CONTINUOUS AND INTERMITTENT RENAL REPLACEMENT THERAPY FOR ACUTE KIDNEY INJURY IN INTENSIVE CARE UNITS

Essay

Submitted for partial fulfilment of Master Degree in **Intensive Care**

By

Ahmed Esam Omar Ibrahim

M.B.B.Ch. Faculty of medicine, Ain Shams University

Under supervision of

Doctor/ Alaa Eid Mohamed

Professor of Anesthesiology, Intensive Care & Pain Management

Faculty of Medicine, Ain Shams University

Doctor/ Amr Mohamed Abd El Fattah

Assistant Professor of Anesthesiology, Intensive Care & Pain Management

Faculty of Medicine, Ain Shams University

Doctor/ Rafik Youssef Attallah

Lecturer of Anesthesiology, Intensive Care & Pain Management

Faculty of Medicine, Ain Shams University

Faculty of Medicine

Ain Shams University

2015

AKNOWLEDGMENT

First of all, I would like to thank Allah who granted me the strength to accomplish this work.

My deepest gratitude and appreciation to Prof. Dr. Alaa Eid Mohamed, Dr. Amr Mohamed Abd El Fattah & Dr. Rafik Youssef Attallah for their excellent guidance and powerful support.

My true affection and love goes to all my family, who were and will always be by my side.

LIST OF CONTENTS

LIST OF TABLES AND FIGURES

LIST OF ABBREVIATIONS

AKI: Acute Kidney Injury

AKIN: Acute Kidney Injury Network

BUN: Blood urea nitrogen

CVVH: continuous venovenous hemofiltration

CVVHD: continuous venovenous hemodialysis

CVVHDF: continuous venovenous hemodiafiltration

ESRD: End-stage renal disease

GFR: Gromelular filtration rate

ICU: Intensive care unit

KDIGO: Kidney disease, improving global outcome

RIFLE: Risk, Injury, Failure, Loss and End stage renal disease

RRT: renal replacement therapy

SCUF: slow continuous ultrafiltration

SLED: Sustained low efficiency dialysis

URR: The urea reduction rate

INTRODUCTION

Acute kidney injury is characterized by rapid and sustained reduction of glomerular filtration rate resulting in the retention of nitrogenous (creatinine and urea) and non‑nitrogenous metabolic waste products and dysregulation of body fluid volume status, electrolyte and acid base homeostasis ***(Schiffl et al., 2014).***

Acute kidney injury is considered one of the most common serious complications in critically ill patients. Severe acute kidney injury occurs in more than 1 of every 20 patients requiring intensive care unit and has been associated with mortality rates ranging from 50% to more than 70%. Although conservative therapies provide the initial measures of acute kidney injury management, renal replacement therapy using one or more of the multiple modalities of dialysis and hemofiltration is often required ***(Palevsky, 2013).***

Intermittent renal replacement therapy was introduced in the early 1940s for treatment of renal failure as a bridge until recovery of kidney function. Since then it was considered as the standard treatment for patients with End Stage Renal Disease, furthermore, it is still the mainstay of supportive care for acute kidney injury worldwide. It has the advantages of being highly efficient, practical, and flexible. It is also very useful in management of life threatening conditions due to its capability of rapid solute removal ***(Vanholder et al., 2011).***

In the 1980s, continuous renal replacement therapy was introduced as an alternative, allowing blood purification 24 hours per day at least in principle. Continuous renal replacement therapy is gaining popularity in intensive care units and is often viewed as the preferable approach in critically ill patients with hemodynamic instability. It remains, however, unclear whether the choice of initial renal replacement therapy modality may affect patient outcomes, as only few prospective randomized controlled trials have directly compared the different approaches ***(Schefold et al., 2014).***

Continuous renal replacement therapy is performed using much slower blood flow rates as compared with intermittent renal replacement therapy, and is typically only delivered in an intensive care setting. Continuous renal replacement therapy is better tolerated hemodynamically as it provides slower solute clearance per unit of time compared with intermittent therapies, but over 24 hours, the total clearance may exceed that provided by intermittent renal replacement therapy, especially for larger solutes such as cytokines ***(Himmelfarb, 2007).***

While fluid is removed more slowly using continuous renal replacement therapy, it requires continuous anticoagulation (thus creating the potential for bleeding) and involves continuous exposure to an extracorporeal circuit (which might lead to depletion of nutrients, subtherapeutic levels of antimicrobial agents, or infection) ***(Pannu et al., 2008).***

The superiority of continuous over intermittent renal replacement therapy in the intensive care unit remains controversial, although there is increasing agreement that initial therapy with continuous renal replacement therapy is preferable in hemodynamically unstable patients. To identify a renal replacement therapy option of choice would potentially have a major impact on clinical procedures. This might be of particular importance in sepsis-induced renal injury and might also affect treatment costs ***(Prowle et al., 2011).***

AIM OF THE WORK

The aim of the work is to review the advantages and disadvantages of continuous and intermittent renal replacement therapy in the treatment of acute kidney injury in intensive care units as regard their hemodynamic side effects, effect on renal recovery and mortality rates.

CHAPTER ONE: Acute Kidney Injury

Acute kidney injury is an international consensus term -formerly referred to as acute renal failure - that was introduced to emphasize the gradual progress of renal dysfunction long before renal failure occurs. The term describes a major complication of critically ill patients that is seen as an acute deterioration of previously normal kidney functions, usually over hours or days, and it is considered as an independent risk factor for increased mortality ***(Kellum et al., 2012)***.

Definition:

Acute kidney injury is currently defined as a rapid decline in the glomerular filtration rate resulting in retention of nitrogenous wastes, primarily creatinine and blood urea nitrogen. Consequently, the diagnosis currently is dependent on the serial measurement over time of these substances in the blood of patients. The rapidity of this decline may occur over a time course of hours to months, but typically occurs over the course of hours to days. The ability of these measurements to serve as a marker of glomerular filtration rate is relatively imprecise and improved methods for evaluating glomerular filtration rate and a direct assessment of renal injury are needed in the practice of medicine ***(Edelstein, 2008)***.

Acute kidney injury can be defined and also classified using the RIFLE criteria that divide acute kidney injury into the categories of Risk, Injury, Failure, Loss and End stage renal disease **(*Bellomo et al., 2004).***

Table (1.1)
Risk, Injury, Failure, Loss and End stage renal disease (RIFLE) criteria for diagnosis of acute kidney injury ***(Bellomo et al., 2004).***

	Serum creatinine/ Gromelular filtration rate (GFR)	Urine output
Risk	Serum Creatinine increase × 1.5 above baseline or GFR decline > 25%	< 0.5 ml/kg/h × 6 h
Injury	Serum Creatinine increase × 2 above baseline or GFR decline > 50%	< 0.3 ml/kg/h × 24 h
Failure	Serum Creatinine increase × 3 above baseline or ≥ 4 mg/dl or GFR decline > 75%	< 0.3 ml/kg/h 24 h or anuria × 12 h
Loss	Persistent kidney injury > 4 weeks	
End stage	End-stage renal disease (acute kidney injury > 3 months)	

Later on after the introduction of the RIFLE criteria, the Acute Kidney Injury Network (AKIN) introduced revised criteria with few modifications: it requires a smaller change in serum creatinine level (>0.3mg/dl) for the diagnosis of acute kidney injury, and a time limit of 48 hours is imposed on the change of serum creatinin ***(Bagshaw et al., 2008).***

Table (1.2)
Acute Kidney Injury Network (AKIN) criteria for classification and diagnosis of acute kidney injury ***(Bagshaw et al., 2008).***

	Serum creatinine criteria	Urine output criteria
Stage 1	Increase in Creatinine to >0.3 mg/dl or1.5-2 x baseline	< 0.5 ml/kg/h for > 8h
Stage 2	Increase in Creatinine to > 2-3 x baseline	< 0.5 ml/kg/h for > 12 h
Stage 3	Increase in Creatinine to > 3 x baseline or > 4 mg/dl with an acute increase of > 0.5 mg/dl	< 0.5 ml/kg/h for 24 h or anuria for 12 h

However, comparison studies have not demonstrated a difference between the RIFLE and AKIN criteria for predicting outcomes, and are equivalent for predicting mortality rates ***(Chang et al., 2010).***

Epidemiology:

The incidence of acute kidney injury is not precisely measured, and appears to be rising over time, which may reflect differences in how acute kidney injury is precisely defined. Before the introduction of the RIFLE criteria a large multinational, multicenter, epidemiological study was conducted and found a period prevalence of acute renal failure in the intensive care units of approximately 6%, with close to two thirds of such patients receiving renal replacement therapy **(*Uchino et al., 2005*).**

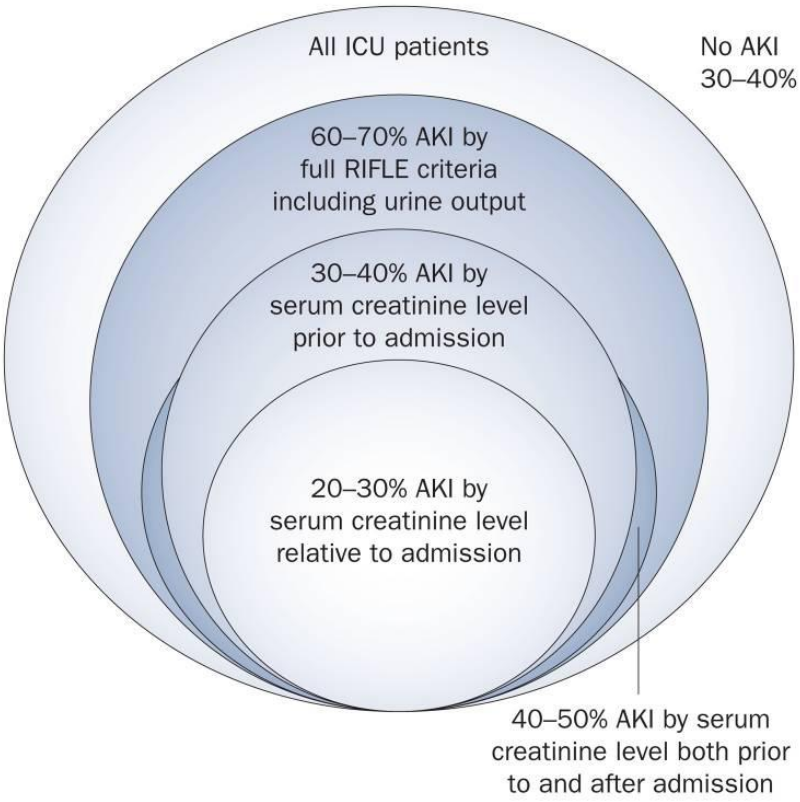

Figure (1.1): Risk of acute kidney injury (AKI) varies by definition used and timing of assessment in intensive care units (ICU) ***(Murugan et al., 2011).***

After the application of the RIFLE criteria, one study reported that the incidence of some degree of renal dysfunction has reported to be up to 67% in a study of >5000 intensive care unit patients ***(Hoste et al., 2006).***

Later on, another study showed that up to 70% of intensive care unit patients have acute kidney injury and about 5% of intensive care unit patients require renal replacement therapy ***(Dennen et al., 2010).***

In a study of patients admitted to Australian and New Zealand intensive care units on day one, 36% of patients had a degree of acute kidney injury ***(Bagshaw et al., 2007).***

Prerenal etiologies account for up to 60% and renal etiologies account for around 35% of acute kidney injury. Ischemic injury or nephrotoxins contribute to 80–90% of the renal etiologies. Postrenal etiologies generally account for <5% of acute kidney injury patients. The diagnosis of acute kidney injury increases the risk of mortality 5.5 to 6.5-fold as compared to a similarly ill patient without acute kidney injury. Unfortunately, despite advances in knowledge of the pathophysiology of acute kidney injury, this figure has not significantly changed since the introduction of dialytic therapy which is required in 20 – 75% of patients ***(Chertow et al., 2005).***

There is an evidence for the direct negative impact that acute kidney injury has an effect on distant vital organs. These distant organ effects may significantly contribute to the overall mortality observed in patients with acute kidney injury despite the initiation of dialytic therapy ***(Grams et al., 2011).***

For those patients surviving an episode of acute kidney injury requiring dialytic therapy, 10–50% continues dialytic therapy after discharge. Furthermore, patients that survive an episode of acute kidney injury requiring dialytic therapy and recover function are at increased risk of progressing to end stage renal disease. In fact, it has been estimated that these patients make up 3% of the overall yearly incidence of end stage renal disease. Clearly, acute kidney injury has serious acute and chronic sequelae ***(Uchino et al., 2005).***