NUTRITIONAL SUPPORT IN CRITICALLY ILL PATIENTS WITH ACUTE KIDNEY INJURY

An Essay

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Mohamed Mansour Hassan

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List of Abbreviations

Abb.	Full term
ACE	*Angiotensin-Converting Enzyme*
AIN	*Acute Interstitial Nephritis*
AKI	*Acute Kidney Injury*
AKIN	*Acute Kidney Injury Network*
ARDS	*Acute Respirtory Distress Sydrome*
ARF	*Acute Renal Failure*
ATN	*Acute Tubule Necrosis*
AUC	*Area Under The Curve*
BEE	*Basal Energy Expenditure*
BIA	*Bioelectrical Impedance Analysis*
BMC	*Basal Metabolic Chart*
BMI	*Body Mass Index*
BUN	*Blood Urea Nitrogen*
BW	*Body Weight*
CIN	*Contrast- Induced Nephropathy*
CKD	*Chronic Kidney Disease*
CO_2	*Carbon Dioxide*
CPB	*Cardio-Pulmonary Bypass*
CRP	*C-Reactive Protein*
CRRT	*Continuous Renal Replacement Therapy*
CVVH	*Continuous Veno- Venous Haemodialysis.*
CVVHDF	*Continuous Venovenous Hemodiafiltration*
EAA	*Essential Amino Acids*
EE	*Energy Expenditure*
EN	*Enteral Nutrition*
ESPEN	*European Society of Parentral and Enteral Nutrition*
FeNa	*Fractional Excretion Of Sodium*
GI	*Gastrointestinal*
GFR	*Glomerular Filtration Rate*
HDL	*High-Density Lipoprotein*
HIV	*Human Immunodeficiency Virus*
HRS	*Hepatorenal Syndrome*
HUS	*Hemolytic-Uremic Syndrome*
ICU	*Intensive Care Unit*
IGF-1	*Insulin-like Growth Factor-1*
IGF-2	*Insulin-like Growth Factor-2*

IL-8	*Interleukin-18*
INOS	*Inducible Nitric Oxide Synthase*
ISRNM	*International Society of Renal Nutrition and Metabolism*
kDa	*Kilodaltons*
KIM-1	*Kidney Injury Molecule-1*
LCT	*Long-Chain Triglyceride*
LDL	*Low-Density Lipoprotein*
MCT	*Medium-Chain Triglycerides*
MOD	*Multiple Organ Dysfunction*
NAC	*N-Acetylcysteine*
NAG	*N-Acetyl-β-(D)-Glucosaminidase*
NEAA	*Non Essential Amino Acids*
NGAL	*Neutrophil Gelatinase-Associated Lipocalin*
NSAIDS	*Non-Steroidal Anti-Inflammatory Drugs*
PCT	*Proximal Convoluted Tubule*
PEW	*Protein-Energy-Wasting*
PICARD	*Program to Improve Care in Acute Renal Disease*
PN	*Parenteral Nutrition*
pNGAL	*Plasma NGAL*
RCT	*Randomized Controlled Trials*
REE	*Resting Energy Expenditure*
RIFLE	*Risk, Injury, Failure, Loss, End Stage Kidney Disease*
RRT	*Renal Replacement Therapy*
SAFE	*Saline versus Albumin Fluid Evaluation*
SCr	*Serum Creatinine*
SGA	*Subjective Global Assessment*
SIRS	*Systemic Inflammatory Response Syndrome*
SLED	*Sustained Low-Efficiency Dialysis*
SOAP	*Simple Object Access Protocol*
TTP	*Thrombotic Thrombocytopenic Purpura*
uNGAL	*Urinary NGAL*
US	*United States*
UOP	*Urine Output*
VLDL	*Very-Low-Density Lipoprotein*

INTRODUCTION

Acute kidney injury (AKI) is a complex and heterogeneous syndrome occurring in different clinical settings, especially in the intensive care unit (ICU) **(Himmelfarb and Ikizler, 2007; Xue et al., 2006).**

AKI can be defined as an abrupt (within 48 h) reduction in kidney function with an absolute increase in serum creatinine of either ≥0.3 mg/dl (≥0.25 μmol/l) or a percentage increase of ≥50% or a reduction in urine output of ≤0.5 ml/kg/h for >6 h. The incidence of AKI is increasing, with incidence rates of 3%-10% observed among hospitalized patients, which can rise up to 10%–30% in those admitted to the ICU **(Mehta et al., 2007).**

Patients with AKI have a high prevalence of malnutrition. AKI develops mostly in the context of critical illness and multiple organ dysfunction (MOD), which are associated with major changes in substrate metabolism and body composition. Key effectors of these changes are a host of inflammatory mediators and neuroendocrine alterations. The development of AKI further adds fluid overload, azotemia, acidosis, and electrolyte disturbances to these changes **(Fiaccadori et al., 1999; Himmelfarb et al., 2006).**

The evaluation of nutritional status can be difficult in critically ill patients, especially if AKI is present, and

traditional methods in this clinical setting have shown limited sensitivity and specificity (**Fiaccadori et al., 1999**).

To better characterize the condition of lean body mass wasting and fat mass depletion occurring in AKI, the term 'protein-energy wasting' (PEW) has been recently proposed, along with the recommendation to use four categories of diagnostic criteria: biochemical markers (such as albumin or prealbumin), body weight loss, decreased muscle mass and low energy and protein intakes **(Fouque et al., 2008).**

PEW seems to be a frequent problem in AKI. As a matter of fact, severe malnutrition, as defined by the Subjective Global Assessment (SGA), can be observed in about 40% of patients with AKI in the ICU. Many factors are likely to contribute to PEW in these patients, including inadequate nutritional support, preexisting poor nutritional status, superimposed catabolic illnesses (sepsis, trauma, surgery, chemotherapy, etc.), acidosis, blood losses, nutrient losses during extracorporeal circulation, etc. **(Fouque et al., 2008).**

Nutritional status is a major prognostic factor in the patients with AKI. Severe PEW severely impairs patient's outcome, whether defined in terms of length of hospital stay, increased risk of complications (sepsis, bleeding, arrhythmia, respiratory failure, etc.) or increased in-hospital mortality, along with other well-known complications and co-morbidities of AKI. Thus, it is likely that optimizing nutritional status and

preventing nutritional status deterioration could improve patient outcome **(Fiaccadori et al., 1999; Guimaraes et al., 2008).**

The timing, route, and ideal composition of ICU nutritional support remain a matter of discussion and even official guidelines and consensus statements are not always consistent**.** Feeding of critically ill patients should be started early. Early nutrition is defined as the initiation of nutritional therapy within 48 hours of either hospital admission or surgery.

The traditional ICU doctrine is that enteral nutrition is always better than parenteral nutrition because it keeps the intestinal mucosa active and reduces bacterial translocation **(De Aguilar-Nascimento and Kudsk, 2008).**

AIM OF THE WORK

The aim of this study is to review the metabolic alterations underlying critical illness and AKI, to discuss nutritional and metabolic support in these patients, and to address the nutritional implication of continuous renal replacement therapy.

Chapter I

ACUTE KIDNEY INJURY IN THE CRITICALLY ILL

Acute kidney injury (AKI), previously termed acute renal failure, refers to a sudden decline in kidney function causing disturbances in fluid, electrolyte, and acid-base balance because of a loss in small solute clearance and decreased glomerular filtration rate (GFR). The nomenclature shift to AKI more accurately represents the spectrum of disease from subclinical injury to complete organ failure.

Acute kidney injury is common in critically ill patients and is associated with significant morbidity and mortality. This requires clinicians to be familiar with recent advances in definitions, diagnosis, prevention, and management of acute kidney injury in the intensive care unit. The purpose of this concise review, therefore, is to address, for the non-nephrologist, clinically relevant topical questions regarding acute kidney injury in the intensive care unit **(Dennen et al., 2010).**

Definition of AKI

More than 35 definitions of AKI currently exist in the literature. The Acute Dialysis Quality Initiative convened in 2002 and proposed the Risk, Injury, Failure, Loss, End Stage

Kidney Disease (RIFLE) classification specifically for AKI in critically ill patients (Table 1**) (Bellomo et al., 2004).**

Using serum creatinine (SCr) and urine output, the RIFLE criteria define three grades of severity and two outcome classes. The most severe with primary kidney diseases such as glomerulonephritis were excluded from this definition. More recently the Acute Kidney Injury Network (AKIN), an international multidisciplinary organization composed of nephrologists and intensivists, further modified the RIFLE criteria recognizing that even very small changes in SCr (≥ 0.3 mg/dl) adversely impact clinical outcome **(Hoste et al., 2006; Ostermann and Chang, 2007).**

According to the AKIN, the most current consensus diagnostic criteria for AKI is "an abrupt (within 48 hrs) reduction in kidney function currently defined as an absolute increase in serum creatinine of more than or equal to 0.3 mg/dl (≥26.4 μmol/l), a percentage increase in serum creatinine of ≥ 50% (1.5-fold from baseline), or a reduction in urine output (documented oliguria of < 0.5 ml/kg/hr for > 6 hrs)**.** Importantly, the AKIN definition and classification system incorporates creatinine, urine output, and time (Table 1) **(Mehta et al., 2007)**.

Both the RIFLE and AKIN criteria were developed to facilitate clinical investigation and comparison across study populations. Epidemiologic data comparing the RIFLE and

AKIN criteria have demonstrated concordance in critically ill patients **(Bagshaw et al., 2008; Lopes et al., 2008).**

Table (1): Classification/staging systems for acute kidney injury

RIFLE	SCr Criteria	UOP Criteria	AKIN Stage	SCr Criteria	UOP Criteria
R	↑ SCr×1.5	< 0.5 ml/kg/hr × 6 hrs	1	↑in SCr ≥ 0.3 mg/dL or ↑ ≥ 150% to 200% from baseline (1.5- to 2-fold)	< 0.5 ml/kg/hr for > 8 hrs
I	↑ SCr×2	< 0.5 ml/kg/hr × 12 hrs	2	↑in SCr to > 200% to 300% from baseline (>2- to 3-fold)	< 0.5 ml/kg/hr for > 12 hrs
F	↑ SCr×3, or SCr ≥4 mg/dL with an acute rise of at least 0.5 mg/dL	< 0.5 ml/kg/hr × 24 hrs or anuria × 12 hrs	3	↑ in SCr to > 300% (3-fold) from baseline or SCr ≥ 4 mg/dL with an acute rise of at least 0.5 mg/dL	< 0.5 ml/kg/hr × 24 hrs or anuria × 12 hrs
L	Persistent loss of kidney function for >4 wks				
E	Persistent loss of kidney function for >3 months				

AKIN, acute kidney injury network; RIFLE, risk, injury, failure, loss, end-stage kidney disease; SCr, serum creatinine; UOP, urine output**.** Adapted from **Mehta et al. (2007).**