption filter as other modalities of treatment for HDMTX toxicity was not encouraging (leucoverin and sodium bicarbonate infusion).She was subjected to four sessions of extracorporeal therapy with HA-230 hemoadsorption and discharged in hemodynamically stable condition with serum creatinine of 1.12 mg/dl and serum MTX level of 0.4 µmol/L.
Figure 1:

Conclusions
Hemoadsorption is safe and can be offered as treatment modality in severe AKI secondary to HDMTX toxicity without any modality of RRT, provided hemoadsorption (with HA-230) is done very early.
Further large studies are needed to implement this in most of the cases of HDMTX toxicity.



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Zorro-Flow™: an external urine collection device designed for small neonates and infants.

David j Askenazi[1], Elizabeth Dechant[2], Jessica Potts[1], Martin Holland[1]

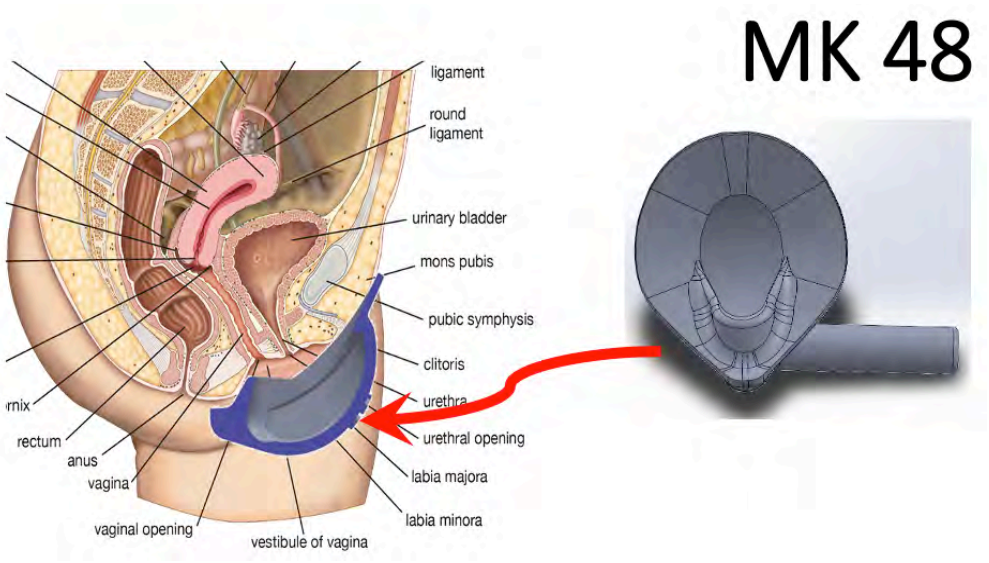
[1]*University of Alabama at Birmingham,* [2]*Children's of Alabama*

Introduction:
The ability to collect urine in ICU patients is standard of care because urine alerts the physician about end-organ perfusion. failure to account for oliguria will miss 20-30% of acute kidney injury (AKI), appropriate fluid provision requires knowledge of urine output, and urine analysis is important to diagnose urinary tract infection, electrolyte abnormalities, and nephrolithiasis. In addition, novel urine tests to diagnose AKI are being incorporated into clinical care algorithms. Unfortunately, safe and effective urine collection devices for neonates and small children are not available. Urine catheters are difficult to use and traumatic. Diaper weights are misleading (if they quantify stool). Cotton balls absorb electrolytes and proteins and can't be used to test for a urinary tract infection. In small children, urine collection bags are poor urine collectors, and the tape can damage the fragile skin of premature neonates.

Methods
Using an iterative process, we developed an external urine collection device designed with the female neonates in mind. Each cycle included designing, printing, testing and evaluation. For each cycle, 3-5 female participated after informed consent from the family. During one cycle, we used wall suction of 20 mmHg. Silicone adhesive tape/gel were used to adhere the device to the skin. Testing of skin color, temperature, turgor, moisture and integrity were performed before, immediately after removal and at 24 hours after removal.

Results
We tested 82 female neonates and infants with 8 different 3-D printed devices. The average weight was 2.42 kg. The corrected gestational age ranged from 24 weeks to 72 weeks. The 8th design (MK48) is ergonomic and has a ramp to limit urine leak. We did not find any major issues with skin integrity based on formal skin tests, except during the cycle where we used wall suction (4/5 had mild transient skin changes that resolved by 24 hours). The design is pictured in the figure below.

Conclusions
Zorro-Flow™ is an external urine collection device design for the smallest neonates. Current plans are underway to manufacture a sterile device which will include tubing, a 3-way stopcock, and a urine reservoir bag.



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A Novel Approach to Monitoring Drugs for Therapeutic Efficacy during CRRT: in vitro Validation

Jeng-Jong Shieh[1], H. Rhodes Hambrick[2], Richard B Dorshow[1], Stuart L Goldstein[2]

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Background / Purpose:
For patients requiring continuous renal replacement therapy (CRRT), a critically ill population for whom appropriate antibiotic dosing is crucial, monitoring administered antimicrobial drugs to ensure efficacy is not clinically amenable. We have previously shown in an in vivo nephrectomized porcine model that relmapirazin (MB-102), a novel fluorescent tracer agent of glomerular filtration rate (GFR), correlates with meropenem concentrations upon IV administration of both during CRRT. Relmapirazin and meropenem each have negligible protein binding, thus the correlation of MB-102 with drugs with higher degrees of protein binding commonly employed during CRRT is unknown.

Methods: An in vitro mock continuous veno-venous hemofiltration (CVVH) circuit was constructed using a polyethersulfone filter with selectivity for molecules up to 12 kDa. A reservoir solution was prepared containing equimolar concentrations of relmapirazin with each of four different antibiotic drugs (meropenem, cefepime, ceftriaxone, and ganciclovir) in a mixture of human plasma and phosphate-buffered saline. Ultrafiltrate was collected at intervals from 30 - 360 minutes while the retentate was re-circulated to the reservoir for refiltration. Concentrations of relmapirazin and antibiotics in the ultrafiltrate were assessed by high performance liquid chromatography.

Summary of Results: The in vitro molar ratio of antibiotic drug to relmapirazin for each antibiotic drug was determined. The result for this ratio with meropenem verified the previous in vivo work in that there is an almost perfect correlation to relmapirazin due to its negligible protein binding. However, ceftriaxone with protein binding on the order of 90% also correlates to relmapirazin but with a lower ratio. All drugs tested correlated with relmapirazin with antibiotic to relmapirazin ratios in the range of 0.3 to close to 1 depending on protein binding (Table).

Conclusion: Relmapirazin can be correlated with antibiotic drugs regardless of their protein binding during CRRT. The capability to measure relmapirazin by transdermal detection should eventually yield a noninvasive methodology to monitor commonly employed drugs in CRRT for therapeutic efficacy.

Antibiotic	Protein Binding (%)	Antibiotic to Relmapirazin Ratio
Meropenem	~ 2	1.20
Ganciclovir	~ 2	1.15
Cefepime	~ 20	0.95
Ceftriaxone	~ 90	0.32

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CytoSorb hemoperfusion markedly attenuates circulating cytokine concentrations during systemic inflammation in humans in vivo

Aron Jansen[1], Nicole Waalders[1], Dirk van Lier[1], Efthymios N Deliargyris[2], Joerg Scheier[3], Matthijs Kox[1], Peter Pickkers[1]

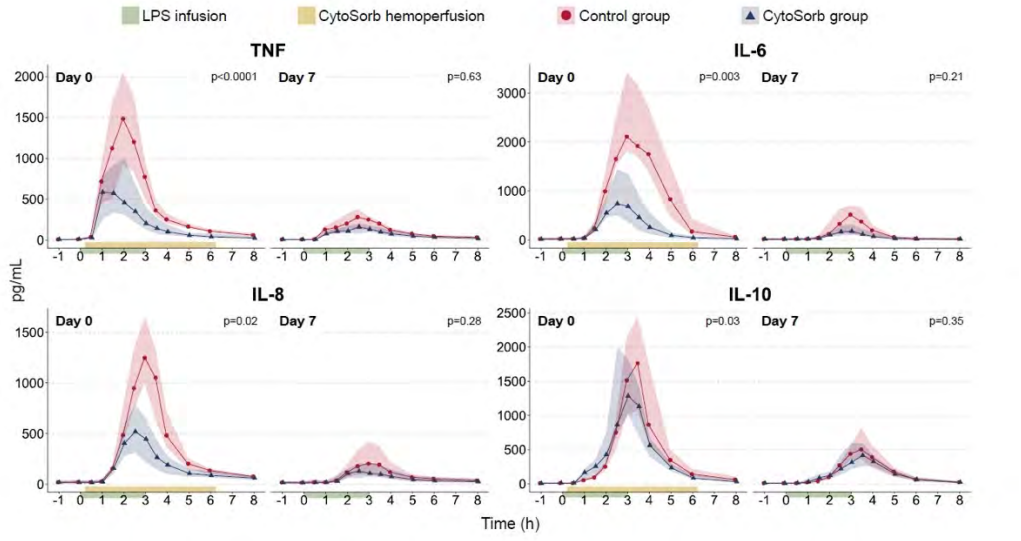
[1]*Radboud university medical center,* [2]*CytoSorbents Corporation, Princeton, New Jersey, USA,* [3]*CytoSorbents Europe, Berlin, Germany*

Introduction:
Although the CytoSorb hemoadsorption device has been demonstrated to be capable of clearing inflammatory cytokines, it has not yet been shown to attenuate plasma cytokine concentrations in humans in vivo. We investigated the effects of CytoSorb hemoperfusion on plasma levels of various cytokines using the repeated human experimental endotoxemia model, a highly standardized and reproducible human in vivo model of systemic inflammation and immunological tolerance induced by administration of bacterial lipopolysaccharide (LPS).

Methods:
Twenty-four healthy male volunteers (age 18-35) were intravenously challenged with LPS (a bolus of 1 ng/kg followed by continuous infusion of 0.5 ng/kg/hr for three hours) twice: on day 0 to quantify the initial cytokine response and on day 7 to quantify the degree of endotoxin tolerance. Subjects were randomized to receive either CytoSorb hemoperfusion for 6 hours during the first LPS challenge (CytoSorb group), or no intervention (control group). Blood samples were serially obtained to determine cytokine plasma concentrations and clearance rates.

Results:
LPS administration led to a profound increase in cytokine plasma concentrations during both LPS challenge days (Fig. 1). Compared to the control group, significantly lower plasma levels of tumor necrosis factor (TNF, -58%, p<0.0001), interleukin (IL)-6 (-71%, p=0.003), IL-8 (-48%, p=0.02) and IL-10 (-26%, p=0.03) were observed in the CytoSorb group during the first LPS challenge. Peak clearance rates ranged from a median of 75.1 [70.7 – 87.1] mL/min for TNF, to 32.5 [28.0 – 44.2] mL/min for IL-6. The degree of endotoxin tolerance apparent during the second LPS challenge was not affected by previous CytoSorb use.

Conclusions:
CytoSorb hemoperfusion effectively attenuates circulating cytokine concentrations during systemic inflammation in humans in vivo, whereas it does not affect tolerance induction. Therefore, CytoSorb therapy may be of benefit in conditions characterized by excessive cytokine release.



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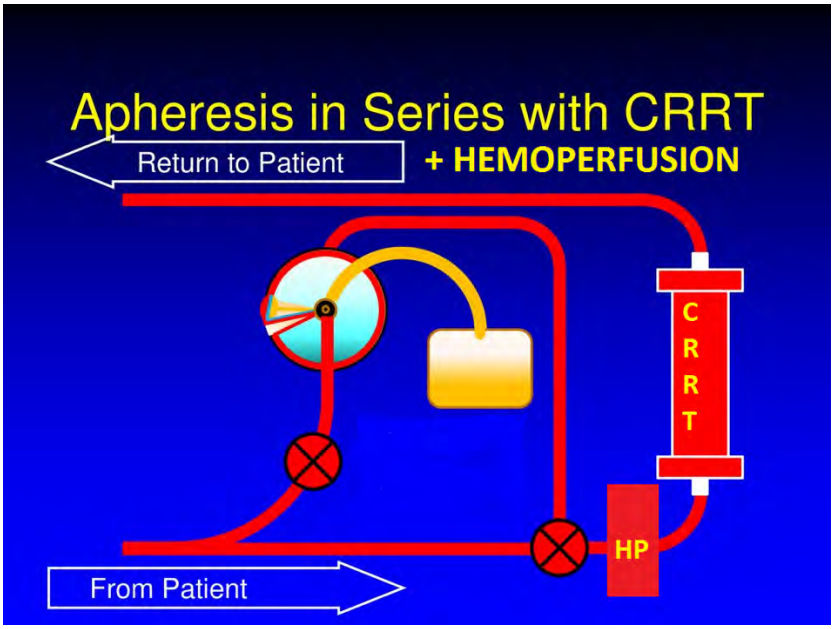
Centrifugal Plasma Exchange In Series With CRRT And Hemoperfusion With Seraph-100®. A Case Report.

Vedran Premuzic[1], Katja Jankov[2], Ivana Vukovic-Brinar[1], Margareta Fistrek[1], Ema Ivandic[1], Jelena Kos[1], Tamara Knezevic[1], Vlatka Sinkovic[1], Goranka Erzen[1], Denis Maric[1]

[1]*University Hospital Center Zagreb,* [2]*School of Medicine, University of Zagreb*

Purpose: When a critically ill patient requires more than one extracorporeal procedure, options include performing procedures sequentially, pause one therapy to perform the other or perform the procedures simultaneously via a single access but a combined circuit, either in series or in parallel. The purpose of this case report was to explore the therapeutic effectiveness and technical implementation of serial combined circuits with hemoperfusion device.
Methods: We present a case of a patient (male, 86 years of age) admitted to the hospital due to acute kidney injury (serum creatinine 667 umol/L). Since the renal function did not improved we have performed the first hemodialysis procedure. Subsequently, the finding of antibodies to the glomerular basement membrane was positive and centrifugal plasma exchange with citrate anticoagulation was indicated as an urgent procedure. At the same day, after the first plasma exchange procedure, control swab for SARS CoV-2 arrives positive. At this time, we decided to use centrifugal plasma exchange in series with CRRT and hemoperfusion with citrate anticoagulation (Figure 1). Due to positive swab for SARS CoV-2 we used the Seraph-100® Microbind Affinity Blood Filter (Seraph-100; Exthera Medical Corporation, Martinez, CA) which is an hemoperfusion device with a broad-spectrum sorbent capable of binding bacteria, viruses and fungi in the blood, including SARS-CoV-2. The procedure went without complications and we haven´t seen any signs of circuit clotting.
Results: In total, 3 procedures of plasma exchange were performed while one of these three plasma exchange procedures was performed in series with CRRT and hemoperfusion with Seraph. The duration of treatment with Seraph was 4 h, while the duration of CRRT was 8 h, by which we obtained reduction of serum creatinine from 661 to 483 mmol/L, reduction of C-reactive protein from 88,3 to 18,8 mg/L while antibodies to the glomerular basement membrane remained positive but the laboratory only performed the qualitative analysis. The control swab for SARS CoV2 was not performed.
Conclusion: Based on presented case, it could be concluded that serial combined circuits with the Seraph hemoperfusion device can achieve therapeutic effectiveness and can be technically implemented without complications during treatment. Furthermore, citrate anticoagulation applied only for circuit of centrifugal plasma exchange was sufficient in preventing clotting of all serial combined circuits.



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Selective Cytopheretic Device (SCD) Immunomodulation Used with Extracorporeal Membrane Oxygenation (ECMO) and Pathogen Removal in Septic Shock Secondary to Streptococcal Toxic Shock Syndrome (STSS)

Stephen J Amerson[1], McKenna Hoffman[5], Matt Jacques[3], Fadi Abouzahr[2], Rachel K Sterling[1], Hitesh Gidwani[2], Linda E Sousse[1], H. David Humes[4], Kevin K Chung[3], Jeffrey D DellaVolpe[1]

[1]*The Institute for Extracorporeal Life Support and Texas IPS - Intensivist, Pulmonary & Sleep Medicine,* [2]*Texas IPS - Intensivist, Pulmonary & Sleep Medicine,* [3]*SeaStar Medical,* [4]*University of Michigan Nephrology and SeaStar Medical,* [5]*The Institute for Extracorporeal Life Support*

Background
STSS is a highly fulminant disease characterized by sudden onset of shock, hyperinflammation, and organ failure. Mortality typically exceeds 50% of all cases. Treatment primarily includes the use of vasopressors to restore sepsis-induced hypotension. Patients often develop catecholamine-resistant shock, which can lead to multiple organ failure and death. Here, we describe a novel multi-extracorporeal intervention strategy in a case of severe septic shock secondary to STSS starting with venous-arterial (VA)-ECMO with subsequent initiation of pathogen hemoperfusion using the Seraph 100 Microbind Affinity Blood Filter, followed by the SCD. The SCD promotes an immunomodulatory effect of the host septic response when circuit ionized calcium is maintained at <0.40 mmol/L with regional citrate anticoagulation.

Methods
A 28-year old female patient 5-days post cesarean-section presented with respiratory distress and hypotension. Blood cultures grew S. pyogenes. The course progressed to multiple organ failure, including anuric acute kidney injury, shock liver, respiratory failure, and refractory shock. Conventional therapy initially involved stabilization through intubation, fluid resuscitation, vasopressors, and antibiotics. Due to increasing instability, the patient was placed on VA-ECMO and was initiated on Seraph 100 for 36 hours for pathogen clearance, followed by SCD treatment for 12 days.

Results
No device-related adverse events were observed. The patient's condition gradually stabilized, with discontinuation from vasopressors after 4 days, ECMO decannulation after 6 days, evidence of renal recovery after 7 days, and extubation from mechanical ventilation after 14 days. She was transferred to conventional hemodialysis after 13 days and discontinued all kidney replacement therapy 11 days later. Her course was complicated by skin necrosis and extremity ischemia, which required fasciotomy and eventual amputations. She continues to recover with a focus on physical therapy and function.

Conclusion
The patient's outcome in relation to initial prognosis demonstrated success through the use of multiple modalities of EC support. This is the first reported use of VA-ECMO, Seraph 100 hemoperfusion, and SeaStar Medical's SCD; this strategy combines a cardiopulmonary stabilization on ECMO, pathogen removal, and cell-directed immunomodulation. This multi-modal approach to EC support may represent the future of critical care for the most refractory cases.

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A Novel Case Series of Shiga Toxin-Producing Escherichia Coli Induced Hemolytic Uremic Syndrome-Induced AKI Treated Through Immunomodulation with the Selective Cytopheretic Device

H. Rhodes Hambrick[1], Kara Short[2], Stuart L Goldstein[1], David Askenazi[2], Kelli Krallman[1], Christopher Pino[3], Lenar Yessayan[3], Angela Westover[3], H. David Humes[3]

[1]*Center for Acute Care Nephrology, Cincinnati Children's Hospital Medical Center, Cincinnati, OH, USA,* [2]*Pediatric and Infant Center for Acute Nephrology, Children's Hospital of Alabama, Birmingham, AL, USA,* [3]*University of Michigan Medicine Division of Nephrology, Ann Arbor, MI, USA*

Purpose
Shiga-toxin associated-hemolytic uremic syndrome (STEC-HUS) is the most common cause of thrombotic microangiopathy (TMA) in children. Although most children recover, about 5% die and 30% develop long-term renal morbidity. HUS pathophysiology includes activated neutrophils which damage vascular endothelial cells, resulting in inflammation, vasoconstriction, and thrombosis. Therapeutic immunomodulation of activated neutrophils may alter the progression of organ dysfunction in STEC-HUS. We present 3 pediatric patients treated with the selective cytophoretic device (SCD) who showed rapid improvements in stigmata of TMA.

Methods
We describe a 12 yo (Patient 1) and two 2 yo twins (Patients 2 and 3) with STEC-HUS requiring continuous kidney replacement therapy (CKRT) who were enrolled in two separate studies of the SCD, Patient 1 in an ongoing multicenter single-arm study (NCT02820350) and Patients 2 and 3 as part of a subsequent study (NCT04869787).

Results
Patient 1 had Trisomy 21 and obesity and presented with diarrhea, microangiopathic anemia, thrombocytopenia, acute hepatitis, and acute kidney injury (AKI) due to STEC-HUS who received a total of 7 days of SCD and CKRT treatment. Once started on CKRT with SCD treatment, the patient stabilized and showed steady improvement. He had normalizations of elevated WBC, platelets, transaminases, and hemodynamics, was able to be extubated, and had gradual return of kidney function. His SCD treatment was associated with recovery of multiorgan dysfunction. 60-day follow-up evaluation demonstrated normal hematologic parameters and renal function.

Patients 2 and 3 presented with STEC-HUS with AKI requiring CKRT. Each twin received 24 hours of SCD therapy. With CKRT and SCD treatment both patients underwent successful extubation to room air with discontinuation of CKRT and SCD treatment. Thereafter, both patients' hematologic parameters, urine output, and kidney function all gradually improved, with normalization (patient 2) and near-normalization (patient 3) of kidney function at 60-day follow-up post SCD initiation.

Conclusion
Immunomodulatory treatment with the SCD resulted in improvements across multiple disease parameters in STEC-HUS induced AKI and was well-tolerated without any device-related adverse-events. This report expands on previously reported cases of successful SCD use across multiple underlying etiologies in AKI.

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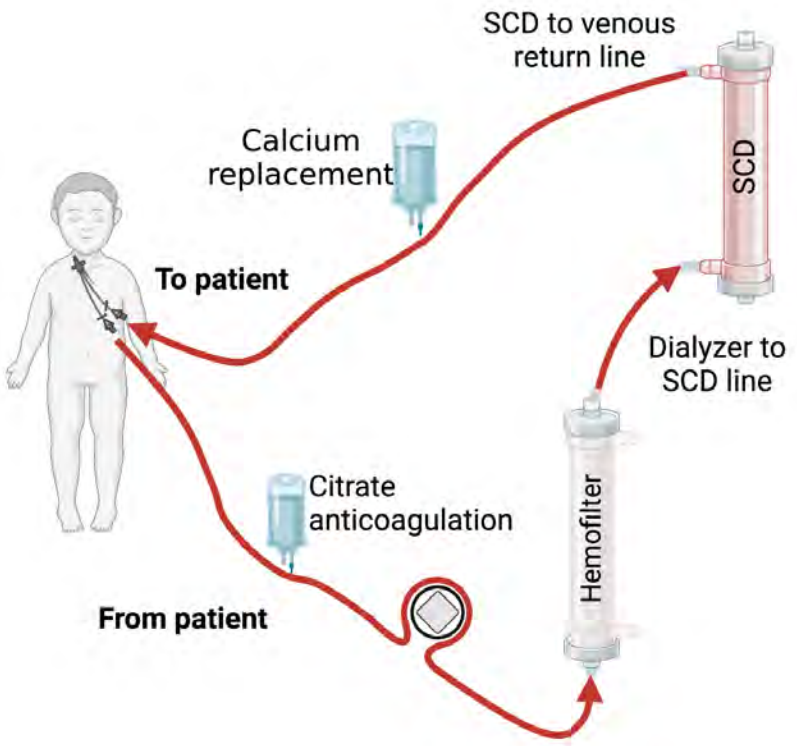

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Understanding Use of a Neonatal CRRT Machine in the United States through ICONIC: Improving Carpediem™ Outcomes in Neonates and Infants through Collaboration

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BACKGROUND
Carpediem (trademark, Medtronic, US) is a dedicated infant dialysis device designed to provide continuous renal replacement therapy (CRRT) safely. Its use to be important, yet likely rare, therefore the need for multicenter collaboration is necessary. We created a multicenter quality improvement and research registry dedicated to informing best practices and treatment strategies to understand and improve outcomes in this population.

METHODS
This ICONIC study (NCT05161078) prospectively assesses infants receiving Carpediem (CD). Data related, but not limited to, demographics, diagnosis, fluid balance, renal function, CRRT prescription, treatment courses and outcomes are recorded. Treatment courses are defined as <72 hours between subject CD procedures, and treatment course survival is considered survival to 72 hours post CD discontinuation. Variables are described by median and interquartile ranges [IQR] or percent (%).

RESULTS

Three centers have entered 27 subjects into the research registry, who underwent 36 treatment courses utilizing 514 filters. Median weight at admission was 3.4 kg [IQR: 2.6, 5.0 kg]. The commonest catheter characteristics were: 7.5 Fr (32%), tunneled catheter (49%), and placement in an Internal Jugular Vein (80%). Median catheter insertions per subject was two. Treatment start was most often the neonatal intensive care unit (72%) with congenital anomalies of the kidney and urinary tract accounting for 42% of indications. Weight-based fluid accumulation at time of treatment start was 23%. Regional citrate anticoagulation was used for 55% filters. 64% of circuits were initiated with a blood prime. CVVH was the most common modality (99%). Following procedure start, hypotension requiring intervention occurred 24 times (5%). Filter survival to planned treatment time occurred 73% of the time. Unplanned filter change was indicated most for clotting (70%) followed by vascular access issues (24%). Two subjects have incomplete ICU discharge data. Survival to treatment course end was 81%, with overall 56% surviving to ICU discharge. The most common primary cause of death was pulmonary hypoplasia (40%).

CONCLUSIONS

We present initial results of subjects receiving dialysis through a dedicated infant CRRT device in the United States. Outcomes remain consistent with historical cohorts. As more centers enroll, understanding practice and prescription patterns will provide key baseline information for benchmarking efforts.

RRT RESEARCH

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Lacosamide dosing in patients receiving continuous renal replacement therapy

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Objective: To suggest appropriate lacosamide dosing regimens from available published pharmacokinetic studies in critically ill patients receiving continuous renal replacement therapy (CRRT) via Monte Carlo simulations and to define the factors associated to lacosamide dosing recommendations

Methods: Mathematical pharmacokinetic models were created using published demographic and pharmacokinetic data in adult critically ill patients with known variability and correlations between pharmacokinetic parameters. CRRT modalities (continuous venovenous hemofiltration and continuous venovenous hemodialysis) with different effluent rates were modeled. Lacosamide regimens from available clinical resources were evaluated on the probability of target attainment (PTA) using pharmacodynamic target of the trough concentrations and area under the time-concentration curve within a range of 5-10 mg/L and 80.25-143 and 143-231 mgxhour/L for the initial 72 hour-therapy, respectively. Optimal regimens were defined from regimens that yielded the highest PTA. Each regimen was tested in a group of different 10,000 virtual patients.

Results: Our results revealed the optimal lacosamide dosing regimen of 300-450 mg per day is recommended for adult patients receiving both CRRT modalities with 20-25 effluent rates of 25. When higher effluent rates of 35 mL/kg/h. was applied, the dose of 600 mg per day was suggested. However, some patients might need the aggressive AUC target for better symptom control, the dosing regimens exceeded the maximum literature-based doses would be required. Interestingly, some of literature-based dosing regimens for kidney impairment patients were not able to attain the pharmacokinetic and pharmacodynamic targets.

Conclusion: Volume of distribution, total clearance, CRRT clearance and body weight were significantly correlated with the PTA targets. Body weights more than 100 kilograms could not achieve the target and needed drug dosing modification. Clinical validation of the finding is strongly needed.

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Effect of Intestinal dialysis using Polyethylene Glycol on fluid balance and thirst in maintenance Haemodialysis patients: A Comparative Study

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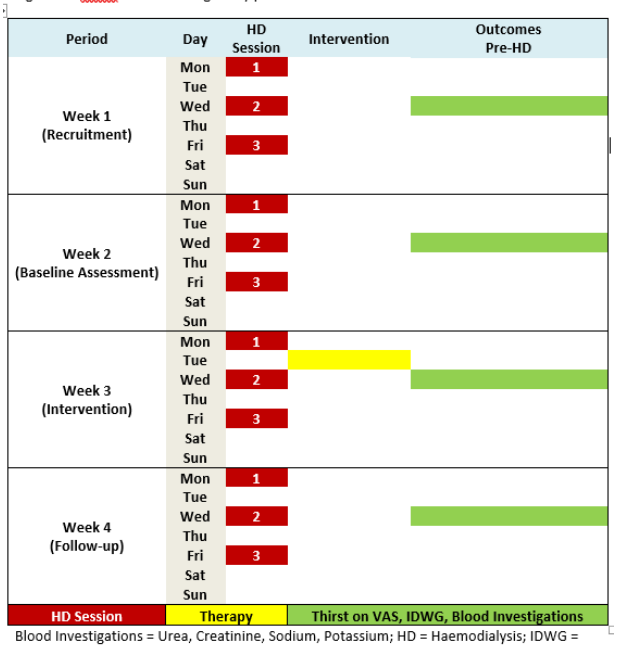
Background
High Inter-dialytic weight gains (IDWG) and Hyperkalemia have been associated with adverse outcomes like poor quality of life and high mortality. Thirst remains an unsolved problem in Haemodialysis (HD) patients. The aim of this study was to evaluate the effect of Polyethylene Glycol (PEG) based intestinal dialysis on IDWG, thirst and biochemical parameters.

Methodology
A Prospective Interventional based comparative single centre study was conducted. 35 anuric patients on weekly thrice HD were studied for 4 consecutive dialysis weeks. Before the mid-week dialysis day of week 3, Patients received 2L polyethylene glycol solution. The primary end points were change in mean relative IDWG and change in mean subjective thirst feeling as measured on Visual analog scale (VAS) with secondary endpoints being change in small molecule clearance.

Results
There was significant reduction in IDWG after the therapy from 3 ± 0.81liters to 2.35 ± 0.72 (P=0.002). The therapy also reduced the % IDWG BW from 5.1 ± 1.7% to 4.15 ± 1.6% (P=0.017). No change in thirst was seen i.e. 6.16 ± 0.66, 6.14 ± 0.64, 6.16 ± 0.65 (P=0.986). A multivariate linear regression did not reveal any effect of age, gender and co-morbidities on the reduction of IDWG. The therapy achieved a significant Urea, Creatinine and Potassium reduction of 8.23%, 8.13% and 8.33% respectively with an increase in sodium levels by 0.86%.

Conclusions
This modality reduced the IDWG, was found to be a potent treatment modality for hyperkalemia but did not affect thirst sensation even after consumption of 2Litre solution.

Figure 1 – Gnatt Chart showing Study protocol



Blood Investigations = Urea, Creatinine, Sodium, Potassium; HD = Haemodialysis; IDWG = Inter-dialytic weight gain; VAS = Visual Analog Scale.

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Effects of Continuous Kidney Replacement Therapy for Volume-management Purposes on Short and Long-Term Outcomes of Patients Treated with ECMO: A Propensity-Score Matched Analysis

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Purpose of the study:

Previous studies showed that Extracorporeal Membrane Oxygenation (ECMO) patients receiving Continuous Renal Replacement Therapy (CRRT) before clinical acute kidney injury (AKI) had better survival than those who did not undergo CRRT. Therefore, we aimed to evaluate the effects of combined ECMO and CRRT treatment among those with and without AKI on survival rate, length of stay (LOS), and mechanical ventilation duration (MVD) in a larger population.

Methods:

This is a single-center, retrospective cohort study. We collected data retrospectively in tertiary hospitals from 2015 to 2021. We included adult patients (≥18 years old) receiving ECMO with or without CRRT and survived to the third day of ECMO. ECMO patients receiving CRRT without AKI or AKI stage 1 were categorized based on the indication of CRRT initiation as volume management vs. clearance group. Patients who received CRRT while data for AKI diagnosis was unavailable were excluded. We performed a propensity score matching to reduce bias for the estimated treatment effect.

Results:

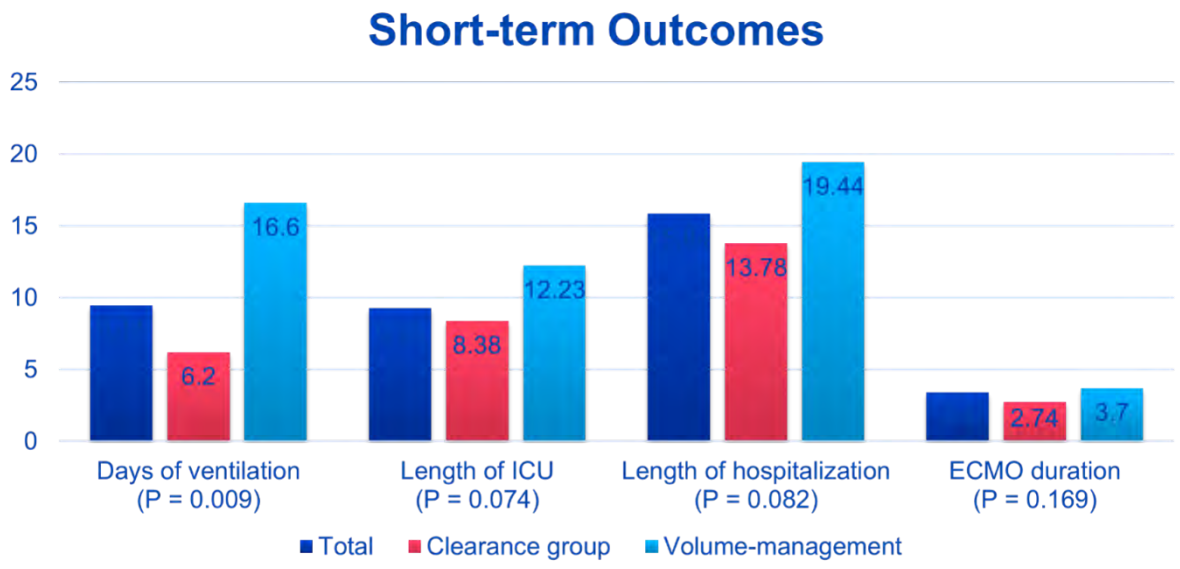
Of 202 ICU patients who received ECMO, 28 pairs of the volume management vs. clearance group were matched. Compared to the clearance group, the volume management group required significantly longer MVD with 16.60 (7.20-43.52) days vs. 6.20 (2.76-11.58) days, P=0.009, and no difference in the ICU LOS, hospital LOS, and ECMO duration. In addition, there were no differences in survival rate and incidence of chronic kidney disease in 90 days and one-year follow-up after hospital discharge.

Conclusion:

Patients who received CRRT for volume management purposes are at increased risk of long MVD without improved survival rate and CKD development.

Table and Figure on following page

Variables	Total (n=56)	Clearance group (n=28)	Volume-management group (n=28)	p, (95% C.I.)
Age, n=56, mean (SD)	67.54 (12.36)	68.8 (10.71)	66.26 (13.91)	0.43
Sex , n=56, no (%)				
Male	34 (62%)	18 (65%)	16 (58%)	0.58
Baseline creatinine, n=56, mean (SD)	1.07 (0.42)	0.987 (0.32)	1.15 (0.49)	0.13
CKD before hospital admission, no (%)	16 (28.5)	6 (21.4)	10 (35.7)	0.24
APACHE III score, n=56, mean (SD)	99.7 (33.43)	99.54 (34.84)	99.86 (32.61)	0.97
Days of ventilation (days), n=56, median (IQR)	9.44 (4.03-21.73)	6.20 (2.76-11.58)	16.60 (7.20-43.52)	0.009
Length of ICU (days), n=56, median (IQR)	9.26 (4.03-17.51)	8.38 (3.63-12.79)	12.23 (4.32-28.86)	0.074
Length of hospitalization (days), n=56, median (IQR)	15.84 (7.57-34.74)	13.78 (5.81–25.523)	19.44 (8.84-49.53)	0.082
ECMO duration (days), n=56, median (IQR)	3.40 (2.01-6.64)	2.74 (1.85-4.63)	3.7 (2.56-7.50)	0.169
CKD 90 days after hospital discharge, n=56, no. (%)	8 (14.2)	5 (17.8)	3 (10.7)	0.445
CKD 1 year after hospital discharge, n=56, no. (%)	7 (12.5)	4 (14.2)	3 (10.7)	0.60
Long-term dialysis, n=56, no. (%)	1 (1.78)	0 (0)	1 (3.57)	
Survival, n=56, no. (%)	18 (32.1)	11 (39.3)	7 (25)	0.252



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Identification of Renal Recovery Factors After CRRT Performance in Critical Ill Patients with Severe AKI

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Introduction: Due to the lack of standardization for continuous renal replacement therapy (CRRT) cessation and predictive factors that would help determine renal recovery, the need for new research about this topic its essential. There are several international studies with this objective. For the prognosis, management, and adequate discontinuation of CRRT, having a precise definition of renal recovery after acute kidney injury (AKI) is essential. The aim of our study is to assess the renal recovery capacity based on predictive factors such as urine output, albumin, creatinine, and blood urea nitrogen (BUN) that were taken prior the start of CRRT, 24 hours, and 48 hours after the start. This study was carried with patients admitted to the intensive care unit (ICU) due to multiple causes of a hospital in northern Mexico with AKI KDIGO 3 that required CRRT.

Methods: A retrospective, observational, analysis study was carried out on a population of adults admitted to the ICU in the last five years. A linear regression model was performed and ANOVA technique by steps was used to test for group mean differences. We analyzed urine output and BUN 24 hours after the start of CRRT.

Results: A total of 39 subjects were analyzed, 29 (74.4%) were men; mean (SD) age 66 (14). 16 (41.1%) patients are overweight, and 8 (20.5%) have diabetes. Where the dependent variable was renal recovery to the basal renal function prior to CRRT. The independent variables were urine output and BUN 24 hours after the initiation of CRRT. The model we used in linear regression showed that urine output (p 0.030) and BUN (p 0.028) help us predict by 24.7% with p <0.003, the renal recovery.

Conclusion: There is an association between urine output and BUN 24 hours after the start of CRRT. We can compare the results with other studies which take urine output as the indicator for cessation CRRT therapy and possible renal recovery. It is suggested that there are sociodemographic factors that can serve as predictors of renal function recovery in these patients, so, it is important to continue conducting studies that help us find one or several standardized predictors of renal function recovery in the context of AKI and the use of CRRT.

Table 1. Predictive factors of renal recovery by independent values of urinary output and BUN.

	B	SE	CI 95% (L-U)	p-value
Model				<0.003
Urinary output **	0.0	0.0	0-0	0.030
BUN **	-0.34	0.148	-0.641- -0.04	0.028

A lineal regression model was performed for urinary output and bun 24 hours post initiation of CRRT. A p-value <0.05 was significant. R-squared value 0.247.
**24 hours post initiation of CRRT.

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Dialysis Dependence At 90-days Post-discharge For Patients Treated With Continuous Renal Replacement Therapy (CRRT) Vs. Intermittent Hemodialysis (IHD)

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Introduction
It is unclear if hospitalized patients with acute kidney injury (AKI) treated with CRRT have lower risk of dialysis dependence after discharge than patients treated with IHD.

Methods
This multicenter retrospective observational cohort study linked claims data to US hospital discharge data from the Premier PINC AI Healthcare Database (PHD). All adult patients with first inpatient CRRT or IHD in the ICU of a PHD hospital and discharged alive from January 1, 2018-June 30, 2021, with linked claims data were included, after applying these exclusion criteria: had end stage renal disease, renal transplant or more than 1 dialysis in the past 12 months, no AKI ICD-10 diagnosis code, or non-continuous hospital data submission. Dialysis dependence was defined as 2+ days of dialysis in last 7 days prior to discharge or to 90-days post-discharge. We used inverse probability treatment weighting (IPTW) to balance potential confounders by the inverse of the propensity score, and additionally adjusted the weighted logistic regression model for teaching hospital, shock, mechanical ventilation (MV), and any use of vasopressors.

Results
Among 3,790 (CRRT: n=1,042; IHD: n=2,748) eligible patients from 380 hospitals who survived index hospitalization and had claims coverage, CRRT patients were younger (mean age 52.4 vs. 55.4 years), more likely to be treated in large (>500 beds) (58.8% vs. 37.5%), teaching (74.9% vs. 51.8%) hospitals, surgical patients (60.7% vs. 41.9%), to have sepsis (65.2% vs. 52.3%), shock (76.6% vs. 47.9%), MV (77.2% vs. 53.1%), and any vasopressor use (90.1% vs. 59.4%) than IHD patients. CRRT patients had lower prevalence of hypertension (48.8% vs. 56.8%), diabetes (46.9% vs. 52.1%), chronic kidney disease (39.0% vs. 50.5%) and a lower proportion of 5+ Charlson comorbidities (38.4% vs. 42.5%) ($p<0.05$ for all). Compared to IHD patients, CRRT patients had lower dialysis dependence at hospital discharge (25% vs. 28.5%, p=0.036), with adjusted OR(95%CI) of 0.88 (0.71-1.08) p=0.22, and lower dialysis dependence at 90-days post-discharge (4.9% vs. 8.0% p=0.001) with aOR of 0.63 (0.44-0.91), p=0.01. Results were unchanged in sensitivity analyses excluding patients discharged to hospice (n=105) or who switched from IHD to CRRT (n=59).

Conclusion
Patients treated with CRRT vs. IHD as first modality in the ICU had 37% lower adjusted odds of dialysis dependence at 90 days post-discharge.

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Predictors of Successful Discontinuation of Continuous Kidney Replacement Therapy in a Pediatric Cohort

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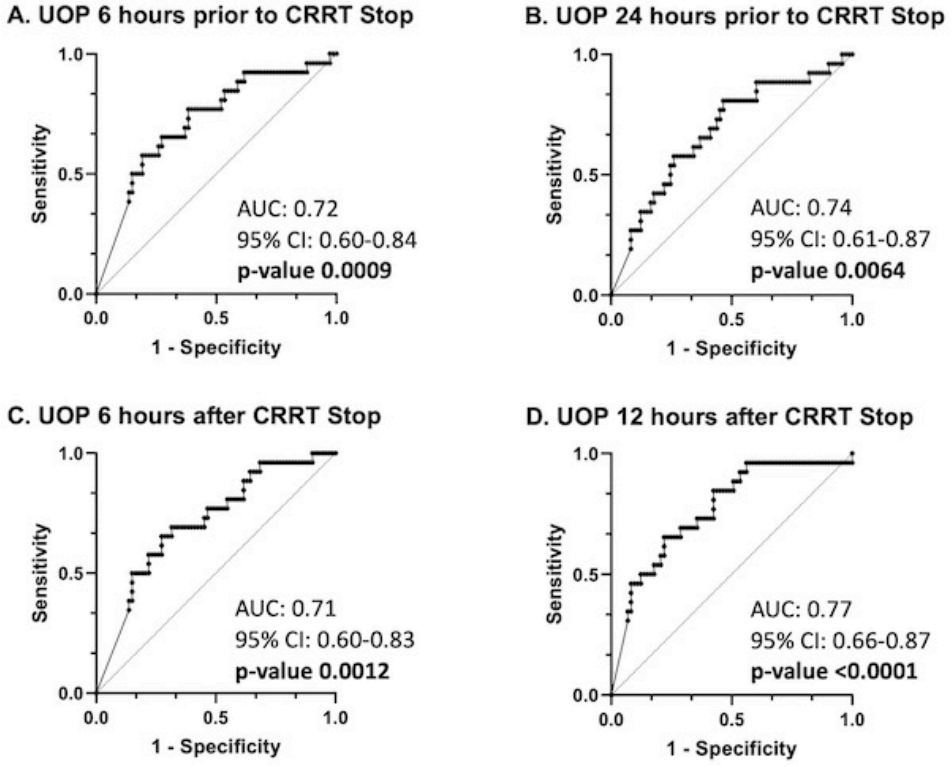
Background: Recognizing the optimal time to discontinue continuous kidney replacement therapy (CKRT) is necessary to advance patient recovery and mitigate complications. The aim of this study was to identify predictors of successful CKRT cessation in pediatric patients.
Methods: All patients requiring CKRT between January 2010 and March 2021 were evaluated. Patients on peritoneal or hemodialysis, who transferred between institutions, or who did not trial off CKRT were excluded. Successful discontinuation was defined as remaining off CKRT for at least seven days. Demographics, admission diagnoses, PRISM III scores, and reasons for CKRT initiation were obtained. Clinical and biochemical variables were evaluated at CKRT initiation and discontinuation and in the 12-hour period following discontinuation. Comparisons were conducted using Wilcoxon rank sum and Fisher's Exact tests for continuous and categorical variables, respectively. A logistic regression model was fitted to identify significant factors.
Results: Ninety-nine patients underwent a trial of CKRT. Admission and initiation characteristics of the success and failure groups were similar. Patients who required reinitiation (n=26) had longer ICU lengths of stay (27.2 vs 44.5 days, p=0.046) and higher in-hospital mortality (15.1% vs 46.2%, p=0.002). Urine output greater than 0.5mL/kg/hr irrespective of diuretic administration in the 6-hour period before CKRT discontinuation was a significant predictor (AUC 0.72, 95% CI 0.60-0.84, p=0.0009).
Conclusions: Determining predictors of sustained CKRT discontinuation is critical. Urine output greater than 0.5mL/kg/hr in this pediatric cohort predicted successful discontinuation. Future studies are needed to validate this threshold in disease- and age-specific cohorts and evaluate additional biomarkers of kidney injury.



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Selective Cytopheretic Device (SCD) Using Regional Citrate Anticoagulation (RCA) Limits The Release Of Extracellular Vesicles In An Experimental Model Of Sepsis

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Background and aims: During sepsis, extracellular vesicles (EV) are released from activated leukocytes and platelets, playing a role in organ dysfunction including AKI. Aims of this study were to evaluate: 1) the effect of Selective Cytopheretic Device (SCD) with Regional Citrate Anticoagulation (RCA) vs. heparin to limit EV release in an experimental pig model of sepsis; 2) the decrease of in vitro EV-induced swine endothelial (EC) and tubular epithelial cell (TEC) injury.

Methods: Plasma samples were collected from pigs subjected to intraperitoneal administration of E. Coli to induce septic shock and after SCD placement using RCA or heparin. Data were correlated with EV analysis isolated from patients with sepsis-associated AKI (SA-AKI) treated by CVVHDF: we evaluated EV concentration/size (Nanosight) and their protein/RNA content. In vitro, swine plasma EVs were used to challenge EC and TEC to study leukocyte adhesion, ROS generation, viability, mitochondrial dysfunction, senescence and early fibrosis biomarkers.

Results: In comparison to baseline, Nanosight analysis showed a significant decrease of circulating plasma EV in septic pigs treated by SCD with RCA already after 1 hr and up to 12 hr: this decrease was less marked when heparin was used. Similar observations were found in SA-AKI patients treated by CVVHDF with RCA vs. heparin. However, the decrease of EV in SCD RCA-treated pigs was significantly higher than that observed in SA-AKI patients. In SCD RCA-treated pigs, we also found a significant decrease of plasma EV surface markers of cell activation such as CD11b, CD14, CD62L, CD62P and CD105. In vitro, we found that swine plasma EV were internalized in both EC and TEC inducing an increase of leukocyte adhesion, endothelial/epithelial-to-mesenchymal transition, ROS generation, mitochondrial dysfunction and senescence: SCD RCA blunted these detrimental effects of plasma EV. In LPS-activated neutrophils, monocytes or platelets, we observed that citrate but not heparin reduced intracellular calcium and consequently the EV release.

Conclusions: SCD treatment using RCA but not heparin significantly reduced the concentration of detrimental circulating plasma EV in septic pigs: these results correlated with data obtained in SA-AKI patients treated by CVVHDF. SCD in association with RCA may limit EV release and consequently organ dysfunction as confirmed by in vitro results showing a significant decrease of EC and TEC alterations typical of SA-AKI.

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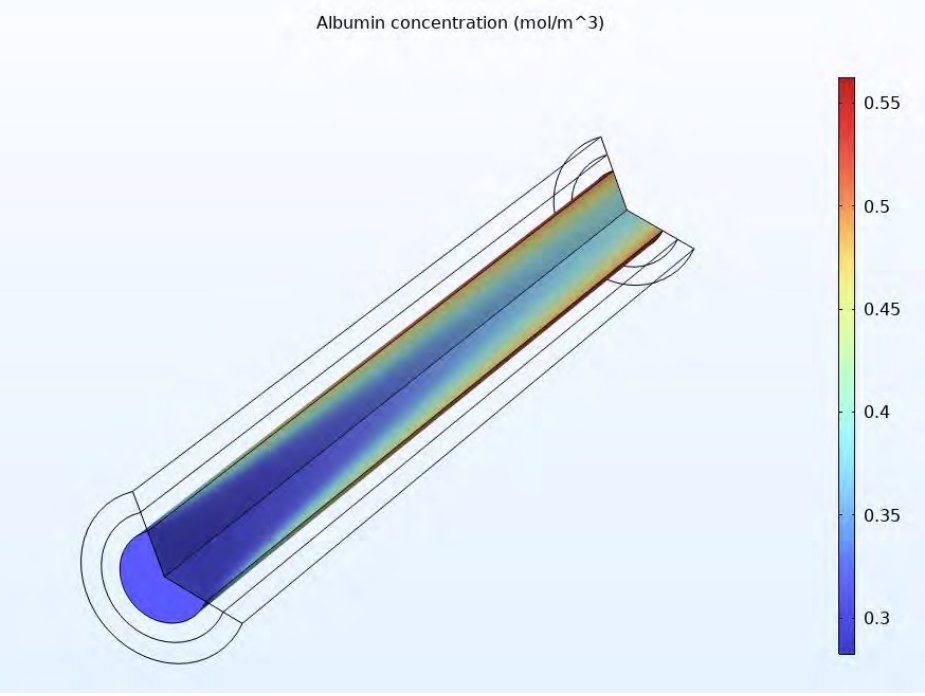
Multiscale Multiphysics Computational Model of Transport Dynamics in Renal Replacement Therapy

Steven A Conrad[1]

[1]*LSU Health Shreveport*

Background: At the 2022 CRRT & AKI Conference, a multiphysics computational model of transport dynamics in renal replacement therapy was presented. Additional development was subsequently undertaken to add reaction engineering kinetics to the hemofilter and body compartments that includes acid-base balance incorporating intracellular and plasma bicarbonate buffering systems, non-bicarbonate plasma buffering systems of albumin and phosphate, and non-bicarbonate intra-erythrocytic buffering with hemoglobin, tissue CO2 generation, CO2 elimination by the hemofilter, and citrate binding kinetics.
Model Description: The multiscale model consists of an axisymmetric finite element model of an AN-69 hollow fiber consisting of blood, membrane and dialysate phases incorporating the following physics: 1) fluid transport in blood, membrane and dialysate phases, including effect of plasma oncotic pressure and concentration polarization, 2) transport of charged and uncharged protein fractions including the Gibbs-Donnan effect, 3) transport of all major electrolytes with constraint of electroneutrality, 4) plasma and intra-erythrocyte acid-base equilibrium, 5) citrate kinetics and calcium binding during regional anticoagulation, 6) body compartment volume and electrolyte kinetics, 7) heat transport, and 8) restricted membrane convection due large molecular weights. Boundary conditions were blood inflow velocity and outflow pressure, dialysate inflow velocity and outflow velocity or pressure, concentrations of all chemical species at blood and dialysate inlets, and temperature of blood and dialysate. This spatially distributed model was coupled to well-mixed volume-varying reactors representing body compartments (blood, interstitial, and intracellular fluid). Additional inlet conditions included calcium chloride and sodium citrate infusions. Chemical equilibrium reactions were included that represented acid-base balance, calcium binding to citrate, and calcium binding to protein.
Validation: Validation is ongoing, including ultrafiltration rate against published data, sodium transport during hypertonic saline dialysis for controlled hypernatremia following brain injury, restricted transport of large species, and calcium handling during regional anticoagulation.
Summary: Multiscale multiphysics finite element models can simulate complex transport and chemical reaction processes, providing insight into fluid and species handling during hemofiltration and hemodialysis.



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Impact of Fluid overload and Continuous Renal Replacement Therapy Initiation phenotypes on outcomes: A retrospective analysis of the WE-ROCK Collaborative

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Purpose: Acute kidney injury (AKI) and fluid overload (FO) are common in critically ill patients. Among adults, accelerated initiation of continuous renal replacement therapy (CRRT) was not associated with a reduction in 90-day mortality. The purpose of this study was to evaluate the association of different FO and CRRT phenotypes at CRRT initiation on outcomes.

Methods: The Worldwide Exploration of Renal Replacement Outcomes Collaborative in Kidney Disease (WE-ROCK) study is an international multicenter study (32 centers, 7 nations) of children aged 0-25 years treated with CRRT for AKI or FO. Patients with end stage kidney disease, congenital anomalies of the kidney and urinary tract perceived to require long-term CRRT, concurrent use of extracorporeal membrane oxygenation, and use of peritoneal dialysis prior to CRRT were excluded. Patients were delineated into 4 phenotypes of FO at CRRT start (<10% vs. ≥10%) and timing of CRRT initiation from ICU admission (early, ≤48 hours vs late: >48 hours). Primary outcome: hospital mortality. Secondary outcomes: intensive care unit (ICU) length of stay (LOS) and duration of mechanical ventilation (MV)

Results: 984 patients were included. Patients with ≥10%FO were younger and more often had sepsis irrespective of CRRT start timing. Late CRRT start, regardless of FO status was more common in Hispanic/Latino ethnicity (Table). PRISM-III, VIS and PELOD-2 score at CRRT initiation were significantly higher in Early/FO≥10% compared to the other groups (all p<0.001). Hospital mortality was 35% which was significantly different across groups (p=0.02). Among survivors, ICU LOS and duration of MV were significantly longer in late CRRT start patients, independent of FO. The adjusted odds of mortality were significantly higher in late CRRT/FO<10% (OR 1.56, 95% CI: 1.07, 2.28) and late CRRT/≥10%FO (OR: 1.50, 95% CI: 1.04, 2.15) compared to early CRRT/<10% FO. The adjusted median duration of LOS was 5 days longer for late CRRT/≥10%FO and 15 days longer for late CRRT/<10%FO compared to early CRRT<10% FO. There was no association between mortality or LOS between early CRRT/≥10%FO and early CRRT/<10%FO

Conclusions: Late CRRT start, independent of the degree of FO, conferred the greatest risk of mortality and increased resource utilization (ICU LOS and MV). Randomized trials are needed to determine whether early vs. late start CRRT impacts mortality in this population.

Table 1. Demographics and Clinical Characteristics across CRRT initiation and fluid overload phenotypic categories.

	Early CRRT/ FO<10% N = 382	Early CRRT/ ≥10%FO N = 139	Late CRRT/ <10%FO N = 193	Late CRRT/ ≥10%FO N = 270	P Value
Age (years)	10.4 (2.8, 15.9)	3.8 (0.9, 10.7)	13.3 (5.9, 16.6)	3.7 (0.8, 12.9)	<0.001
Sex (Female)	174 (46)	59 (42)	86 (45)	129 (48)	0.8
Race (White)	253 (76)	92 (75)	134 (76)	183 (78)	1.0
Ethnicity (Hispanic/Latino)	68 (20)	9 (7.6)	41 (24)	41 (17)	0.003
Weight (kg)	37.5 (14.2, 63)	15.4 (9.2, 33.4)	47.4 (23.6, 67.4)	16.10 (87.3, 37.0)	<0.001
Sepsis	146 (38)	84 (60)	83 (43)	136 (50)	<0.001
PRISM-III Score	14 (10, 18)	16 (12, 21)	12 (10, 18)	14 (9, 18)	<0.001
VIS CRRT Initiation	0 (0, 15)	18.4 (0, 37.9)	3 (0, 12)	5 (0, 17)	<0.001
PELOD-2 CRRT Initiation	6 (3, 8.8)	8 (6, 11)	6 (4, 8)	7 (5, 10)	<0.001
CRRT Dose (ml/kg/min)	39.1 (29.7, 57.7)	52.0 (40, 73.8)	35.7 (26.9, 49.8)	47.0 (32.9, 63.5)	<0.001
Ventilation duration (survivors)	6.5 (4, 11)	12.5 (10.5, 16)	13 (6.5, 33)	14 (12, 32.5)	<0.001
ICU LOS (survivors)	12 (8, 18)	16 (4, 20)	29 (15, 92)	20 (20, 54)	<0.0001
Hospital Mortality	120 (31)	55 (40)	82 (43)	112 (41)	0.02
MAKE-90	230 (60)	85 (61)	124 (64)	183 (68)	0.2

Categorical variables as n (%) and Continuous variable as median (IQR). P-values calculated using chi-square test or Wilcoxon rank-sum test.

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Urine Flow Rates Following Furosemide Stress Test Associated with Liberation from Continuous Renal Replacement Therapy

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While significant effort has been expended to study initiation of (continuous) renal replacement therapy (RRT/CRRT), relatively less effort has been spent on liberation from CRRT. Data guiding CRRT discontinuation could benefit patients given prevalence of RRT utilization in intensive care (1.5-13.5% of all admits). Urine flow rates (UFR) following furosemide (furosemide stress test, FST) as a marker of renal functional reserve has been shown to predict persistent severe acute kidney injury. We sought to provide introductory data regarding FST as it correlates to liberation from CRRT.

We conducted a single-center, retrospective cohort study of patients (pts) requiring CRRT in the pediatric ICU between Jan 2018 and Dec 2021. Cohorts were denoted by primary outcome: pts reinitiated on RRT (any modality) within 7 days (T7) of discontinuation (R+) vs. those not reinitiated (R-). R- was defined as having successfully weaned from CRRT (equivocal to liberation). Secondary outcomes were mortality in T30 and peak creatinine (Cr) in T7. Both R+ and R- groups received furosemide within 48 hours (hr) following discontinuation of CRRT (mean 8 hours). 2 and 6hr UFR (ml/kg/hr) were determined in first 2hr and first 6hr following FST.

In 32 pts studied (mean age 13.2 years, 31.1% male), 8 (25%) were R+ and 24 (75%) were R-. 2hr UFR in R+ was 0.37+0.70 vs. 2.38+2.25 ml/kg/hr ($p<0.01$) in R-. R+ 6hr UFR was 0.24+0.33 vs. 1.77+1.35 in R- ($p<0.01$). T30 mortality was 1 of 32 (3.1%) (R+ 0.0%). Cr fold-change difference was not statistically significant between the 2 groups ($p=0.45$).

In this exploratory study FST results were different between pts who were reinitiated on RRT and those not. The study was limited by small sample size. Timing of FST was suboptimal, coming after decision to liberate had occurred. This data set supports exploration in a larger population of pts, moving toward creation of an algorithmic approach to RRT liberation. Leveraging this research future study should evaluate pre-discontinuation FST, including optimal UFR cutoffs for decision making.

Difference in UFR following FST in pts liberated from CRRT vs. those requiring reinitiation was statistically significant. Further large population study of pre-discontinuation FST is warranted to confirm statistical significance and determine UFR cutoffs.

	R+(Mean+SD)	R-(Mean+SD)	p-value
2hr UFR (ml/kg/hr)	0.37+0.70	2.38+2.25	0.002
6hr UFR (ml/kg/hr)	0.24+0.33	1.77+1.35	0.0003
Cr Fold-Change in T7 (mmol/L)	2.09+0.55	2.00+1.03	0.45

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Timing of Continuous Kidney Replacement Therapy Initiation and Major Adverse kidney events at 90 days: A retrospective analysis of the WE-ROCK Registry

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Purpose: Acute kidney injury (AKI) and fluid overload (FO) are common in critically ill children. Among adults, accelerated or early initiation of continuous renal replacement therapy (CRRT) was not associated with a reduction in 90-day mortality. The purpose of this study was to evaluate the association of early (≤48 hours) vs. late CRRT start (>48 hours from ICU admission) with major adverse kidney events at 90 days (MAKE-90).

Methods: The WE-ROCK study is an international, multicenter study (32 centers, 7 nations) of patients aged 0-25 years treated with CRRT for AKI or FO. Patients were excluded for the following reasons: end stage kidney disease, congenital anomalies of the kidney and urinary tract perceived to require long-term CRRT, concurrent use of extracorporeal membrane oxygenation, and use of peritoneal dialysis prior to CRRT. The primary outcome was MAKE-90 (defined as dialysis dependence, death, persistent kidney dysfunction>25% above baseline). Secondary outcomes were ICU Length of stay (LOS) and duration of mechanical ventilation (MV) (survivors only)

Results: 1000 patients were included. The median time to CRRT initiation in the entire cohort was 2 days (IQR: 1, 6 days). CRRT was started >48h in 470 (47%). MAKE-90 occurred in 628 (63%) of which 50% (n=312) had late CRRT start. Admission diagnoses and comorbid conditions were different between groups based on timing of CRRT initiation and MAKE 90 outcomes. %FO at CRRT was greater among those with late CRRT start ($p<0.001$) but not MAKE-90. The proportion of patients with late CRRT start was not different between those with and without MAKE-90 ($p=0.07$). LOS and duration of MV were significant longer among those with late CRRT start. Later time to CRRT start was associated with a higher odds of having a MAKE-90 (interquartile OR = 1.08, 95% CI = 1.02-1.15)

Conclusions: Late CRRT start was associated with MAKE-90. A randomized controlled trial like STARRT-AKI is necessary in pediatric patients to evaluate whether it impacts outcomes.

Table on following page

Table 1. Patient demographic and clinical characteristics among patients with and without major adverse kidney events at 90 days.

Variable	Whole cohort (n=991)	No MAKE-90 (n=623)	MAKE-90 (n=368)	p-value
Age (years)	8.8 (1.65, 15)	7.9 (2.0, 14.1)	9.2 (1.4, 15.4)	0.6
Sex (female)	455 (46)	164 (44)	291 (46)	0.6
Admission category				<0.001
Shock/ infection/ trauma	368 (37)	162 (44)	206 (33)	
Respiratory failure	203 (20)	43 (12)	160 (25)	
Post-surgical or minor trauma	50 (5)	19 (5.1)	31 (4.9)	
CNS dysfunction	40 (4)	12 (3.2)	28 (4.5)	
Pain/sedation management	8 (0.8)	3 (0.8)	5 (0.8)	
Primary cardiac	31 (3.1)	6 (1.6)	25 (4)	
Primary cardiac post-surgical	49 (4.9)	21 (5.6)	28 (4.5)	
Primary cardiac (HF)	39 (3.9)	13 (3.5)	26 (4.1)	
Other	212 (21%)	93 (25)	119 (19)	
Sepsis at ICU admit	455 (46)	155 (42)	300 (48)	0.07
Cardiac comorbidity	200 (20)	57 (15)	143 (23)	<0.001
Oncologic comorbidity	224 (22)	63 (17)	161 (26)	0.002
Immunologic comorbidity	155 (16)	34 (9.1)	121 (19)	<0.001
PRISM-III	14 (10, 18)	14 (10, 18)	14 (10, 18)	1.0
VIS CRRT initiation	5 (0, 20)	2.5 (0, 15)	5 (0, 20)	0.01
PELOD-2 CRRT initiation	7 (4, 9)	6 (4, 8)	7 (5, 10)	0.01
%FO CRRT start	7.4 (2.4, 9)	7.0 (2.1, 15.6)	7.9 (2.6, 19.9)	0.08
Time to CRRT start	2 (1, 6)	2 (1, 4)	2 (1, 8)	0.08
Late CRRT start	470 (47)	158 (43)	312 (50)	0.07
CRRT duration	6 (3, 14)	5 (3, 10)	8 (3, 18)	<0.001
CRRT dose (ml/kg/min)	42.2 (30.9, 60)	43.1 (30.8, 59.7)	41.7 (31.0, 60.1)	0.8

Categorical variables as n (%) and Continuous variable as median (IQR). P-values calculated using chi-square test or Wilcoxon rank-sum test.

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FGF23 and α-Klotho clearance on continuous kidney replacement therapy in pediatric patients

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Introduction: Prolonged continuous kidney replacement therapy (CKRT) with regional citrate anticoagulation (RCA) of ≥ 28 days is associated with increased risk of osteopenia and fractures. Mineral bone disease in chronic kidney disease is associated with derangements in Fibroblast Growth Factor 23 (FGF23)/ α-Klotho pathway, and mineral bone disease in acute kidney injury/disease could similarly be related to changes in systemic concentrations of these hormones. Our aim is to determine FGF23 and α-Klotho clearance in critically sick patients on CKRT with continuous veno-venous hemodiafiltration (CVVHDF) using RCA.

Methods: Patients ≤ 21-years-old in the pediatric intensive care unit on CVVHDF with RCA were prospectively enrolled. Concentrations of FGF23 and soluble α-Klotho were measured by ELISA on simultaneously obtained pre and postfilter plasma and effluent samples. FGF23 and urea clearance was estimated based on pre filter convective clearance and effluent volume over 24 hours. Paired t-test was used to analyze continuous variables.

Results: We enrolled 8 patients with a median age of 43 months (11 days to 13.8 years), with 7/8 female patients. We had 13 samples each of prefilter plasma, postfilter plasma, and effluent. Patients had variable clearance, with a median of 73 mL/kg/hour (49-236 ml/kg/hr). Median pre and postfilter plasma FGF23 were 707 pg/mL (Q1-85; Q3-1034) and 716 pg/mL (Q1-52; Q3-1100) with no statistical difference (p-0.9). Consecutive sampling in 3 patients showed rising plasma FGF23 over time, with a median of 96, 542, and 1144 pg/mL at Day 7, 14, and 21, respectively. FGF23 was undetectable in 9/13 effluent samples, median effluent FGF23 concentration 8 pg/mL. Median FGF23 clearance was 1 mL/min, whereas median urea clearance was 132 mL/min. The median pre and post filter α-Klotho were 594 pg/mL (Q1-475; Q3-4063) and 627 pg/mL (Q1-601; Q3-4342), respectively, with no statistical difference (p-0.78) and was undetectable in the effluent samples.

Discussion: There is no FGF23 clearance and no α-Klotho clearance on CVVHDF even at prescribed dose as high as 236 ml/kg/hr. The trajectory of rising FGF23 concentration proportional to the duration on CKRT, could possibly indicate bone mineral dysregulation similar to CKD and needs further exploration.

Table 1: Plasma and Effluent FGF23 and α-Klotho on CKRT

Patient ID	Sample Number	Days on CKRT at the time of sample collection	Prescribed clearance (mL/kg/hr)	Convective clearance (%)	Plasma prefilter FGF23 (pg/mL)	Plasma postfilter FGF23 (pg/mL)	Effluent FGF23 (pg/mL)	FGF23 clearance (mL/min)	Urea clearance (mL/min)	Urea clearance (mL/kg/hr)	Plasma prefilter α-Klotho (pg/mL)	Plasma postfilter α-Klotho (pg/mL)	Effluent α-Klotho (pg/mL)
1	1	14	67	17	924	936	8	1	67	1200	594	627	ND*
1	2	21	67	17	2269	2274	10	0	63	1129	240	255	ND*
2	1	7	97	28	101	105	ND*		57	1349	4231	4547	ND*
2	2	14	99	13	160	176	1	1	130	3079	2719	3068	ND*
2	3	21	139	13	361	383	ND*		106	2517	4275	4534	ND*
2	4	28	135	12	815	1012	ND*		93	2200	5041	5176	ND*
3	1	7	85	31	79	30	ND*		122	1172	107	58	ND*
4	1	1	49	15	23	17	ND*		16	683	3560	3768	ND*
5	1	7	62	32	91	74	ND*		54	761	573	659	ND*
5	2	21	84	24	1144	1187	ND*		126	1782	443	593	ND*
6	1	1	236	26	ND*	ND*	ND*			ND*	2555	2614	ND*
7	1	1	56	34	1574	1769	7	1	108	1117	2296	2577	ND*
8	1	1	80	54	491	495	ND*		197	1656	ND*	ND*	ND*

* ND - Not detected

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The Association of Patient and Technical Characteristics and Survival: A retrospective analysis of the Worldwide Exploration of Renal Replacement Outcomes Collaborative in Kidney Disease (WE-ROCK)

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Background: There are limited large multicenter studies of epidemiology and outcomes of pediatric patients receiving continuous renal replacement therapy (CRRT). We aimed to describe the association between patient characteristics, initial CRRT prescription and ICU survival.

Methods: The WE-ROCK study is a retrospective international multicenter study (32 centers, 7 nations) of patients aged 0-25 years treated with CRRT for Acute Kidney Injury (AKI) or Fluid Overload (FO) from 2018-21. Patients with previous dialysis dependence, ECMO, or receiving CRRT for non-AKI/FO were excluded. Primary outcome was survival to ICU discharge, and univariate analyses performed to assess associations.

Results: Data from 991 children were included (45% female) and 639 (64.5%) survived to ICU discharge. Ages were newborn to 25 years with a median weight of 26.8kg (IQR 11.6–55.0). The most common reason for admission was shock, infection, or trauma (37%), followed by respiratory failure (20%) and 45% had sepsis at ICU admission. Co-morbidities were seen in 81%, with oncologic (23%) and cardiac (20%) being most common.

CRRT was initiated a median of 2 days (IQR 1,6) after ICU admission and lasted a median of 6 days (IQR 3, 14). At time of CRRT initiation, patients were on average 7.2% FO. Patients that did not survive to ICU discharge were more likely to have higher degrees of FO (8.9% vs 6.8%, $p=0.001$), later initiation (3d vs 2d, $p<0.001$), and longer duration of CRRT (8d vs 6d, $p=0.01$).

The most common modality prescribed at initiation was CVVHDF (76%) with polysulfone filters (79%). Median blood flow was 3.96 ml/min/kg (IQR 2.7, 5.5). Median hourly CRRT dose was 2070ml/1.72m2 or 42.4 ml/kg, with most patients (55%) prescribed a dose of >40ml/kg/hr. Anticoagulation was with citrate in 62% and heparin in 25%. The most common location of catheter placement was internal jugular (66%) with size ranging from 6Fr to 14Fr. There were no differences between ICU survivors and non-survivors with regards to CRRT dose, filter type, blood flow, or anticoagulation.

Conclusions: This is the largest epidemiological study of patients receiving CRRT in the pediatric ICU. Sicker patients with comorbidities may have lower survival. While techniques in dialysis mode, dose, catheter size and location and anticoagulation existed in this cohort, there were no survival differences seen. Center differences might present opportunities to define best practices with future study.

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Table 1. Patient and CRRT Technique Characteristics and Association with ICU Survival

	Cohort (N=991)	Survivor to ICU discharge (N = 639)	Non-Survivor to ICU discharge (N = 352)	p-value
Patient Characteristics				
Male	541 (55%)	341 (53%)	200 (57%)	0.3
Admission Weight, kg	26.8 (11.6, 55.0)	27.6 (12.7, 57.9)	24.80 (9.8, 51.6)	**0.016**
Age, years	8.8 (1.6, 15.0)	9.0 (2.0, 14.8)	8.3 (1.1, 15.2)	0.3
Race				0.6
White	667 (76%)	440 (76%)	227 (76%)	
Black	130 (15%)	89 (15%)	41 (14%)	
Native Americans	16 (1.8%)	10 (1.7%)	6 (2.0%)	
Asian/Pacific Islander	43 (4.9%)	24 (4.2%)	19 (6.4%)	
More than one race	18 (2.1%)	13 (2.3%)	5 (1.7%)	
Hispanic	162 (18%)	92 (16%)	70 (23%)	**0.018**
Reason for Admission				**<0.001**
Shock/Infection/Major Trauma	367 (37%)	245 (38%)	122 (35%)	
Respiratory Failure	198 (20%)	91 (14%)	107 (30%)	
Post-surgical/minor trauma	50 (5.0%)	36 (5.6%)	14 (4.0%)	
CNS Dysfunction	40 (4.0%)	23 (3.6%)	17 (4.8%)	
Pain/Sedation Management	8 (0.8%)	6 (0.9%)	2 (0.6%)	
Congenital Heart disease	31 (3.1%)	14 (2.2%)	17 (4.8%)	
Post-Operative Cardiac:	49 (4.9%)	40 (6.3%)	9 (2.6%)	
Heart failure and/or cardiomyopathy	39 (3.9%)	23 (3.6%)	16 (4.5%)	
Other	209 (21%)	161 (25%)	48 (14%)	
Sepsis at ICU admission	450 (45%)	268 (42%)	182 (52%)	**0.004**
Comorbidities				
None	193 (19%)	153 (24%)	40 (11%)	**<0.001**
Respiratory	138 (14%)	84 (13%)	54 (15%)	0.4
Cardiac	194 (20%)	111 (17%)	83 (24%)	**0.023**
Neurologic/Neuromuscular	134 (14%)	85 (13%)	49 (14%)	0.9
Nephrologic/Urologic	92 (9.3%)	68 (11%)	24 (6.8%)	0.061
Hematologic	133 (13%)	80 (13%)	53 (15%)	0.3
Oncologic	223 (23%)	122 (19%)	101 (29%)	**<0.001**
Immunologic	154 (16%)	72 (11%)	82 (23%)	**<0.001**
Gastrointestinal	187 (19%)	128 (20%)	59 (17%)	0.2
Endocrinologic	64 (6.5%)	45 (7.0%)	19 (5.4%)	0.4
PRISM III Score at ICU admission	14 (10, 18)	14 (9, 18)	15 (10, 19)	0.11
Vasopressor-Inotrope Score at CRRT initiation	5 (0, 20)	2 (0, 13)	10 (0, 27)	**<0.001**
PELOD-2 Score at CRRT initiation	7 (4, 9)	6 (4, 8)	8 (6, 11)	**<0.001**
% fluid overload (ICU admit to CRRT initiation)	7.2 (2.4, 18.1)	6.8 (1.9, 16.6)	8.9 (3.5, 22.1)	**0.001**
CRRT Start and Technique				
Time from ICU Admission to CRRT Initiation (days)	2 (1, 6)	2 (1, 5)	3 (1, 10)	**<0.001**
Duration of CRRT	6 (3, 14)	6 (3, 12)	8 (3, 19)	**0.010**
Initial Modality				0.2
SCUF	12 (1.2%)	7 (1.1%)	5 (1.4%)	
CVVH	114 (12%)	84 (13%)	30 (8.5%)	
CVVHD	99 (10%)	63 (9.9%)	36 (10%)	
CVVHDF	756 (76%)	479 (75%)	277 (79%)	
mCVVH	8 (0.8%)	4 (0.6%)	4 (1.1%)	
Filter				>0.9
PAES	780 (79%)	503 (79%)	277 (79%)	
Non-Polysulfone	209 (21%)	134 (21%)	75 (21%)	
Anticoagulation				0.062
None	70 (7.1%)	35 (5.5%)	35 (9.9%)	
Citrate	613 (62%)	397 (62%)	216 (61%)	
Heparin	248 (25%)	167 (26%)	81 (23%)	
Other	58 (5.9%)	38 (6.0%)	20 (5.7%)	
Calculated CRRT Dose per 1.73m2	2070 (1753, 2681)	2053 (1730, 2654)	2087 (1788, 2790)	0.4
Calculated CRRT Dose per kg	42.4 (31.0, 60.0)	41.3 (30.1, 59.6)	45.6 (32.3, 60.6)	0.081
Calculated CRRT Dose				0.3
<25 ml/kg/hr	130 (13%)	90 (14%)	40 (11%)	
25-40 ml/kg/hr	310 (32%)	204 (32%)	106 (30%)	
>40ml/kg/hr	543 (55%)	338 (53%)	205 (58%)	
Blood flow rate scaled to body weight (ml/min/kg)	4.0 (2.7, 5.5)	3.9 (2.6, 5.2)	4.1 (2.7, 6.6)	**0.026**

[1] Statistics presented: n (%); median (IQR), [2] Statistical tests performed: chi-square test of independence; Wilcoxon rank-sum test

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Factors Associated with Major Adverse Kidney Events at 90 Days Among Children Requiring Continuous Renal Replacement Therapy: A Retrospective Analysis of the Worldwide Exploration of Renal Replacement

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Study Purpose: Continuous renal replacement therapy (CRRT) is an important supportive care modality used in critically ill children, but little is known about outcomes. We aimed to characterize the factors associated with major adverse kidney events at 90 days from admission (MAKE90).

Methods: The Worldwide Exploration of Renal Replacement Outcomes Collaborative in Kidney Disease (WE-ROCK) is an international multicenter observational collaboration (32 centers, 7 nations) conducted from 2018-2021 in patients aged 0-25 years treated with CRRT for acute kidney injury or fluid overload. Patients with previous dialysis dependence, ECMO use, or who received CRRT for a different indication were excluded. Successful liberation was defined as ≥72 hours without CRRT need within the first 28 days. The primary outcome was MAKE90: death, dialysis dependence or ≥ 25% decline in estimated glomerular filtration rate from baseline. Multivariable logistic regression was used to assess the association between clinical features and MAKE90.

Results: 990 children who received CRRT were included and 627 (63%) developed MAKE90 outcomes. After adjusting for sepsis at admission and illness severity parameters at CRRT initiation (vasopressor-inotrope score, PELOD-2 score, % fluid balance), patients with cardiac comorbidity (OR 2.04) and longer CRRT duration (OR 1.23) were associated with higher odds of developing MAKE90 (Table 1). Patients with successful first liberation within 28 days (OR 0.26) were associated with lower odds of MAKE90.

Conclusion: MAKE90 outcomes are common in critically ill children requiring CRRT, and highest among patients with cardiac co-morbidities and longer CRRT duration. Successful liberation within 28 days was associated with lower MAKE90 outcomes.

Table 1: Multivariable regression models predicting MAKE90 Outcome

Variable	OR (95% CI)
Primary Comorbidities: Cardiac	2.04 (1.37-3.03)*
Sepsis at ICU admission	1.01 (0.62-1.63)
Vasopressor-Inotrope Score at CRRT initiation#	0.87 (0.73-1.05)
PELOD-2 Score at CRRT initiation#	1.18 (0.86-1.62)
% fluid balance (ICU admit to CRRT initiation) #	1.06 (0.97-1.16)
Duration of CRRT through day of liberation attempt#	1.23 (1.01-1.49)*
Successful liberation within 28 days#	0.26 (0.17-0.38)*

* Denotes p <0.05, # Interquartile OR for continuous variables compares reference (25 percentile) to contrast (75 percentile). Odds ratio (OR) and 95% confidence intervals (CI) obtained by logistic regression accounting for the nesting of patients within centers via the Huber-While cluster sandwich estimator of variance.

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Hypophosphatemia in Critically Ill Patients Undergoing Prolonged Intermittent vs. Prolonged Intermittent-Sequential Kidney Replacement Therapy

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Purpose: Critically ill patients requiring kidney replacement therapy are at risk for developing hypophosphatemia, particularly with continuous, prolonged or frequent dialysis. We compared the incidence of hypophosphatemia between prolonged intermittent (PIKRT) and prolonged intermittent-sequential (PIKRT-S) kidney replacement therapies.
Methods: Retrospective study of critically ill patients who were prescribed dialysis treatments between 6 and 18 hours. Traditional PIKRT was performed using diffusion based therapy for the duration of the treatment, whereas PIKRT-S consisted of diffusion based dialysis for 4 hours followed by ultrafiltration only for the remainder of the treatment.
Results: There were 868 post dialysis serum phosphate measurements; the median was 2.7(2.0-3.6) mg/dL. The incidence of severe hypophosphatemia was 199/868(23%); 28%(177/868) occurred in the PIKRT group and 9%(22/868) in the PIKRT-S group (p<.001).
Conclusion: Incidence of severe hypophosphatemia was much lower with PIKRT-S vs PIKRT in the current study. PIKRT-S should be considered as an alternative to PIKRT modality in patients at high risk for hypophosphatemia.

	PIKRT (n=625)	PIKRT-S (n=243)	
Pre-BUN	45(29-68)	45(28-65)	0.6
Post-BUN	24(16-37)	36(24-46)	<0.001
Dialysis duration			
6 hours	437(70%)	108(49%)	<0.001
8 hours	94(15%)	26(12%)	
> 8 hours	89(15%)	87(39%)	
Blood flow rate			
200 mL/min	410(66%)	104(47%)	<0.001
300 mL/min	213(34%)	117(53%)	
Dialysate flow rate			
200 mL/min	361(58%)	70(32%)	<0.001
300 mL/min	246(39%)	148(67%)	

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Design of the Multi-Center International Retrospective Study included in Worldwide Exploration of Renal Replacement Outcomes Collaborative in Kidney Disease (WE-ROCK)

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Background: Pediatric acute kidney injury (AKI) and fluid overload (FO) occurring in the intensive care unit (ICU) can be managed using continuous renal replacement therapy (CRRT). The prospective pediatric CRRT (ppCRRT) study group performed the seminal work describing practice patterns and outcomes in pediatric CRRT almost two decades ago. The retrospective Worldwide Exploration of Renal Replacement Outcomes Collaborative in Kidney Disease (WE-ROCK) study was designed to provide an update of the current international practice patterns for CRRT in pediatric AKI and FO.

Methods: WE-ROCK is an international collaborative of pediatric providers from nephrology, cardiology, neonatology, and critical care, with the defined mission to improve short and longer-term outcomes of children treated with CRRT. Participating sites collected data from patients < 25 years of age who received CRRT for AKI or FO. Patients were excluded if they had (1) end stage kidney disease, (2) congenital kidney failure likely to require long-term CRRT, (3) required CRRT for ingestions, inborn errors of metabolism, or hyperammonemia, (4) received CRRT using the CARPEDIEM™ device, (5) received peritoneal dialysis prior to CRRT, or (6) received CRRT concurrently with extracorporeal membrane oxygenation (ECMO).

Results: To date, 990 pediatric patients treated with CRRT from 2018 through 2021 are in the study. These patients come from 32 centers in 7 countries across 4 continents. Data collection included baseline characteristics, information about CRRT prescription, and outcomes through 90 days after CRRT initiation. Planned analyses, based on study aims, include (1) epidemiology of AKI, FO, and CRRT, (2) CRRT liberation patterns, (3) CRRT initiation timing, (4) technical aspects of CRRT and patient outcomes, and (5) functional outcomes.

Conclusion: The data from this retrospective study will help inform current best practices, outcomes from CRRT with current medical practices, and provide valuable preliminary data for future prospective research studies. WE-ROCK continues to work collaboratively to identify other areas of research interest to further the collaborative's mission.

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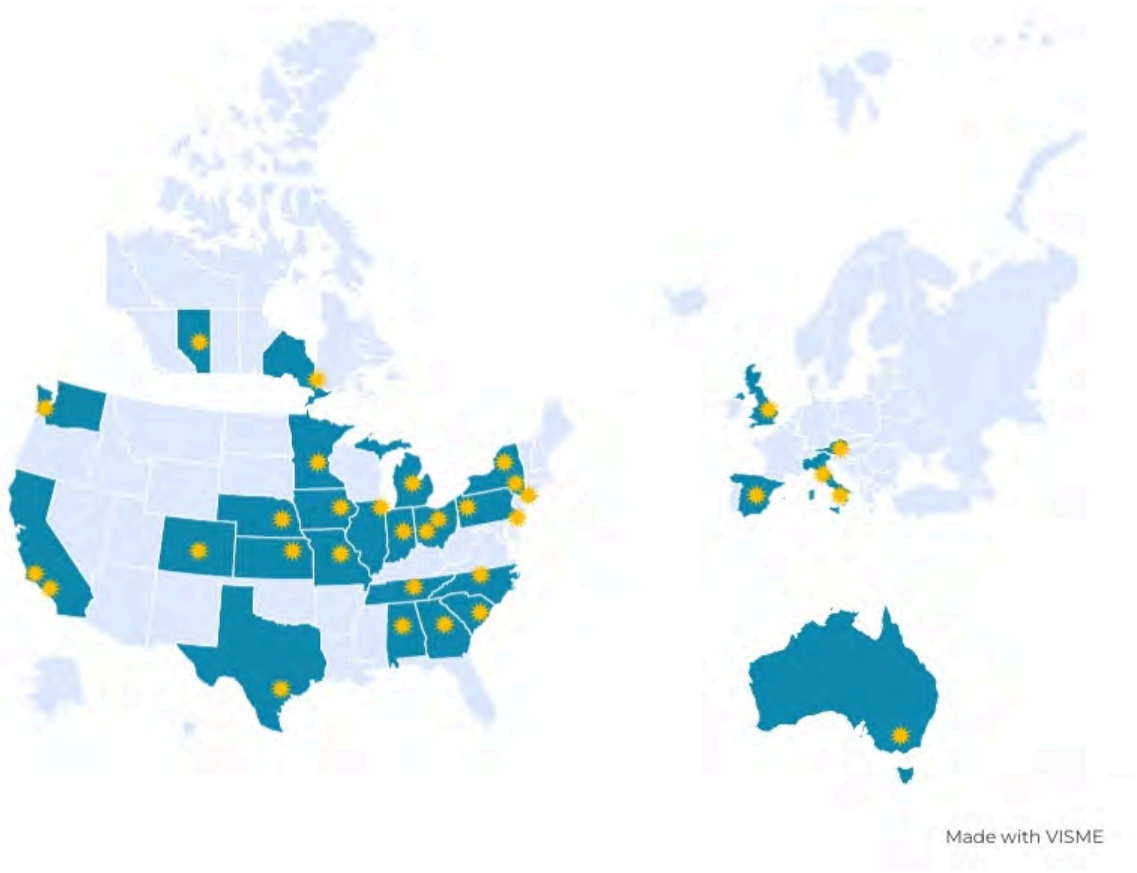

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Effect of Continuous Renal Replacement Therapy Liberation Patterns on Outcomes: A Retrospective Analysis of the Worldwide Exploration of Renal Replacement Outcomes Collaborative in Kidney Disease (WE-

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Study Purpose: Continuous renal replacement therapy (CRRT) is an important therapy used in critically ill children, but little is known regarding CRRT liberation and outcomes. We aimed to characterize the association between liberation patterns and outcomes, including mortality.

Methods: The Worldwide Exploration of Renal Replacement Outcomes Collaborative in Kidney Disease (WE-ROCK) study is an international multicenter observational study (32 centers, 7 nations) conducted from 2018-2021 in patients aged 0-25 years treated with CRRT for acute kidney injury (AKI) or fluid balance (FB). Exclusion criteria: dialysis dependence, ECMO, or CRRT for a different indication. Patients were categorized into 3 liberation categories based on first liberation attempt: failed liberation (any dialysis modality within 72 hours), success (no CRRT for ≥72 hours), or not attempted within the first 28 days of enrollment. Multivariable logistic regression was used to identify factors associated with successful CRRT liberation.

Results: 990 children were enrolled (321 (33%) liberation failure, 340 (34%) liberation success, 329 (33%) no liberation

attempt). Children who successfully liberated had lower ICU mortality (6.5%) compared to children with liberation failure (22%) and children without liberation attempts (78%)(p <0.001). Multivariable modeling (Table 1) showed that children with higher urine output prior to CRRT initiation had higher odds of CRRT liberation (aOR 1.22) while children with immunologic co-morbidities had lower odds of CRRT liberation (aOR 0.50).

Conclusion: Inability to liberate from CRRT was common in this retrospective multicenter analysis, higher among children with immunologic co-morbidities, and associated with high mortality rate. Higher urine output prior to CRRT initiation was associated with higher odds of liberation success.

Table 1: Multivariable regression models predicting CRRT liberation.

Variable	OR (95% CI)
Primary Comorbidities: Immunologic	0.50 (0.27-0.91)*
Sepsis at ICU admission	0.72 (0.47-1.10)
Vasopressor-Inotrope Score at CRRT initiation#	1.19 (0.99-1.43)
PELOD-2 Score at CRRT initiation#	1.12 (0.89-1.40)
% FB (ICU admit to CRRT initiation) #	1.01 (0.91-1.11)
Urine output (24h prior to CRRT initiation) (ml/kg/h) #	1.22 (1.05-1.41)*

* Denotes p <0.05, # Interquartile OR for continuous variables compares reference (25 percentile) to contrast (75 percentile). Odds ratio (OR) and 95% confidence intervals (CI) obtained by logistic regression accounting for the nesting of patients within centers via the Huber-While cluster sandwich estimator of variance.

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Functional outcomes in infant survivors of continuous renal replacement therapy (CRRT)

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Purpose: Data on non-renal functional outcomes of neonates with end stage kidney disease (ESKD) supported on CRRT are limited. We aimed to describe the functional status of neonatal survivors with ESKD treated with the Cardio-Renal, Pediatric Dialysis Emergency Machine (CARPEDIEM) system.

Methods: Single center retrospective cohort of neonates with ESKD who received CRRT with the CARPEDIEM system between June 1-Dec 31, 2021, and survived to hospital discharge. Score for Neonatal Acute Physiology II (SNAP-II) was used for illness severity. Functional Status Scale (FSS) was used for functional outcome at intensive care unit (ICU) admission, ICU discharge, hospital discharge, and follow-up periods (3 and 6 months). New morbidity was defined as change in FSS of at least 3.

Results: Out of 8 neonates, 5 (62.5%) survived to discharge (60% male, 80% preterm) and 6 month follow-up. At ICU admission, median age was 0 [0-30] days (60% admitted on day of birth) and median weight was 2.61 [2.61-3.95] kg. SNAP-II was 5 [5-16], and functional status was 40% very severely, 20% severely, and 20% moderately abnormal. At ICU discharge, hospital discharge, and 3 month follow-up, functional status was 80% moderately and 20% mildly abnormal. By 6 month follow-up, functional status was 20% severely, 40% moderately, and 40% mildly abnormal. New

morbidity occurred in 20% at hospital discharge (FSS 6 to 11). After discharge, 20% developed new morbidity between 3 and 6 month follow up (FSS 14 to 18), and this infant subsequently passed away. All CRRT survivors had neonatal ESKD (80% were discharged on continuous cycling peritoneal dialysis and 20% on hemodialysis), were newly dependent on gastrostomy tube for nutrition, and required outpatient rehabilitation services after discharge.

Conclusion: Survivors of CRRT with the CARPEDIEM system were successfully transitioned to alternative kidney replacement therapy. Neonates with ESKD are a vulnerable population at risk of sustained impacts on functional status and need long term, global developmental follow-up. Larger cohort studies would be beneficial to better characterize these long-term outcomes.

Pediatric Overall Performance Category groups by FSS score	ICU stay		Non-ICU stay	Follow-up	
	Admission	Discharge	Discharge	3 months	6 months
Good (FSS 6-7)	20%	0%	0%	0%	0%
Mildly abnormal (FSS 8-9)	0%	20%	20%	20%	40%
Moderately abnormal (FSS 10-15)	20%	80%	80%	80%	40%
Severely abnormal (FSS 16-21)	20%	0%	0%	0%	20%
Very severely abnormal (FSS 21-30)	40%	0%	0%	0%	0%

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Risk factors associations and outcomes of Thrombocytopenia in pediatric patients prior to Initiation of Continuous Renal Replacement Therapy (CRRT). An analysis of the Worldwide Exploration of Renal R

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Thrombocytopenia is common in critically ill patients, with prevalence estimated
to be between 15-50%, and is independently associated with mortality. The prevalence is likely higher for patients with acute kidney injury (AKI) in need of CRRT.
Studies of adults in the Acute Renal Failure Trial Network demonstrate that thrombocytopenia prior to CRRT initiation is an independent risk factors for mortality and lack of renal recovery. However, the outcomes associated with thrombocytopenia before CRRT initiation in pediatric patients are unknown. Therefore, we aimed to describe the incidence of thrombocytopenia
in pediatric patients prior to CRRT initiation and evaluate the risk factors and outcomes of these patients.
Methods: The Worldwide Exploration of Renal Replacement Outcomes Collaborative in Kidney Disease (WE-ROCK) study is a retrospective international multicenter study (32 centers, 7 nations) of patients aged 0-25 years treated with CRRT for AKI or Fluid Overload(FO) from 2018-2021. For this analysis, patients with a diagnosis of chronic thrombocytopenia, hematological malignancy, atypical hemolytic uremic syndrome, or thrombotic thrombocytopenic purpura were excluded. The primary exposure variable was baseline thrombocytopenia defined by platelets <100000/microliter recorded prior to CRRT initiation. The primary outcome was survival to ICU discharge.
Results: A total of 781 patients met inclusion criteria. Baseline thrombocytopenia (BT) was seen in 497 patients (63.6%) and was most common in patients admitted for shock, infection and major trauma N=183(37%). Patients with BT had higher medianPRISM-III scores (15 vs 13, $p<0.001$), higher PELOD scores at CRRT initiation (7 vs 5, $p<0.001$), and greater FO (9% vs 6%, $p<0.001$) at initiation compared to those with platelet count >100000/microLiter (Table 1). There were no significant differences in CRRT technical characteristics

between the cohorts. BT was associated with higher ICU mortality [OR (95% CI) 1.44 (1.06-1.97)] in univariate analysis. However, this association was not significant on multivariate adjustment [aOR 0.79 (0.54, 1.16)].
Conclusions:This is the largest study of epidemiology and outcomes of thrombocytopenia in pediatric CRRT. Like in adults, baseline thrombocytopenia was common and associated with higher severity of illness. We plan to conduct further analyses plan including platelets trends through CRRT course and the influence of anticoagulation and filter

Patient Characteristics	Baseline Platelets > $100X10^3$ N=284	Baseline Platelets < $100X10^3$ N=497	p
Age, yrs	10.0 (2.0, 15.8)	7.0 (1.6, 14.2)	0.067
Female	143 (50%)	219 (44%)	0.09
Weight, kg	31 (12, 60)	24 (11, 50)	0.032
Primary diagnosis categories			
• Shock/Infection/Major trauma	92 (32%)	183 (37%)	
• Respiratory failure	46 (16%)	109 (22%)	
• Other	81 (28.7)	148 (29.4)	
• Cardiac	58 (20.4)	38 (7,6)	
• CNS Dysfunction	7(2.5)	19 (3.8)	
Sepsis at CRRT initiation	107 (38%)	235 (47%)	0.09
PRISM III	13 (8, 18)	15 (11, 20)	<0.001
Mechanical ventilation (CRRT start)	231 (70.2)	857 (86.3)	0.001
% fluid overload at CRRT initiation	7 (2, 14)	9 (3, 20)	<0.001
PELOD-2 Score at CRRT initiation	5.0 (3.0, 6.0)	7.0 (5.0, 10.0)	<0.001
Platelets prior to CRRT*	189 (140, 285)	38 (21, 63)	<0.001
Platelet nadir in 72 hours*	57 (35, 95)	27 (14, 44)	<0.001
Platelet nadir in 7 days*	46 (20, 91)	23 (12, 38)	<0.001
Survival to ICU discharge	198 (70%)	307 (62%)	0.021
Duration of CRRT	5 (2, 12)	7 (3, 15)	0.019
All values as N (%) or median (interquartile range) * In 10^3/cmm			

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Implementation of a Novel Renal Therapy in the Neonatal/Infant and Cardiac Intensive Care Units: Rapid Results from a Multimodal Educational Approach

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Background/Purpose: A novel vascular renal replacement therapy, Aquadex™, was scheduled for implementation in the Neonatal/Infant Intensive Care Unit (N/IICU) to support patients not eligible for conventional hemodialysis due to their small physical size. Training of nurses needed to progress quickly but achieve high fidelity, since a vascular approach would not only be new, but also complex and associated with multiple potential safety risks.

Methods: A multimodal education approach was deployed, including pre-assignments, online modules, didactic presentations, skills demonstrations, and group discussions. Just-In-Time Training (JITT) followed across all shifts, including 3 preceptor shifts, with special attention paid to risks associated with vascular access and an extracorporeal circuit. Continued JITT, education and support involved unit-based Education Nurse Specialists, Clinical Nurse Specialists and Clinical Nurse Experts. After identifying patients in the Cardiac ICU (CICU) that would benefit from Aquadex™, this model was then rapidly applied to the training of the bedside staff of this unit.

Summary: Upon completion, 91% of N/IICU nurses were trained to a high level of competency in under 6 months, with 56 nurses completing training to maintain the therapy and 19 completing additional training to prime and initiate therapy. Yearly competency assessments, including simulations and gaming activities, were established to remain up to date and competent in this therapy. The same approach was then applied to train 40 nurses in the CICU within a month timeframe.

Conclusion: Rapid clinical change poses challenges for nurse education when complex new procedures or treatment-eligible populations are introduced. Leading through change poses challenges with hesitant and resistant staff, but with continued education, coaching and unwavering leadership support, our bedside staff gained independence and confidence in this new therapy. Deployed across all shifts and utilizing all available resources, a multimodal education approach enabled us to meet the challenge, ensuring safe care for an extremely fragile population, and the successful implementation of a novel therapy.

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The CRRT Nursing Quality Council

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Background: Studies have demonstrated that nursing engagement improves outcomes. To achieve engagement and ensure CRRT decisions affecting nursing were occurring at the point of service, CRRT nurses developed a shared governance council. The council has worked to clarify CRRT practices and use share that information with colleagues, however barriers to CRRT council progress included a focus on non-nursing concerns and diminished membership.

Methods: Various strategies were implanted to increase staff nurse membership in the council including verbal invitations to personalize the request, early evening meetings to encourage night shift participation, text messages to remind RNs of

upcoming meetings, and relevant agenda items to address current practice concerns. Topics discussed in meetings included opportunities to improve CRRT calculations and documentation, supply issues, learning needs, interprofessional communication, and special considerations for CRRT. After deciding how to proceed with each topic, the council developed action plans for staff and patient education projects.

Results: Membership in the council improved with participation in meetings increasing from four to 14 RNs. Average night shift representation increased from two to ten RNs. Over the last year, CRRT projects completed increased from zero to nine with four other projects in progress, policy and practice decisions increased from zero to two, and education provided increased from zero to ten topics. Future goals include measuring and improving CRRT-specific quality metrics.

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Improving Continuous Renal Replacement Therapy Nursing Communication

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Purpose: This project aimed to identify and implement an effective approach in communicating CRRT practice updates or improvement opportunities. Introduction: Prior to 2021, CRRT was considered a specialized nursing skill with initial user classes offered to less than 40 nurses each year. An increase in nursing attrition in all seven of the hospital's critical care units negatively impacted CRRT nurse staffing, prompting the organization to mandate a large-scale CRRT training of all critical care nurses. The expansion of the CRRT workforce to include less experienced nurses presented several challenges, including a gap in communication. Traditional informal approaches to sharing information with a small group of CRRT nurses were less effective when attempted with the larger group. A total of 35 CRRT nurses were surveyed regarding communication. Results showed that 77.1% inconsistently received CRRT practice updates in huddle. Only 11.4% of CRRT nurses said they received information from a colleague, and another 11.4% said there were no updates given. Method: CRRT Quality Council nurses developed two different approaches to communicate CRRT information and practice updates. The first approach was the creation of a practice update flyer to highlight any CRRT changes and practice opportunities. Content for flyers was developed after querying CRRT RNs regarding their concerns, and discussing improvement opportunities with Clinical Nurse Specialists and Physicians. Flyers were distributed to critical care units, huddled on each shift by the nurse leads, emailed to ICU staff, and posted on CRRT poster boards. The second approach was a CRRT Fair coordinated and hosted by the CRRT quality council. Topics addressed at the Fair were those that warranted more interpersonal communication or further reinforcement. To foster a fun environment, learning methods included game-based learning, hands-on demonstrations, and open discussions. Participants received prizes. Results: A post-survey revealed that 100% of CRRT RNs stated that they consistently receive updated information about CRRT practice changes or opportunities. Of those surveyed, 88.5% stated that they receive CRRT practice updates by viewing the dedicated CRRT practice update poster board. The other 11.4% of RNs viewed the updates sent via email. The CRRT Fair was attended by 109 CRRT RNs with 100% participating in all activities.

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Optimization of Electronic Continuous Renal Replacement Therapy Documentation to Reduce Time Spent Charting

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Purpose: Nursing work includes the time spent documenting patient care provided. Up to 35% of nursing work time is spent on documentation. Continuous Renal Replacement Therapy (CRRT) calculations and documentation, specifically, are noted to be one of the most time-intensive activities nurses perform in Critical Care Units. The aim of this project was to decrease time spent performing calculations and completing documentation for CRRT by optimizing electronic documentation.

Significance: Accurate nursing documentation has been associated with improved nursing outcomes. Precise CRRT calculations and documentation are required to ensure optimal fluid balance for each patient. In this organization, nurses perform hourly CRRT calculations that include cumulative fluid balances. The primary barrier to efficient documentation included limitations to the electronic health record platform that required nurses to perform calculations manually.

Methods: The CRRT Quality Council met to discuss possible strategies for improving electronic documentation. Nurses viewed electronic CRRT documentation from other hospitals and found none that met the needs of this organization. Members of the group drafted possible solutions and selected an option that required no manual calculation. The Nursing Information Technology Analyst built and tested the proposed solution. Members of the CRRT Quality Council then sought approval from other CRRT nurses to ensure the decision was made by those who would be performing the calculations and documenting. Next, the solution was presented and approved at hospital committees, education was delivered, and the new documentation fields were incorporated into the electronic health record.

Evaluation: Prior to implementation, CRRT calculations and documentation took 142 seconds each hour for experienced CRRT nurses and 264 seconds for less experienced CRRT nurses. Post-implementation, time taken for calculations and documentation decreased to an average of 53 seconds for experienced CRRT nurses and 55 seconds for less experienced CRRT nurses. The time saved per day for experienced CRRT nurses totaled 35.6 minutes while less experienced CRRT nurses saved 83.6 minutes.

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Bedside RN Experience with Novel Cartridge for CKRT

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Introduction

Maintaining the circuit is paramount when delivering Continuous Kidney Replacement Therapy (CKRT) in critically ill ICU patients. Clotting and clogging of the filter are common problems and various methods have been attempted to increase circuit up-time. These include systemic heparin, regional citrate anticoagulation and prostacyclin therapy. Each of these methods, with their own added cost and potential complications. If these methods fail to prevent clotting and clogging the entire CKRT circuit needs to be replaced which decreases therapy time and is costly. These costs can be direct: supplies and waste removal, and indirect: bedside nurse time and workload.
At the end of 2021, UMass Memorial Health undertook a pilot of a novel CKRT cartridge with a swappable filter

(Speedswap) in collaboration with its CKRT partner NxStage Medical Inc. The pilot was done in 3 adult ICUs and then with a full product rollout in October 2022 as the first hospital in the US.

Education approach

The two-phase pilot was done in the 3 ICUs with hand-on training prior to starting as well as direct bedside support by Nxstage staff for phase 1 of the pilot. Phase 2 was done with staff nurse teams of 2 or more, with Nxstage staff on standby to determine the feasibility of filter swaps and nurse to nurse training. Filter swaps were done on a scheduled every 12-hour basis for a total of 50 filters over the 2 phases of the pilot.

Bedside RN Experience

The previous method of cartridge swaps had a downtime of 30-40 minutes for priming and air removal. This approach was very time consuming for the nurses and patients would often miss significant therapy time when critically ill. The Speedswap approach cut this downtime to 3-4 minutes.

Discussion

Currently all new CKRT patients in the 3 ICUs are initiated on the Speedswap cartridge. All filter swaps are on an as needed basis when clotting/clogging is evident. Patients transition back to the traditional cartridge when less than 2 filter swaps have been done in 72 hours.
Implementation of this new approach obviously come with costs such as machine upgrades, staff training and initial supplies. Quantifying costs of previously attempted methods or in-direct nursing care are hard as they are variable or hard to measure. The consensus among nursing staff have been that the quality improvement for them with a decreased workload and the positive impact on their patients with increased therapy time has been worth it.

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ICONIC (Improving Carpediem™ Outcomes in Neonates and Infants through Collaboration): A Survey to Understand Carpediem™ Education Practices and Care Delivery Models

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Background
Carpediem (Trademark Medtronic, United States) is a dedicated infant continuous renal replacement therapy (CRRT). The multidisciplinary collaborative, Improving Carpediem (CD) Outcomes in Neonates and Infants through collaboration (ICONIC), aims to understand best education and clinical practices. Nursing (RN) competency is critical for successful therapy. Often, the number of trained CRRT RNs exceeds the number of patients making it challenging for consistent exposure and skill acquisition. Training methods impact the RN's ability to safely initiate, troubleshoot and resolve circuit issues, potentially influencing filter life and delay in care.

Methods
We designed and disseminated a survey to ICONIC sites that actively provide CD as of August 1, 2022 or will provide therapy after January 1, 2023. Information collected related to intensive care units (ICUs) offered, care delivery models, staff roles, education and training were uploaded into the Research Electronic Data Capture (REDCap) database.

Results

Of the 23 sites, 11 reported the ability to provide CRRT with CD. CD is offered at 10 sites in the pediatric ICU, 6 sites additionally in the neonatal ICU, and 1 site only in the neonatal ICU. A collaborative RN model was the most used (n=8), most commonly with dialysis and critical care (n=5). All but two sites reported that bedside RNs had a role related to providing CD. Of the 10 sites that reported trained RN totals, median ratio of CD trained RNs for every unit bed was 1:1. Median ratio of CD trained RNs to ICU total RNs was 1:4 (range 1:10 and 4:10). RN-to-patient ratios were predominantly 1:1, although 4 sites had at least one ICU with 2:1. Table 1 demonstrates initial RN education requirements from 10 sites with 3 sites currently requiring annual competencies.

Conclusions
Standards for ideal RN educational requirements and care delivery models are limited and vary amongst institutions. Understanding initial and ongoing educational requirements and how it influences the quality of delivered therapy and patient outcomes will help inform best practices related to CRRT in the future.

	Bedside RN		CRRT RN	
Type of Education	# of Sites	Range of Hours Required	# of Sites	Range of Hours Required
Didactic with Hands-on	8	4-8	8	2-15
Bedside Mentoring	3	8-12	3	4-36
Simulation	1	4	2	2-34
Online Modules	0	N/A	1	2
Exam	3	N/A	7	N/A

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Navigating Unchartered Waters: Initiating Aquadex with Continuous Veno-Venous Hemofiltration Therapy in a Pediatric Cardiac Intensive Care Patient

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PURPOSE:
In October 2022, a patient's urgent medical need necessitated the initiation of Aquadex renal replacement therapy (RRT) for the first time within the pediatric cardiovascular intensive care unit (CICU). The patient's renal failure due to complications from hypoplastic left heart syndrome was no longer manageable with peritoneal dialysis and prior attempts at Prismaflex RRT had failed. Previously, Aquadex therapy had only been utilized in the neonatal/infant intensive care unit (N/IICU), and RN experience and competency was confined to the N/IICU alone. Therefore, our goal was to develop a sound Aquadex educational plan that would ensure proficiency and begin training the multidisciplinary CICU team as quickly as possible.

METHODS:
A team comprising N/IICU and CICU Clinical Nurse Specialists and Educational Nurse Specialists and a Dialysis Nursing Leader partnered to plan nursing education. In November 2022, instructors offered 11 90-minute training sessions over a 3-day period for 42 CICU and 9 Dialysis RNs with previous RRT knowledge. Each session included 30-minutes of didactic learning to discuss care principles and 60-minutes of situational learning to troubleshoot alarms, augment settings, baseline hematocrit, trend pressures, obtain labs, and review history. Class sizes were limited to 2 learners per Aquadex console to ensure a tactile and engaged learning environment. Each participant received an anonymous online

post-training survey consisting of demographics, three likert-type evaluation questions, and one open-ended question. Following training, CICU RNs worked with Aquadex-experienced N/IICU or CICU RNs for 3 shifts to support clinical experience development.

RESULTS:
Preliminary responses (n=16) from post-education evaluations show that the education met objectives (100%), was engaging (94%), and can be applied to the clinical environment (100%). Evaluations are continuing, and learners will self-assess sustained knowledge and comfort in providing clinical care with Aquadex at 60-90 days post-initial training. In October 2022, N/IICU RNs supported all Aquadex therapy needs for CICU patients. By December 2022, CICU RNs provided 85% of all RN staffing needs required for any patient receiving Aquadex in the CICU.

CONCLUSION:
Rapid attainment of knowledge related to a new RRT is possible through interdisciplinary collaboration and institutional support for swift staff education.